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MORGAN OFFSHORE WIND PROJECT: GENERATION ASSETS

Preliminary Environmental Information Report

Volume 2, chapter 20: Inter-related effects

Image of an offshore wind farm

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FINAL

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Glossary

Term	Meaning
Inter-related effects	Multiple effects upon the same receptor arising from the Morgan Generation Assets. 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 sound and collision risk, affect a single receptor.
Project lifetime effects	Assessment of the scope for effects that occur throughout more than one phase of the Morgan Generation Assets (construction, operations 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 sound effects from construction piling, operational wind 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.

Acronyms

Acronym	Description
AEZ	Archaeological Exclusion Zone
ATC	Air Traffic Control
BEIS	Department for Business, Energy and Industrial Strategy
CMS	Collision Mitigation System
DCO	Development Consent Order
EIA	Environmental Impact Assessment
EMF	Electromagnetic Field
EMP	Environmental Management Plan
IEF	Important Ecological Feature
GVA	Gross Value Added
HMR	Helicopter Main Route
HVAC	High Voltage Alternating Current
INNS	Invasive and Non-native Species
INNSMP	Invasive and Non-native Species Management Plan
MHWS	Mean High Water Springs
MOD	Ministry of Defence
OSP	Offshore Substation Platform
NPS	National Policy Statement
NRW	Natural Resources Wales
NSIP	Nationally Significant Infrastructure Project
PEIR	Preliminary Environmental Information Report
PTS	Permanent Threshold Shifts
REWS	Radar Early Warning Systems
SAC	Special Area of Conservation
SAR	Search and Rescue
SSC	Suspended Sediment Concentration
SSSI	Site of Special Scientific Interest
TTS	Temporary Threshold Shifts
UXO	Unexploded Ordnance
ZOI	Zone of Influence

20 Inter-related effects

20.1 Introduction

20.1.1 Overview

20.1.1.1 This chapter of the Preliminary Environmental Information Report (PEIR) presents the assessment of the potential impact of the Morgan Offshore Wind Project Generation Assets (hereafter referred to as the Morgan Generation Assets) on inter-related effects. Specifically, this chapter considers the potential offshore impacts of the Morgan Generation Assets during the construction, operations and maintenance, and decommissioning phases.

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

- Volume 2, chapter 6: Physical processes of the PEIR
- Volume 2, chapter 7: Benthic subtidal ecology of the PEIR
- Volume 2, chapter 8: Fish and shellfish ecology of the PEIR
- Volume 2, chapter 9: Marine mammals of the PEIR
- Volume 2, chapter 10: Offshore ornithology of the PEIR
- Volume 2, chapter 11: Commercial fisheries of the PEIR
- Volume 2, chapter 12: Shipping and navigation of the PEIR
- Volume 2, chapter 13: Marine archaeology of the PEIR
- Volume 2, chapter 14: Other sea users of the PEIR
- Volume 2, chapter 15: Seascape, landscape and visual resources of the PEIR
- Volume 2, chapter 16: Aviation and radar of the PEIR
- Volume 2, chapter 17: Climate change of the PEIR
- Volume 2, chapter 18: Socio-economics of the PEIR
- Volume 2, chapter 16: Human health of the PEIR.

20.1.2 Purpose of chapter

20.1.2.1 The primary purpose of the PEIR is outlined in volume 1, chapter 1: Introduction of the PEIR. In summary, the primary purpose of an Environmental Statement is to support the Development Consent Order (DCO) application for the Morgan Generation Assets under the Planning Act 2008 (the 2008 Act). The PEIR constitutes the Preliminary Environmental Information for the Morgan Generation Assets and sets out the findings of the Environmental Impact Assessment (EIA) to date to support the 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.

20.1.2.2 The PEIR forms the basis for statutory consultation which will last for 47 days and conclude on 4 June 2023 as outlined in volume 1, chapter 2: Policy and legislation of the PEIR. 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 quarter one of 2024.

20.1.2.3 In particular, this PEIR chapter presents:

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

20.1.3 Study area

20.1.3.1 Due to the differing spatial extent of effects experienced by different offshore receptors, the study area for potential inter-related effects varies according to topic and receptor. The potential inter-related effects considered in this chapter are, therefore, also limited to the study areas defined in each of the topic-specific chapters outlined in paragraph 20.1.1.2. The rationale for the exclusion of other topics from further inter-related effects assessment is presented in section 20.5.2 (see Table 20.3).

20.2 Policy context

20.2.1 National Policy Statements

20.2.1.1 Planning policy on renewable energy infrastructure is presented in volume 1, chapter 2: Policy and legislation of the PEIR. Planning policy on offshore renewable energy Nationally Significant Infrastructure Projects (NSIPs), specifically in relation to inter-related effects, is contained in the Overarching National Policy Statement (NPS) for Energy (NPS EN-1; DECC, 2011a) and the NPS for Renewable Energy Infrastructure (NPS EN-3; DECC, 2011b).

20.2.1.2 NPS EN-1 includes guidance on what matters are to be considered in the assessment. This is summarised in Table 20.1 below.

20.2.1.3 Table 20.1 refers to the current NPSs, specifically NPS EN-1 (DECC, 2011a). If the NPSs are updated prior to the application for Development Consent, the revised NPSs will be fully considered in relation to inter-related effects within the Environmental Statement.

Table 20.1: Summary of the NPS EN-1 provisions relevant to inter-related effects.

Summary of NPS EN-1 provision	How and where considered in the PEIR
The Secretary of State should consider how the accumulation of, and interrelationship between, effects might affect the environment, economy or community as a whole, even though they may be acceptable when considered on an individual basis with mitigation measures in place. (EN-1, paragraph 4.2.6)	Project lifetime effects and receptor-led effects are assessed throughout this chapter of the PEIR.

20.3 Consultation

20.3.1.1 No key issues have been raised during consultation activities undertaken to date specific to inter-related effects.

20.4 Data sources

20.4.1.1 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 assessment are presented in the PEIR chapters outlined in section 20.1.1.

20.5 Impact assessment methodology

20.5.1.1 The inter-related effects impact assessment has followed the methodology set out in volume 1, chapter 5: EIA methodology of the PEIR. The following definition of inter-related effects has been applied throughout this chapter:

- Multiple effects upon the same receptor arising from the Morgan Generation Assets. 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 sound and collision risk, affect a single receptor, for example marine mammals.

20.5.1 Guidance

20.5.1.1 Specific to the inter-related effects impact assessment, the Planning Inspectorate Advice Note 9 (PINS, 2018) has been considered, with specific regard to the following text (paragraph 4.13) “ensure that interactions (interactions between aspect assessments includes where a number of separate impacts, eg noise and air quality, affect a single receptor such as fauna) between aspect (the Planning Inspectorate refers to ‘aspects’ as meaning the relevant descriptions of the environment identified in accordance with the EIA Regulations) assessments are taken into account relevant to the worst case scenario(s) established and that careful consideration is given to how these are assessed.”

20.5.1.2 The approach also serves to accommodate Planning Inspectorate Advice Note 9 regarding the need to consider the assessment as a whole and not as a series of unconnected specialist reports.

20.5.2 Approach to assessment

20.5.2.1 The approach to assessing inter-related effects within this chapter has followed a four-stage process, as summarised in Table 20.2 and outlined below. Further details on the approach summarised below and used to develop this chapter are presented in volume 1, chapter 5: EIA methodology of the PEIR.

Table 20.2: Summary of staged approach to the inter-related effects assessment for the Morgan Generation Assets.

Stage	Description
1	Assessment of effects undertaken for individual EIA topic areas within chapters 6 to 16.
2	Review of assessments undertaken within chapters 6 to 16 to identify ‘receptor groups’ requiring assessment.
3	Identification of potential inter-related 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: • ‘Project lifetime effects’ (i.e. during construction, operations and maintenance and decommissioning phases) • ‘Receptor-led effects’ (i.e. multiple effects on a single receptor).

Stage 1: Topic-specific assessments

20.5.2.2 The first stage of the assessment of inter-related effects is presented in each of the individual offshore PEIR topic chapters and comprises the individual assessments of effects on receptors across the construction, operations and maintenance and decommissioning phases of the Morgan Generation Assets.

Stage 2: Identification of receptor

20.5.2.3 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:
  - Physical processes
- Biological environment:
  - Benthic subtidal ecology
  - Fish and shellfish ecology
  - Marine mammals
  - Offshore ornithology
- Human environment:
  - Commercial fisheries
  - Shipping and navigation
  - Marine archaeology
  - Other sea users

- Seascape, landscape and visual resources
- Aviation and radar
- Climate change
- Socio-economics
- Human health.

20.5.2.4 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.

20.5.2.5 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 20.3.

Table 20.3: Topics not included in the Morgan Generation Assets inter-related effects assessment.

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

Topic	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 has therefore already been assessed within the individual chapters of the PEIR, and within the Draft Information to Support the Appropriate Assessment. No additional levels of inter-related or receptor led effects are therefore considered to occur at the site level beyond those identified in the topic specific chapters of the PEIR and the Draft Information to support the Appropriate Assessment.
Climate Change	The assessment of inter-related effects is central to the assessment of potential effects on climate change and has therefore been assessed within volume 2, chapter 17; Climate change and individual chapters as applicable. No additional levels of inter-related or receptor led effects are therefore considered to occur at the site level beyond those identified in volume 2, chapter 17; Climate change and individual chapters of the PEIR.

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

20.5.2.6 Following the identification of receptor groups, the potential inter-related effects on those receptor groups was 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 the Morgan Generation Assets was based on the professional judgement and experience of the project team.

Linked receptor groups

20.5.2.7 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. This is outlined in the following bullet points:

- Volume 2, chapter 7: Benthic subtidal ecology of the PEIR addresses effects on benthic habitats and species arising from potential changes to the physical environment (as described in chapter 6: Physical processes of the PEIR)
- Volume 2, chapter 7: Fish and shellfish ecology of the PEIR addresses effects on fish and shellfish receptors arising from potential changes to the physical environment and colonisation of hard substrates (as described in chapter 6: Physical processes and Volume 2, chapter 7: Benthic subtidal ecology of the PEIR)
- Volume 2, chapter 9: Marine mammals of the PEIR assesses the effects on marine mammal receptors arising from potential changes in the distribution of fish, which form their principal prey (as described in volume 2, chapter 8: Fish and shellfish ecology of the PEIR)
- Volume 2, chapter 10: Offshore ornithology of the PEIR assesses the effects on offshore ornithology receptors arising from potential indirect impacts from underwater sound and changes to prey resources (as described in volume 2, chapter 8: Fish and shellfish ecology of the PEIR)
- Volume 2, chapter 11: Commercial fisheries of the PEIR 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 electromagnetic fields (EMFs), increased risk of introduction and spread of invasive and non-native species, suspended sediments, habitat alteration/loss and underwater sound impacts (as described in volume 2, chapter 8: Fish and shellfish ecology and Volume 2, chapter 7: Benthic subtidal ecology of the PEIR)
- Volume 2, chapter 12: Shipping and navigation of the PEIR assesses the effects on shipping and navigation receptors arising from potential impacts on shipping and navigation as a result of a combination of effects caused by marine mammal collision (as described in volume 2, chapter 9: Marine mammals of the PEIR)
- Volume 2, chapter 13: Marine archaeology of the PEIR assesses the effects on marine archaeology receptors arising from potential impacts on Marine archaeology as a result of potential increase in suspended sediment concentrations (SSCs) and deposition and effects on sediment transport pathways (as described in volume 2, chapter 6: Physical processes of the PEIR)
- Volume 2, chapter 14: Other sea users of the PEIR assesses the effects on aggregate extraction areas arising from potential impacts on aggregate resource as a result of potential increase in suspended sediment concentrations (SSCs) and deposition and effects on sediment transport pathways (as described in volume 2, chapter 6: Physical processes of the PEIR)
- Volume 2, chapter 15: Seascape, landscape and visual resources of the PEIR assesses the effects on seascape, landscape and visual resources receptors arising from potential impacts on seascape, landscape and visual resources as a result of employment, Gross Value Added (GVA), and supply chain demand and the impact on combined national population benefits relating to wider

societal resources (volume 2, chapter 18: Socio-economics and volume 2, chapter 19: Human health of the PEIR)

- Volume 2, chapter 16: Aviation and radar of the PEIR assesses the effects on aviation and radar receptors arising from potential impacts on restriction of access to infrastructure by both helicopter and vessels (as described in volume 2, chapter 14: Other sea users of the PEIR)
- Volume 2, chapter 18: Socio-economics of the PEIR assesses the effects on socio-economic receptors arising from potential impacts to commercial fisheries, shipping and navigation, other sea users and seascape, landscape and visual resources (as described in volume 2, chapter 11: Commercial fisheries, volume 2, chapter 12: Shipping and navigation, volume 2, chapter 14: Other sea users and volume 2, chapter 15: Seascape, landscape and visual resources of the PEIR)
- Volume 2, chapter 19: Human health of the PEIR assesses the effects on human health receptors arising from potential impacts to the impact on economic receptors including employment, Gross Value Added (GVA), and supply chain demand and the impact on seascape, landscape and visual resources (volume 2, chapter 15: Seascape, landscape and visual resources and volume 2, chapter 18: Socio-economics of the PEIR).

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

20.5.2.9 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 inter-related effects chapter.

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

20.5.2.10 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 20.4. This information has been presented within the assessment tables in this chapter (see Table 20.5 to Table 20.17).

Table 20.4: 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 Morgan Generation Assets, (construction, operations 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 sound effects from construction piling, operational wind 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.

20.5.2.11 The significance of the individual effects is presented in the summary of impacts, mitigation measures and monitoring tables for each receptor group within the topic-specific chapters (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 20.5 to Table 20.17). 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.

20.5.2.12 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 measures adopted as part of the Morgan Generation Assets 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 the construction phase but not the operations and maintenance or decommissioning phases). 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.

20.6 Assessment of inter-related effects

20.6.1.1 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.

20.6.1 Physical environment

Physical processes

20.6.1.1 For physical processes, the following potential impacts have been considered within the inter-related assessment:

- Increase in suspended sediments due to construction, operations and maintenance and/or decommissioning related activities, and the potential impact to physical features
- Changes to tidal currents, wave climate, littoral currents and sediment transport.

20.6.1.2 Table 20.5 lists the inter-related effects (project lifetime effects) that are predicted to arise during the construction, operations and maintenance, and decommissioning phases of the Morgan Generation Assets and also the inter-related effects (receptor-led effects) that are predicted to arise for physical processes receptors.

20.6.1.3 As previously noted in paragraph 20.5.2.7, there are linked receptor groups between the topic-specific chapters. Effects on physical processes 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:

- Benthic subtidal ecology (volume 2, chapter 7: Benthic subtidal ecology of the PEIR)
  - Increased SSC
  - Sediment deposition
- Fish and shellfish ecology (volume 2, chapter 8: Fish and shellfish ecology of the PEIR)
  - Increased SSC
  - Sediment deposition
- Marine mammals (Volume 2, chapter 9: Marine mammals of the PEIR)
  - Changes to tidal current and wave climate
  - Increased SSC
  - Sediment deposition
- Other sea users (Volume 2, chapter 14: Other sea users of the PEIR)
  - Increased SSC
  - Changes to tidal current and wave climate.

Table 20.5: Summary of likely significant inter-related effects on the environment for individual effects occurring across the construction, operations and maintenance and decommissioning phases of the Morgan Generation Assets and from multiple effects interacting across all phases (receptor-led effects) – physical processes.

[a] C=construction, O=operations and maintenance, D=decommissioning

Description of impact	Phase[a]			Likely significant inter-related effects	Inter-related significance
	C	O	D		
Increase in suspended sediments due to construction, operations and maintenance and/or decommissioning related activities, and the potential impact to physical features	✓	✓	✓	Increases in SSC during construction phase would not extend into the operations and maintenance phase. Similarly, those increases which occur in the operations and maintenance phase due to maintenance activities would not extend to decommissioning. Across the project lifetime, the effects on physical processes 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 or when considered in conjunction with other topics addressed in the PEIR.	No change resulting from inter-related assessment
Impacts to the tidal regime due to presence of infrastructure and the associated potential impacts along adjacent shorelines	✓	✓	✓	Changes to tidal regime, wave climate and sediment transport due to infrastructure relate to the same structures within the construction, operations and maintenance, and decommissioning phases. The decommissioning phase structures are those remaining bed structures such as colonised scour protection when wind turbine structures have been removed, thus resulting in a lesser magnitude of the same impact. Across the project lifetime, the effects on physical processes 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 or when considered in conjunction with other topics addressed in the PEIR.	No change resulting from inter-related assessment
Impacts to the wave regime due to presence of infrastructure and the associated potential impacts along adjacent shorelines					No change resulting from inter-related assessment
Impacts to sediment transport and sediment transport pathways due to presence of infrastructure and associated potential impacts to physical features and bathymetry					No change resulting from inter-related assessment
Receptor-led effects					
West of Walney Marine Conservation Zone (MCZ) and West of Copeland MCZ: During principally the operations and maintenance phase increased SSCs and associated deposition on physical features may occur due to maintenance activities; this would coincide with changes to tidal currents, wave climate, littoral currents and sediment transport due to the presence of the structures. Maintenance activities are sporadic, with the impacts predicted to be of local spatial extent, short term duration and intermittent. Within the West of Walney MCZ and the West of Copeland MCZ these impacts would be indistinguishable from background variations and would therefore not be significant in EIA terms.					

20.6.2 Biological environment

Benthic subtidal ecology

20.6.2.1 For benthic subtidal ecology, the following potential impacts have been considered within the inter-related assessment:

- Temporary and long term habitat loss/disturbance
- Increased SSCs and associated sediment deposition
- Disturbance/remobilisation of sediment-bound contaminants
- Colonisation of hard substrate
- Increased risk of introduction and spread of Invasive and Non-Native Species (INNS).
- Removal of hard substrate
- Alteration of seabed habitats arising from effects of physical processes
- EMFs from subsea electrical cabling
- Heat from subsea electrical cabling.

20.6.2.2 Table 20.6 lists the inter-related effects (project lifetime effects) that are predicted to arise during the construction, operations and maintenance and decommissioning phases of the Morgan Generation Assets and also the inter-related effects (receptor-led effects) that are predicted to arise for benthic ecology receptors.

20.6.2.3 As previously noted in paragraph 20.5.2.7, effects on benthic 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:

- Physical processes (volume 2, chapter 6: Physical processes of the PEIR)
  - Increased SSC
  - Sediment transport
- Fish and shellfish ecology (volume 2, chapter 8: Fish and shellfish ecology of the PEIR)
  - Colonisation of hard substrates
- Commercial fisheries (volume 2, chapter 11: Commercial fisheries of the PEIR)
  - Increased risk of introduction and spread of Invasive and Non-native Species (INNS).

Table 20.6: Summary of likely significant inter-related effects on the environment for individual effects occurring across the construction, operations and maintenance and decommissioning phases of the Morgan Generation Assets and from multiple effects interacting across all phases (receptor-led effects) – benthic ecology.

[a] C=construction, O=operations and maintenance, D=decommissioning

Description of impact	Phase[a] C	O	D	Likely significant inter-related effects	Inter-related significance
Temporary and long term habitat loss/disturbance	✓	✓	✓	The total area of habitat potentially affected, when disturbance and loss are considered additively across all phases, is greater than for each individual phase (e.g. just the construction phase). However, temporary habitat loss/disturbance arising during each phase of the Morgan Generation Assets will be highly localised to the vicinity of the activities being undertaken (i.e. limited to the immediate footprints) during each phase (i.e. construction, operations and maintenance, and decommissioning). Individual activities (e.g. jack-up activities, cable burial etc.) resulting in temporary habitat loss/disturbance will occur intermittently throughout this time with only a small proportion of the total area of habitat being impacted at any one time. The predominantly mixed sediment habitats present within the Morgan Array Area are typical of, and widespread throughout, the UK and in the east Irish Sea. All sediments and associated benthic communities are predicted to recover. Whilst there is the potential for repeat disturbance to occur during the operations and maintenance phase to habitats previously disturbed during the construction phase (e.g. as a result of jack-up activities and cable repair/reburial etc.) it is predicted that the benthic communities will have fully recovered from construction impacts by this time. 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 or when considered in conjunction with other topics addressed in the PEIR.	No change resulting from inter-related assessment
Increased SSCs and associated sediment deposition	✓	✓	✓	Activities with the potential to result in the greatest level seabed disturbance and, therefore, highest increases in SSC/deposition, will occur during the construction phase. Any effects on benthic communities during this time will be intermittent, temporary and short term. The benthic subtidal IEFs potentially affected by increased SSC and deposition are predicted to have recovered in the intervening period between phases (i.e. prior to any localised increases in SSC during maintenance activities in the operations and maintenance phase). 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 or when considered in conjunction with other topics addressed in the PEIR.	No change resulting from inter-related assessment
Disturbance/remobilisation of sediment-bound contaminants	✓	✓	✓	This impact is expected to occur in the construction, operations and maintenance, and decommissioning phases of the Morgan Generation Assets during activities that disturb seabed sediments. However, additive effects across the lifetime of the Morgan Generation Assets are considered highly unlikely on the basis of the physical processes modelling outputs which have shown that increases in SSC (and therefore associated contaminants) will be temporary and will return to baseline within a few tidal cycles. This is not predicted to result in any significant combined impact across phases greater than what has been assessed for each individual phase. For example, remobilisation as a result of construction activities will only result in low concentrations of sediment-bound contaminants which as noted above will have been dispersed over a large area therefore they will not interact with potential contaminants released from operations and maintenance activities. 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 or when considered in conjunction with other topics addressed in the PEIR.	No change resulting from inter-related assessment
Colonisation of Hard Substrate	✓	✓	×	This impact will occur throughout the construction and operations and maintenance phases of the Morgan Generation Assets. The communities that develop on the introduced hard structures will likely differ from the surrounding sedimentary biotopes but may be typical of areas of coarse and stony substrate in the area and is likely to result in an increase in biodiversity. Also, the amount of the hard infrastructure is expected to be consistent between the construction and operations and maintenance phases, and this will provide long-term stability to any communities which form. 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 or when considered in conjunction with other topics addressed in the PEIR.	No change resulting from inter-related assessment
Increased risk of introduction and spread of invasive and non-native species	✓	✓	✓	Although the presence and movement of construction/decommissioning vessels in the area may facilitate the introduction and spread of INNS across all phases of the Morgan Generation Assets, this effect will predominantly arise during the operations and maintenance phase, if it does occur. This is because, the presence of the hard substrate associated with the infrastructure will be present in the operations and maintenance phase which may provide INNS with the necessary substrate on which to settle. However, the measures adopted as part of the Morgan Generation Assets include the implementation of the Offshore Environmental Management Plan with provisions for management of invasive and non-native species. This will ensure that the risk of potential introduction and spread of INNS will be minimised across all phases. As a result, any additional inter-related effect is judged to be of minor significance in all phases of the Morgan Generation Assets (i.e. of no greater significance than those assessed for each individual phase). 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 or when considered in conjunction with other topics addressed in the PEIR.	No change resulting from inter-related assessment
Removal of Hard Substrate	×	×	✓	This effect will only arise during the decommissioning phase. 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 or when considered in conjunction with other topics addressed in the PEIR.	No change resulting from inter-related assessment

Description of impact	Phase[a] C	O	D	Likely significant inter-related effects	Inter-related significance
Alteration of seabed habitats arising from effects of the Morgan Generation Assets on physical processes	×	✓	×	This effect will only arise during the operations and maintenance phase. 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 or when considered in conjunction with other topics addressed in the PEIR.	No change resulting from inter-related assessment
Electromagnetic Fields (EMF) from subsea electrical cabling	×	✓	×	This effect will only arise during the operations and maintenance phase. 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 or when considered in conjunction with other topics addressed in the PEIR.	No change resulting from inter-related assessment
Heat from subsea electrical cabling.	×	✓	×	This effect will only arise during the operations and maintenance phase. 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 or when considered in conjunction with other topics addressed in the PEIR.	No change resulting from inter-related assessment

Receptor-led effects

There is the potential for spatial and temporal interactions between the effects arising from habitat loss/disturbance/alteration and increased SSC and associated sediment deposition and resuspension of contaminants, EMF and heat on benthic habitats during the lifetime of the Morgan Generation Assets.

Based on current understanding, and expert knowledge, the greatest potential for inter-related impacts is predicted to arise through the interaction of direct (both temporary and permanent) habitat loss/disturbance from seabed preparation, foundation installation/jack-up/anchor placement/scour, indirect habitat disturbance due to sediment deposition and indirect effects of changes in physical processes due to the Morgan Generation Assets.

These individual impacts were assigned a significance of negligible to minor as individual impacts and although potential combined impacts may arise (i.e. spatial and temporal overlap of habitat disturbance), it is not predicted that this will result in effects of more significance than the individual impacts in isolation. This is because the combined extent of habitat potentially affected would be typically restricted to the Morgan Generation Assets and wider Zone of Influence (ZOI), the habitats affected are widespread across the UK and east Irish 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 Morgan Array Area) and also in magnitude, with benthic ecology receptors having low sensitivity or high recoverability to the scale of the changes predicted.

Across the project lifetime, the additive 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 or when considered in conjunction with other topics addressed in the PEIR.

Fish and shellfish ecology

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

- Temporary and long term habitat loss/disturbance
- Underwater sound impacting fish and shellfish receptors
- Increased SSCs and associated sediment deposition
- EMFs from subsea electrical cabling
- Colonisation of hard structures
- Disturbance/remobilisation of sediment-bound contaminants
- Injury due to increased risk of collision with vessels (basking shark only).

20.6.2.5 Table 20.7 lists the inter-related effects (project lifetime effects) that are predicted to arise during the construction, operations and maintenance and decommissioning phases of the Morgan Generation Assets and also the inter-related effects (receptor-led effects) that are predicted to arise for fish and shellfish ecology receptors.

20.6.2.6 As previously noted in paragraph 20.5.2.7, 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 (Volume 2, chapter 9: Marine mammals of the PEIR)
  - Changes in fish and shellfish communities affecting prey availability
- Offshore Ornithology (Volume 2, chapter 10: Offshore ornithology of the PEIR)
  - Indirect impacts from underwater sound affecting prey species
  - Changes in fish and shellfish communities affecting prey availability
- Commercial fisheries (Volume 2, chapter 11: Commercial fisheries of the PEIR)
  - Impacts on commercially important fish and shellfish resources.

Table 20.7: Summary of likely significant inter-related effects on the environment for individual effects occurring across the construction, operations and maintenance and decommissioning phases of the Morgan Generation Assets and from multiple effects interacting across all phases (receptor-led effects) – fish and shellfish ecology.

[a] C=construction, O=operations and maintenance, D=decommissioning

Description of impact	Phase[a]			Likely significant inter-related effects	Inter-related significance
	C	O	D		
Temporary and long term habitat loss/disturbance	✓	✓	✓	When subtidal habitat loss (temporary and long term) is considered additively across all phases of the project, the total area of habitat affected is larger than for the individual project stages. However, similar habitats are widespread across the fish and shellfish ecology study area and the wider Irish Sea and the impact will therefore be proportionally small in this context. During the operations and maintenance phase, most of the disturbance will be highly localised, and the habitats affected are predicted to recover quickly following completion of maintenance activities with fish and shellfish IEFs recovering into the affected areas. Also, many operational and maintenance activities will be located in the same areas affected during construction (e.g. jack up operations adjacent to wind turbines, or reburial of exposed cables). Decommissioning will also be impacting the same locations, to a lesser degree than during construction. Across the project lifetime, the effects on fish and shellfish 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 or when considered in conjunction with other topics addressed in the PEIR.	No change resulting from inter-related assessment
Underwater sound impacting fish and shellfish receptors	✓	×	×	The impact of underwater sound from piling will only arise during the construction phase and as such there will be no interaction effects across the project phases. Across the project lifetime, the effects on fish and shellfish 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 or when considered in conjunction with other topics addressed in the PEIR.	No change resulting from inter-related assessment
Increased suspended SSCs and associated sediment deposition	✓	✓	✓	The majority of the seabed disturbance (resulting in highest SSC/deposition) will occur during the construction and decommissioning phases, with minor increases in SSC/deposition during the operations and maintenance phase. IEFs and associated spawning/nursery habitats potentially affected by increased SSC and deposition will recover quickly following impact exposure such that there will be no inter-related effects across the construction, operations and maintenance and decommissioning phases. Across the project lifetime, the effects on fish and shellfish 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 or when considered in conjunction with other topics addressed in the PEIR.	No change resulting from inter-related assessment
EMFs from subsea electrical cabling	×	✓	×	This effect will only arise during the operations and maintenance phase and as such there will be no interaction effects across the project phases. Across the project lifetime, the effects on fish and shellfish 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 or when considered in conjunction with other topics addressed in the PEIR.	No change resulting from inter-related assessment
Increased risk of introduction and spread of invasive and non-native species	×	✓	×	The presence of the hard substrate associated with the infrastructure will be present in the operations and maintenance phase which may provide INNS with the necessary substrate on which to settle. However, the measures adopted as part of the Morgan Generation Assets include the implementation of an Offshore Environmental Management Plan with provisions for management of invasive and non-native species. This will ensure that the risk of potential introduction and spread of INNS will be minimised across all phases. Across the project lifetime, the effects on fish and shellfish 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 or when considered in conjunction with other topics addressed in the PEIR.	No change resulting from inter-related assessment
Colonisation of hard structures	✓	✓	✓	This impact will occur throughout all phases of the Morgan Generation Assets, with the expected development of hard substrate communities throughout the lifetime of the infrastructure. These communities will differ from the surrounding sedimentary biotopes but are unlikely to represent a significant decrease in biodiversity. Also, much of the hard infrastructure is expected to be left in place following decommissioning (except wind turbine and Offshore Substation Platform (OSP) foundations), and this will provide long-term stability to any communities which form.	No change resulting from inter-related assessment

Description of impact	Phase[a]			Likely significant inter-related effects	Inter-related significance
	C	O	D		
				Across the project lifetime, the effects on fish and shellfish 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 or when considered in conjunction with other topics addressed in the PEIR.	
Disturbance/remobilisation of sediment-bound contaminants	✓	✓	✓	This impact is expected to occur in all project phases. However, it is unlikely to have any additive effects due to the modelling and literature suggesting re-sedimentation to negligible concentrations within a few tidal cycles, which will not cause any significant combined impact across phases greater than what has been assessed for each individual phase. Across the project lifetime, the effects on fish and shellfish 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 or when considered in conjunction with other topics addressed in the PEIR.	No change resulting from inter-related assessment
Injury due to increased risk of collision with vessels (basking shark only)	✓	✓	✓	This impact is unlikely to have any additive effect across the three phases of the Morgan Generation Assets, due to the implementation of provisions for vessels and vessel movements within the Environmental Management Plan (EMP) to be followed by every vessel engaged in the project to avoid collisions where possible. Should any collisions occur, the impact will be limited to that phase of activity. Across the project lifetime, the effects on fish and shellfish 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 or when considered in conjunction with other topics addressed in the PEIR.	No change resulting from inter-related assessment

Receptor-led effects

Potential exists for spatial and temporal interactions between habitat loss or disturbance, underwater noise, increased SSC/deposition, colonisation of hard substrates, EMF effects, disturbance and remobilisation of sediment-bound contaminants, and injury to basking shark from vessel collisions during the lifetime of the Morgan Generation Assets.

Based on current understanding, and expert knowledge, the greatest scope for potential interaction impacts is predicted to arise through the interaction of habitat loss (temporary and long term), increased SSC, underwater sound from piling during the construction phase, and EMF effects during the operations and maintenance phase.

These individual impacts were assigned a significance of negligible to 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, most effects associated with an increase in SSC/deposition will arise from seabed preparation and sandwave clearance works installation of the Morgan inter-array and interconnector cables, whereas most noise effects will arise from foundation piling undertaken at a different time. In addition, these impacts will be temporary and reversable following cessation of construction or decommissioning, with fish and shellfish communities expected to recover into wind farm areas. Furthermore, underwater noise from piling operations is predicted to 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. 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 effects would not be additive to EMF effects. There may be localised changes in fish and shellfish communities in the areas affected by long term habitat loss, due to potential changes in substrate type and foraging opportunities, and potential behavioural effects associated with EMF. Any shifts in baseline assemblage will be limited to these areas and, therefore, effects of greater significance than the individual impacts in isolation (i.e. negligible to moderate) are not predicted.

Overall, the evidence presented in volume 2, chapter 8: Fish and shellfish ecology of the PEIR, indicates that impacts on fish and shellfish receptors from construction operations (particularly piling) are found to be temporary and reversible and that fish and shellfish communities are not significantly adversely affected by the presence of operational wind farms and therefore additive effects across impacts and phases are not expected to occur.

Across the project lifetime, the additive effects on fish and shellfish 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 or when considered in conjunction with other topics addressed in the PEIR.

Marine mammals

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

- Injury and disturbance from elevated underwater sound during piling
- Injury and disturbance from elevated underwater sound during site investigation surveys
- Injury and disturbance from elevated underwater sound during unexploded ordnance (UXO) clearance
- Injury and disturbance from elevated underwater sound due to vessel use and other activities
- Increased risk of injury due to collision with vessels
- Underwater sound from wind turbine operation
- Changes in fish and shellfish communities affecting prey availability.

20.6.2.8 Table 20.8 lists the inter-related effects (project lifetime effects) that are predicted to arise during the construction, operations and maintenance, and decommissioning phases of the Morgan Generation Assets and also the inter-related effects (receptor-led effects) that are predicted to arise for marine mammal receptors.

20.6.2.9 As previously noted in paragraph 20.5.2.7, 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 volume 2, chapter 9: Marine mammals of the PEIR.

Table 20.8: Summary of likely significant inter-related effects on the environment for individual effects occurring across the construction, operations and maintenance and decommissioning phases of the Morgan Generation Assets and from multiple effects interacting across all phases (receptor-led effects) – marine mammals.

[a] C=construction, O=operations and maintenance, D=decommissioning

Description of impact	Phase[a] C	O	D	Likely significant inter-related effects	Inter-related significance
Injury and disturbance from elevated underwater sound during piling	✓	×	×	The impact of elevated underwater sound during piling will only arise during the construction phase and as such there will be no inter-related effects across the project phases of the Morgan Generation Assets. 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 or when considered in conjunction with other topics addressed in the PEIR.	No change resulting from inter-related assessment
Injury and disturbance to marine mammals from elevated underwater sound during site investigation surveys	✓	×	×	The impact of elevated underwater sound during site investigation surveys will only arise during the construction phase and as such there will be no inter-related effects across the project phases of the Morgan Generation Assets. 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 or when considered in conjunction with other topics addressed in the PEIR.	No change resulting from inter-related assessment
Injury and disturbance to marine mammals from elevated underwater sound during UXO clearance	✓	×	×	The impact of elevated underwater sound during UXO clearance will only arise during the construction phase and as such there will be no inter-related effects across the project phases of the Morgan Generation Assets. 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 or when considered in conjunction with other topics addressed in the PEIR.	No change resulting from inter-related assessment
Injury and disturbance to marine mammals from elevated underwater sound due to vessel use and other activities	✓	✓	✓	Vessels will be used throughout all stages of the Morgan Generation Assets and therefore the impact of injury and disturbance to marine mammals from elevated underwater sound due to vessel use could cause additional disturbance to marine mammals. However, the impact during all phases is considered to be of minor adverse significance and the uplift in vessel activity during each of the phases is considered to be relatively small in the context of the baseline levels of vessel traffic in the Morgan marine mammal study area. Therefore, over the lifetime of the Morgan Generation Assets impacts are not predicted to cause any significant combined effects across phases greater than what has been assessed for each individual phase. 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 or when considered in conjunction with other topics addressed in the PEIR.	No change resulting from inter-related assessment
Increased risk of injury of marine mammals due to collision with vessels	✓	✓	✓	Over the lifetime of the Morgan Generation Assets there will be an ongoing risk of collision associated with vessel activity throughout all phases. If injury to marine mammals from collisions did occur this could lead to losses of individuals and potentially have an effect at the population-level, particularly for species with smaller populations, such as bottlenose dolphin and harbour seal. However, there is a high likelihood that marine mammals will avoid vessels, as they will be disturbed by underwater sound from the vessel, thereby reducing collision risk. In addition, with designed-in measures the risk of collisions will be further reduced through a Environmental Management Plan (EMP) with provisions for vessels and vessel movements, which includes provisions for vessels and vessel transit corridors to minimise the potential for collision risk. 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 or when considered in conjunction with other topics addressed in the PEIR.	No change resulting from inter-related assessment
Underwater sound from wind turbine operation	×	✓	×	The impact of underwater sound from wind turbine operation will only arise during the operations and maintenance phase and as such there will be no inter-related effects across the project phases of the Morgan Generation Assets. 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 or when considered in conjunction with other topics addressed in the PEIR.	No change resulting from inter-related assessment
Changes in fish and shellfish communities affecting prey availability	✓	✓	✓	Fish and shellfish communities may be impacted through all phases of the Morgan Generation Assets and therefore could present a long-term effect on marine mammals through changes to prey availability. Inter-related effects on fish and shellfish receptors are described in more detail in Table 20.7 and in volume 2, chapter 8: Fish and shellfish of the PEIR. For all potential impacts and at all phases of the Morgan Generation Assets the effects were, however, predicted to be very localised and unlikely to lead to significant effects on marine mammals. Even in the context of longer-term impacts there is unlikely to be an additive effect as marine mammals can exploit a suite of prey species and only a small area will be affected when compared to available foraging habitat in the east Irish Sea.	No change resulting from inter-related assessment

Description of impact	Phase[a] C	O	D	Likely significant inter-related effects	Inter-related significance
				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 or when considered in conjunction with other topics addressed in the PEIR.	

Receptor-led effects

There is the potential for spatial and temporal interactions between the effects arising from elevated underwater sound (due to piling, UXO clearance, site investigation surveys, and vessel use and other (non-piling) activities), collision risk with vessels and changes in prey availability during the lifetime of the Morgan Generation Assets.

Based on current understanding and expert knowledge, the greatest potential for inter-related effects is predicted to arise through the interaction of injury and disturbance from elevated underwater sound during piling, elevated underwater sound during UXO clearance, elevated underwater sound due to vessel use and other (non-piling) activities and elevated underwater sound during site investigation surveys, due to the Morgan Generation Assets.

These impacts were assigned a significance of minor as individual impacts and although potential combined effects may arise (i.e. spatial and temporal overlap of noise impacts) it is not predicted that this will result in effects of greater significance than the individual impacts in isolation. Whilst individual impacts could add to the overall duration of elevated underwater sound spatially, the extent of noise disturbance will be restricted to the Morgan Generation Assets and the extent of the largest Zone of Influence (i.e. piling). As Permanent Threshold Shifts (PTS) are not predicted to occur in any marine mammal species, with the implementation of measures adopted as part of the Morgan Generation Assets, and Temporary Thresholds Shifts (TTS) is a recoverable impact, it is predicted that there would be no interrelated effect with respect to injury to marine mammal IEFs. With respect to disturbance, the potential for interrelated effects is considered to be minimal as individual animals are likely to be disturbed over a range dictated by the 'loudest' noise (i.e. leading to the greatest disturbance range) such that the potential for secondary (additive) effects from other activities that result in smaller ranges is reduced where animals are already disturbed over the largest effect range.

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 or when considered in conjunction with other topics addressed in the PEIR.

Offshore ornithology

20.6.2.10 For offshore ornithology, the following potential impacts have been considered within the inter-related assessment:

- Disturbance and displacement from airborne noise, underwater sound, and presence of vessels and infrastructure
- Indirect impacts from underwater sound affecting prey species
- Temporary habitat loss/disturbance and increased SSCs
- Collision risk
- Barrier effects.

20.6.2.11 Table 20.9 lists the inter-related effects (project lifetime effects) that are predicted to arise during the construction, operations and maintenance phase, and decommissioning of the Morgan Generation Assets and also the inter-related effects (receptor-led effects) that are predicted to arise for offshore ornithology receptors.

20.6.2.12 As previously noted in paragraph 20.5.2.7, 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 volume 2, chapter 10: Offshore ornithology of the PEIR.

Table 20.9: Summary of likely significant inter-related effects on the environment for individual effects occurring across the construction, operations and maintenance and decommissioning phases of the Morgan Generation Assets and from multiple effects interacting across all phases (receptor-led effects) – offshore ornithology.

[a] C=construction, O=operations and maintenance, D=decommissioning

Description of impact	Phase[a]			Likely significant inter-related effects	Inter-related significance
	C	O	D		
Disturbance and displacement from airborne noise, underwater sound, and presence of vessels and infrastructure	✓	✓	✓	The impact of disturbance and displacement caused by construction activities and associated vessel movements is predicted to be of negligible to minor significance depending on species, which is insignificant in EIA terms. The birds disturbed during the construction phase are expected to return as soon as the specific and locally active works are completed at the operations and maintenance phase. Although the short construction period has a displacement impact of lower magnitude than operation, it slightly extends the period over which displacement impacts may occur overall. During the operations and maintenance phase, the presence of operational wind turbines has the potential to directly disturb common guillemot, razorbill, Atlantic puffin, northern gannet, and black-legged kittiwake, leading to displacement from the Morgan Generation Assets including an area of variable size or buffer (depending on species' sensitivity) around it. This effect was predicted to be of negligible to minor significance depending on species. Whilst the operations and maintenance phase will feature a much-reduced level of boat activity in comparison to the construction phase, the decommissioning phase will require similar number of vessels to the construction phase. The effects of decommissioning activities are expected to be similar magnitude to those arising from construction. Like the construction phase, the decommissioning phase has a displacement impact of lower magnitude than operation. Yet, it slightly extends the period over which displacement impacts may occur during the lifetime of the Morgan Generation Assets. Across the project lifetime, the effects on offshore ornithology 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 or when considered in conjunction with other topics addressed in the PEIR.	No change resulting from inter-related assessment
Indirect impacts from underwater sound affecting prey species	✓	×	✓	Indirect impacts caused by a change in prey species (e.g., cod, sprat, herring, and sandeel) will occur during the construction and decommissioning phases. There will be no inter related effects between construction and decommissioning which do not overlap. Across the project lifetime, the effects on offshore ornithology 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 or when considered in conjunction with other topics addressed in the PEIR.	No change resulting from inter-related assessment
Temporary habitat loss/disturbance and increased suspended sediment concentrations (SSCs)	✓	✓	✓	During construction and decommissioning, seabirds may be indirectly disturbed and displaced as a result of direct impacts on habitat and increased SSCs, which may result in the loss of a food resource to birds in the Morgan Generation Assets. This will lead to temporary habitat disturbance at a local scale. During the operations and maintenance phase, activities within Morgan Generation Assets may lead to increases in SSCs and associated sediment deposition over the operational lifetime of the Morgan Generation Assets. The magnitude of the impacts would be a small fraction of those quantified for the construction and decommissioning phase. The prey species and habitats potentially affected by construction and decommissioning are likely to recover during the operations and maintenance phase. Across the project lifetime, the effects on offshore ornithology 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 or when considered in conjunction with other topics addressed in the PEIR.	No change resulting from inter-related assessment
Collision risk	×	✓	×	Across the project lifetime, the effects on offshore ornithology 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 or when considered in conjunction with other topics addressed in the PEIR.	No change resulting from inter-related assessment
Barrier effects	×	✓	×	Barrier effects may arise in addition to displacement. However, because the effect will only arise during the operations and maintenance phase, there will be no inter-related effects across the project phases of the Morgan Generation Assets. Across the project lifetime, the effects on offshore ornithology 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 or when considered in conjunction with other topics addressed in the PEIR.	No change resulting from inter-related assessment

Description of impact	Phase[a] C	O	D	Likely significant inter-related effects	Inter-related significance
Receptor-led effects					
Potential exists for spatial and temporal interactions between disturbance and displacement, indirect disturbance and displacement resulting from changes to prey species and habitats during the project's lifetime. Based on current understanding and expert knowledge, the greatest scope for potential interaction impacts is predicted to arise through the following: • Combined disturbance, displacement, and changes in prey species during construction; • Combined collision risk, displacement and barrier effects during operation and maintenance. Individual impacts were assigned a significance of negligible to minor adverse as standalone impacts. Although potential combined impacts may arise, it is essential to acknowledge that some of the activities potentially resulting in combined effects would not be additive. For instance, the displacement effect on seabirds is expected to be very localised, intermittent, and short during the construction phase. Prey availability and habitats might also be altered during construction phase, forcing the birds to re-distribute. In this scenario, the inter-related effects are expected to cancel each other out to a degree: a re-distribution of prey due to indirect disturbance/displacement will reduce the direct displacement effect of seabirds caused by construction activities. Compounding inter-related effects will only occur if seabirds continued to use the site where prey have been displaced from. Individual impacts were assigned a significance of negligible to minor 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. Species cannot simultaneously exhibit a high level of avoidance (displacement effect) and a high level of collision risk (collision effect). Furthermore, there are differences in the species' susceptibility to the collision and displacement effects. Typically, species that forage on the wing (e.g. surface feeders such as gull species) will be more susceptible to collision risk and less affected by displacement as they move quickly between feeding opportunities – thus more likely to fly within rotor height. In contrast, sub-surface feeders and in particular species diving at great depths (e.g. Manx shearwater, divers and auks) would be more susceptible to displacement/disturbance: they feed for a prolonged period of time and fly less frequently between feeding patches, and thus at much-reduced level of collision risk. Two species were assessed for the combined impact of displacement and collision risk: black-legged kittiwake and northern gannet. For both these species, the combined impact was of minor adverse significance, which is not significant in EIA terms. Across the project lifetime, the additive effects on offshore ornithology 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 or when considered in conjunction with other topics addressed in the PEIR.					

20.6.3 Human environment

Commercial fisheries

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

- Loss or restricted access to fishing grounds
- Displacement of fishing activity into other areas
- Interference with fishing activity
- Temporary increase in steaming distances
- Loss or damage to fishing gear due to snagging
- Potential impacts on commercially important fish and shellfish resources
- Supply chain opportunities for local fishing vessels
- Potential impacts on commercial fisheries as a result of increased risk of introduction and spread of INNS.

20.6.3.2 Table 20.10 lists the inter-related effects (project lifetime effects) that are predicted to arise during the construction, operations and maintenance and decommissioning phases of the Morgan Generation Assets and also the inter-related effects (receptor-led effects) that are predicted to arise for commercial fisheries receptors.

20.6.3.3 As previously noted in paragraph 20.5.2.7, commercial fisheries receptors and fish and shellfish receptors are linked and the inter-related effects associated with potential impacts on commercially important fish species has been fully assessed in volume 2, chapter 11: Commercial fisheries of the PEIR.

20.6.3.4 In addition, there are linked receptor groups between the topic-specific chapters. Effects on commercial fisheries have the potential to have secondary effects on:

- Socio-economics (volume 2, chapter 18: Socio-economics)
  - The impact on economic receptors including employment, Gross Value Added (GVA), and supply chain demand.

Table 20.10: Summary of likely significant inter-related effects on the environment for individual effects occurring across the construction, operations and maintenance and decommissioning phases of the Morgan Generation Assets and from multiple effects interacting across all phases (receptor-led effects) – commercial fisheries.

[a] C=construction, O=operations and maintenance, D=decommissioning

Description of impact	Phase[a]			Likely significant inter-related effects	Inter-related significance
	C	O	D		
Loss or restricted access to fishing grounds	✓	✓	✓	During the construction and decommissioning 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 500m safety zones around wind turbines and OSPs. During operation, all commercial fisheries receptor groups will be able to continue fishing within the Morgan Array Area. A negligible effect is predicted for all receptor groups with the exception of Scottish west coast scallop vessels, which will be able to continue fishing but would be severely restricted due to the presence of the offshore infrastructure and the minimum spacing between turbines; combined with their limited spatial tolerance and dependence on the area, it is predicted that the effect on this receptor will be moderate adverse. While access may be restricted due to the presence of the offshore infrastructure and the minimum spacing between wind turbines during operation, during construction and decommissioning vessels will be able to operate across the Morgan 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 all project phases, 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. Across the project lifetime, the effects on commercial fisheries 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 or when considered in conjunction with other topics addressed in the PEIR.	No change resulting from inter-related assessment
Displacement of fishing activity into other areas	✓	✓	✓	During operation, the Scottish west coast scallop vessels may be restricted from fishing within the Morgan Array Area due to the presence of the offshore infrastructure and the minimum spacing between wind turbines. This receptor group has limited spatial tolerance due to significant dependence upon the commercial fisheries study area for queen scallop dredging. However, it is noted that the other mobile gear receptor groups and offshore static gear vessels target a relatively large area in comparison to the Morgan Array Area. It is also currently understood that a spatial 'gentleman's agreement' exists between the different gear types in operation in this area and it is assumed that this would continue during the operations and maintenance phase. Across the project lifetime, the effects on commercial fisheries 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 or when considered in conjunction with other topics addressed in the PEIR.	No change resulting from inter-related assessment
Interference with fishing activity	✓	✓	✓	Smaller vessel sizes associated with inshore static gear vessel and offshore static gear vessel receptor groups may be affected by the presence of construction vessels during the construction and decommissioning phases within the Morgan Array Area. The marker buoys and actual gear deployed by the inshore static gear vessels are vulnerable to potential interference by construction vessels, due to their poor visibility. Although operations and maintenance vessel traffic will add to the existing level of shipping activity in the area, there are already moderate levels of vessel traffic in the area, and there is co-existence of fishing vessels with other marine traffic. Across the project lifetime, the effects on commercial fisheries 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 or when considered in conjunction with other topics addressed in the PEIR.	No change resulting from inter-related assessment
Loss or damage to fishing gear due to snagging	✓	✓	✓	The construction, operations and maintenance and decommissioning of the Morgan Array Area may lead to loss or damage to fishing gear due to snagging. Snagging risks may occur as a result of infrastructure on the seabed, such as inter-array cables and associated cable protection. Across the project lifetime, the effects on commercial fisheries 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 or when considered in conjunction with other topics addressed in the PEIR.	No change resulting from inter-related assessment
Potential impacts on commercially important fish and shellfish resources	✓	✓	✓	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 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 or when considered in conjunction with other topics addressed in the PEIR.	No change resulting from inter-related assessment
Supply chain opportunities for local fishing vessels	✓	✓	✓	During the construction, operations and maintenance and decommissioning of the Morgan Array Area, there may the opportunity for commercial fisheries operators to provide support to the Morgan Generation Assets, such as guard vessels and scouting surveys. Across the project lifetime, the effects on commercial fisheries 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 or when considered in conjunction with other topics addressed in the PEIR.	No change resulting from inter-related assessment

Description of impact	Phase[a]			Likely significant inter-related effects	Inter-related significance
	C	O	D		
Potential impacts on commercial fisheries as a result of increased risk of introduction and spread of INNS	✓	✓	✓	As assessed in chapter 7: Benthic subtidal and intertidal ecology of the PEIR, no significant effects are likely to occur as a result of the risk of introduction and spread of INNS during the construction, operations and maintenance and decommissioning phases. Across the project lifetime, the effects on commercial fisheries 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 or when considered in conjunction with other topics addressed in the PEIR.	No change resulting from inter-related assessment

Receptor-led effects

There is potential for an inter-related effect from the combination of supply chain benefits for local fishing vessels and reduction in loss or restricted access to fishing grounds; this is because fishing vessels are likely to be providing marine operational support during periods of construction or major maintenance works which would have resulted in a loss or restricted access to fishing grounds if the vessel had not been providing support to the Morgan Generation Assets. This means that the benefit to the local fishing vessels as a result of the supply chain opportunities is acting more as an alleviation of potential losses than an additional benefit. It is therefore predicted that any potential inter-related effect will reduce the beneficial significance of supply chain opportunities, which would result in a negligible beneficial significance.

There is potential for an inter-related effect from the combination of the loss or restricted access to fishing grounds and the consequent displacement of fishing activity into other areas. This could result in increased gear conflict and pressure on other fishing grounds. During construction, static gear vessels may be required to relocate pots from areas of activity, which could increase intensity of activity in other areas or cause conflict with mobile gear species (e.g. scallop vessels). However, with successful implementation of the measures outlined in volume 2, chapter 11: Commercial fisheries of the PEIR, and the temporary nature of the works, it is not predicted that there will be any inter-related effect of greater significance than those already assessed in isolation.

During the operations and maintenance phase of the Morgan Generation Assets, there will be no complete exclusions to mobile or static vessels, however some mobile gear vessels may not fish within the Morgan Array Area due to risks associated with the minimum spacing of wind turbines; this could result in conflict with static gear vessels or other mobile gear vessels and increase pressure on other fishing grounds. With consideration of the measures outlined in volume 2, chapter 11: Commercial fisheries of the PEIR, it is anticipated that the appropriately mitigated loss of access will reduce displacement and, therefore, any inter-related effect will not be of greater significance than those assessed in isolation (negligible to moderate adverse significance).

Shipping and navigation

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

- Displacement/interference of fishing activity
- Collision and allision risk of fishing vessels
- Interference with oil and gas activities
- Impact on emergency response capability
- Impact on marine navigation, communications and positioning systems
- Impact on vessel emissions.

20.6.3.6 Table 20.11 lists the inter-related effects (project lifetime effects) that are predicted to arise during the construction, operations and maintenance and decommissioning phases of the Morgan Generation Assets and also the inter-related effects (receptor-led effects) that are predicted to arise for shipping and navigation receptors.

20.6.3.7 As previously noted in paragraph 20.5.2.7, 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 volume 2, chapter 9: Marine mammals of the PEIR, with effects of minor adverse significance predicted across all project phases and volume 2, chapter 10: Offshore ornithology of the PEIR with effects of no greater than minor adverse significance across all project phases.

20.6.3.8 In addition, there are linked receptor groups between the topic-specific chapters. Effects on shipping and navigation have the potential to have secondary effects on:

- Socio-economics (volume 2, chapter 18: Socio-economics)
  - The impact on economic receptors including employment, Gross Value Added (GVA), and supply chain demand.

Table 20.11: Summary of likely significant inter-related effects on the environment for individual effects occurring across the construction, operations and maintenance and decommissioning phases of the Morgan Generation Assets and from multiple effects interacting across all phases (receptor-led effects) – shipping and navigation.

[a] C=construction, O=operations and maintenance, D=decommissioning

Description of impact	Phase[a]			Likely significant inter-related effects	Significance
	C	O	D		
Displacement/interference of fishing activity	✓	✓	✓	Displacement of fishing activity due to the presence of the Morgan Generation Assets and avoidance of other vessels. These impacts are assessed in volume 2, chapter 11: Commercial fisheries. The Navigational Risk Assessment (NRA) conducted in volume 2, chapter 12: Shipping and navigation was of sufficient detail that interactions between effects were considered, both from different phases and different receptors, and therefore the results would be the same. Across the project lifetime, the effects on shipping and navigation 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 or when considered in conjunction with other topics addressed in the PEIR.	No change resulting from inter-related assessment
Collision and allision risk of fishing vessels	✓	✓	✓	Displacement of fishing activity due to the presence of the Morgan Generation Assets increases the risk of collision or allision of fishing vessels. These impacts are assessed within this chapter but further details on fishing activity are provided in volume 2, chapter 11: Commercial fisheries. The NRA conducted in volume 2, chapter 12: Shipping and navigation was of sufficient detail that interactions between effects were considered, both from different phases and different receptors, and therefore the results would be the same. Across the project lifetime, the effects on shipping and navigation 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 or when considered in conjunction with other topics addressed in the PEIR.	No change resulting from inter-related assessment
Interference with oil and gas activities	✓	✓	✓	The proximity of oil and gas assets and the movements of supply ships would be impacted by the presence of the Morgan Generation Assets. These impacts are assessed in volume 2, chapter 14: Other sea users. The NRA conducted in volume 2, chapter 12: Shipping and navigation was of sufficient detail that interactions between effects were considered, both from different phases and different receptors. Across the project lifetime, the effects on shipping and navigation 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 or when considered in conjunction with other topics addressed in the PEIR.	No change resulting from inter-related assessment
Impact on emergency response capability	✓	✓	✓	The need for SAR assets to enter the Morgan Array Area has impacts upon aviation receptors. These impacts are assessed in volume 2, chapter 16: Aviation and radar. The NRA conducted in volume 2, chapter 12: Shipping and navigation was of sufficient detail that interactions between effects were considered, both from different phases and different receptors, and therefore the results would be the same. Across the project lifetime, the effects on shipping and navigation 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 or when considered in conjunction with other topics addressed in the PEIR.	No change resulting from inter-related assessment
Impact on marine navigation, communications position fixing equipment	✓	✓	✓	Impacts to shore-based radar may occur in addition to marine radar. These impacts are assessed in volume 2, chapter 16: Aviation and radar. The NRA conducted in volume 2, chapter 12: Shipping and navigation was of sufficient detail that interactions between effects were considered, both from different phases and different receptors, and therefore the results would be the same. Across the project lifetime, the effects on shipping and navigation 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 or when considered in conjunction with other topics addressed in the PEIR.	No change resulting from inter-related assessment
Receptor-led effects					
The presence of the buoyed construction and decommissioning areas during the construction and decommissioning phases, respectively, may result in the displacement from fishing grounds of commercial fishing vessels. This displacement and the associated reduction in available sea room will increase the vessel to vessel collision risk between third-party vessels. However, it is unlikely that effects will act together and that any interactions between effects will be of any greater significance than those already assessed for the Morgan Offshore Wind Project alone. Across the project lifetime, the additive effects on shipping and navigation 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 or when considered in conjunction with other topics addressed in the PEIR.					

Aviation and radar

20.6.3.9 For aviation and radar, the following potential impacts have been considered within the inter-related assessment:

- Creation of physical obstacle to aircraft operations
- Wind turbines causing interference on civil and military primary surveillance radar systems.

20.6.3.10 Table 20.12 lists the inter-related effects (project lifetime effects) that are predicted to arise during the construction, operations and maintenance and decommissioning phases of the Morgan Generation Assets and also the inter-related effects (receptor-led effects) that are predicted to arise for aviation and radar receptors.

20.6.3.11 As previously noted in paragraph 20.5.2.7, aviation and radar and other sea 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 volume 2, chapter 16: Aviation and radar of the PEIR.

Table 20.12: Summary of likely significant inter-related effects on the environment for individual effects occurring across the construction, operations and maintenance and decommissioning phases of the Morgan Generation Assets and from multiple effects interacting across all phases (receptor-led effects) – aviation and radar.

[a] C=construction, O=operations and maintenance, D=decommissioning

Description of impact	Phase[a]			Likely significant inter-related effects	Inter-related significance
	C	O	D		
Creation of physical obstacle to aircraft operations	✓	✓	✓	The individual standalone impacts were assigned significance of no greater than minor adverse. Air Traffic Service (ATS) provision and the rules of air, including the 'see and be seen principle', will mean reduced potential for inter and intra-related effects for helicopter operators and the Ministry of Defence (MOD) alike, operating at low level in the airspace surrounding the Morgan Generation Assets. Across the project lifetime, the effects on aviation and radar 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 or when considered in conjunction with other topics addressed in the PEIR.	No change resulting from inter-related assessment
Wind turbines causing interference on civil and military primary surveillance radar systems	×	✓	×	This effect will only arise during the operations and maintenance phase. Across the project lifetime, the effects on aviation and radar 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 or when considered in conjunction with other topics addressed in the PEIR.	No change resulting from inter-related assessment

Receptor-led effects

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

- The interaction of the disruption to helicopters using Helicopter Main Routes (HMRs), impact on available airspace, and disruption to cross-zone transit helicopter traffic on the same receptor (helicopter operator). Helicopters using HMRs may need to deviate around the Morgan Generation Assets 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 Morgan Generation Assets, 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 Air Traffic Control (ATC) services will continue to apply to helicopter operators within the east Irish Sea. No significant inter-related effect has therefore been identified
- The 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). It is possible for both helicopter and vessel access to existing and future infrastructure to be disrupted by the presence of the Morgan Generation Assets. Disruption of vessel access to oil and gas platforms and subsea infrastructure has been assessed as minor adverse (volume 2, chapter 14: Other sea users of the PEIR). Within the Morgan Generation Assets area, blocks 110/2c, 113/26a, 113/27a are currently operated by Chrysaor Resources (Irish Sea) Limited (part of Harbour Energy). Disruption of helicopter access to oil and gas platforms, drilling rigs and operational vessels has been assessed as minor adverse. The MOD, ATC service providers and helicopter operators have been consulted with regard to the potential for the Morgan Generation Assets to create an obstruction to aviation activities conducted in the vicinity of construction infrastructure, operations and maintenance activities, and decommissioning activities. 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

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

- Sediment disturbance and deposition leading to indirect impacts on marine archaeology receptors
- Alteration of sediment transport regimes.

20.6.3.13 Table 20.13 lists the inter-related effects (project lifetime effects) that are predicted to arise during the construction, operations and maintenance and decommissioning phases of the Morgan Generation Assets and also the inter-related effects (receptor-led effects) that are predicted to arise for marine archaeology receptors.

20.6.3.14 As previously noted in paragraph 20.5.2.7, 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 volume 2, chapter 13: Marine archaeology of the PEIR.

Table 20.13: Summary of likely significant inter-related effects on the environment for individual effects occurring across the construction, operations and maintenance and decommissioning phases of the Morgan Generation Assets and from multiple effects interacting across all phases (receptor-led effects) – marine archaeology.

[a] C=construction, O=operations and maintenance, D=decommissioning

Description of impact	Phase[a]			Likely significant inter-related effects	Inter-related significance
	C	O	D		
Sediment disturbance and deposition leading to indirect impacts on marine archaeology receptors	✓	✓	✓	The construction, operations and maintenance, and decommissioning phases of the Morgan Generation Assets may lead to sediment disturbance and deposition leading to indirect impacts on marine archaeology receptors. Impacts of sediment disturbance and deposition during each project phase have the potential to expose previously unrecorded marine archaeology receptors, and also to bury or partially bury known marine archaeology receptors. Across the project lifetime, the effects on marine archaeology 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 or when considered in conjunction with other topics addressed in the PEIR.	No change resulting from inter-related assessment
Alteration of sediment transport regimes	×	✓	×	This effect will only arise during the operations and maintenance phase and as such there will be no inter-related effects across the project phases. Across the project lifetime, the effects on marine archaeology 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 or when considered in conjunction with other topics addressed in the PEIR.	No change resulting from inter-related assessment

Receptor-led effects

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:

- Combined effects on different elements of the historic environment (e.g. submerged prehistoric receptors and wrecks). The mitigation measures proposed for the Morgan Generation Assets will minimise combined effects on different elements of the historic environment. This includes implementation of Archaeological Exclusion Zones (AEZs) to avoid sites of identified archaeological significance as well as micrositing of wind turbines to avoid archaeological constraints. It is therefore predicted that any inter-related effect will not be of any greater significance than those impacts already assessed in isolation (i.e. minor adverse).
- The direct physical impact on marine archaeology receptors interacting with indirect impacts from sediment disturbance and deposition which may lead to further damage to the same receptor, due to increased exposure. The combined inter-related effect will be minimised by the implementation of AEZs so that it will not be of any greater significance than those direct and indirect impacts already assessed in isolation (i.e. minor adverse).

Other sea users

20.6.3.15 For other sea users, the following potential impacts have been considered within the inter-related assessment:

- Displacement of recreational sailing
- Impacts to existing cables or pipelines or restrictions on access to cables or pipelines
- Reduction or restriction of oil and gas exploration activities (including surveys, drilling and the placement of infrastructure) within the Morgan Array Area
- Interference with the performance of Radar Early Warning Systems (REWS) located on oil and gas platforms
- Interference with offshore microwave fixed communication links.

20.6.3.16 Table 20.14 lists the inter-related effects (project lifetime effects) that are predicted to arise during the construction, operations and maintenance and decommissioning phases of the Morgan Generation Assets and also the inter-related effects (receptor-led effects) that are predicted to arise for other sea users receptors.

20.6.3.17 As previously noted in paragraph 20.5.2.7, other sea 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 volume 2, chapter 14: Other sea users of the PEIR, with effects of minor significance predicted across all project phases.

20.6.3.18 Infrastructure and other users receptors, and aviation and radar receptors are also linked receptors (as noted in paragraph 20.5.2.7) and the inter-related effects (i.e. restriction on access to infrastructure by vessel and helicopter) are described in Table 20.14 below.

20.6.3.19 In addition, there are linked receptor groups between the topic-specific chapters. Effects on other sea users have the potential to have secondary effects on:

- Socio-economics (volume 2, chapter 18: Socio-economics)
  - The impact on economic receptors including employment, Gross Value Added (GVA), and supply chain demand.

Table 20.14: Summary of likely significant inter-related effects on the environment for individual effects occurring across the construction, operations and maintenance and decommissioning phases of the Morgan Generation Assets and from multiple effects interacting across all phases (receptor-led effects) – other sea users.

[a] C=construction, O=operations and maintenance, D=decommissioning

Description of impact	Phase[a]			Likely significant inter-related effects	Inter-related significance
	C	O	D		
Displacement of recreational sailing	✓	✓	✓	During the construction, operations and maintenance and decommissioning phases, the presence of infrastructure, safety zones and advisory safety distances, may lead to the displacement of recreational sailing from the Morgan Generation Assets. The level of recreational sailing within the Morgan Generation Assets is low. Across the project lifetime, the effects on other sea users' 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 or when considered in conjunction with other topics addressed in the PEIR.	No change resulting from inter-related assessment
Impacts to existing cables or pipelines or restrictions on access to cables or pipelines	✓	✓	✓	During the construction, operations and maintenance and decommissioning phases existing cables and pipelines may be affected where they are crossed by Morgan Generation Assets inter-array and interconnector cables. In addition, access to existing cables and pipelines may be restricted during construction, maintenance and decommissioning activities due to the presence of Morgan Generation Assets infrastructure, safety zones and advisory safety distances. Across the project lifetime, the effects on other sea users' 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 or when considered in conjunction with other topics addressed in the PEIR.	No change resulting from inter-related assessment
Reduction or restriction of oil and gas exploration activities (including surveys, drilling and the placement of infrastructure) within the Morgan Generation Assets	✓	✓	✓	Drilling and the placement of infrastructure will be restricted within the Morgan Generation Assets area, with a 500m rolling advisory safety zones around cable installation vessels during the construction phase, and 500m safety zones established around infrastructure such as wind turbines during periods of major maintenance. As infrastructure is installed, the area available for seismic surveys and drilling will be restricted, and the presence of safety zones around infrastructure and vessels may also further restrict the ability to use certain alternative survey methods. The effects of decommissioning activities are expected to be the same or similar to the effects from construction. Across the project lifetime, the effects on other sea users' 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 or when considered in conjunction with other topics addressed in the PEIR.	No change resulting from inter-related assessment
Interference with the performance of REWS located on oil and gas platforms	×	✓	×	These effects will only arise during the operations and maintenance phase and as such there will be no inter-related effects across the project phases. Across the project lifetime, the effects on other sea users' 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 or when considered in conjunction with other topics addressed in the PEIR.	Consultation with stakeholders is ongoing to determine the magnitude of this impact and the sensitivity of receptors. This impact will be fully assessed in the Environmental Statement.
Interference with offshore microwave fixed communication links	×	✓	×		Consultation with stakeholders is ongoing to determine the magnitude of this impact and the sensitivity of receptors. This impact will be fully assessed in the Environmental Statement.

Receptor-led effects

Potential exists for spatial and temporal interactions between direct and indirect impacts to infrastructure and other user receptors. Based on current understanding and expert knowledge, the greatest scope for potential inter-related impacts for other sea users is predicted to arise from the following:

- The interaction of the physical restriction of seismic survey activity and the interference of piling noise with seismic survey activity on the same receptor (oil and gas licence block operator). 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. Within the Morgan Generation Assets area, blocks 110/2c, 113/26a, 113/27a are currently operated by Chrysaor Resources (Irish Sea) Limited (part of Harbour Energy) and as such may be impacted by noise interference. This potential inter-related effect is considered and presented in Table 20.14. Consultation with the operators of the blocks within and in proximity to the Morgan Generation Assets has aimed to establish a line of communication to ensure coexistence can be achieved and any future operational issues can be addressed. Any future operator of unlicensed blocks will be aware of the Morgan Generation Assets and will have taken potential coexistence into consideration.
- The potential interaction between the physical presence of wind turbines within the Morgan Generation Assets and platforms with REWS installed. To be fully assessed in the Environmental Statement.

Description of impact	Phase[a] C	O	D	Likely significant inter-related effects	Inter-related significance
				• The potential interaction between the physical presence of wind turbines within the Morgan Generation Assets and platforms with microwave communications installed. To be fully assessed in the Environmental Statement. • The interaction between 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 volume 2, chapter 20: Inter-related effects of the PEIR: Shipping and navigation.	

Seascape, landscape and visual resources

20.6.3.20 For seascape, landscape and visual resources, the following potential impacts have been considered within the inter-related assessment:

- Seascape impacts – potential change to seascape and marine character through the introduction of the Morgan Generation Assets infrastructure
- Landscape impacts - potential change to landscape character through the introduction of the Morgan Generation Assets infrastructure
- Visual receptor impacts – changes to the visual baseline scenario may cause effects on a variety of visual receptors.

20.6.3.21 Table 20.15 lists the inter-related effects (project lifetime effects) that are predicted to arise during the construction, operations and maintenance and decommissioning phases of the Morgan Generation Assets, and also the inter-related effects (receptor-led effects that are predicted to arise for seascape, landscape and visual resources and receptors.

20.6.3.22 As previously noted in paragraph 20.5.2.7, seascape, landscape and visual resources receptors, socio-economics and human health are linked receptors and the inter-related effects (i.e. the impact on economic receptors including employment, Gross Value Added (GVA), and supply chain demand and the impact on combined national population benefits relating to wider societal resources has been fully assessed in volume 2, chapter 18: Socio-economics and volume 2, chapter 19: Human health of the PEIR.

Table 20.15: Summary of likely significant inter-related effects on the environment for individual effects occurring across the construction, operations and maintenance and decommissioning phases of the Morgan Generation Assets and from multiple effects interacting across all phases (receptor-led effects) – seascape, landscape and visual resources.

[a] C=construction, O=operations and maintenance, D=decommissioning

Description of impact	Phase[a]			Likely significant inter-related effects	Inter-related significance
	C	O	D		
Seascape impacts – potential change to seascape and marine character through the introduction of the Morgan Generation Assets infrastructure	✓	✓	✓	The potential effects of the presence of the Morgan Array Area within the seascape and marine character areas is directly in relation to the scale and size of development proposed, the geographic extent of impact, and the distance and context factors in relation to the receptor. The scale of potential effects is likely to be high in relation to the array area itself and diminishing with distance from the array area. The scale of effects will also increase through the construction phase and remain throughout operations and maintenance, decreasing again through the decommissioning phase. Although this indicates that there is a potential lengthening of the temporal effect, across the project lifetime, the effects on seascape and marine character 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. Across the project lifetime, the effects on seascape, landscape and visual resources' 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 or when considered in conjunction with other topics addressed in the PEIR.	No change resulting from inter-related assessment
Seascape impacts – potential change to seascape and marine character through the introduction of the Morgan Generation Assets infrastructure	✓	✓	✓	The potential effects of the presence of the Morgan Array Area within the seascape and marine character areas is directly in relation to the scale and size of development proposed, the geographic extent of impact, and the distance and context factors in relation to the receptor. The scale of potential effects is likely to be high in relation to the array area itself and diminishing with distance from the array area. The scale of effects will also increase through the construction phase and remain throughout operations and maintenance, decreasing again through the decommissioning phase. Although this indicates that there is a potential lengthening of the temporal effect, across the project lifetime, the effects on seascape and marine character 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. Across the project lifetime, the effects on seascape, landscape and visual resources' 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 or when considered in conjunction with other topics addressed in the PEIR.	No change resulting from inter-related assessment
Landscape impacts - potential change to landscape character through the introduction of the Morgan Generation Assets infrastructure	✓	✓	✓	The potential effects of the presence of the Morgan Array Area on landscape character areas is directly in relation to the scale and size of development proposed, the geographic extent of impact, and the distance and context factors in relation to the receptor. The scale of effects will increase through the construction phase and remain throughout operations and maintenance, decreasing again through the decommissioning phase. Although this indicates that there is a potential lengthening of the temporal effect, across the project lifetime, the effects on landscape character 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. Across the project lifetime, the effects on seascape, landscape and visual resources' 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 or when considered in conjunction with other topics addressed in the PEIR.	No change resulting from inter-related assessment
Receptor-led effects					
There is the potential for spatial and temporal interactions between the potential impacts identified on seascape, landscape and visual resources receptors. The greatest potential for inter-related effects is through the interaction of impacts on the known visual receptors within the seascape, landscape and visual resources study area. Combined effects on visual receptors will vary temporally and spatially across the seascape and visual resources study area according to the project activities that are being undertaken. The mobile nature of many of the visual receptors (e.g. ferry passengers, people working on fishing vessels, users of recreational vessels and commercial vessels) means that impacts will only occur when those receptors are in the vicinity of the Morgan Array Area. The significance therefore varies depending on the receptor's distance to the Morgan Array Area with those closest to the array experiencing major impacts which then diminish with distance. The potential effects of construction will be temporary and will give way to operation and maintenance phase effects which will be fully reversible when the Morgan Generation Assets 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 major adverse).					

Socio-economics

20.6.3.23 For socio-economics, the following potential impacts have been considered within the inter-related assessment:

- The impact on economic receptors including employment, Gross Value Added (GVA), and supply chain demand
- The impact of increased employment opportunities
- The impact on the demand for housing, accommodation and local services
- The impact of disruption on tourism and recreation.

20.6.3.24 Table 20.16 lists the inter-related effects (project lifetime effects) that are predicted to arise during the construction, operations and maintenance and decommissioning phases of the Morgan Generation Assets, and also the inter-related effects (receptor-led effects that are predicted to arise for socio-economics receptors).

20.6.3.25 As previously noted in paragraph 20.5.2.7, socio-economic receptors and commercial fisheries, shipping and navigation, other sea users and SLVIA receptors are linked and the inter-related effects associated with potential impacts on these receptors has been assessed in volume 2, chapter 18: Socio-economics of the PEIR.

Table 20.16: Summary of likely significant inter-related effects on the environment for individual effects occurring across the construction, operations and maintenance and decommissioning phases of the Morgan Generation Assets and from multiple effects interacting across all phases (receptor-led effects) – socio-economics.

[a] C=construction, O=operations and maintenance, D=decommissioning

Description of impact	Phase[a]			Likely significant inter-related effects	Inter-related significance
	C	O	D		
The impact on economic receptors including employment, Gross Value Added (GVA), and supply chain demand.	✓	✓	✓	There will be beneficial effects on employment and GVA throughout the construction and installation; operations and maintenance; and decommissioning phases. Employment and GVA effects will occur within different locations and sectors of the economy and at different times and intensities. The socio-economic effects from each phase of the Morgan Generation Assets will provide long term employment and GVA stimulus. Across the project lifetime, the effects on socio-economic resources' 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 or when considered in conjunction with other topics addressed in the PEIR.	No change resulting from inter-related assessment
The impact of increased employment opportunities.	✓	✓	✓	There will be beneficial effects on the potential for local workers to access employment throughout the construction and installation; operations and maintenance; and decommissioning phases. Access to employment effects will occur within different locations, sectors of the economy, and labour market – and at different times and intensities. The socio-economic effects from each phase of the Morgan Generation Assets will provide a long term employment stimulus. Across the project lifetime, the effects on socio-economic resources' 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 or when considered in conjunction with other topics addressed in the PEIR.	No change resulting from inter-related assessment
The impact on the demand for housing, accommodation and local services.	✓	✓	✓	Direct and indirect employment generated during the construction phase could increase demand for housing, accommodation and local services during the construction phase. Direct and indirect employment generated during the operations and maintenance phase could increase demand for housing, accommodation and local services. It is anticipated that due to the long term nature of the operations and maintenance requirements the workforce will live locally. Some of those may relocate to the area requiring long term/permanent housing within the vicinity of the operations and maintenance port. Direct and indirect employment generated during the decommissioning phase could increase demand for housing, accommodation and local services during the decommissioning phase. The housing and accommodation needs of employment during each phase differs. Across the project lifetime, the effects on socio-economic resources' 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 or when considered in conjunction with other topics addressed in the PEIR.	No change resulting from inter-related assessment
The impact of disruption on tourism and recreation.	✓	✓	✓	Potential impacts of the construction, operations and maintenance, and decommissioning of the Morgan Generation Assets on tourism and recreation are indirect in nature. Across the project lifetime, the effects on socio-economic resources' 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 or when considered in conjunction with other topics addressed in the PEIR.	No change resulting from inter-related assessment
Receptor-led effects					
By definition, most of the impacts outlined above will interact. The exception is the tourism receptor, which is primarily determined on the basis of visual impact. Expenditure associated with the Morgan Generation Assets will result in employment and GVA impacts – these impacts are the basis for assessing potential socio-economic effects. Therefore the interactions between socio-economic receptors are inherent in the assessments of these impacts. It is not possible for socio-economic impacts to act together in a manner that multiplies effects. Employment-related receptors are likely to interact with the demand for housing, accommodation and local services receptor. In the event that employment and GVA impacts were to increase or decrease, effects related to the demand for housing, accommodation and local services would similarly increase or decrease. However, these impacts would not act together in a manner that multiplies effects.				

Human health

20.6.3.26 For human health, the following potential impacts have been considered within the inter-related assessment:

- Combined transport modes, access and connections effects across project phases
- Combination of reduced transport modes, access and connections and effects on community identity locally on the population of the Isle of Man
- Combined national population benefits relating to climate change and wider societal resources.

20.6.3.27 Table 20.17 lists the inter-related effects (project lifetime effects) that are predicted to arise during the construction, operations and maintenance and decommissioning phases of the Morgan Generation Assets, and also the inter-related effects (receptor-led effects that are predicted to arise for human health receptors).

20.6.3.28 As previously noted in paragraph 20.5.2.7, seascape, landscape and visual resources and socio-economic receptors are linked and the inter-related effects associated with potential impacts on these receptors has been assessed in volume 2, chapter 19: Human health of the PEIR.

Table 20.17: Summary of likely significant inter-related effects on the environment for individual effects occurring across the construction, operations and maintenance and decommissioning phases of the Morgan Generation Assets and from multiple effects interacting across all phases (receptor-led effects) – human health.

[a] C=construction, O=operations and maintenance, D=decommissioning

Description of impact	Phase[a]			Likely significant inter-related effects	Inter-related significance
	C	O	D		
Combined transport modes, access and connections effects across project phases.	✓	✓	✓	Effects relating to ongoing disruption to access across all project stages are already taken into account by the health assessment, including where effects are characterised as 'long-term'. Across the project lifetime, the effects on human health 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 or when considered in conjunction with other topics addressed in the PEIR.	No change resulting from inter-related assessment
Receptor-led effects					
A small minority of the population of the Isle of Man may experience views of the wind farm (adversely affecting community identity health outcomes) and adverse impacts affecting health due to shipping route disruption. Combined effects are considered likely during the operational phase, once the windfarm is a feature of the seascape. The combined effects may particularly affect vulnerable groups with existing poor mental health. At a population level it is not expected that the combination of effects would interact in a way that would significantly reinforce health outcomes. No greater effect is therefore likely. Nationally the population would benefit both from a reduction in the severity of health effects associated with climate change and from the benefits to public health of energy security. Effects would be greatest for vulnerable groups, particularly those on low incomes less able to adapt or afford alternatives. As the effects associated with climate change are expected to be driven by the benefit to deprived populations globally, the combined effect in the UK of these health determinants is not expected to be greater than the individual effects. Across the project lifetime, the additive effects on socio-economic resources' 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 or when considered in conjunction with other topics addressed in the PEIR.					

20.7 Summary

20.7.1.1 The tables presented within this chapter assess potential inter-related effects arising from the Morgan Generation Assets 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 has noted 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.

20.8 Conclusion

20.8.1.1 This chapter has defined the potential inter-related effects considered to arise from the Morgan Generation Assets. 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 the Morgan Generation Assets.

20.8.1.2 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.

20.9 References

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