



Cerulean Winds Aspen Project Limited

Aspen Offshore Wind Farm

Environmental Impact Assessment Report and Habitats Regulations
Appraisal Addendum

Appendix 1: Blue Carbon Assessment



GoBe
APEM Group



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Contents

1	Introduction	8
2	Purpose of the Assessment.....	9
3	Legislation and Policy Context	10
4	Blue Carbon Science	11
5	Baseline Environment.....	14
5.1	Study Area	14
5.2	Description of Baseline Environment	14
5.3	Carbon Characteristics of the Study Area	18
5.4	Data Limitations and Assumptions	20
6	Assessment Methodology	22
6.2	Guidance	22
6.3	Scope of Assessment.....	23
6.4	Criteria for Assessment	24
7	Impact Pathways	28
7.1	Evidence of Impacts and Evidence Gaps	28
7.2	Impacts Scoped into the Assessment	29
7.3	Worst-case Design Scenario	31
8	Assessment of Likely Significant Effects	43
8.2	Subtidal Carbon Stores - Marine Sediment	43
	Impacts 2, 5, 6, 11, and 12: Temporary and Permanent Habitat Disturbance	43
	Impact 3, 4, 8, 9, 13 and 14: Reduction in Access to, or Exclusion from Established Fishing Grounds.....	46
	Impact 7: Changes in Physical Processes Resulting from the Presence of the Subsea Infrastructure	47
8.3	Subtidal Carbon Stores - Bryozoan Thickets.....	48
	Impact 1 and 10: Temporary Increases in SSC and Sediment Deposition	48
8.4	Nearshore Carbon Stores - Kelp Beds	49
	Impact 1 and 10: Temporary Increases in SSC and Sediment Deposition	49
9	Cumulative Effects Assessment	50
10	Conclusions	51
11	References.....	52



Figures

Figure 4.1 Illustration Showing A) Summary of how Organic Carbon can Enter the sea and B) Summary of how Organic Carbon and Inorganic Carbon can Reach the Seabed, and how Marine Carbon can Re-enter the Atmosphere (source: Turrell <i>et al.</i> , 2023)	12
Figure 5.1 Surficial Sediment Characterisation	17
Figure 5.2 Surficial Sedimentary Carbon of the Organic Carbon in the top 10cm in Relation to the Proposed Development (Smeaton <i>et al.</i> , 2021a).....	21

Tables

Table 3.1 Legislation and Policies Relevant to Blue Carbon Habitats	10
Table 5.1 Continental Shelf Mean Sedimentary Organic Carbon (%), Organic Stores (Mt) and OC Density for the Scottish Continental Shelf Derived (source: Smeaton <i>et al.</i> , 2020; Burrows <i>et al.</i> , 2024)	19
Table 6.1 Summary of Key Guidance Documents and Data Sets.....	23
Table 6.2 Impact Magnitude Criteria for Blue Carbon Habitats	25
Table 6.3 Receptor Sensitivity Criteria for Blue Carbon Habitats	26
Table 6.4 Matrix Used for Assessment of the Significance of the Effect	27
Table 7.1 Worst-case Design Scenarios with Respect to the Blue Carbon Assessment	32
Table 8.1 Calculation of Potential CO2 Emissions Caused by the Proposed Development.....	44



Defined Terms

Term	Definition
Addendum	The document which supplements the submitted Offshore Environmental Impact Assessment Report and Report to Inform Appropriate Assessment by providing additional environmental information and clarifications in response to the MD-LOT Request for Additional Information.
Applicant	Cerulean Winds Aspen Project Limited.
Aspen Array Area	The area in which the generation infrastructure for Aspen Offshore Wind Farm, including Wind Turbine Generators and Offshore Substation Platforms will be located.
Blue carbon	Blue carbon refers to carbon that is captured from the atmosphere and stored in marine and coastal ecosystems like seagrass meadows, mangroves, subtidal sediments and tidal marshes
Carbon sequestration	The long-term storage of carbon in plants, soils, geologic formations, and the ocean.
Carbon store	The total amount of carbon stored within a specific area or volume, measured as mass per unit
Design Envelope	A description of the range of possible elements that make up the Proposed Development’s design options under consideration, as set out in detail in the project description. This envelope is used to define the Proposed Development for Environmental Impact Assessment and Habitats Regulation Appraisal purposes when the exact engineering parameters are not yet known. This is also known as the “Rochdale Envelope” approach.
Floating Foundations	The foundations on which the Wind Turbine Generators are installed.
Inorganic Carbon	Inorganic carbon refers to carbon compounds that do not contain carbon-hydrogen bonds, such as carbon dioxide and carbonates. It is typically found in the atmosphere, oceans, and rocks
Inter-array Cables (IACs)	Cables which link the Wind Turbine Generators to each other and to the Offshore Substation Platforms within the Aspen Array Area.
Inter-link Cables	Cables that will link Offshore Substation Platforms within the Aspen Array Area.
Landfall	The area between Mean Low Water Spring and Mean High Water Spring where the Offshore Transmission Cables will connect onshore to offshore.
Offshore Environmental Impact Assessment Report (Offshore EIAR)	The published report of the Environmental Impact Assessment that will be undertaken for the Proposed Development.
Offshore Substation Platform (OSP)	Offshore platform consisting of High Voltage Alternating Current substations or High Voltage Direct Current substations.
Offshore Transmission Cable Corridor (OTC Corridor)	The area within which the Offshore Transmission Cables will be installed.
Offshore Transmission Cables (OTCs)	The subsea electricity cables running from Landfall in the region of Stonehaven to the Offshore Substation Platform(s) in Aspen Array Area. The OTCs will act as both a demand and supply cable. The OTCs



Term	Definition
	will provide both traditional supply of power to grid but also ensures robust secure power supply to oil and gas assets when the Aspen Array Area is not generating sufficient renewable power to support their demand.
Project	Aspen Offshore Wind Farm - comprises the wind farm and all associated offshore and onshore components.
Proposed Development	The offshore components of the Project (Aspen Offshore Wind Farm) which include all offshore infrastructure associated with Aspen Array Area and the Offshore Transmission Cables.
Wind Turbine Generator (WTG)	The wind turbine that generates electricity consisting of tubular towers and blades attached to a nacelle housing mechanical and electrical generating equipment.
Worst-case Design Scenario	The maximum design parameters of each offshore asset of the Proposed Development considered to be a worst case for any given assessment.



Abbreviations

Abbreviation	Definition
BGS	British Geological Survey
CEA	Cumulative Effects Assessment
CO ₂	Carbon Dioxide
CO ₂ e	Carbon Dioxide Equivalent
BGS	British Geological Survey
EEZ	Economic Exclusion Zone
EIA	Environmental Impact Assessment
EIAR	Environmental Impact Assessment Report
HDD	Horizontal Directional Drilling
IAC	Inter-array Cables
JUV	Jack Up Vessels
LSE	Likely Significant Effect
MD-LOT	Marine Directorate – Licensing Operations Team
MHWS	Mean High Water Springs
OSP	Offshore Substation Platform
OTC	Offshore Transmission Cable
OWF	Offshore Wind Farm
PSA	Particle Size Analysis
SPA	Special Protection Area
SSC	Suspended Sediment Concentration
TOC	Total Organic Carbon
t CO ₂ e	Tonnes of Carbon Dioxide Equivalent
WTG	Wind Turbine Generator



1 Introduction

- 1.1.1 Cerulean Winds Aspen Project Limited (hereafter referred to as the ‘Applicant’) is proposing to develop the Aspen Offshore Wind Farm (hereafter referred to as ‘the Project’). The Project is made up of both offshore and onshore components. The subject of the Offshore Environmental Impact Assessment Report (Offshore EIAR) is the offshore infrastructure of the Project seaward of Mean High Water Springs (MHWS) which is hereafter referred to as ‘the Proposed Development’.
- 1.1.2 The Aspen Array Area covers an area of approximately 333 km² and is located approximately 84 km east of Peterhead off the east coast of Scotland. The offshore infrastructure of the Proposed Development includes Wind Turbine Generators (WTGs) and associated floating foundations, Offshore Substation Platform(s) (OSP(s)) and associated foundations, Inter-array Cables (IACs), Inter-link Cables, Offshore Transmission Cables (OTCs) and Landfall.



2 Purpose of the Assessment

- 2.1.1 Several definitions of blue carbon exist. In Scotland, blue carbon is defined by the Scottish Government Blue Carbon Action Plan (2025) as follows:

“Blue carbon is the carbon captured and stored in marine and coastal ecosystems that accumulates over long timescales through natural processes.”

- 2.1.2 In Scotland, blue carbon habitats include saltmarshes, seagrasses, kelp beds, biogenic reefs and geological sedimentary stores, such as seafloor and sea loch sediments (Cunningham and Hunt, 2023). These ecosystems are recognised for their exceptional capacity to capture and retain organic carbon. Compared with terrestrial forests, coastal and marine systems can accumulate organic (biological) material more rapidly due to high primary productivity enabling carbon to be stored within living biomass, root systems, and sediments over centennial to millennial timescales (Cunningham and Hunt, 2023). As a result, blue carbon habitats represent important long term carbon sinks within Scotland’s marine environment that have the potential to contribute to climate change mitigation efforts (Scottish Government, 2025).
- 2.1.3 Blue carbon habitats in Scotland, as in other regions, face a growing number of pressures. The protection and restoration of blue carbon habitats take place within a wider policy landscape that has developed around nature conservation and environmental protection, as well as mitigating climate change. The Scottish Government’s priority for blue carbon is to ensure these habitats are protected and supported to minimise and avoid unnecessary release of this carbon, while also recognising that enhancement and restoration of habitats may also be able to make a small contribution to climate change mitigation (Scottish Government, 2025).
- 2.1.4 Marine Directorate – Licensing Operations Team (MD-LOT) issued an Additional Information request on the basis of the NatureScot representation:
- Rationale why a blue carbon assessment was not possible, or, alternatively, a blue carbon assessment must be presented.
 - Any justification for not undertaking a blue carbon assessment, or any assessment provided must align with the advice provided in the Scoping opinion adopted for the project by Scottish Ministers on 12 May 2025, and the NatureScot advice contained therein.
- 2.1.5 This blue carbon assessment satisfies the MD-LOT requirements (NatureScot, 2025), presenting potential impacts on local blue carbon stores from the Proposed Development, mainly as a qualitative assessment, supplemented by quantitative analysis where possible. The assessment also discusses appropriate mitigation and monitoring where required to address any likely significant effects (LSE).



3 Legislation and Policy Context

3.1.1 Overarching legislation, policy, and guidance in relation to the Offshore EIAR for the Proposed Development is provided in **Volume 1, Chapter 2: Policy and Legislative Context** of the Offshore EIAR. A summary of relevant policy and legislation directly applicable or relevant to blue carbon habitats and blue carbon assessments is outlined in Table 3.1. Legislation and policy applicable to climate can be found in **Volume 2, Chapter 18: Climate** of the Offshore EIAR, and specific benthic receptors in **Volume 2, Chapter 9: Benthic Subtidal and Intertidal Ecology** of the Offshore EIAR.

Table 3.1 Legislation and Policies Relevant to Blue Carbon Habitats

Policy/Legislation	Summary	How This Blue Carbon Assessment Has Considered This Policy/Legislation?
UK Marine Strategy Part Three: 2025 UK Programme of Measures	Part 3 (measures) acknowledges blue carbon as a crucial measure for meeting net-zero targets, and the work towards understanding blue carbon stores in Scotland, England, Wales and Northern Ireland.	This report looks at the value of blue carbon habitats and assesses the Likely Significant Effect (LSE) from the Proposed Development on blue carbon stores in Section 8.
Scotland's National Marine Plan	Contains policies on climate change (General Policy 5) and on protecting the natural environment (General Policy 9), which included the protection of marine habitats that store blue carbon.	
Scottish Biodiversity Strategy to 2045 (and Scottish Biodiversity Strategy Delivery Plan 2024–29)	Sets out how Scotland will become nature positive by 2030 and restore and regenerate biodiversity by 2045. The delivery plan sets targets for restoring biodiversity across land and sea, including protection of marine habitats that store carbon.	
Scottish National Adaptation Plan 2024–29	Commits Scotland to climate adaptation actions, including integrating blue carbon considerations into marine planning and resilience strategies.	
Scottish Climate Change Plan 2018 to 2032	Sets out Scotland's pathway to meet statutory emissions-reduction targets. Recognises the importance of natural carbon sinks, including coastal and marine ecosystems. Commits to enhancing carbon sequestration through nature-based solutions and improving understanding of marine carbon stores.	
Scottish Blue Carbon Action Plan 2025	Sets out Scotland's priorities for protecting and restoring blue carbon habitats (saltmarsh, seagrass, kelp, seabed sediments). Emphasises integrating blue carbon into marine policy and addressing evidence gaps.	
		This report assesses the LSE of the Proposed Development on blue carbon habitats. Qualitative and quantitative assessments are included, where possible, assessing the carbon storage and sequestration capacity of blue carbon habitats within the Study Area (see Section 5) in Section 8.



4 Blue Carbon Science

- 4.1.1 As mentioned in Section 2, blue carbon refers to the carbon captured and stored in marine and coastal ecosystems through natural biogeochemical processes over extended timescales. Specifically, this refers to the capture of carbon dioxide (CO₂) into carbon and storage of organic carbon for more than 100 years (Scottish Government, 2025).
- 4.1.2 Carbon from CO₂ can enter the marine environment in two forms. One form is through photosynthesis, an action by marine plants and algae which remove the CO₂ dissolved in seawater and fixes it into what is known as organic carbon (Turrell *et al.*, 2023). As part of the natural carbon cycle, this carbon is released back into the environment through respiration, excretion, and decomposition following mortality, and can settle onto marine sediments (as seen in Figure 4.1). While this biological carbon is fundamental to nutrient cycling and supports marine food webs, it does not contribute to long-term (over 100 years) carbon storage or climate mitigation.
- 4.1.3 Calcifying organisms such as native oysters, mussels, maerl and other biogenic reefs produce another form known as inorganic carbon through calcification which involves producing calcium carbonate (CaCO₃) skeletons, which over time build up a store of carbon (Turrell *et al.*, 2023). The process of calcification changes seawater chemistry which in turn results in an increase in dissolved CO₂.
- 4.1.4 These processes occur across a diverse range of habitats such as mangroves, saltmarshes, seagrass meadows, macroalgal forests, biogenic reefs, and marine sediments that collectively contribute to the long-term regulation of atmospheric CO₂ (as seen in Figure 4.1). Globally mangroves, saltmarshes, and seagrass habitats (also known as vegetated habitats) occupy less than 0.5% of the global seafloor yet are estimated to account for approximately 50% of organic carbon burial in ocean sediments (Cunningham and Hunt, 2023). This disproportionate contribution reflects their high primary productivity and efficient trapping of particulate organic matter. However, much of the carbon stored within these habitats is retained within living biomass or shallow soils, meaning that it is generally considered a short- to medium-term carbon store that may be vulnerable to disturbance, degradation, or environmental change.



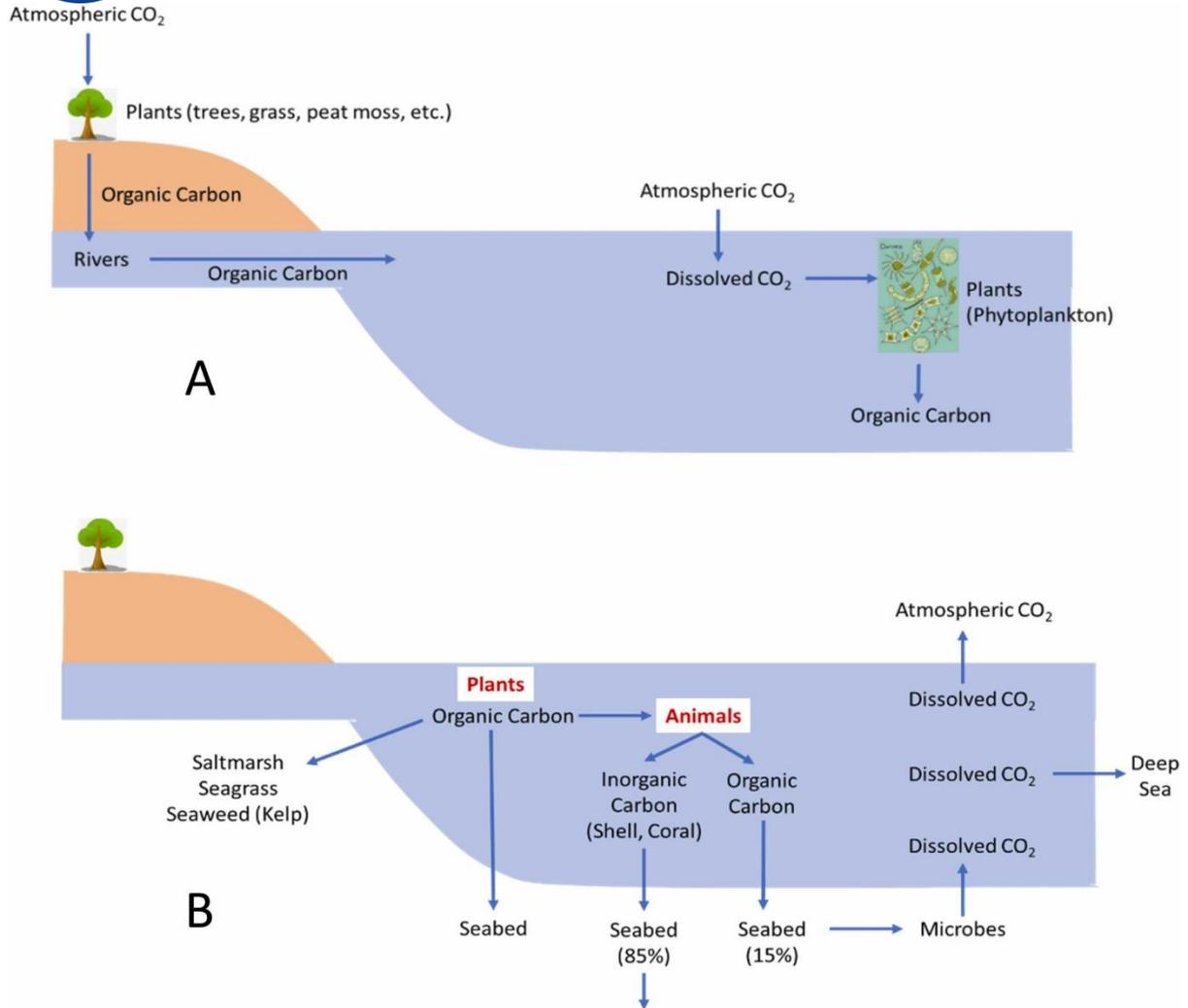


Figure 4.1 Illustration Showing A) Summary of how Organic Carbon can Enter the sea and B) Summary of how Organic Carbon and Inorganic Carbon can Reach the Seabed, and how Marine Carbon can Re-enter the Atmosphere (source: Turrell *et al.*, 2023)



- 4.1.5 Seabed sediments also function as significant carbon stores capable of isolating organic carbon from the atmosphere for periods exceeding 100 years (Burrows *et al.*, 2024), as well as inorganic forms. The longevity of carbon storage in these deeper sedimentary systems is typically greater than that of vegetated habitats (normally long timescales >1000 years (Cunningham and Hunt, 2023), although uncertainties remain regarding the stability, burial efficiency, and vulnerability of carbon under different disturbance regimes. Marine sediments also contain buried carbon from marine (Santschi *et al.*, 1990; Glud, 2008; Krause-Jensen and Duarte, 2016), terrestrial (Bianchi, 2011; Bauer *et al.*, 2013; Cui *et al.*, 2016; Smeaton and Austin, 2017) and geological sources (Galy *et al.*, 2015; Cunningham and Hunt, 2023).
- 4.1.6 From a biogeochemical perspective, the climate change mitigation potential of blue carbon ecosystems depends on both their capacity to sequester carbon and the stability of the resulting carbon stores. Protecting and restoring these habitats enhances ongoing carbon fixation while safeguarding existing sedimentary carbon stores, reducing the risk of carbon re-mobilisation to the atmosphere.
- 4.1.7 As such, blue carbon ecosystems are more increasingly recognised as critical components of nature-based climate solutions, providing a scientifically credible way to support national and global emissions-reduction efforts. However, significant uncertainties and evidence gaps remain for certain blue carbon habitats, as eluded to in the Blue Carbon Action Plan (Scottish Government, 2025), limiting our understanding of their full potential to contribute to climate change mitigation.



5 Baseline Environment

5.1 Study Area

5.1.1 For the purposes of this report, the blue carbon study areas mirror the study areas of **Volume 2, Chapter 9: Benthic Subtidal and Intertidal Ecology** of the Offshore EIAR and has been defined by the following:

- The Aspen Array Area and OTC Corridor: this is the area where the offshore components of the Proposed Development will be developed and, therefore, where direct impacts on the benthic environment will occur. This area also represents where site-specific survey data was collected.
- The benthic subtidal ecology study area: this area encompasses a buffer of approximately 10 km as this represents the area that will be potentially impacted from indirect or secondary impacts such as increases in Suspended Sediment Concentrations (SSC) and deposition as a result of the development. This was informed by the spring tidal excursion ellipses and was scaled as 10 km which is considered to be precautionary, see **Volume 2, Chapter 7: Marine and Coastal Processes**; and **Volume 3, Appendix 7.1: Marine and Coastal Processes Technical Report**.
- The benthic intertidal ecology study area: this area is defined by the intertidal habitats up to the MHWS mark within the OTC Corridor with a buffer of 10 km around the OTC Corridor to encompass coastal blue carbon habitats (**Volume 2, Chapter 9: Benthic Subtidal and Intertidal Ecology** of the Offshore EIAR), based on the same theory presented for the subtidal area above.

5.1.2 The offshore infrastructure associated with the Aspen Array Area and OTC Corridor includes WTGs and associated floating foundations, foundation moorings and anchors, OSPs and associated foundations, IACs, Inter-link Cables, and OTCs.

5.2 Description of Baseline Environment

5.2.1 Information on blue carbon habitats was collected through a detailed desktop review of existing literature and available data sources, as well as site-specific surveys as described in **Volume 2, Chapter 9: Benthic Subtidal and Intertidal Ecology** of the Offshore EIAR. This data provided an up-to-date characterisation of the benthic habitats occurring within the boundary of the Aspen Array Area and OTC Corridor.

5.2.2 As described in **Volume 2, Chapter 9: Benthic Subtidal and Intertidal Ecology** of the Offshore EIAR, the Aspen Array Area is predominantly very poor or poorly sorted muddy (Folk, 1954; Folk and Ward, 1957), with Particle Size Analysis (PSA) results showing that all survey stations in the Aspen Array Area were dominated by sand fractions (Gardline, 2025a). Fines accounted for between 11.4 and 31.2% of the sediment content (Gardline, 2025a), and gravel either absent or of negligible contribution, as seen in Figure 5.1.

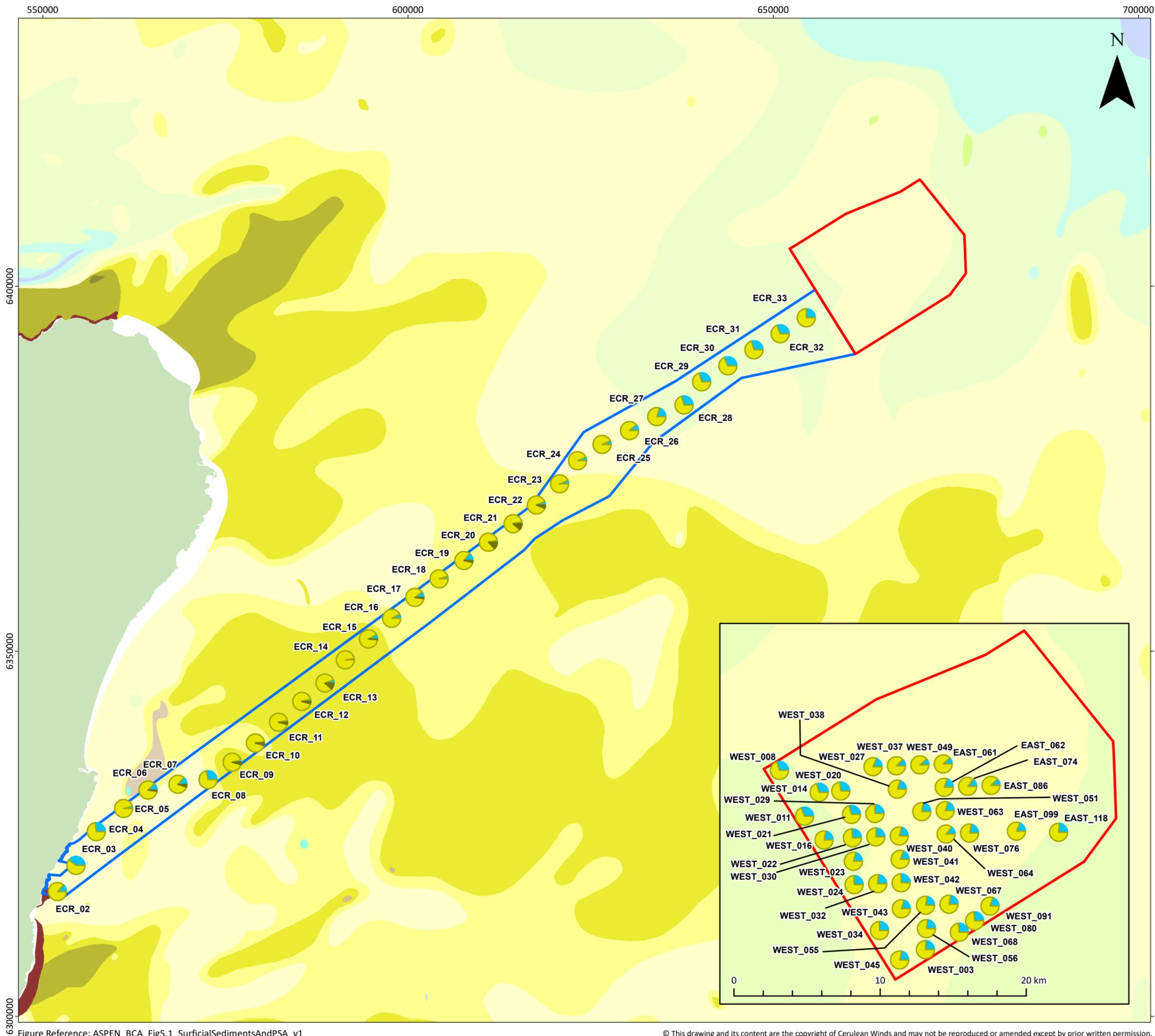


- 5.2.3 Across the Aspen Array Area, the two main biotopes and biotope complexes were:
- Faunal communities in Atlantic offshore circalittoral sand (EUNIS Code: MD521, JNCC Code: SS.SSa.Osa); and
 - Seapens and burrowing megafauna in Atlantic circalittoral fine mud (EUNIS Code: MC6216, JNCC Code: SS.SMu.CFiMu.SpnMeg).
- 5.2.4 Concentrations of Total Organic Carbon (TOC) ranged from 0.20 to 0.51 % in the Aspen Array Area. Increased organic matter is expected in association with fine sediments, as organic compounds tend to adsorb onto the greater surface area provided by fine-grained particles. This was illustrated by a significant positive correlation between increasing fines and TOC. There was also a positive correlation between depth and TOC, indicating that concentrations may be due to natural spatial variation (Gardline, 2025a).
- 5.2.5 As described in **Volume 2, Chapter 9: Benthic Subtidal and Intertidal Ecology** of the Offshore EIAR, the OTC Corridor is more varied, with the most offshore segment predominantly composed of muddy sands. This section of the corridor was similar to the Aspen Array Area, with a fines content between 6.1 and 32.0% (Gardline, 2025a), with negligible gravel content, resulting in classifications of very poor to moderately well sorted muddy sand or sand (Folk, 1954; Folk and Ward, 1957). This is seen in Figure 5.1. Across the OTC Corridor, the main biotopes and biotope complexes were:
- Faunal communities in Atlantic offshore circalittoral mixed sediment (EUNIS Code: MD421, JNCC Code: SS.SMx.OMx);
 - Faunal communities in Atlantic offshore circalittoral sand (EUNIS Code: MD521, JNCC Code: SS.SSa.Osa);
 - *Sabellaria spinulosa* on stable circalittoral mixed sediment (EUNIS Code: MC2211, JNCC Code: SS.SBR.PoR.SpiMx); and
 - Seapens and burrowing megafauna in Atlantic circalittoral fine mud (EUNIS Code: MC6216, JNCC Code: SS.SMu.CFiMu.SpnMeg).
- 5.2.6 In the middle of the OTC Corridor, fines content in these stations ranged from 2.3 to 14.2%, with the exception of one station which recorded 28.3% fines at the most south-west station of the midsection (Gardline, 2025a). The three stations closest to the shore were classified as very poor or poorly sorted muddy sand (Folk, 1954; Folk and Ward, 1957), with fines content between 13.2 and 39.5% (Gardline, 2025a).
- 5.2.7 Concentrations of TOC ranged from 0.11 to 0.77% along the OTC Corridor. However, the concentration of 0.77%, which was recorded at the station nearest to the shore, was identified as a significantly high outlier (Gardline, 2025a).
- 5.2.8 As described in **Volume 2, Chapter 9: Benthic Subtidal and Intertidal Ecology** of the Offshore EIAR, subtidal survey recorded '*Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment' (MC4214) biotope in the wider subtidal study area (within the 10 km buffer), outside the OTC Corridor and Aspen Array Area. Bryozoan thickets (*Flustra foliacea*) can form a biogenic reef; however, no additional data was collected on this biotope.



- 5.2.9 According to **Volume 2, Chapter 9: Benthic Subtidal and Intertidal Ecology** of the Offshore EIAR, kelp beds have been recorded within the benthic intertidal ecology study area. One record is to the north of the OTC Corridor, and several records to the south of the OTC Corridor, within in the Fowlsheagh Special Protection Area (SPA).
- 5.2.10 Other habitats found in in the benthic intertidal ecology study area include intertidal rock, and some coarse sediment and mobile sands (**Volume 2, Chapter 9: Benthic Subtidal and Intertidal Ecology** of the Offshore EIAR).



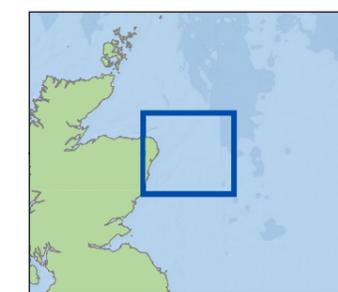


Aspen Offshore Wind Farm Additional Information

Existing Surficial Sediment Characterisation Combined with Site-specific Survey Points

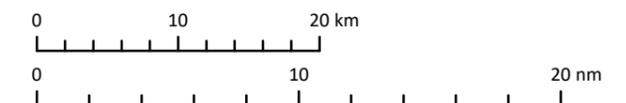
Legend

- Aspen Array Area
- Offshore Transmission Cable Corridor
- Seabed Sediments (Folk, 1954) (EMODnet)**
- 1.1.1 Mud
- 1.2.1 sandy Mud
- 1.2.2 (gravelly) sandy Mud
- 1.3.1 muddy Sand
- 1.3.2 (gravelly) muddy Sand
- 2.1.1 Sand
- 2.1.2 (gravelly) Sand
- 3.1.1 gravelly Sand
- 3.2.1 sandy Gravel
- 3.3.1 Gravel
- 4.1.1 gravelly Mud
- 4.3.1 gravelly muddy Sand
- 5. Rock and Boulders
- PSA Results (%)**
- Fines
- Sand
- Gravel



Notes
Esri, Garmin, GEBCO, NOAA
NGDC, and other contributors
Contains Ordnance Survey data
© Crown copyright and database
rights (2024). OS OpenData.

Coordinate System:
WGS 1984 UTM Zone 30N



Scale Date Drawn by Checked by Approved by
1:500,000 @A3 25/02/2026 EV BPHB KG

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Figure 5.1

5.3 Carbon Characteristics of the Study Area

- 5.3.1 Kelp beds comprise over 75% of the carbon standing stocks in nearshore habitats (Cunningham and Hunt, 2023). Burrows *et al.* (2014) reviewed the carbon standing stock in kelp beds within Scotland within the first national blue carbon audit. Using historic data (Kain, 1979; Walker and Richardson, 1955), total estimates of standing stock of Scottish kelp living biomass equated to approximately 0.6 million tonnes (Mt) of organic carbon (Cunningham and Hunt, 2023). However, it is not possible to quantify kelp-related carbon stocks within the study area due to limited data on the habitat.
- 5.3.2 Similarly, bryozoan thickets are a biogenic reef capable of storing carbon. In one study it was estimated that bryozoan thickets had a total carbon standing stock of 47,362 tonnes in Orkney (Porter *et al.*, 2020). However, estimates of the full Scottish extent are unknown, and it is not possible to quantify bryozoan related carbon stocks within the study area due to limited data on the habitat.
- 5.3.3 Several iterations to map sedimentary carbon stores have taken place in Scotland's marine environment (e.g. Smeaton *et al.*, 2020; Smeaton *et al.*, 2021a; 2021b; 2021c; Cunningham and Hunt, 2023). The most recent version of estimates using previous studies is Burrows *et al.* (2024). Burrows *et al.* (2024) was only able to produce estimates for the parts of Scotland's Exclusive Economic Zone (EEZ) that have been mapped for carbon, an area of 437,883 km² out of the EEZ's total 462,315 km².
- 5.3.4 In total, 152.3 Mt of organic carbon in long-term stores are found in surficial sediments (i.e. in the top 10 cm of the seabed) in the mapped carbon stores in the EEZ region. Of this, 99.7% is stored within seabed sediments. The remaining 0.3% is stored within coastal vegetated blue carbon habitats, which include kelp beds, coastal saltmarsh and seagrass beds. However, this represents a fraction of the overall carbon stored in the full depth of these sediments as it only accounts for the top 10 cm (Burrows *et al.*, 2024).
- 5.3.5 The capacity of sediments to retain carbon varies with sediment type. Coarse, sandy sediments allow oxygen to penetrate easily, leading to low carbon retention, whereas fine, mud-rich sediments limit oxygen exposure and therefore store much higher levels of carbon (Alonso *et al.*, 2012; Burrows *et al.*, 2024). Hotspots of organic carbon have been identified for Scottish sediments within fjords and inshore estuaries and coastal muds (Smeaton *et al.*, 2021c). The mud held within fjords has estimated organic carbon densities of 2.44 ± 1.26 kg/m² (Smeaton *et al.*, 2021c). Coastal sediments also store much higher levels of carbon than equivalent habitats in the subtidal. For example, intertidal sand has been shown to store approximately 6,500 g/m² \pm 4,000 of carbon whereas subtidal sand has been recorded to store approximately 1,700 g/m² \pm 100 of carbon (Parker *et al.*, 2021; Swaile *et al.*, 2022).



- 5.3.6 The study by Smeaton *et al.* (2021a; 2021b) used historical British Geological Survey (BGS) sediment cores to estimate both the organic carbon and inorganic carbon content of sediment in the top 10 cm of the seabed for the whole of the UK EEZ. Figure 5.2 demonstrates the surficial sediment found within the Aspen Array Area and OTC Corridor using Smeaton *et al.* (2021a;2021b) data. The highest TOC content was 0.77 % in the OTC Corridor, and 0.51 % in the Aspen Array Area, both on the higher end of organic carbon values but in line with studies described above.
- 5.3.7 Smeaton *et al.* (2020) provides data to compare estimated carbon stores based on sediment type. Those relevant to the sediment types identified in the study area have been provided in Table 5.1, extracted from Burrows *et al.* (2024). It is noted that this is undertaken across the entire Scotland’s EEZ using the carbon store quantification calculations as defined by Smeaton *et al.* (2020).

Table 5.1 Continental Shelf Mean Sedimentary Organic Carbon (%), Organic Stores (Mt) and OC Density for the Scottish Continental Shelf Derived (source: Smeaton *et al.*, 2020; Burrows *et al.*, 2024)

Substrate Type	Organic Carbon (%)	Organic Carbon Store (Mt)	Organic Carbon Density (tonnes ha ⁻¹)	Organic Carbon Density (kg / m ²)
BGS Seabed Substrate 250k				
Muddy Sand	0.54	31.0	7.1	0.71
EMODnet 5 Folk				
Mud to Muddy Sand	0.67	38.5	6.8	0.68

- 5.3.8 Cunningham and Hunt (2023) also identified the total storage and sequestration capacity values for blue carbon habitats. Sediment¹ in Scotland identified as having 1,308.4 x 10⁶ t CO₂-eq total store (i.e. storage), based on top 10 cm of sediments within the Scottish EEZ; only the organic component (14%) is potentially susceptible to remineralisation to CO₂. In addition, sediment was identified to have a sequestration capacity of 308,280 t CO₂-eq yr⁻¹, based on the burial rate of Sottish fjords, ~84,000 t C yr⁻¹ (Smeaton *et al.*, 2021c).

¹ It is noted that Cunningham and Hunt (2023) do not differentiate between fjord sediment, marine sediment or seabed sediment as they chose not to include a large area of shelf seabed sediments due to limited constraining data, and so estimates given are acknowledged as being lower than the reality of all seabed sediment capability.

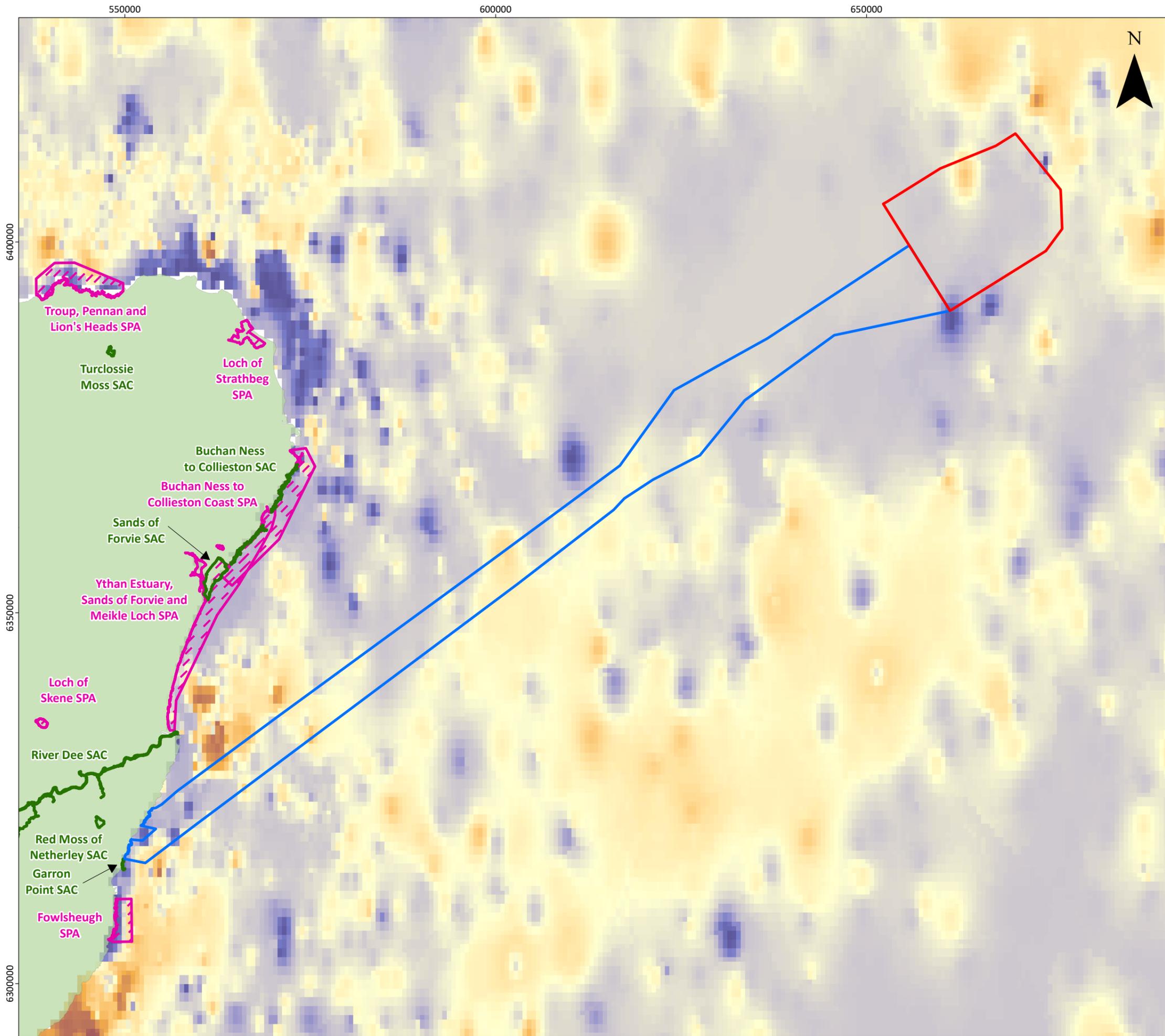


5.3.9 Other studies have used multibeam echosounder (MBES) data to predict the distribution of organic carbon in surface sediments (top 10 cm). The sediments found within the Aspen Array Area and OTC Corridor were identified as mainly muddy sand, with negligible gravel. Hunt *et al.* (2020) found in their study that sediments with small fractions of sand and gravel hold more organic carbon than homogenous fine sediments. In addition, Smeaton *et al.* (2021a) describes that for continental shelf sediments, those highest in sand or gravel content generally have the lowest organic carbon content, meanwhile those with higher amounts of mud, have the highest organic carbon content. This indicates that the study area of the Proposed Development has relatively high levels of organic carbon in the top 10 cm as supported by evidence described above.

5.4 Data Limitations and Assumptions

- 5.4.1 This assessment has been conducted using the best available evidence of blue carbon habitats in Scotland, with many knowledge gaps in potential effects on blue carbon, such as offshore wind farm (OWF) effects on marine primary production (Daewel *et al.*, 2022), as well as blue carbon potential of habitats (Cunningham and Hunt, 2023). Additional information on knowledge gaps can be found in Section 7.
- 5.4.2 Relevant calculations for this assessment are based on best estimates from site-specific data and literature. Due to data limitation this is only for surficial sediment (i.e. the top 10 cm). However, this data assumes that 100% of the organic carbon disturbed will be lost and result in CO₂e being released into the atmosphere (NatureScot, 2025). This over estimation will also factor in some of the deeper sedimentary organic carbon that has not been able to be assessed individually.
- 5.4.3 Anthropogenic pathways for carbon to reach the marine environment such as plastic (C_{plas}) have not been able to be determined. It is assumed that the quantity of C_{plas} currently being deposited on the seabed is likely to exceed the rate at which organic carbon is buried in some marine sediments annually (Smeaton, 2021). This should be included within future assessments if additional information is made available.





Aspen Offshore Wind Farm
Additional Information

Surficial Sedimentary Carbon: Spatial Mapping of the Organic Carbon in the Top 10 cm of Sediments in Relation to the Proposed Development (Smeaton et al., 2021a)

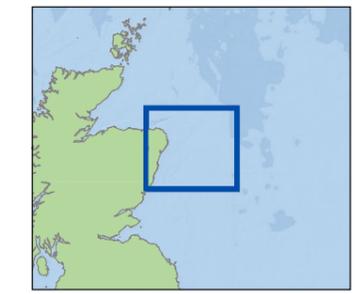
Legend

- Aspen Array Area
- Offshore Transmission Cable Corridor
- Special Area of Conservation (SAC)
- Special Protection Area (SPA)

Organic Blue Carbon (Marine Scotland, 2021)

Value
 High : 0.630462
 Low : 0.000835711

Notes
 Esri, Garmin, GEBCO, NOAA NGDC, and other contributors Contains Ordnance Survey data © Crown copyright and database rights (2024). OS OpenData.



Coordinate System: WGS 1984 UTM Zone 30N
 0 10 20 km
 0 10 20 nm

Scale 1:500,000 @A3 Date 25/02/2026 Drawn by EV Checked by BPHB Approved by KG

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Figure 5.2

Figure Reference: ASPEN_BCA_Fig5.2_OrganicCarbon_v1

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6 Assessment Methodology

- 6.1.1 At present, there is no formal or statutory guidance that prescribes a standardised methodology for undertaking blue carbon assessments, including within the context of major marine developments requiring Section 36 consent and associated marine licences (generation and transmission assets), such as the Proposed Development.
- 6.1.2 This methodology reflects emerging best practice in the UK and aligns with the expectations of consultees including Marine Scotland and NatureScot (NatureScot, 2025).

6.2 Guidance

- 6.2.1 The role of blue carbon habitats as significant global carbon stores is now becoming more widely acknowledged, however their ecological importance and contribution to marine biodiversity are already well established within the scientific evidence base.
- 6.2.2 Blue carbon habitats are not currently included in the UK greenhouse gas (GHG) inventory and are not formally accounted for in reporting on progress to net zero (Scottish Government, 2025). The International Panel on Climate Change (IPCC) has developed guidance that provides the framework for the inclusion of saltmarsh and seagrass in national inventories (Hiraishi *et al.*, 2014). There is currently no IPCC guidance for the inclusion of kelp and other seaweeds, or seafloor sediments into national greenhouse gas inventories, and understanding of the potential role of seabed sediments as a blue carbon habitat is still at a relatively early stage, and managing seabed carbon has only recently emerged as an important driver for policy (Scottish Government, 2025).
- 6.2.3 As there is no specific guidance document for this assessment, the data sets and literature shown in Table 6.1 have been used to inform the blue carbon assessment, including those advised by NatureScot (2025).



Table 6.1 Summary of Key Guidance Documents and Data Sets

Title	Reference
Data sets	
The United Kingdom’s Blue Carbon Inventory: Assessment of Marine Carbon Storage and Sequestration Potential in Scotland (Including Within Marine Protected Areas).	Burrows <i>et al.</i> , 2024
Sediment type and surficial sedimentary carbon stores across the United Kingdom’s Exclusive Economic Zone and the territorial waters of the Isle of Man and the Channel Islands.	Smeaton <i>et al.</i> , 2021a
Organic carbon densities and accumulation rates in surface sediments of the North Sea and Skagerrak	Diesing <i>et al.</i> , 2021
Marine Sedimentary Carbon Stores of the United Kingdom’s Exclusive Economic Zone	Smeaton <i>et al.</i> , 2021b
Re-evaluating Scotland’s sedimentary carbon stores. (2nd edition)	Smeaton <i>et al.</i> , 2020
Quantifying Marine Sedimentary Carbon: A New Spatial Analysis Approach Using Seafloor Acoustics, Imagery, and Ground-Truthing Data in Scotland	Hunt <i>et al.</i> , 2020
Guidance	
Scottish blue carbon action plan	Scottish Government, 2025
The global impact of offshore wind farms on ecosystem services	Watson <i>et al.</i> , 2024
Scottish Blue Carbon - a literature review of the current evidence for Scotland’s blue carbon habitats.	Cunningham and Hunt, 2023
Clarifying the role of inorganic carbon in blue carbon policy and practice.	Turrell <i>et al.</i> , 2023
Offshore wind farms are projected to impact primary production and bottom water deoxygenation in the North Sea.	Daewel <i>et al.</i> , 2022
Prioritizing the management of sedimentary organic matter across continental shelf seas.	Smeaton and Austin, 2022

6.3 Scope of Assessment

- 6.3.1 Based on the science described in Section 4, inorganic carbon is considered outside the scope of this blue carbon assessment. Inorganic carbon does not remain stored for long enough to contribute to climate change mitigation, and it is not converted to CO₂ when disturbed, therefore it is considered irrelevant to the assessment of LSEs resulting from potential emissions caused by impacts on blue carbon stores by the Proposed Development.
- 6.3.2 When sediment is disturbed only the organic carbon fraction is susceptible to remineralisation and subsequent conversion to CO₂. As this component of the sedimentary carbon stores has relevance to greenhouse gas (GHG) emissions, it has the potential to contribute to climate change, and therefore is considered within scope of this assessment.



6.4 Criteria for Assessment

- 6.4.1 This assessment has been undertaken to assess the likely significant effects of the Proposed Development on blue carbon habitats and sediments, including direct blue carbon habitat loss/disturbance as a result of the Proposed Development; and direct blue carbon stores loss through potential CO₂ emissions from disturbed sediments. The process for determining the significance of effects is a two-stage process that involves 1) defining the magnitude of potential impacts and 2) the sensitivity of receptors.
- 6.4.2 The criteria for the blue carbon assessment builds upon the methodology and results presented in **Volume 2, Chapter 9: Benthic Subtidal and Intertidal Ecology** of the Offshore EIA, but focuses specifically on the potential impacts of the Proposed Development on blue carbon habitats. The assessment was informed by data in the Marine Life Information Network (MarLIN) database Marine Evidence based Sensitivity Assessment (MarESA) scale to account for resistance and recoverability to stressors. The terms used to define impact magnitude and receptor sensitivity are based on those described in further detail in **Volume 1, Chapter 4: Environmental Impact Assessment Methodology** of the Offshore EIA.
- 6.4.3 The assessment also identifies and, where possible, quantifies the organic carbon stock that may be lost or disturbed as a result of the Proposed Development. The calculations used to assess potential carbon release from disturbed sediments have been undertaken using a combination of publicly available data and scientific literature, mainly Smeaton *et al.* (2021a; 2021b).
- 6.4.4 For sediment carbon content calculations, organic carbon content data was extracted from Smeaton *et al.* (2021a) and overlain with the location of the total area of disturbance within the Proposed Development blue carbon study area. This calculation is for surficial sediment (i.e., the top 10 cm) due to data limitations as described in Section 4.1.5.
- 6.4.5 The calculation steps are described below:
- Step 1: Define the total area of disturbance associated with the Proposed Development, including all relevant activities and associated impact pathways as per the worst-case scenario (excluding double counting²).
 - Step 2: Calculate organic carbon storage within the potential area of disturbance.

$$\text{Carbon store (kg C)} = \text{total area of disturbance (m}^2\text{)} \times \text{carbon density (kg/m}^2\text{)}$$

- Step 3: Calculate potential loss of organic carbon from the area of disturbance into CO₂ emissions (in carbon dioxide equivalent).

$$\text{Carbon dioxide equivalent (t CO}_2\text{e)} = \text{Carbon store} \times \text{carbon conversion factor (3.67)}^3$$

² Double counting refers to when a single greenhouse gas (GHG) emission reduction, removal, or offset is counted more than once in calculations. For this assessment, it has assumed the same area which lost the ability to store blue carbon due to construction activities can no longer store blue carbon after decommissioning.

³ This is the conversion factor used to convert carbon to CO₂. It follows IPCC (2006) Guidelines: <https://www.ipcc-nggip.iges.or.jp/public/2006gl/>



Magnitude

6.4.6 The magnitude criteria for blue carbon habitats are provided in Table 6.2. In determining magnitude, each assessment considered the spatial extent, duration, frequency, and reversibility / severity of impact and these are outlined within the magnitude section of each assessment of impact (e.g., a duration of hours or days would be considered for most receptors to be of short-term duration, which is likely to result in a low magnitude of impact).

Table 6.2 Impact Magnitude Criteria for Blue Carbon Habitats

Magnitude Value	Description
Negligible	Discernible, temporary change, or barely discernible change for any length of time, over a small area of the receptor, and/or slight alteration to key characteristics or features of the particular receptors character or distinctiveness (e.g. loss of resource and/or quality of the resource).
Low	Discernible, temporary change, over a minority of the receptor, and/or limited but discernible alteration to key characteristics or features of the particular receptors character or distinctiveness (e.g. loss of resource and/or quality of the resource).
Medium	Considerable, permanent/irreversible changes, over the majority of the receptor, with a short- to medium-term change to baseline conditions, and/or discernible alteration to key characteristics or features (of the particular receptors character or distinctiveness (e.g. loss of resource and/or quality of the resource).
High	Fundamental, permanent/irreversible changes, over the whole receptor resulting in widespread, long-term, or permanent changes in baseline conditions, and/or fundamental alteration to key characteristics or features of the particular receptors character or distinctiveness (e.g. loss of resource and/or quality of the resource).

Sensitivity

6.4.7 The sensitivities of different habitats have been classed as ‘High’, ‘Medium’, ‘Low’ or ‘Negligible’, based on the MarESA four-point scale (Tyler-Walters *et al.*, 2023). The scale of sensitivity for a receptor is dependent on the specific environmental topic and receptor in question and considers the value of a receptor in the context of its resistance and ability to recover from impacts (resilience). Specific benchmarks (duration and intensity) are defined for the different impacts for which sensitivity has been assessed and the definition of resistance and resilience can be found on the MarLIN website⁴. Sensitivity also includes for this assessment the carbon stock or sequestration rate potential of that receptor.

6.4.8 For the purposes of this assessment, four sensitivity categories have been defined, each drawing on the four MarLIN MarESA categories and the importance of the receptor. Sensitivity/importance of the environment is defined in Table 6.3.

⁴ <https://www.marlin.ac.uk/>



Table 6.3 Receptor Sensitivity Criteria for Blue Carbon Habitats

Sensitivity Value	Description
Negligible	Equivalent to MarLIN MarESA sensitivity category ‘Not Sensitive’, whereby: <ul style="list-style-type: none"> The habitat is noted as exhibiting ‘High’ resistance (tolerance) to an external factor, whether physical or chemical changes or influences and is expected to recover over short timescales, i.e., <2 years (resilience is ‘High’). The receptor has a negligible carbon stock or sequestration rates as per Burrows <i>et al.</i> (2024).
Low	Equivalent to MarLIN MarESA sensitivity category ‘Low’, whereby: <ul style="list-style-type: none"> The habitat is noted as exhibiting ‘Low’ or ‘Medium’ resistance (tolerance) to an external factor, whether physical or chemical changes or influences, and is expected to recover over < 2 years (resilience is ‘High’). The receptor has a low carbon stock or sequestration rates as per Burrows <i>et al.</i> (2024); or The habitat is noted as exhibiting ‘High’ resistance (tolerance) to an external factor, whether that arises from physical or chemical changes or influences, and is expected to recover over medium to very long timescales, i.e. >2 years or up to 25 years or not at all (resilience is ‘Medium’, ‘Low’ or ‘Very Low’). The receptor has a low carbon stock or sequestration rates as per Burrows <i>et al.</i> (2024).
Medium	Equivalent to MarLIN MarESA sensitivity category ‘Medium’, whereby: <ul style="list-style-type: none"> The habitat is noted as exhibiting ‘None’ or ‘Low’ resistance (tolerance) to an external factor, whether physical or chemical changes or influences, and is expected to recover over medium timescales, i.e., >2 or up to ten years (resilience is ‘Medium’). The receptor has a moderate carbon stock or sequestration rates as per Burrows <i>et al.</i> (2024); or The habitat is noted as exhibiting ‘None’ resistance (tolerance) to an external factor, whether that arises from natural events or human activities, and is expected to recover over <2 years (resilience is ‘High’). The receptor has a moderate carbon stock or sequestration rates as per Burrows <i>et al.</i> (2024); or The habitat is noted as exhibiting ‘Medium’ resistance (tolerance) to an external factor, whether that arises from natural events or human activities, and is expected to recover over medium to very long timescales, i.e., >2 years or up to 25 years or not at all (resilience is ‘Medium’, ‘Low’ or ‘Very Low’) The receptor has a moderate carbon stock or sequestration rates as per Burrows <i>et al.</i> (2024).
High	Equivalent to MarLIN MarESA sensitivity category ‘High’, whereby: <ul style="list-style-type: none"> The habitat is noted as exhibiting ‘None’ or ‘Low’ resistance (tolerance) to an external factor, whether that arises from natural events or human activities, and is expected to recover only over very extended timescales i.e., >25 years or not at all (resilience is ‘Very Low’) The receptor has a high carbon stock or sequestration rates as per Burrows <i>et al.</i> (2024); or The habitat is noted as exhibiting ‘None’ or ‘Low’ resistance (tolerance) to an external factor, whether that arises from natural events or human activities, and is expected to recover only over very extended timescales i.e., >10 or up to 25 years (resilience is ‘Low’). The receptor has a high carbon stock or sequestration rates as per Burrows <i>et al.</i> (2024).



Significance

6.4.9 By assigning and combining magnitude and sensitivity criteria, overall effect significance upon blue carbon habitats can be determined. A level of effect of moderate or more will be considered a 'significant' effect for the purpose of the EIA Regulations. A level of effect of minor or less will be considered 'not significant'.

Table 6.4 Matrix Used for Assessment of the Significance of the Effect

		Magnitude of Impact			
		Negligible	Low	Medium	High
Sensitivity of Receptor	Negligible	Negligible	Negligible	Negligible	Negligible
	Low	Negligible	Minor	Minor	Minor
	Medium	Negligible	Minor	Moderate	Moderate
	High	Minor	Minor	Moderate	Major



7 Impact Pathways

7.1 Evidence of Impacts and Evidence Gaps

- 7.1.1 Evidence of how marine developments affect carbon sequestration and storage remains limited (Watson *et al.*, 2024). Recent research, including the study by Cunningham and Hunt (2023), highlights the need to better understand the fate of carbon within blue carbon habitats, particularly in relation to anthropogenic pressures such as bottom-contact fishing, coastal development, and offshore infrastructure.
- 7.1.2 Some research has looked at the impact of OWFs to primary production, sedimentation and seabed processes. Changes in physical processes resulting from the presence of the subsea infrastructure associated with OWFs (e.g., scour effects, changes in wave/tidal current regimes and resulting effects on sediment transport) have been found to impact carbon stores (van der Molen *et al.*, 2014; Daewel *et al.*, 2022). Model projections from Daewel *et al.* (2022) showed the wind wake effect of OWFs caused changes in annual primary productivity of up to 10% locally to the OWF, and increased sedimentation in the southern North Sea region, linked to reduced current velocities from existing OWFs.
- 7.1.3 Other available evidence indicates that, once operational, OWFs can drive substantial increases in the flux of nutrients, organic matter, and carbon both within and beyond turbine arrays. Ivanov *et al.* (2021) reported that total organic carbon flux to the seabed may rise by up to 50% within approximately 5 km of turbine structures, with detectable effects extending as far as 30 km from the development (Watson *et al.*, 2024). However, the extent to which this enhanced deposition translates into long-term carbon storage remains highly uncertain. Sedimentary carbon retention is likely to be temporary if the seabed is subsequently disturbed resulting in the re-mobilisation of stored carbon into the water column through activities such as bottom-contact fishing or during decommissioning of turbine infrastructure (Watson *et al.*, 2024).
- 7.1.4 Alongside the evidence gaps relating to impacts from OWFs, there are also several evidence gaps regarding the fate of organic carbon in sediments when it is disturbed. For example, some will be oxidised (lost) in the water column; some will resettle and could potentially become reburied; and some may be transported laterally to a new area of seabed while the sediment is within the water column. The impact that the Proposed Development may have on blue carbon stores will be influenced by external factors such as, but not limited to:
- Sediment type - e.g., sediments highest in sand or gravel content generally have the lowest organic carbon content, meanwhile those with higher amounts of mud, have the highest organic carbon content;
 - Sedimentation and accumulation rates for the area - if these are low, then the impact is greater because recovery will take longer;
 - Organic carbon density and reactivity - how quickly microbes can break down the carbon;
 - Benthic activity on the sediment - burrowing species can mix and oxygenate sediments, influencing carbon burial, and high bioturbation can enhance carbon breakdown, reducing long-term storage;



- Currents - strong currents can resuspend sediments, exposing buried carbon to oxygen and accelerating decomposition;
- Temperature - warmer temperatures increase microbial activity, speeding up carbon degradation; and
- Oxygenation - low-oxygen (hypoxic or anoxic) conditions slow decomposition, allowing carbon to accumulate and be preserved, whereas oxygen-rich sediments promote aerobic decomposition, releasing CO₂.

7.2 Impacts Scoped into the Assessment

- 7.2.1 Where sediment is disturbed by the Proposed Development, it is only the organic carbon fraction that has the potential to be remineralised and converted to CO₂, potentially contributing to climate change. This approach and the following impact pathways are consistent with the NatureScot (2025) recommendations.
- 7.2.2 The principal threat to long-term carbon storage associated with the Proposed Development will be those that disturb the top layers of sediment. Pathways of effect relevant to the blue carbon assessment will therefore include activities causing a direct disturbance to the top layers of marine sediment, similar to those as described in **Volume 2, Chapter 9: Benthic Subtidal and Intertidal Ecology** of the Offshore EIAR.
- 7.2.3 However, activities that disturb sediment below surface (sub-surface) will also have an impact on the long-term carbon stores as shown in Figure 4.1. Disturbance to deeper sediments can disturb long-term buried carbon by potentially introducing oxygen into anoxic layers, which could stimulate remineralisation and a potential turnover of otherwise stable organic carbon (Macreadie *et al.*, 2019).
- 7.2.4 The greatest impact of disturbance to both the surface and sub-surface layers is likely to be during construction, including seabed preparation and cable installation activities. Other activities that will cause temporary disturbance include the installation of Offshore Substation Platform (OSP) foundations, installation of cable protection (where required), anchoring operations for WTGs, Jack Up Vessels (JUV) and installation of OTCs through the intertidal area using trenchless technology such as Horizontal Directional Drilling (HDD).
- 7.2.5 Operational impacts will include scour effects from mooring lines and dynamic IAC movements. Maintenance activities also have the potential to cause temporary disturbance to the seabed which may release carbon. This includes JUV operations, potential repairs to IACs, Inter-link Cables and OTC failures.



- 7.2.6 Other activities included as having a pathway of effect to blue carbon stores include displacement from commercial fisheries operations, more specifically bottom trawling (Martin *et al.*, 2022; Cunningham and Hunt, 2023; Donald *et al.*, 2025). On average bottom trawling can penetrate between 2.4 and 16.1 cm into the seabed, and repeated trawling over the same area can deplete organic carbon pools stored in marine sediments (Howard *et al.*, 2023). However, reducing fishing ground as a result of the presence of the OWF, likely causes the displacement of bottom trawling operations, resulting in sediment and associated carbon accumulation from a development (Daewel *et al.*, 2022; Watson *et al.*, 2024). These changes have therefore been included as relevant impact pathways for carbon stores.
- 7.2.7 Lastly, impacts associated with smothering have also been identified as a pathway of effect. Surrounding kelp beds within the benthic intertidal study area may be disturbed by construction activities (e.g. changes to SSCs) and may experience smothering as an impact (as described in **Volume 2: Chapter 9: Benthic Subtidal and Intertidal Ecology** of the Offshore EIAR). Smothering may reduce the capacity of kelp to photosynthesise, and reduce its capacity to sequester carbon. It may also cause plants to die off, converting the kelp's blue carbon back into CO₂.
- 7.2.8 The follows impacts have been included in the assessment across the lifecycle of the Proposed Development:
- Construction phase
 - Impact 1: Temporary Increases in SSC and Sediment Deposition;
 - Impact 2: Temporary Habitat Disturbance;
 - Impact 3: Reduction in access to, or exclusion from established fishing grounds from within the Aspen Array Area; and
 - Impact 4: Reduction in access to, or exclusion from established fishing grounds from within the OTC Corridor.
 - O&M
 - Impact 5: Temporary Habitat Disturbance (it is noted that 'temporary' in this context relates to the relatively short lived disturbance as a result of discrete O&M activities as opposed to the long-term operational phase of the Proposed Development; see Impact 6);
 - Impact 6: Permanent and/or Long-term Habitat Loss/Alteration due to the Addition of Infrastructure to the Area;
 - Impact 7: Changes in Physical Processes Resulting from the Presence of the Subsea Infrastructure (e.g., Scour Effects, Changes in Wave/Tidal Current Regimes and Resulting Effects on Sediment Transport);
 - Impact 8: Reduction in access to, or exclusion from established fishing grounds from within the Aspen Array Area; and
 - Impact 9: Reduction in access to, or exclusion from established fishing grounds from within the OTC Corridor.



- Decommissioning
 - Impact 10: Temporary Increases in SSC and Sediment Deposition;
 - Impact 11: Temporary Habitat Disturbance;
 - Impact 12: Permanent and/or Long-term Habitat Loss/Alteration due to the Removal of Infrastructure;
 - Impact 13: Reduction in access to, or exclusion from established fishing grounds from within the Aspen Array Area; and
 - Impact 14: Reduction in access to, or exclusion from established fishing grounds from within the OTC Corridor.

7.3 Worst-case Design Scenario

- 7.3.1 The Applicant has applied a design envelope approach to the impact assessment (commonly referred to as the “Rochdale Envelope”). In line with MD-LOT and NatureScot guidance (NatureScot, 2025), this approach allows flexibility within the EIAR by assessing potential likely significant effects across a range of plausible design options rather than a single fixed layout.
- 7.3.2 The impacts on blue carbon habitats have been assessed using the information presented in **Volume 1, Chapter 3: Project Description, Volume 2: Chapter 9: Benthic Subtidal and Intertidal Ecology, Volume 2, Chapter 7, Marine and Coastal Processes, and Volume 2, Chapter 13: Commercial Fisheries** of the Offshore EIAR. For each impact, a worst-case design scenario has been identified from within the assessed range of parameters, representing the option most likely to result in the greatest adverse effect on blue carbon habitats, potential to disturb sediment and release CO₂. It is not anticipated that any alternative development scenario, based on the design parameters described in **Volume 1, Chapter 3: Project Description** of the Offshore EIAR (e.g. variations in infrastructure layout) would result in effects of greater adverse significance.
- 7.3.3 Table 7.1 summarises the worst-case design scenario identified for each impact relevant to the assessment of blue carbon stores, together with the associated justification.



Table 7.1 Worst-case Design Scenarios with Respect to the Blue Carbon Assessment

Impact	Embedded Commitment	Worst-case Design Scenario	Justification
Construction			
Impact 1: Temporary increases in SSC and sediment deposition	C-OFF-04, C-OFF-07, C-OFF-39	As described in Volume 2, Chapter 9: Benthic Subtidal and Intertidal Ecology of the Offshore EIAR. <u>Total SSC Released During Construction = 11,040,639 m³</u>	The installation of OTCs using trenchless technology, such as HDD, is expected to have localised and short-term impacts on SSC concentrations due to the potential release of bentonite (or drilling mud) during the punch-out in the nearshore exit pit. A specific landfall site has not yet been confirmed. However, the worst case design scenario may impact intertidal habitats including kelp beds. Seabed Preparation for Cable Installation, Foundation Drilling Cable are covered in Impact 2.
Impact 2: Temporary habitat disturbance	C-OFF-03, C-OFF-04, M-OFF-07	<u>Total Area of Temporary Habitat Disturbance From Construction Activities = 23,944,200 m²</u> Foundation Seabed Preparation Area = 92,170 m² OSPs = 54,000m² <ul style="list-style-type: none"> ▪ Seabed preparation method = boulder clearance grabs and UXO; ▪ Maximum number of OSPs = 3 ▪ Maximum sediment disturbance area per OSP = 18,000 m² ▪ Total maximum sediment disturbance area = 18,000 m² x 3 (no. OSPs) = 54,000 m² 	Temporary habitat disturbance relates to the maximum total area of habitat disturbance during the construction phase. The footprint of infrastructure is assessed as a temporary impact in construction, and as a permanent impact in O&M. The worst-case design scenario presents a precautionary approach to temporary habitat disturbance because it counts both the total footprint of seabed clearance as well as cable burial across both the Aspen Array Area and OTC Corridor. This approach counts the footprint of seabed habitat to be



Impact	Embedded Commitment	Worst-case Design Scenario	Justification
		<p>WTG anchoring = 38,170.44 m²</p> <ul style="list-style-type: none"> ▪ Installation method = suction anchor ▪ Maximum number of WTGs = 72 ▪ Maximum number of anchors per WTG (averaged) = 3 ▪ Maximum number of anchors for 72 WTG = 216 ▪ Anchor diameter = 15 m ▪ Suction Anchor depth = approx. 40 m ▪ Area disturbed per anchor = $\pi \times (7.5 \text{ m (radius)}^2) = 176.7 \text{ m}^2$ ▪ Maximum seabed disturbance = $176.52 \text{ m}^2 \text{ (area)} \times 216 \text{ (max. no. anchors per WTG)} = 38,170 \text{ m}^2$ <p>Jack-Up Vessels (JUV) and Anchoring Operations = 20,430 m²</p> <ul style="list-style-type: none"> ▪ Maximum number of OSPs = 3 ▪ Anchor deployment area of disturbance for installation of OSP jacket foundations = $52,500 \text{ m}^2$ ▪ Anchor deployment area of disturbance for installation of OSP topside = $52,500 \text{ m}^2$ ▪ OSP JUV footprint per leg = 227 m^2 ▪ OSP JUV footprint for six legs per JUV per operation = $1,362 \text{ m}^2$ ▪ Jack-up operations per OSP = 5 ▪ Area disturbed for 3 OSPs = $5 \text{ (Jack-up operations per OSP)} \times 3 \text{ (max. no. OSPs)} \times 1,362 \text{ m}^2 \text{ (footprint per six legs, per operation)} = 20,430 \text{ m}^3$ <p>Cable Seabed Preparation and Installation = 23,830,000 m²</p> <ul style="list-style-type: none"> ▪ Burial of IACs by plough ($264,000 \text{ m} \times 20 \text{ m}$ disturbance width) = $5,280,000 \text{ m}^2$ 	<p>impacted by construction in the same area twice. However, this precautionary approach has been taken because there is some potential for recovery of habitats between the activities due to Project timescales. As the activities will take place within the Study Area, they will disturb identified blue carbon habitats.</p>



Impact	Embedded Commitment	Worst-case Design Scenario	Justification
		<ul style="list-style-type: none"> ▪ Burial of OTC by plough (620,000 m length x 20 m disturbance width) = 12,400,000 m² ▪ Maximum Target Cable Burial Depth for IACs and Inter-link cables = 2 m ▪ Maximum Target Cable Burial Depth for OTC = 3 m ▪ Seabed preparation (boulder clearance, PLGR) for IACs/Interlinks (= 20 m width x 25% length cables)= 1,500,000 m² ▪ Seabed preparation (sandwave clearance, boulder clearance, PLGR) for OTC (= 30 m width x 25% length cables) = 4,650,000 m² ▪ Total = 22,580,000 m² <p>HDD Installation = 1,600 m²</p> <ul style="list-style-type: none"> ▪ Max. no. offshore HDD exit pits = 4 ▪ Length = 20 m ▪ Width = 20 m ▪ Total area evacuated = 400 m² ▪ Total installation area per exit pit = 20 m (length) x 20 m (width) = 400 m² ▪ Total area = 4 (no. exit pits) x 400 m² (area) = 1,600 m² 	
Impact 3: Reduction in access to, or exclusion from established fishing grounds from within the Aspen Array Area	<u>C-OFF-04; C-OFF-05;</u> <u>C-OFF-09; C-OFF-10;</u> <u>C-OFF-13; C-OFF-14;</u> <u>C-OFF-17; C-OFF-20;</u> <u>C-OFF-24; C-OFF-29;</u> <u>C-OFF-30; C-OFF-46;</u> <u>C-OFF-39; C-OFF-42;</u> <u>C-OFF-52; C-OFF-55.</u>	As described in Volume 2, Chapter 13: Commercial Fisheries of the Offshore EIAR. <u>500 m safety zones</u>	The design scenario represents the maximum duration and extent of fishing exclusion throughout the construction phase. It is assumed that fishing is not prohibited from resumption but is unlikely to resume within the Aspen Array Area due to the presence of mooring lines within the water



Impact	Embedded Commitment	Worst-case Design Scenario	Justification
			<p>column, anchors and floating foundations deployed throughout the construction phase making access not practically feasible.</p> <p>Sediment and associated carbon accumulation may occur in the Study Area due to displacement, affecting sequestration within the study area (Daewel <i>et al.</i>, 2022; Watson <i>et al.</i>, 2024).</p>
<p>Impact 4: Reduction in access to, or exclusion from established fishing grounds from within the OTC Corridor</p>	<p><u>C-OFF-04; C-OFF-05; C-OFF-09; C-OFF-10; C-OFF-13; C-OFF-14; C-OFF-17; C-OFF-20; C-OFF-24; C-OFF-29; C-OFF-30; C-OFF-46; C-OFF-39; C-OFF-42; C-OFF-52; C-OFF-55.</u></p>	<p>As described in Volume 2, Chapter 13: Commercial Fisheries of the Offshore EIAR.</p> <p><u>500 m safety zones</u></p>	<p>The design scenario represents the maximum duration and extent of fishing exclusion throughout the construction phase.</p> <p>It is assumed that construction activities would not occur across the entirety of the OTC Corridor at any one time (i.e., exclusion relates to the rolling safety zones). It is assumed that fishing is not prohibited from resumption in areas where construction has not yet commenced or is completed.</p> <p>Sediment and associated carbon accumulation may occur in the Study Area due to displacement, affecting sequestration within the study area (Daewel <i>et al.</i>, 2022; Watson <i>et al.</i>, 2024).</p>



Impact	Embedded Commitment	Worst-case Design Scenario	Justification
Operation and Maintenance (O&M)			
Impact 5: Temporary habitat disturbance	C-OFF-04, C-OFF-10, C-OFF-43	<p><u>Total Temporary Habitat Disturbance From O&M Activities = 1,939,000 m²</u></p> <p>WTGs and OSPs = 294,000 m²</p> <ul style="list-style-type: none"> ▪ No. legs per JUV = 4 ▪ OSP JUV footprint per leg = 350 m² ▪ JUV footprint = 1,400 m² ▪ JUV trips per year = 6 ▪ Total JUV trips across 35-year project lifetime = 210 ▪ Total seabed disturbance = 1,400 m² (JUV footprint) x 210 (total JUV trips) = 294,000 m² <p>IACs and Inter-link Cables = 245,000 m²</p> <ul style="list-style-type: none"> ▪ Maximum IAC failures throughout 35-year project lifetime = 7 ▪ Each repair may disturb up to 7,000 m (length) x 5 m (width) = 35,000 m² ▪ Total seabed disturbance from IAC repairs = 7 (max. no. failures) x 35,000 m²(disturbance area) = 245,000 m² ▪ OTCs = 1,400,000 m² ▪ Maximum number of OTCs = 4 ▪ Maximum repair per OTC every five years = 1 ▪ Maximum repairs per cable throughout 35-year project lifetime = 7 ▪ Maximum repairs for 4 OTCs throughout 35-year project lifetime = 28 ▪ Each repair disturbs an estimated 1,000 m x 50 m = 50,000 m² ▪ Total seabed disturbance from OTC repair = 1,400,000 m² 	<p>The worst-case design scenario is defined by the maximum area of habitat disturbance arising from maintenance activities during the approximately 35-year O&M phase. The worst-case design scenario is defined by the maximum number of jack-up and anchoring operations and the total cable replacement and repairs through maintenance activities that could have an interaction with the seabed during operation. As the activities will take place within the Study Area, they will disturb identified blue carbon habitats.</p>



Impact	Embedded Commitment	Worst-case Design Scenario	Justification
Impact 6: Permanent and/or long-term habitat loss/alteration due to the addition of infrastructure to the area	C-OFF-04, C-OFF-10, C-OFF-43	<p><u>Maximum Area of Permanent and/or Long-term Habitat Loss/Alteration = 1,364,653 m²</u></p> <p>WTG Anchor Footprints, and Scour Protection = 199,553 m²</p> <ul style="list-style-type: none"> ▪ Maximum number of WTGs = 72 ▪ Maximum number of anchors per WTG (averaged) = 4.5 ▪ Maximum number of anchors for 72 WTG = 324 ▪ Anchor length = 50 m ▪ Anchor diameter = 4.5 m ▪ Anchor radius = 2.25 m ▪ Area disturbed per anchor = $\pi \times (2.25 \text{ m (radius)}^2) = 15.90 \text{ m}^2$ ▪ Maximum seabed disturbance = 15.90 m^2 (anchor footprint) x 324 (max. no anchors) = 5,153 m² ▪ Maximum area of scour protection per anchor = 600 m² ▪ Total area of scour protection for 72 WTGs = 194,000 m² <p>Mooring Line Movement (strimming effect) = 432,000 m²</p> <ul style="list-style-type: none"> ▪ Maximum mooring lines per WTG = 6 ▪ Maximum mooring lines for 72 WTG = 432 ▪ Maximum contact of each line with seabed = 1,000 m of line ▪ Maximum width of corridor for potential seabed disturbance = 1 m ▪ Total potential seabed disturbance area = 432 (no. mooring lines) x 1,000 m (line in contact with seabed) x 1 m (disturbance corridor) = 432,000 m² <p>OSP Foundation and Protection Footprint = 23,100 m²</p> <ul style="list-style-type: none"> ▪ OSPs fixed jacket footprint of 60 m (length) x 75 m (width) = 4,500 m² 	<p>The worst-case design scenario is defined by the maximum area of seabed lost by the footprint of WTG anchors on the seabed, OSP foundations, scour and cable protection, and cable crossings. Habitat loss of note here is from drilling and drill arisings as well as presence of infrastructure.</p> <p>There is the potential for the introduction of localised seabed abrasion associated with wind farm infrastructure that moves, for example anchor or mooring chains and dynamic inter-array cables, under the influence of waves, currents, and movement of the turbines ('strimmer effects'). This impact is considered to be permanent over the operational period of the Proposed Development (35 years). As the activities will take place within the Study Area they will disturb identified blue carbon habitats.</p>



Impact	Embedded Commitment	Worst-case Design Scenario	Justification
		<ul style="list-style-type: none"> ▪ Total jacket footprint for all OSPs = 4,500 m² (jacket footprint) x 3 (no. OSPs) = 13,500 m² ▪ Scour protection footprint per OSP = 3,200 m² ▪ Total scour protection footprint for all OSPs = 3,200 m² (scour protection footprint) x 3 (no. OSPs) = 9,600 m² ▪ Total jacket footprint and scour protection footprint for all OSPs = 13,500 m² + 9,600 m² = 23,100 m² <p>IAC and Inter-link Cable Protection Footprint = 225,000 m²</p> <ul style="list-style-type: none"> ▪ Total length of IACs and Inter-link Cables = 300,000 m² ▪ Assumed percentage of the total 300,000 m cable length may be disturbed = 25% ▪ Length of cables which may be disturbed = 25% of 300,000 m² = 75,000 m ▪ Assumed disturbance corridor width = 3 m ▪ Area disturbed = 3 m (corridor width) x 75,000 m (length disturbed) = 225,000 m² <p>OTC Protection Footprint = 465,000 m²</p> <ul style="list-style-type: none"> ▪ Total length of up to four OTCs = 620,000 m ▪ Percentage of total OTC length may be disturbed = 25% ▪ Total length of OTCs which may be disturbed = 25% of 620,000 m = 155,000 m ▪ Width of OTC protection = 3 m ▪ Total area of OTC Protection = 155,000 m (length) x 3 m (width) = 465,000 m² <p>OTC Crossings Footprint = 20,000 m²</p> <ul style="list-style-type: none"> ▪ Maximum number of crossings per OTC = 10 ▪ Crossing length = 100 m 	



Impact	Embedded Commitment	Worst-case Design Scenario	Justification
		<ul style="list-style-type: none"> ▪ Crossing width = 5 m ▪ Crossing area = 100 m (length) x 5 m (width) = 500 m² ▪ Maximum total footprint per OTC = 500 m² (area) x 10 (max. no. crossings) = 5,000 m² ▪ Maximum total footprint for all 4 OTCs = 5,000 m² x 4 = 20,000 m² ▪ Height above seabed = 5 m 	
Impact 7: Changes in physical processes resulting from the presence of the subsea infrastructure (e.g., scour effects, changes in wave/ tidal current regimes and resulting effects on sediment transport)	C-OFF-10	<p>The worst-case design scenario will be identical (or less) to that of Impact 2: Temporary habitat disturbance. The footprint of infrastructure is assessed as a temporary impact in construction, and as a permanent/long-term impact in O&M.</p> <p><u>Total Area of Temporary Habitat Disturbance From Construction Activities = 23,944,200 m²</u></p>	This impact is defined by any anticipated changes to marine and coastal processes as defined in Volume 1, Chapter 7: Marine and Coastal Processes . Sediment and associated carbon accumulation may occur in the Study Area due to changes in physical processes, affecting sequestration within the study area (Daewel <i>et al.</i> , 2022; Watson <i>et al.</i> , 2024).
Impact 8: Reduction in access to, or exclusion from established fishing grounds	<u>C-OFF-22; C-OFF-04; C-OFF-05; C-OFF-09; C-OFF-10; C-OFF-13; C-OFF-14; C-OFF-17; C-OFF-20; C-OFF-24; C-OFF-29; C-OFF-30; C-OFF-46; C-OFF-39;</u>	<p>As described in Volume 2, Chapter 13: Commercial Fisheries of the Offshore EIAR.</p> <p>Maintenance activities</p> <ul style="list-style-type: none"> ▪ 500 m safety zones around major maintenance activities ▪ Up to 11 vessels at any one time supporting maintenance activities across the Proposed Development 	The design scenario represents the maximum duration and extent of fishing exclusion throughout the O&M phase and hence the greatest potential to restrict access to fishing grounds. Commercial fishing is unlikely to resume within the



Impact	Embedded Commitment	Worst-case Design Scenario	Justification
from within the Aspen Array Area	<u>C-OFF-42; C-OFF-52; C-OFF-55.</u>	<ul style="list-style-type: none"> Up to seven IAC failures requiring repair across 35 years 	<p>Aspen Array Area throughout the O&M phase.</p> <p>Sediment and associated carbon accumulation may occur in the Study Area due to displacement, affecting sequestration within the Study Area (Daewel <i>et al.</i>, 2022; Watson <i>et al.</i>, 2024).</p>
Impact 9: Reduction in access to, or exclusion from established fishing grounds from within the OTC Corridor	<u>C-OFF-22; C-OFF-04; C-OFF-05; C-OFF-09; C-OFF-10; C-OFF-13; C-OFF-14; C-OFF-17; C-OFF-20; C-OFF-24; C-OFF-29; C-OFF-30; C-OFF-46; C-OFF-39; C-OFF-42; C-OFF-52; C-OFF-55.</u>	<p>As described for Volume 2, Chapter 13: Commercial Fisheries of the Offshore EIAR.</p> <p>Maintenance activities</p> <ul style="list-style-type: none"> 500 m safety zones around major maintenance activities Up to 11 vessels at any one time supporting maintenance activities across the Proposed Development Up to 28 OTC repairs across 35 years 	<p>The design scenario represents the maximum duration and extent of fishing exclusion throughout the O&M phase and hence the greatest potential to restrict access to fishing grounds. Commercial fishing is unlikely to resume within the Aspen Array Area throughout the O&M phase.</p> <p>Sediment and associated carbon accumulation may occur in the Study Area due to displacement, affecting sequestration within the Study Area (Daewel <i>et al.</i>, 2022; Watson <i>et al.</i>, 2024).</p>
Decommissioning			
Impact 10: Temporary increases in Suspended Sediment Concentration (SSC) and	C-OFF-04, C-OFF-10, C-OFF-39	<p>Cutting of piles associated with the jacket OSP foundations at 1-2 m below seabed level and removal of jacket.</p> <p>Recovery and removal of anchors.</p> <p>Decommissioning of IAC and Inter-link Cables and OTCs:</p> <ul style="list-style-type: none"> IAC and Inter-link Cable length up to 300,000 m; 	<p>The worst-case design scenario assumes complete removal of all infrastructure, including cables and cable protection where it is practicable and appropriate to do so, in accordance with guidance and approach in place at the time of decommissioning. If any infrastructure is left <i>in situ</i> this will</p>



Impact	Embedded Commitment	Worst-case Design Scenario	Justification
sediment deposition		<ul style="list-style-type: none"> OTCs length up to 620,000 m; Decommissioning using jetting; and Recovery and removal of tethers/clump weights. <p>Decommissioning activities lasting approximately three years.</p>	result in reduced levels of suspended sediment and associated deposition during decommissioning.
Impact 11: Temporary habitat disturbance	C-OFF-04, C-OFF-11, C-OFF-43	<p>The worst-case design scenario will be identical (or less) to that of the construction phase (Impact 2: Temporary habitat disturbance).</p> <p>Total Area of Temporary Habitat Disturbance From Construction Activities = 23,944,200 m²</p>	The worst-case design scenario assumes complete removal of all infrastructure, including cables and cable protection where it is practicable and appropriate to do so, in accordance with guidance and approach in place at the time of decommissioning. If any infrastructure is left <i>in situ</i> this will result in reduced levels of suspended sediment and associated deposition during decommissioning.
Impact 12: Permanent and/or long-term habitat loss/alteration due to the removal of infrastructure	C-OFF-10, C-OFF-39	<p>For this assessment, the worst case design scenario will be identical (or less) to that of the O&M phase (Impact 6: Permanent and/or long-term habitat loss/alteration due to the addition of infrastructure), but removal of infrastructure in the context of decommissioning.</p> <p><u>Maximum Area of Permanent and/or Long-term Habitat Loss/Alteration = 1,364,653 m²</u></p>	<p>The worst-case design scenario assumes complete removal of all infrastructure, including cables and cable protection where it is practicable and appropriate to do so, in accordance with guidance and approach in place at the time of decommissioning.</p> <p>Disturbance to deeper sediments can disturb long-term buried carbon by potentially introducing oxygen into anoxic layers, which could stimulate remineralisation and a potential turnover of otherwise stable organic carbon (Macreadie, <i>et al.</i>, 2019). Sediment and associated carbon accumulation may occur</p>



Impact	Embedded Commitment	Worst-case Design Scenario	Justification
			in the Study Area (Daewel <i>et al.</i> , 2022; Watson <i>et al.</i> , 2024).
Impact 13: Reduction in access to, or exclusion from established fishing grounds from within the Aspen Array Area	C-OFF-11; C-OFF-22; C-OFF-04; C-OFF-05; C-OFF-09; C-OFF-10; C-OFF-13; C-OFF-14; C-OFF-17; C-OFF-20; C-OFF-24; C-OFF-29; C-OFF-30; C-OFF-46; C-OFF-39; C-OFF-42; C-OFF-52; C-OFF-55.	<u>As described in Volume 2, Chapter 13: Commercial Fisheries of the Offshore EIAR.</u>	<p>The scenario which represents the potential for the maximum level of infrastructure to be decommissioned. It is assumed that fishing will not resume throughout the decommissioning phase.</p> <p>Sediment and associated carbon accumulation may occur in the Study Area due to displacement, affecting sequestration within the Study Area (Daewel <i>et al.</i>, 2022; Watson <i>et al.</i>, 2024).</p>
Impact 14: Reduction in access to, or exclusion from established fishing grounds from within the OTC Corridor	C-OFF-11; C-OFF-22; C-OFF-04; C-OFF-05; C-OFF-09; C-OFF-10; C-OFF-13; C-OFF-14; C-OFF-17; C-OFF-20; C-OFF-24; C-OFF-29; C-OFF-30; C-OFF-46; C-OFF-39; C-OFF-42; C-OFF-52; C-OFF-55.	<u>As described in Volume 2, Chapter 13: Commercial Fisheries of the Offshore EIAR.</u>	<p>The scenario which represents the potential for the maximum level of infrastructure to be decommissioned. It is assumed that fishing will not resume throughout the decommissioning phase.</p> <p>Sediment and associated carbon accumulation may occur in the Study Area due to displacement, affecting sequestration within the Study Area (Daewel <i>et al.</i>, 2022; Watson <i>et al.</i>, 2024).</p>



8 Assessment of Likely Significant Effects

- 8.1.1 Based on available data, the assessment has split impacts into the blue carbon habitats identified in the study area. These include:
- Marine sediments;
 - Bryozoan thickets; and
 - Kelp beds.
- 8.1.2 Assessment of LSE on blue carbon habitats has been undertaken for all phases of the Proposed Development. The assessment evaluates potential impacts on carbon stores over the lifecycle of the Proposed Development, acknowledging the extended temporal scales required for blue carbon habitats to develop and accumulate measurable carbon stocks. Impacts on these habitats may result in delayed carbon emissions, as the potential sequestration of carbon or loss of stored CO₂ typically occurs over extended periods. Therefore, the assessment has grouped impacts together over all phases of the Proposed Development to assess the effect on the carbon stores within the Study Area over the lifetime of the Proposed Development.
- 8.1.3 The assessment determines whether any LSE may arise by evaluating both the magnitude of predicted impacts and the sensitivity of the relevant blue carbon habitats from the impact(s), following the criteria set out in Section 6.

8.2 Subtidal Carbon Stores - Marine Sediment

Impacts 2, 5, 6, 11, and 12: Temporary and Permanent Habitat Disturbance

- 8.2.1 As set out in **Volume 2, Chapter 9: Benthic Subtidal and Intertidal Ecology** of the Offshore EIA, sediments may be disturbed temporarily as a result of construction or O&M activities or permanently lost as a result of habitat loss/alteration due to the addition of infrastructure to the area, including the introduction of scour protection. It is envisaged that during decommissioning, the removal of the WTGs and their associated floating foundations will largely follow the reverse of the installation methodology. Based on high level assumptions for decommissioning options (as described in **Volume 1, Chapter 3: Project Description** of the Offshore EIA), on that basis assumed temporary sediment disturbance will result in the same, or no worse than, impact as construction on carbon stores within the Proposed Development. Permanent or long-term habitat loss or alteration resulting from infrastructure removal is assumed to affect the same footprint to the area that has already lost its capacity to store carbon during O&M, due to the potential introduction of oxygen during removal (Macreadie, *et al.*, 2019). As this area would still be unable to store carbon, it has not been included in the total area of disturbance to avoid double counting.
- 8.2.2 To note, the area of permanent habitat loss is likely to be included in the area of temporary habitat disturbance, as all infrastructure is likely to be placed in areas that were already temporarily disturbed during construction. As such, the inclusion of these permanent habitat loss areas represents a precautionary worst case and the assessment has looked at these areas together in terms of their impact on blue carbon stocks.



- 8.2.3 Carbon density values previously reported for UK waters have been shown to vary by substrate, as seen in Table 5.1. Using the mean carbon density values for each sediment category, the potential loss of carbon dioxide equivalent (CO₂e) associated with the Proposed Development has been estimated over the lifetime of the Project. The calculation approach is detailed in the methodology (Section 6).
- 8.2.4 These estimates assume that each disturbance area is underlain by a single, uniform sediment type. Consequently, the values presented in Table 8.1 should be interpreted as midpoint or blended estimates.

Table 8.1 Calculation of Potential CO₂ Emissions Caused by the Proposed Development

Variable	Muddy Sand	Mud to Muddy Sand
Total Study Area (m ²)	1,046,000,000	
Total area of disturbance (m ²) resulting from temporary or permanent habitat disturbance	51,192,053	
Mean carbon density (kg/m ²) as seen in Table 5.1	0.71	0.68
Total organic carbon store within the Study Area (tonnes)	742, 660	711, 280
Total organic carbon stored within area of disturbance (tonnes) ⁵	36,346	34, 811
Percentage of total organic carbon within the Study Area that may be disturbed (%)	4.9	
Potential loss of CO ₂ e from the Proposed Development (t CO ₂ e) over its lifecycle	133,375	127,753

- 8.2.1 Using Table 8.1, the Proposed Development has the potential to disturb up to 51.2 km² of marine sediments and carbon stores. This is a very small proportion (0.01%) of the marine sediment within the Scottish EEZ of 462,315 km² (Burrows *et al.*, 2024) from which carbon could be released. This also represents a small percentage of the overall carbon stores of the Study Area, accounting for 4.9% of the total organic carbon store within the entire Proposed Development area.
- 8.2.2 Similarly, while there is a suggestion within the literature that there may be an increase in accumulation of sedimentary organic carbon as a result of the infrastructure associated with OWF modifying current speeds (e.g. Watson *et al.*, 2024), it is unlikely that this will compensate for sediment disturbance and loss over the lifetime of an OWF.

⁵ It is assumed that 100% of the organic carbon disturbed will be lost and result in CO₂e to the atmosphere (NatureScot, 2025). This is an over-estimation, however as a precautionary approach this is considered the worst-case scenario. Assuming 100% of organic carbon is lost will also factor in some of the deeper sedimentary organic carbon. Reactivity (biodegradability) of sedimentary carbon across shelf seas is highly variable with low reactivity organic matter typically found in the offshore region (Smeaton and Austin, 2022), again indicating that assumptions here are an over estimation.



- 8.2.3 Much of the evidence in Section 7 describes how impacts effect the surficial sediment (top 10 cm). However, there is potential disturbance below this level, with some of the Proposed Development activities occurring to a depth of 40 m below the seabed. Given the limited availability of literature on organic carbon content and carbon stores within deeper sediments, it is not possible to assess or quantify the magnitude or significance of potential impacts on sub-surface carbon stores, however it is likely there will be additional disturbance to deeper carbon stores.
- 8.2.4 As it assumed that 100% of the organic carbon disturbed will be lost and result in CO₂e released to the atmosphere, this over estimation (as explained above)⁵ will also factor in some of the deeper sedimentary organic carbon that has not been able to be assessed.
- 8.2.5 For Impacts 2, 5, 6, 7, 10, and 11, muddy sand is considered to have moderate to high vulnerability to physical disturbance. The presence of a substantial fine-fraction (silt and clay), higher organic content, and relatively low natural mobility means that this sediment type is easily resuspended, compacted, or structurally altered when disturbed. Exposure of previously buried material to oxygen can also accelerate organic carbon oxidation, increasing the potential for long-term carbon loss.
- 8.2.6 Recoverability is assessed as low to moderate. Fine sediments re-accumulate slowly, particularly in low-energy environments, and the physical and biogeochemical characteristics of muddy sand may take several years to return to baseline conditions.
- 8.2.7 Based on the above, the potential release of carbon from marine sediments from the temporary or permanent disturbance within the Study Area is considered to be of **Low** magnitude. Only a very small proportion of sediment within the Study Area will be disturbed (<5%), and any resulting carbon release would represent a small fraction of the wider sedimentary carbon stores present across the Study Area, and a negligible fraction across the entire Scottish EEZ carbon stores.
- 8.2.8 In addition to the limited spatial extent, the temporal characteristics of disturbance impacts further constrain the scale of impact. The majority of activities are temporary and short-lived, meaning that any sediment disruption will be brief relative to natural sedimentary processes in the Study Area and background conditions. Although carbon released from disturbed sediments is expected to be irrecoverable within timescales relevant to long-term carbon storage and the lifetime of the Proposed Development, the volume of carbon potentially mobilised in absolute terms remains extremely small.

Sensitivity

- 8.2.9 The sensitivity of carbon stores associated with marine sediments to temporary or permanent disturbance within the Study Area has been given a precautionary value of **High** as the exact fate of carbon when sediments are disturbed is poorly understood, however sediment accumulation on the seabed can be very low and recovery slow.



Significance of Effect

8.2.10 As carbon stores associated with marine sediments is considered to have **High** sensitivity to disturbance, combined with **Low** magnitude of change, the overall effect significance on marine sediment to permanent and temporary habitat disturbance will therefore be **Minor**, which is **Not Significant in EIA terms**.

Impact 3, 4, 8, 9, 13 and 14: Reduction in Access to, or Exclusion from Established Fishing Grounds

8.2.11 As set out in **Volume 2, Chapter 13: Commercial Fisheries** of the Offshore EIAR, reducing fishing ground as a result of the presence of the OWF, likely causes the displacement of bottom trawling operations, resulting in sediment accumulation and potential carbon sequestration from a development. This could have the potential to increase carbon stocks within the study area.

Magnitude

8.2.12 Sequestration potential from the displacement of fishing grounds, more specifically bottom trawling practises is not possible to quantify. There is a lack of evidence and data for seabed organic carbon sequestration rates in literature, outside those identified in Scottish fjords (Smeaton *et al.*, 2021c). As the Proposed Development is coastal and offshore, data that is available on sequestration rates (that is based on fjords), is unreliable for this impact.

8.2.13 However, based on the sedimentation that could occur within the Study Area and generally low sediment accumulation rates in the North Sea, noting that this does vary spatially (Diesing *et al.*, 2021), the magnitude from reduction in access to, or exclusion from established fishing grounds on carbon stores associated with marine sediments is considered **Negligible** as there is likely to be little to no effect on additional sequestration of blue carbon during the lifetime of the Proposed Development compared to baseline or background conditions.

Sensitivity

8.2.14 Although this impact pathway could theoretically represent a positive impact, the scale of such benefit is expected to be minimal due to the low sediment accumulation rates in the North Sea. Although a quantitative assessment could not be undertaken, the available evidence indicates that any increase in carbon burial resulting from changes in fishing activity would be minimal compared to the baseline and unlikely to produce a measurable enhancement in sequestration at the scale of the Proposed Development.

8.2.15 In addition, UK and non-UK pelagic mobile fleets actively target a wide range of grounds on a seasonal basis, and frequency of their activity within the Study Area is unknown. Compared to baseline, and with low sediment accumulation rates in the North Sea, the sensitivity of carbon stores associated with marine sediments to additional sedimentation and potential carbon sequestration from reduction in access to, or exclusion from established fishing grounds is considered **Negligible**.



Significance of Effect

8.2.16 As carbon stores associated with marine sediments is considered to have **Negligible** sensitivity to changes in fishing grounds, and **Negligible** magnitude, the overall effect significance on marine sediment of the reduction in access to, or exclusion from established fishing grounds, based on available evidence, will therefore be **Negligible**, which is **Not Significant in EIA terms**.

Impact 7: Changes in Physical Processes Resulting from the Presence of the Subsea Infrastructure

8.2.17 **Volume 2, Chapter 7: Marine and Coastal Processes** and **Volume 2, Chapter 9: Benthic Subtidal and Intertidal Ecology** of the Offshore EIAR set out how changes in physical processes may result in changes to sediment transport in the study area. The presence of anchors, foundations, scour protection and cable protection material may introduce changes to the local hydrodynamic and wave regime, resulting in changes to the sediment transport pathways.

Magnitude

8.2.18 Any impacts of the Proposed Development on tidal regimes will not result in significant impacts to coastal and physical processes and will therefore not result in any significant changes to sediment transport (**Volume 2, Chapter 7: Marine and Coastal Processes** of the Offshore EIAR). Based on this there would be no significant changes to sediment transport compared to natural sedimentary processes and background conditions and this would result in no significant changes to associated carbon stocks found in the marine sediment. The magnitude from this impact is therefore considered to be **Low**.

Sensitivity

8.2.19 The sensitivity of carbon stores in marine sediments to changes in physical processes has been given a precautionary value of **High** as the exact fate of carbon when sediments are disturbed is poorly understood, noting that sediment accumulation on the seabed can be very low and recovery is therefore slow.

Significance of Effect

8.2.20 The sensitivity of carbon stores associated with marine sediment to changes in physical processes based on worst-case scenario is classified as **High** sensitivity, and magnitude of the impact is deemed to be **Low**. The effect will therefore be of **Minor** significance, which is **Not Significant in EIA terms**.



8.3 Subtidal Carbon Stores - Bryozoan Thickets

Impact 1 and 10: Temporary Increases in SSC and Sediment Deposition

8.3.1 Temporary localised increases in SSC and associated sediment deposition are expected from foundation and cable installation works and seabed preparation works, as well as decommissioning works, and during JUV usage during maintenance. Bryozoan thickets were identified within the wider study area, outside the zones of direct seabed disturbance, associated with the biotope '*Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment'. As a result, the assessment focuses on potential indirect impacts from SSC and sediment deposition on smothering bryozoan thickets and its ability to sequester carbon.

Magnitude

8.3.2 As detailed within **Volume 2, Chapter 9: Benthic Subtidal and Intertidal Ecology** of the Offshore EIAR, the magnitude of SSC and deposition associated with the Proposed Development is considered to be low within the Study Area, beyond the OTC Corridor and Array Area boundaries, and is expected to remain comparable to natural background levels. Furthermore, any deposition will be short-lived and confined to the duration of the construction activity, resulting in a temporary impact. With this the magnitude from increased SSC and smothering on blue carbon associated with bryozoan thickets is considered Low.

Sensitivity

8.3.3 There is little information available on this habitat within the Study Area, and the quantity and extent of carbon stocks associated with this habitat is unknown. However, bryozoan thickets are considered not sensitive to changes in SSC and turbidity, not sensitive to light smothering (<5 cm), and low sensitivity to heavy smothering (5-30 cm), based on MarESA. Although unlikely to affect the carbon sequestration potential, and low potential to smothering based on the worst case scenario, the uncertainty of carbon stores associated with this habitat has considered the overall sensitivity of bryozoan thickets to be **Medium** to temporary increases in SSC and smothering and deposition.

Significance of Effect

8.3.4 As bryozoan thickets is considered to have **Medium** sensitivity to the impact of increased SSC and sediment deposition, and a **Low** magnitude from the impact, there is little to no impact on the ability for bryozoan thickets to sequester carbon compared to baseline. In line with **Volume 2, Chapter 9: Benthic Subtidal and Intertidal Ecology** of the Offshore EIAR, the significance of impact of increased SSC on bryozoan thickets associated blue carbon stores is considered **Minor**, and thus **Not Significant in EIA terms**.



8.4 Nearshore Carbon Stores - Kelp Beds

Impact 1 and 10: Temporary Increases in SSC and Sediment Deposition

8.4.1 As mentioned in Section 5.2, kelp beds have not been confirmed within the proposed the OTC Corridor boundary, however they have been identified in the wider study area (i.e., within 10 km of the OTC corridor). However, surrounding kelp beds may still be indirectly affected by construction activities. Increased SSC and associated sediment deposition have the potential to reduce the ability of kelp beds to photosynthesise and sequester carbon.

Magnitude

8.4.2 Increases in SSC are not expected to impact local kelp beds, as described in **Volume 2, Chapter 9: Benthic Subtidal and Intertidal Ecology** of the Offshore EIAR. The magnitude of SSC and deposition associated with the Proposed Development is considered to be low within the wider study area, beyond the OTC Corridor and Array Area boundaries. Associated deposition from sediment plumes is expected to remain comparable to natural background levels experienced by kelp beds. Furthermore, any deposition will be short-lived and confined to the duration of the construction activity, resulting in a temporary impact. The magnitude from increases in SSC on kelp beds has been assessed as **Low**.

Sensitivity

8.4.3 Kelp beds are considered to have medium sensitivity to changes in SSC and turbidity, not sensitive to light smothering (<5 cm), and low sensitivity to heavy smothering (5-30 cm), based on MarESA. Overall kelp beds have been assessed as having a **Low** sensitivity to the smothering, and temporary SSC based on the worst-case scenario, and unlikely to affect the carbon sequestration of kelp beds.

Significance of Effect

8.4.4 As kelp is considered to have **Low** sensitivity based on the worst case scenario to increased SSC and sedimentation, and a **Low** magnitude from the impact, there is little to no impact on the ability for kelp beds to sequester carbon compared to baseline. In line with **Volume 2, Chapter 9: Benthic Subtidal and Intertidal Ecology** of the Offshore EIAR, the significance of impact of increased SSC on kelp beds and associated blue carbon stores is considered **Minor**, and thus **Not Significant in EIA terms**.



9 Cumulative Effects Assessment

- 9.1.1 Section 9.8 of **Volume 2, Chapter 9: Benthic Subtidal and Intertidal Ecology** of the Offshore EIAR outlines the developments considered likely to contribute to cumulative effects with the Proposed Development. However, certain impacts assessed from the Proposed Development alone were not considered within the cumulative effects assessment due to:
- The highly localised nature of the impacts (i.e., they occur entirely within the Proposed Development boundary only);
 - Management measures in place for the Proposed Development will likely also be in place on other projects reducing the risk of the impact occurring; and/or
 - Where the LSE from the Proposed Development alone has been assessed as negligible.
- 9.1.2 In terms of impacts to blue carbon stocks the projects expected to overlap with the construction phase of the Proposed Development and located within the 10 km study area are highlighted within Table 9.35 of **Volume 2, Chapter 9: Benthic Subtidal and Intertidal Ecology** of the Offshore EIAR.
- 9.1.3 As detailed in **Volume 2, Chapter 9: Benthic Subtidal and Intertidal Ecology** of the Offshore EIAR, no likely cumulative effects are predicted for any phase of the Proposed Development in the Study Area blue carbon habitats. The blue carbon assessment does not introduce any additional impact pathways related to temporary or permanent habitat disturbance beyond those already considered in **Volume 2, Chapter 9: Benthic Subtidal and Intertidal Ecology** of the Offshore EIAR, and all relevant blue carbon habitats are fully encompassed within that assessment. Similarly for deeper carbon stores, as mentioned in Section 7, carbon below the top 10cm cannot be quantified independently. However, as with the top 10 cm sediment layer, as no likely cumulative effects are predicted within the Study Area, it is assumed that this will also be the case for deeper carbon stores within the Study Area.
- 9.1.4 For commercial fisheries, as set out in **Chapter 13: Commercial Fisheries** of the Offshore EIAR, no cumulative effects are predicted for any phase of the Proposed Development on blue carbon stores for reduction in access to, or exclusion from established fishing grounds, as they are likely to result in potential positive impacts from carbon sequestration, and not disturbance within the Study Area.
- 9.1.5 Consequently, there is no evidence to suggest that the Proposed Development would give rise to cumulative effects on the blue carbon habitats. On this basis, the cumulative effects on blue carbon are assessed as **Negligible**, which is **Not Significant in EIA terms**.



10 Conclusions

- 10.1.1 Based on the available evidence and the outcomes of this assessment, and the application of a precautionary, worst-case scenario approach, this assessment concludes the Proposed Development does not present any LSE on blue carbon habitats. While uncertainties remain and further research would strengthen future assessments, under the worst-case parameters and available data on blue carbon stores, impacts on blue carbon processes are limited, manageable, and **Not Significant in EIA terms**.
- 10.1.2 Whilst further research is required to improve understanding in this field, it is recognised that the presence of offshore wind infrastructure may also give rise to potential positive effects on blue carbon habitats over the long term. These include the potential for increased organic carbon deposition in areas where near-bed current speeds are reduced around foundations, scour protection, or cable protection features, as well as the opportunity for localised enhancement of benthic communities that contribute to carbon sequestration. In addition, the exclusion or reduction of certain demersal fishing activities within safety or operational zones surrounding offshore wind assets may allow sensitive benthic habitats to recover, potentially increasing their capacity to store and retain carbon.
- 10.1.3 Although these potential beneficial processes remain subject to ongoing scientific investigation and have not been considered within this assessment, they indicate that the potential net influence of offshore wind development on blue carbon stocks may not be solely adverse and could include longer-term ecological gains.



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