Cambois Connection – Marine Scheme

Environmental Statement – Volume 2

ES Chapter 7: Physical Environmental and Seabed Conditions

SSE Renewables

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Acronyms

Acronym	Description
EA	Environment Agency
BBWF	Berwick Bank Wind Farm
BBWFL	Berwick Bank Wind Farm Limited
Cefas	Centre for Environment, Fisheries and Aquaculture Science
CIRIA	Construction Industry Research And Information Association
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EMODnet	European marine observation and data network
ES	Environmental Statement
EU	European Union
GCR	Geological Conservation Review
HAT	Highest Astronomical Tide
HDD	Horizontal Directional Drilling
Hs	Significant Wave Height
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
HW	High Water
INNS	Invasive Non-Native Species
JNCC	Joint Nature Conservation Committee
LAT	Lowest Astronomical Tide
LPA	Local Planning Authority
LW	Low Water
MCZ	Marine Conservation Zone
MHWS	Mean High Water Springs
MLWS	Mean Low Water Springs
MMO	Marine Management Organisation
MD-LOT	Marine Directorate Licensing and Operations Team
NCC	Northumberland County Council
oEMP	Outline Environmental Management Plan

Acronym	Description
OCSP	Offshore Converter Station Platform
PLONOR	Pose Little or No Risk
PSA	Particle Size Analysis
RIAA	Report to Inform Appropriate Assessment
SAC	Special Area of Conservation
SPA	Special Protection Area
SSC	Suspended Sediment Concentration
SSER	SSE Renewables
SSSI	Site Special Scientific Interest
Tp	Peak Period
UK	United Kingdom
ZoI	Zone of Influence

Units

Unit	Description
GW	Giga watt (power)
km	Kilometre (distance)
km^2	Kilometre squared (area)
kg/s	Kilograms per second (discharge rate)
m	Metres (distance)
m^2	Metre squared (area)
mg/l	Milligrams per litre (Concentration of solids within a liquid)

7. Offshore Physical Environment and Seabed Conditions

7.1. Introduction

1. This chapter presents the assessment of the likely significant effects (as per the "Environmental Impact Assessment (EIA) Regulations"[1]) on the environment arising from the Cambois Connection (hereafter referred to as "the Project") Marine Scheme on offshore physical environment and seabed conditions. Specifically, this chapter of the Marine Scheme Environmental Statement (ES) considers the potential impact of the Marine Scheme seaward of Mean High Water Springs (MHWS) during the construction, operation and maintenance, and decommissioning phases.

2. This assessment informs the following technical chapters:

- Volume 2, Chapter 8: Benthic Subtidal and Intertidal Ecology;
- Volume 2, Chapter 9: Fish and Shellfish Ecology;
- Volume 2, Chapter 10: Offshore and Intertidal Ornithology;
- Volume 2, Chapter 11: Marine Mammals;
- Volume 2, Chapter 14: Marine Archaeology and Cultural Heritage; and
- Volume 2, Chapter 15: Other Sea Users.

7.2. Purpose of this chapter

3. This chapter:

- Presents the existing environmental baseline established from desk based studies, site-specific surveys and feedback obtained during technical engagement with stakeholders;
- Identifies any assumptions and limitations encountered in compiling the environmental information;
- Presents the potential environmental impacts on the Offshore Physical Environment and Seabed Conditions arising from the Marine Scheme, and reaches a conclusion on the likely significant effects on the Offshore Physical Environment and Seabed Conditions based on the information gathered and the analysis and assessments undertaken;
- Identifies where impacts are relevant to Scottish waters, English waters, or both. Where there is no separation of assessment of effects, the assessment for the Marine Scheme (as a whole entity) applies to the Marine Scheme in both Scottish waters and English waters; and
- Highlights any necessary monitoring and/or mitigation measures recommended to prevent, minimise, reduce or offset the likely significant adverse environmental effects of the Marine Scheme on the offshore physical environment and seabed conditions.

7.3. Study Area

4. The Offshore Physical Environment and Seabed Conditions Study Area for the Marine Scheme is illustrated in Volume 4, Figure 7.1 and encompasses the:

- Marine Scheme;

[1] For the Marine Scheme, this is The Marine Works (Environmental Impact Assessment) Regulations 2007 (as amended).

- Seabed and coastal areas that may be influenced by changes to physical processes due to the Marine Scheme.

5. The Marine Scheme comprises the Berwick Bank Wind Farm (BBWF) array area and the Offshore Export Cable Corridor and the Landfall seaward of MHWS at Cambois, Northumberland

6. The Marine Scheme is located in both Scottish and English waters. In Scotland, the Marine Scheme is entirely in offshore waters (i.e., between the 12 nautical mile (NM) limit and the Scottish Exclusive Economic Zone (EEZ)). The Marine Scheme begins within the BBWF array area located approximately 47.6 km offshore of the East Lothian coastline and 37.8 km from the Scottish Borders coastline at St. Abbs.

7. The Marine Scheme then extends south into English offshore waters along the Northumberland coast, approximately 80 km offshore at its furthest extent, before turning west, crossing into English territorial waters, to the Landfall along the coast at Cambois Bay, Northumberland.

8. The Offshore Physical Environment and Seabed Conditions Study Area is based on the tidal excursion extent around the Marine Scheme. The tidal excursion distance in the vicinity of the Marine Scheme is approximately 5 km (based on a mean spring tide) (ABPmer, 2008). In order to ensure more infrequent metocean conditions are represented and capture the spatial extent influenced by these conditions, the applied Offshore Physical Environment and Seabed Conditions Study Area buffer around the Marine Scheme has been conservatively set at 10 km.

7.3.1. Intertidal Area

9. The Offshore Physical Environment and Seabed Conditions Study Area includes the intertidal area. This intertidal area overlaps with the Onshore topic of Geology and Soils, and Hydrology and Hydrogeology.

10. The Cambois Connection comprises two distinct proposals, or ‘Schemes’, which will require separate consents. For the onshore components of the Project down to the seaward extent of the Landfall at mean low water springs (MLWS) (‘the Onshore Scheme’), consent will be sought via a planning application to Northumberland County Council (NCC) as the local planning authority (LPA) under Section 57 of the Town and Country Planning Act 1990. An EIA has been carried out by the Applicant for the Onshore Scheme which includes an assessment of the likely significant effects on the environment of the works landward of MLWS, including the topics referenced above. The Environmental Statement for the Onshore Scheme will be provided in support of the planning application.

11. This Offshore Physical Environment and Seabed conditions chapter will assess the likely significant effects on the beach and intertidal physical environment and seabed conditions features. An overall summary of the likely significant effects associated with the intertidal area is also provided within the NTS for both the Onshore Scheme and the Marine Scheme. Potential impacts from the Onshore Scheme and are also considered cumulatively with the Marine Scheme, as outlined in section 7.14.

7.4. Legislative Context, Policy and Guidance

12. The general legislative context applicable to the Offshore Physical Environment and Seabed conditions assessment is set out in Volume 2, Chapter 2: Policy and Legislative Context. However, it is noted there are no specific legislative controls relevant to the scope of the marine physical and coastal processes.

7.4.1. Policy

13. In addition to the policies set out in Volume 2, Chapter 2: Policy and Legislative Context, policy relating to Offshore Physical Environment and Seabed Conditions, is set out in Table 7.1. Policy specifically in relation to this chapter relevant to Scotland, is contained in the Scottish National Marine Plan (NMP) (Scottish Government, 2015) and the United Kingdom (UK) Marine Policy Statement (MPS) (HM Government, 2011).

Table 7.1 Summary of relevant policy to the offshore physical environment and seabed conditions

Relevant Policy	Summary of Relevant Policy Framework	How and Where Considered in the ES
Scotland and England		
Marine Strategy Framework Directive (MSFD)	MSFD high-level descriptors of Good Environmental Status relevant to marine processes. Descriptor 6: Sea floor integrity: Seafloor integrity is at a level that ensures that the structure and functions of the ecosystems are safeguarded and benthic ecosystems are not adversely affected.	This chapter assesses anticipated changes to the seabed as a pathway. The effects of this pathway on marine ecosystems are considered in Volume 2, Chapter 8: Benthic Subtidal and Intertidal Ecology.
	"Descriptor 7: Permanent alteration of hydrographical conditions does not adversely affect marine ecosystems.	The potential permanent alteration of hydrographical conditions during the operational and maintenance phase of the Marine Scheme is considered in section 7.12.2.
UK Marine Policy Statement	Coastal change and coastal flooding are likely to be exacerbated by climate change, with implications for activities and development on the coast. These risks are a major consideration in ensuring that proposed new developments are resilient to climate change over their lifetime Account should be taken of the impacts of climate change throughout the operational life of a development including any de-commissioning period.	Section 7.7.2 considers climate change influences relevant to a future baseline. The assessment of effects is undertaken in respect of the current and future baselines (the future baseline is detailed in section 7.7.2).
	Interruption or changes to the supply of sediment due to infrastructure has the potential to affect physical habitats along the coast or in estuaries.	Potential changes to sediment supply (pathways) due to the operational presence of seabed infrastructure (in particular cable protection affecting the nearshore pathways) are considered in section 7.12.2. The potential for habitat change/ loss is discussed within Volume 2, Chapter 8: Benthic Subtidal and Intertidal Ecology.
Scotland		
Scottish NMP[2]	Sustainable development of offshore wind, wave and tidal renewable energy in the most suitable locations.	Consideration of sustainable development is discussed in Volume 2, Chapter 6: Route Appraisal and Alternatives.
	Marine planners and decision makers must ensure that renewable energy projects demonstrate compliance with EIA and HRA legislative requirements	As set out in section 7.12 and Volume 2, Chapter 2: Policy and Legislative Context, this assessment complies with legislative and policy requirements.

[2] In the Programme for Government 2022-23, Scottish Ministers committed to start the process of developing a new National Marine Plan for Scotland, to address the global climate and nature crises, by carefully managing increased competition for space and resources in the marine environment (NMP2). It is currently at the pre-consultation stage, with no substantive detail yet published and it is therefore not possible to consider further.

Relevant Policy	Summary of Relevant Policy Framework	How and Where Considered in the ES
	A strategic approach to mitigating potential impacts and cumulative impacts on the marine environment forms an integral part of marine planning and decision making, whilst issues arising in the coastal interface should align between marine and terrestrial processes.	A Cumulative Effect Assessment (CEA) has been undertaken and is outlined in section 7.14. Information on embedded mitigation measures are presented in section 7.11.
	A changing climate may result in changes in extreme weather events which could create difficult operating conditions for offshore installations.	Baseline and post-construction physical processes were compared alongside extreme storm conditions to consider the wave climate and hydrodynamics detailed in section 7.7. The future baseline detailed in section 7.7.2 outlines the baseline environment over an extended period of time, taking climate change into account.
	GEN 9 Natural Heritage Development and use of the marine environment must: (a) Comply with legal requirements for protected areas and protected species. (b) Not result in significant impact on the national status of Priority Marine Features. (c) Protect and, where appropriate, enhance the health of the marine area	Within the Marine Scheme ES, the potential for adverse impacts to marine protected areas, protected species and priority marine features as a result of the Marine Scheme is considered within this chapter and also in Volume 2, Chapter 8: Benthic Subtidal and Intertidal Ecology; Volume 2, Chapter 9: Fish and Shellfish Ecology; Volume 2, Chapter 10: Offshore and Intertidal Ornithology; Volume 2, Chapter 11: Marine Mammals; and their respective technical appendices. Furthermore, a marine protected area and Marine Conservation Zone (MCZ) Assessment has been carried out and is provided as an accompanying document to the Marine Licence applications submitted to MD-LOT and the MMO.
England		
North East Inshore and North East Offshore Marine Plan	North East Inshore and North East Offshore Marine Plan – NE-MPA-1; NE-MPA-2; NE-MPA-3; NE-MPA-4: With respect to NE-MPA-1: "Proposals that may have adverse impacts on the objectives of marine protected areas must demonstrate that they will, in order of preference: avoid, minimise or mitigate – adverse impacts with due regard given to statutory advice on an ecologically coherent network. With respect to NE-MPA-2: Proposals that may have adverse impacts on an individual marine protected area's ability to adapt to the effects of climate change, and so reduce the resilience of the marine protected area network, must demonstrate that they will, in order of preference: avoid, minimise or mitigate – adverse impacts With respect to NE-MPA-3: Where statutory advice states that a marine protected area site condition is deteriorating or that features are moving or changing due to climate change, a suitable boundary change to ensure continued protection of the site and coherence of the overall network should be considered.	The potential impacts of the Marine Scheme activities on designated sites designated for geological, geomorphological and sedimentological features is assessed in section 7.12.1. Furthermore, the Marine Scheme MCZ/MPA Assessment, has been carried out and is provided as an accompanying document to the Marine Licence applications submitted to MD-LOT and the MMO.

Relevant Policy	Summary of Relevant Policy Framework	How and Where Considered in the ES
	With respect to NE-MPA-4: Proposals that may have significant adverse impacts on designated geodiversity must demonstrate that they will, in order to preference: avoid, minimise or mitigate – adverse impacts so they are no longer significant.	
	North East Inshore and North East Offshore Marine Plan – NE-CC-1; NE-CC-2; NE-CC-3; NE-MPA-4: With respect to NE-CC-1: Proposals that may have significant adverse impacts on habitats that provide a flood defence or carbon sequestration ecosystem service must demonstrate that they will, in order of preference: avoid, minimise, mitigate - adverse impacts so they are no longer significant or compensate for significant adverse impacts that cannot be mitigated With respect to NE-CC-2: Proposals in the north east marine plan areas should demonstrate for the lifetime of the project that they are resilient to the impacts of climate change and coastal change. With respect to NE-CC-3: Proposals in the north east marine plan areas, and adjacent marine plan areas, that are likely to have significant adverse impacts on coastal change, or on climate change adaptation measures inside and outside of the proposed project areas, should only be supported if they can demonstrate that they will, in order of preference: avoid, minimise or mitigate adverse impacts so they are no longer significant.	As presented in the Marine Scheme Scoping Report (BBWFL, 2022c), the Marine Scheme being a subsea cable, there are no likely significant effects from climate change on the Marine Scheme during the construction, operation and maintenance and decommissioning phases of the Marine Scheme and hence assessment of climate resilience of the Marine Scheme has been scoped out of the Environmental Impact Assessment (EIA). Scoping out of Climate Change impacts has been confirmed by the MMO during a meeting held on 18 April 2023. No significant effects have been identified based on habitats, including those which could provide flood defence or carbon sequestration ecosystem service. In wider relation to climate change, the Applicant has also carried out a Greenhouse Gas assessment – this is reported in Volume 3, Appendix 5.1. Characterisation of the coastal morphology and the potential effect of the Marine Scheme's construction / decommissioning and operation activities are set out on section 7.7.2.6, 7.12.1 and 7.12.2 respectively.
	North East Inshore and North East Offshore Marine Plan – NE CE-1: With respect to NE-CC-1: Proposals which may have adverse cumulative effects with other existing, authorised, or reasonably foreseeable proposals must demonstrate that they will, in order or preference: avoid, minimise, mitigate adverse cumulative and/or in-combination effects so they are no longer significant.	Cumulative effects are considered in section 7.14.2.
	North East Inshore and North East Offshore Marine Plan – NE-WQ-1: Proposals that protect, enhance and restore water quality will be supported. Proposals that cause deterioration of water quality must demonstrate that they will, in order of preference: avoid, minimise deterioration of water quality in the marine environment."	Within the Marine Scheme ES, the potential for deterioration of water quality as a result of the Marine Scheme is assessed within this chapter. Additionally, a Water Framework Directive (WFD) Assessment has been undertaken is provided as an accompanying document to the Marine Licence applications submitted to MD-LOT and the MMO.
	Coastal Change *"Where relevant, applicants should undertake coastal geomorphological and sediment transfer modelling to predict and understand impacts and help identify relevant mitigating or compensatory measures"* (Paragraph 5.5.6 of NPS EN-1).	Assessments have been made through consideration of existing numerical modelling from the BBWF ES which overlaps with the Marine Scheme ES (BBWFL, 2022a; 2022b). As agreed with the MMO and MD-LOT during the EIA Scoping process, a semi-quantitative assessment methodology has been

Relevant Policy	Summary of Relevant Policy Framework	How and Where Considered in the ES
NPS EN-1 and EN-3 provisions[3][4]		employed (the methodology is described in full detail within section 5.10 below).
	"The direct effects on the physical environment can have indirect effects on a number of other receptors. Where indirect effects are predicted, the [Secretary of State] should refer to relevant sections of this NPS and EN 1" (Paragraph 2.6.195 of NPS EN-3).	The predicted changes to the offshore physical environment and seabed conditions have been considered in relation to indirect effects on other receptors elsewhere in the ES, namely Volume 2, Chapter 8: Benthic Subtidal and Intertidal Ecology; Volume 2, Chapter 9: Fish and Shellfish Ecology; Volume 2, Chapter 10: Offshore and Intertidal Ornithology; Volume 2, Chapter 11: Marine Mammals; Volume 2, Chapter 12: Commercial Fisheries; Volume 2, Chapter 13: Shipping and Navigation; and Volume 2, Chapter 14: Marine Archaeology and Cultural Heritage; and Volume 2, Chapter 15: Other Sea Users.
	the methods of construction, including use of materials should be such as to reasonably minimise the potential for impact on the physical environment […]" (Paragraph 2.6.196 of NPS EN-3).	The Marine Scheme has proposed design and installation methods that seek to reasonably minimise significant adverse effects on the Offshore Physical Environment and Seabed Conditions Study Area so far as reasonably practicable, as set out in Volume 2. Chapter 5: Project Description. Where necessary, the assessment has set out mitigation to avoid or reduce significant adverse effects.

7.4.2. Guidance

14. The most up-to-date technical guidance for offshore wind related Physical Environment and Seabed Conditions assessments includes:

- Offshore Wind Energy in Scottish Waters. Regional Locational Guidance. Marine Scotland. October 2020;
- Guidance Note. Marine Physical Processes Guidance to inform Environmental Impact Assessment (EIA). GN041. NRW, 2020;
- Nature conservation considerations and environmental best practice for subsea cables for English Inshore and UK offshore waters, Natural England and JNCC (2022);
- Coastal Process Modelling for Offshore Wind Farm Environmental Impact Assessment: Best Practice Guidance. COWRIE, 2009;
- Guidelines in the use of metocean data through the lifecycle of a marine renewables development, Construction Industry Research and Information Association (CIRIA) C666, ABPmer Ltd et al., (2008);

[3] Whilst it is acknowledged that neither BBWF nor the Marine Scheme comprise or form part of an NSIP (please see Volume 2: Chapter 2: Policy and Legislative Context) , NPSs are however a statement of government intention relating, in this case, to renewable energy projects, therefore can be taken into consideration during the preparation of the Marine Scheme ES.

[4] A suite of draft revised Energy NPSs were published and consulted on by the UK Government in March 2023, and consultation closed on 23rd June. The consultation responses will be subject to consideration and the draft revised NPSs may now be revised before the NPSs are formally adopted. There is currently no date for the next stage of the review process and therefore this ES presents the current adopted NPSs which have been considered during the preparation of this ES. It is however noted by the Applicant that the new draft NPSs state that they may be material considerations in other applications which are not considered under the Planning Act (2008), this includes the Marine Scheme. Further detail on the consideration of the draft NPSs in this ES is provided in Volume 2 Chapter 2 Policy and Legislation.

- Guidance on Environmental Impact Statement (EIS) and Natura Impact Statement (NIS) Preparation for Offshore Renewable Energy Projects, Department of Communications, Climate Action and Environment, (2017);
- Advice on key sensitivities of habitats and Marine Protected Areas in English Waters to offshore wind farm cabling within Proposed Round 4 leasing areas. Natural England and JNCC, 2019.

7.5. Consultation and Technical Engagement

15. Consultation with regulators and stakeholders has been undertaken pre-scoping, through the submission of the Marine Scheme Scoping Report (BBWFL, 2022c) and with the Scoping Opinions received from the MMO (MMO, 2023), MD-LOT (MD-LOT, 2023) and associated Scoping Advice contained therein.

16. A summary of the key issues raised during consultation and technical engagement activities undertaken to date specific to this chapter is presented in Table 7.2 below, together with how these issues have been considered in the production of this chapter. A summary of all consultation and engagement completed in relation to the Marine Scheme is presented within Volume 2, Chapter 3: EIA Methodology.

Table 7.2 Summary of key consultation and technical engagement undertaken for the Marine Scheme relevant to offshore physical environment and seabed conditions

Date	Consultee and Type of Consultation	Issue(s) Raised	Response to Issue Raised and/or Where Considered in this Chapter
Pre-Scoping engagement			
13 January 2022	Northumberland County Council (NCC)	A meeting was held to introduce the Project to the Local Planning Authority for the Onshore Scheme. Owing to the requirement for a landfall along the Cambois coastline, the approach to the consent application process for this area was discussed, including in terms of any potential overlap in environmental assessments for the Marine Scheme and the Onshore Scheme between MHWS and MLWS, and how NCC may work with the MMO. Confirmation was received that NCC is not a signatory to the Coastal Concordat, however the Applicant confirmed their intention to adopt these principles where practicable to help guide the EIA process.	Advice from NCC was used to inform the landfall selection process. Following the discussions with NCC regarding the coastal concordat, an aligned approach to the Report to Inform Appropriate Assessment (RIAA) and Marine Conservation Zone (MCZ) Assessment has been followed (this has included an assessment of the nearshore habitat and physical features of the MCZ, as reported in the MPA and MCZ Assessment. In practice, this means that the MMO will carry out (“lead”) the MCZ Assessment, for the Marine Scheme. Furthermore, the RIAA carried out by the Applicant which will support the MMO’s Habitats Regulation Appraisal / Assessment (HRA) will help to inform the NCC HRA, as required. This is considered technically appropriate, given the marine focus of the relevant designated sites, and represents a meaningful efficiency during the consenting process.
16 March 2022	MMO and MD-LOT	A meeting was held to introduce the Project to the relevant marine regulators for the Marine Scheme. The approach to the MLAs was presented, as well as the intended approach regarding MLA submissions in both Scotland and England. The Applicant also presented on the key constraints of the broad Offshore Export Cable Corridor and how they would be considered going forward.	Advice from both the MMO and MD-LOT was used to guide the refinement of the route within the corridor from BBWF to Cambois presented during EIA Scoping, and then further refinement of the Marine Scheme route. As part of this workshop, the Applicant discussed the need for coordination between authorities and how this may aid

Date	Consultee and Type of Consultation	Issue(s) Raised	Response to Issue Raised and/or Where Considered in this Chapter
		A summary of the intended scope of and approach to surveys was provided (benthic and geophysical for the Marine Scheme, and Phase 1 Habitats and Species surveys for the Onshore Scheme which were presented for completeness).	the consenting process for the Marine Scheme and Onshore Scheme. Both MD-LOT and MMO were briefed regarding the intended timeframes of and approach to EIA Scoping. The MMO's advice to engage with Natural England regarding the scope of and approach to surveys was followed.
6 July 2022	Natural England	The Applicant held a meeting with Natural England to discuss the scope of and approach to a suite of surveys planned for 2022, including offshore geophysical and benthic surveys. Interactions with relevant designated sites were discussed, as was the Applicant's position with regards to overwintering birds, including the proposed scope of the assessment, use of existing data and the need for supporting surveys.	Advice from Natural England associated with a number of designated sites was used to inform the selection of a preferred corridor, in particular advice on avoiding the Farnes East MCZ. BBWFL received an associated advice letter in August 2022. Advice was used to inform the offshore surveys carried out by the Applicant, as reported below.
15 September 2022	MMO Cefas JNCC	The Applicant along with their benthic survey contractor (Natural Power), held a meeting with stakeholders to discuss the approach to the benthic survey and sampling plan for the Marine Scheme. The Applicant presented the proposed survey design, methodology, sampling locations and approach to reporting. Stakeholders followed up in writing to confirm their agreement on the approach presented. Whilst MD-LOT and NatureScot were invited to the meeting they were unable to attend, however, both stakeholders also confirmed in writing their agreement on the approach.	Surveys and sampling for the Marine Scheme commenced in September/October 2022 following methodology agreed with stakeholders.
Scoping Advice and Opinion in relation to submitted Scoping Report			
December 2022	NatureScot – Scoping Advice	Study Area - We are content with the study area as defined in section 6.3.	The Offshore Physical Environment and Seabed Conditions Study Area is detailed in section 7.3
December 2022	NatureScot – Scoping Advice	Baseline - We are content with the key data sources as listed in section 6.4.	The key data sources are listed in section 7.6.1
December 2022	NatureScot – Scoping Advice	Increases in suspended sediment - We welcome the inclusion of increases in suspended sediment as a potential impact to be scoped in. The assessment method proposes examination of geophysical and benthic survey information. We are broadly content with this approach. However, we advise the	Increases in suspended sediment and the nature and distribution of re-deposition is fully detailed within section 7.12.

Date	Consultee and Type of Consultation	Issue(s) Raised	Response to Issue Raised and/or Where Considered in this Chapter
		assessment needs to consider the likely generation of suspended sediment and the nature and distribution of re-deposition also.	
December 2022	NatureScot – Scoping Advice	Impact to designated features - As well as the impact pathways mentioned, we advise that there is also potential for cable installation to cause loss of integrity of designated landforms which are relict and therefore cannot re-form (e.g. moraines).	Section 7.12 assessed the potential for cable installation to cause loss of integrity of designated landforms.
December 2022	NatureScot – Scoping Advice	Physical process changes from scour protection - We welcome the inclusion of potential changes to the tidal, wave and sediment transport regimes as a result of blockage effects from scour protection measures. However, we note that the assessment method refers only to a landfall assessment. We advise that this is not sufficient and that the impact should also be assessed along the corridor, including within the ncMPA. The assessment should also encompass effects from any physical cable protection measures (e.g. rock armour, etc.), not just that deemed as scour protection.	The potential changes to the tidal, wave and sediment regime is fully assessed in section 7.12 along the corridor and including within the ncMPA as a result of any physical cable protection measures including but not limited to scour protection.
December 2022	NatureScot – Scoping Advice	Introduction of scour - The reasoning for scoping out potential scour is unclear, especially as the embedded mitigation merely refers to minimising rock protection and scour protection, and thus a level of protection may still be required. We recommend that the potential introduction of scour is explicitly included within the preceding potential impact as discussed above. This will mean that it is also assessed in combination with any other changes to sediment transport.	Assessment of the potential for scour has been assessed under potential effects during the operational phase in section 7.12.2.
December 2022	NatureScot – Scoping Advice	Approach to impact assessment - Firth of Forth Banks Complex ncMPA. All three areas within the ncMPA need to be considered with respect to the geodiversity features, both alone and in-combination, as part of the assessment on the site. The EIAR should therefore include detailed information and figures on the potential impact to the three areas, as well as the overall MPA. More detailed maps, which include the Firth of Forth Banks Complex ncMPA, particularly in relation to the Cambois Connection, Berwick Bank wind farm, Seagreen Alpha & Bravo wind farm and Seagreen 1A export cable, should be included in EIAR. We also advise that further maps should be included which show the location of protected features within the MPA – please see JNCC mapper for further information."	Table 7.5 details all three areas within the Firth of Forth Banks Complex ncMPA with respect to the geodiversity features including more detailed maps to show the location of designated features within the ncMPA. The assessment covers all three areas within the ncMPA, both alone and in-combination. Section 7.12.1 also assesses for the potential impact on designated interest features, with a MCZ / MPA assessment which is provided as an accompanying document to the Marine Licence applications submitted to MD-LOT and the MMO. A 10 km buffer around the Marine Scheme (equating to double the tidal extent) was applied in determining the

Date	Consultee and Type of Consultation	Issue(s) Raised	Response to Issue Raised and/or Where Considered in this Chapter
			nearby projects scoped in for cumulative effects described below, which only included Seagreen 1 OWF and the Inch Cape OFTO. The Seagreen 1A project was beyond the study area extent and therefore not included. Other operational projects are considered to be part of the baseline.
December 2022	NatureScot – Scoping Advice	Cumulative impacts - As discussed above, the EIAR must consider the cumulative effect of key impacts such as habitat disturbance/loss from Berwick Bank wind farm in combination with the neighbouring wind farms in the Forth and Tay area, especially in relation to impacts across the Firth of Forth Banks Complex ncMPA as discussed above. It would be beneficial for the analysis to contain tables, or another format, to enable accurate assessment of the impact of the project alone and in combination with the neighbouring offshore wind projects, and any other relevant marine activities, which will occur in the Firth of Forth Banks Complex ncMPA. This will need to cover the three areas of the ncMPA, as well as overall for this composite site.	The cumulative assessment detailed in section 7.14.2 take account of all neighbouring installations relevant to the assessment, which are those within the 10 km buffer study area, which is also applied as the zone of influence at approximately double the tidal excursion extent. It is noted that the Seagreen 1 OWF and Inch Cape OFTO fall within the applied study area and are cumulatively assessed in section 5.14.2. The potential for cumulative impacts to designated sites (including but not limited to the Firth of Forth Banks Complex ncMPA) in relation to cumulative projects with the Marine Scheme, under the relevant project phases, is assessed in detail in section 5.14.2.1.3. The cumulative assessment, for the scoped in projects, covers the three areas of the ncMPA and the composite site. In support of the Marine Scheme, the Applicant has also prepared the Marine Scheme MCZ/MPA Assessment, which accompanies this application, and provides further information on CEA for the Firth of Forth Banks Complex ncMPA.
December 2022	NatureScot – Scoping Advice	Mitigation and monitoring - Where impact pathways have been identified and are scoped in, we advise that the full range of mitigation techniques and published guidance is considered and discussed in the EIAR.	Mitigation and monitoring is detailed in section 7.13. Published guidance is detailed in section 7.4 and has guided the completion of the impact assessment in section 7.12.
December 2022	NatureScot – Scoping Advice	Transboundary impacts - We agree that transboundary impacts are scoped out from further consideration in the EIAR.	Noted, transboundary impacts have been scoped out from further assessment as detailed in section 5.14.
January 2023	Centre for Environment Fisheries & Aquaculture Science	Cefas are content with the data sources used identified the marine physical processes baseline.	The key data sources are listed in section 7.6.1

Date	Consultee and Type of Consultation	Issue(s) Raised	Response to Issue Raised and/or Where Considered in this Chapter
	– Scoping Comments		
January 2023	Centre for Environment Fisheries & Aquaculture Science – Scoping Comments	Cefas is content with marine physical processes being defined as pathways not receptors if the assessment does not by this method allow major environmental changes to be unconsidered or unquantified. Cefas notes the receptors (Section 6.1) defined for the project area 'designated sites' and 'bedforms' so is rather broad at this stage. The same Section 6.1 also defines (and also broadly) the relevant aspects of the physical environment that should be considered.	This assessment presents in more detail the potential pathway for effects in addition to what are considered physical environment receptors. The assessment in section 7.12.1, considers in more the detail the designated interest features identified as receptors, elaborating on the broader terms presented in the Scoping Report (BBWFL, 2022c).
January 2023	Centre for Environment Fisheries & Aquaculture Science – Scoping Comments	Cefas notes that for the impacts scoped out the only activity scoped out in Table 6.2 is scour, the reason given being that there is limited potential due to widespread burial and the application of mitigation. However, Cefas consider that mitigation (rock dumping) also leads to secondary scour (in the case of a cable, the dumped rock presents a larger obstruction to flow and so increases the likely scale of scour) so this impact should be calculated and quantified, especially within any designated areas – this is part and parcel of the loss or damage to the seabed and the affected area should be adequately quantified. This is a relatively simple and quick calculation for a desktop assessment and is of particular importance for accurately assessing cumulative impacts.	Assessment of the potential for scour has been assessed under potential effects during the operational phase in section 7.12.2. This also includes consideration of the potential for the development of secondary scour associated with any installed scour protection.
January 2023	Centre for Environment Fisheries & Aquaculture Science – Scoping Comments	Cefas notes for the impacts scoped in the proposed methods (for all impact assessments) are described as 'desktop assessment' i.e., no numerical modelling. In general, I would consider this appropriate for a cable impacts study, but the exact methods (i.e., what desktop studies, which methods, formulae etc,) are not given and so cannot be assessed at this time. In particular, for the impact "changes to the landfall morphology", given the potential to increase environmental despoliation at the eroding landfall site as described in Section 6.5.2, it may become appropriate to conduct a local modelling study for the worst case proposed (cofferdam installation).	Desktop analytical methods used to assess for potential impacts of the Marine Scheme are described within section 7.12.1 for construction phase impacts and section 7.12.2 for operational phase impacts. Following submission of the Scoping Report, the Applicant has confirmed the use of trenchless techniques (such as HDD) for cable installation at the Landfall. Therefore, there is no requirement for a cofferdam or open cut trenching and negates the need for a specific local modelling study at the Landfall.
January 2023	Centre for Environment Fisheries & Aquaculture Science – Scoping Comments	Cefas notes for the embedded mitigation measures the scoping does not provide a detailed review of designed-in mitigation measures. Cefas also notes as outlined in Section 6.6, the principal mitigation for offshore impacts is cable burial for avoidance of scour (which itself leads to direct sediment and seabed disturbance over a similar area), and the placement of rock protection where burial is not possible or at cable crossings, in turn leading to downstream physical process changes over a similar extent. Thus, mitigation	The indirect impacts resulting from the designed in mitigation detailed in section 7.11 are assessed throughout the assessment in section 7.12.

Date	Consultee and Type of Consultation	Issue(s) Raised	Response to Issue Raised and/or Where Considered in this Chapter
		(for largely engineering concerns) creates further impacts at comparable scale and so these should be fully assessed in the EIA.	
January 2023	Centre for Environment Fisheries & Aquaculture Science – Scoping Comments	Cefas notes for the marine physical processes modelling methodology Section 6.3 defines the study areas as the tidal excursion (4 km) rounded up to 10 km – this more than doubling appears adequate but the assessment should also be responsive to any evidence that impacts extend beyond this (this is highly unlikely but would be appropriate, for example, if impacts on a sediment transport pathway are significant and lead to downstream deficits beyond the envelope of direct impacts). This would be of particular importance for accurately assessing cumulative impacts.	The assessment detailed in section 7.12 considers any impacts which may extend beyond the 10 km Study Area based on the completed semi-quantitative analyses of sediment dispersion in relation to flows. Further detail on the completed analyses are presented in section 5.12.1.2.
January 2023	Centre for Environment Fisheries & Aquaculture Science – Scoping Comments	Cefas notes there are no further comments at the scoping stage, as the quantified details of the specific assessments proposed are not yet available.	Noted, no further action.
February 2023	MD-LOT / Scottish Ministers – Scoping Opinion	The Scottish Ministers are content with the study area and baseline data sources described by the Applicant in the Scoping Report regarding the offshore physical environment and seabed conditions.	Noted, the Offshore Physical Environment and Seabed Conditions Study Area is detailed in section 7.3 and the baseline data sources are detailed in section 7.6.1.
February 2023	MD-LOT / Scottish Ministers – Scoping Opinion	In Table 6-2 of the Scoping Report the Applicant summarises the potential impacts to be scoped in and out of the EIA Report during the different phases of the Proposed Works. The Scottish Ministers broadly agree with the Applicant's proposal however advise that NatureScot's representation regarding increases in suspended sediment, impact to designated features, physical process changes from scour protection and introduction of scour must be fully implemented by the Applicant in the EIA Report.	Assessment of the potential increases in suspended sediment, impact to designated features, physical process changes from scour protection and introduction of scour is fully detailed within section 7.12.
February 2023	MD-LOT / Scottish Ministers – Scoping Opinion	In relation to the approach to EIA proposed by the Applicant, the Scottish Ministers advise that the assessment must consider all three areas within the Firth of Forth Banks Complex ncMPA with respect to the geodiversity features both alone and in combination and direct the Applicant to the NatureScot representation on this topic which should be fully addressed in the EIA Report, including the provision of more detailed information, maps and figures to aid assessment.	Table 7.5 details all three areas within the Firth of Forth Banks Complex ncMPA with respect to the geodiversity features including the provision of more detailed maps to aid assessment.
February 2023	MD-LOT / Scottish Ministers – Scoping Opinion	With regard to mitigation outlined by the Applicant at section 6.6 of the Scoping Report, the Scottish Ministers agree with the NatureScot representation that for the impact pathways scoped in the full range of	Noted, the impact assessment considering the impact pathways scoped in is considered in section 7.12.

Date	Consultee and Type of Consultation	Issue(s) Raised	Response to Issue Raised and/or Where Considered in this Chapter
		mitigation techniques and published guidance should be considered and discussed in the EIA Report.	Published guidance is detailed in section 7.4 and has guided the completion of the impact assessment in section 7.12.
February 2023	MD-LOT / Scottish Ministers – Scoping Opinion	In relation to cumulative effects detailed at section 6.8, the Scottish Ministers draw attention to NatureScot representation advising that habitat disturbance and/or loss from the Berwick Bank wind farm, in combination with neighbouring wind farms in the Forth and Tay area, and in particular with regard to those which overlap with the Firth of Forth Banks Complex ncMPA, should be explicitly included within the cumulative impact assessment. The Scottish Ministers consider that the Seagreen Alpha and Bravo wind farm and the Seagreen 1A export cable corridor should be included in Table 4-5 in this regard. The Scottish Ministers further draw the Applicant's attention to NatureScot's recommendation to include tables in their CIA analysis of the Proposed Works which should cover the three areas of the ncMPA composite site as well as the site as a whole.	The cumulative assessment detailed in section 7.14.2 take account of all nearby projects relevant to the assessment including but not limited to BBWF, Scotland to England Green Link 1 amongst others, as listed in Table 7.19. Based on the applied zone of influence of 10 km in relation to the Marine Scheme, export cable corridors in relation to the Seagreen Alpha and Bravo wind farm and the Seagreen 1A were not within the zone of influence and therefore not included in the cumulative assessment, bearing in mind that these are already considered to be part of the baseline.
February 2023	MD-LOT / Scottish Ministers – Scoping Opinion	The Scottish Ministers are in agreement that transboundary impacts on physical processes can be scoped out of the EIA Report as outlined at Table 16-1 of the Scoping Report.	Noted, transboundary impacts have been scoped out, as detailed in section 5.14.
February 2023	MMO – Scoping Opinion	The only activity scoped out in Table 6.2 is scour, the reason given being that there is limited potential due to widespread burial and the application of mitigation. The MMO consider that mitigation (rock dumping) also leads to secondary scour (in the case of a cable, the dumped rock presents a larger obstruction to flow and so increases the likely scale of scour) so this impact should be calculated and quantified, especially within any designated areas – this is part and parcel of the loss or damage to the seabed and the affected area should be adequately quantified. This is a relatively simple and quick calculation for a desktop assessment and is of particular importance for accurately assessing cumulative impacts.	Assessment of the potential for scour has been assessed under potential effects during the operational phase in section 7.12.2. This also includes consideration of the potential for the development of secondary scour associated with any installed scour protection.
February 2023	MMO – Scoping Opinion	The proposed methods (for all impact assessments) are described as 'desktop assessment' i.e., no numerical modelling. The MMO consider this appropriate for a cable impacts study, but the exact methods (i.e., what desktop studies, which methods, formulae etc,) are not given and so cannot be assessed at this time.	Analytical methods used to inform the impact assessments are described within the chapter as relevant under the construction decommissioning phase in section 7.12.1 and operation phase in section 7.12.2.
February 2023	MMO – Scoping Opinion	In particular, for the impact "changes to the landfall morphology", given the potential to increase environmental despoliation at the eroding landfall site as	Following submission of the Scoping Report, the Applicant has confirmed the use of trenchless techniques (such as

Date	Consultee and Type of Consultation	Issue(s) Raised	Response to Issue Raised and/or Where Considered in this Chapter
		described in Section 6.5.2, it may become appropriate to conduct a local modelling study for the worst case proposed (cofferdam installation).	HDD) for cable installation at the Landfall. Therefore, there is no requirement for a cofferdam or open cut trenching and negates the need for a specific local modelling study at the Landfall.
February 2023	MMO – Scoping Opinion	As outlined in Section 6.6, the principal mitigation for offshore impacts is cable burial for avoidance of scour (which itself leads to direct sediment and seabed disturbance over a similar area), and the placement of rock protection where burial is not possible or at cable crossings, in turn leading to downstream physical process changes over a similar extent. Thus, mitigation (for largely engineering concerns) creates further impacts at comparable scale and so these should be fully assessed in the EIA.	Assessment of operational impacts are considered in section 7.12.2, this includes the potential blockage effects associated with Marine Scheme infrastructure (section 5.12.2.1) and the potential for scour (section 5.12.2.2).
February 2023	MMO – Scoping Opinion	Section 6.3 defines the study areas as the tidal excursion (4km) rounded up to 10km – this more than doubling appears adequate but the assessment should also be responsive to any evidence that impacts extend beyond this. This would be of particular importance for accurately assessing cumulative impacts.	The assessment detailed in section 7.12 considers any impacts which may extend beyond the 10 km Study Area based on the completed semi-quantitative analyses of sediment dispersion in relation to flows. Further detail on the completed analyses are presented in section 5.12.1.2. .

7.6. Methodology to Inform Baseline

7.6.1. Desktop Study

17. Information on the offshore physical environment and seabed conditions within the Offshore Physical Environment and Seabed Conditions Study Area was collected through a detailed desktop review of existing studies and datasets. These are summarised in Table 7.3 below.

18. The baseline was characterised by a combination of literature review of the reports.

Table 7.3 Summary of key desktop studies & datasets

Topic	Title	Source	Year	Author
Bathymetry	EMODnet Bathymetry	EMODnet	2021	EMODnet
	Marine Environmental Data Information Network (MEDIN) including Admiralty Marine Data Portal			
	UKHO Bathymetry	ADMIRALTY Marine Data Portal	N/A	N/A
Metocean and Suspended Sediment Concentration	ABPmer - Modelled data on wind, waves and tides	Atlas of UK Marine Renewable Energy	2008	ABPmer
	ABMmer - Seastates Metocean Data and Statistics Interactive Map	Atlas of UK Marine Renewable Energy	2018	ABPmer
	Cefas - WaveNet telemetry data from the Newbiggin Waverider buoy	Cefas	2022	Cefas
	Admiralty Total Tide (ATT) tidal prediction software	UK Hydrographic Office (UKHO)	2022	UK Hydrographic Office (UKHO)
	Real-time/near real-time data display for North Shields	National Tidal and Sea Level Facility (NTSLF)	2023	NTSLF)
	European Centre for Medium-Range Weather Forecasts (ECMWF)	ECMWF	2022	ECMWF
	National Network of Regional Coastal Monitoring Programmes - Metocean data for the Northeast of England	National Network of Regional Coastal Monitoring Programmes	2022	National Network of Regional Coastal Monitoring Programmes
	Suspended Sediment Climatologies around the UK	Cefas	2016	Cefas
	UKCP 18 Science Overview Report	UKCP 18	2018	Lowe *et al.*,
Sediments, Geology and Geomorphology	British Geological Survey - Geological data	British Geological Survey	2001; 2021	British Geological Survey
Coastal Properties	Coastal Cells in Scotland: Cell 1 - St Abb's Head to Fife Ness	N/A	2000	Ramsay and Brampton
	Dynamic Coast - National Coastal Change Assessment: Cell 1 - St Abb's Head to Fife Ness	N/A	*2017*	Hansom *et al.*,
	Dynamic Coast 2	N/A	2021	Rennie *et al.*,
	Monitoring Reports: Cell 1 Sediment Transport Study. Phase 2: Main Report	North East Coastal Observatory	2014	Scarborough Borough Council

Topic	Title	Source	Year	Author
	Northumberland and North Tyneside Shoreline Management Plan 2	North East Coastal Observatory	2009	Northumbrian Coastal Authority Group
	Cell 1 Regional Coastal Monitoring Programme. Analytical Report 14: 'Full Measures' Survey 2021	North East Coastal Observatory	2022	Northumberland County Council
Designated Sites	Coquet to St. Mary's Marine Conservation Zone factsheet	Defra	2016	Defra
	Farnes East Marine Conservation Zone factsheet	Defra	2016	Defra
	Berwick to St. Mary's Marine Conservation Zone site details	Defra	2019	Defra
	Farnes East MPA Summary	JNCC	2017	JNCC
	Tynemouth to Seaton Sluice SSSI Citation and Conditions of Features and Units	Natural England	1989; 2011	Natural England
	Creswell and Newbiggin Shores SSSI Citation and Conditions of Features and Units	Natural England	1992; 2012	Natural England
	Northumberland Shore SSSI Citation and Condition of Units	Natural England	1992; 2009	Natural England
	Natural England Conservation Advice for Marine Protected Areas. Coquet to St Mary's MCZ Site Information	Natural England	2019	Natural England
Supporting Information	Berwick Bank Wind Farm (BBWF) Offshore Environmental Impact Assessment. Volume 2, Chapter 7: Physical Processes and Appendix 7.1: Physical Processes Technical Report	BBWFL	2022	BBWFL
Supporting Information (Third-Party EIA)	Environmental baseline for Eastern Green Link 1	https://marine.gov.scot/data/marine-licence-application-segl-eastern-link-1-hvdc-cable-and-cable-protection-torness-hawthorn	2022	National Grid and Scottish Power
Supporting Information (Third-Party EIA)	Environmental baseline for Eastern Green Link 2	https://marine.gov.scot/data/marine-licence-application-segleastern-link-2-hvdc-cable-and-cable-protection-peterhead-drax	2022	National Grid Electricity Transmission and Scottish and Southern Electric Networks Transmission (SSEN)
Supporting Information (Third-Party EIA)	Environmental baseline for the BBWF EIA (in particular the survey results from the benthic surveys for the BBWF area)	https://www.berwickbank.com/planning-and-consent	2022	SSE
Supporting Information (Third-Party EIA)	Environmental baseline for Norway-UK Interconnector UK Marine Environmental Statement	https://northsealink.com/media/1196/p1568_rn3057-norway-uk-environmental-statement.pdf	2014	National Grid NSN Link Limited

Topic	Title	Source	Year	Author
Supporting Information (Survey output specific to the BBWF)	00338 SSE Berwick Bank Lot 1 and 2 Operations and Results Report Proposed Development export cable corridor.	XOCEAN Ltd	2021	XOCEAN Ltd.
	Geophysical survey Proposed Development array area and Proposed Development export cable corridor. Geophysical study to establish bathymetry, seabed geology, morphology and sediments	Fugro	2020	Fugro (2020a) and Fugro (2020b)
	Benthic subtidal survey Proposed Development array area and Proposed Development export cable corridor. Grab and Drop-Down Video (DDV) sampling with chemical analysis and particle sieve analysis	Ocean Ecology Ltd	2021	Ocean Ecology Ltd.
	SSE Berwick and Marr Bank Metocean Proposed Development array area Waverider buoy deployments	Partrac	2020	Partrac (2020)
Supporting Information (Third-Party EIA	Environment; Volume 3: Appendix E2 Metocean and Geophysical Surveys; and Volume 3: Appendix E3: Geomorphological Assessment	Seagreen and Royal Haskoning DHV	2012a; 2012b; 2012c	Royal Haskoning DHV

7.6.2. Site-specific Surveys

19. Site specific surveys provide more detailed and up to date information across the Marine Scheme to complement the publicly available data referred to in section 7.6.1. Baseline surveys carried out by the Applicant to support the separate EIA and consenting process for the BBWF with coverage over the northernmost extent of the Scottish Marine Scheme have also informed this chapter. In addition to surveys covering the baseline characterisation extent of the BBWF array, which overlaps the Marine Scheme.

20. A summary of the site-specific surveys undertaken to inform the offshore physical environment and seabed conditions assessment of effects are outlined below. During July to September 2022 XOCEAN undertook geophysical surveys across the Marine Scheme. The information that was obtained was Sub-bottom profiler data (SBP), Unmanned Aerial Vehicle (UAV) data using a senseFly eBeeX and Hull-mounted Norbit Winghead Multi-Beam Echo Sounder (MBES) data. Volume 4, Figure 7.2 shows the site-specific survey 'survey corridors' with the naming convention used (XOCEAN, 2022), which have helped inform the geological and geomorphological baseline characterisation in section 7.7.1.2.

21. An environmental and benthic habitat sampling survey was also completed across the Marine Scheme by Natural Power (2023), which included sampling, analyses and characterisation of seabed sediment. Across the Marine Scheme, of the 110 proposed sample locations (Volume 4, Figure 7.3), a total of 58 stations were successfully sampled and analysed for particle size analyses (PSA), which directly inform the baseline characterisation in section 7.7.1.2.3.

22. Geophysical and benthic survey campaigns were undertaken in 2019, 2020 and 2021 for the BBWF array area as outlined in Table 7.4 below.

Table 7.4 Summary of site-specific survey data

Title	Extent of Survey	Overview of Survey	Survey Contractor	Date
Geophysical survey[5]	BBWF array area	High resolution side scan sonar and multibeam bathymetry	Fugro Ltd.	2019 and 2021
Benthic survey[5]	BBWF array area	Grab samples, DDV sampling and epibenthic trawls	Ocean Ecology Ltd	2020
Geophysical Survey[5]	BBWF array area	Geophysical study to establish bathymetry, seabed geology, morphology and sediments	XOCEAN Ltd.	2021
Geophysical survey	Proposed export cable corridors	Geophysical study to establish bathymetry, seabed geology, morphology and sediments	XOCEAN Ltd.	2022
Cambois connection benthic ecology baseline. Phase I survey report	Proposed export cable corridors	Environmentaal and benthic survey including seabed sediment and benthic sampling	Natural Power Ltd	2023 (I)
Cambois connection benthic ecology baseline. Phase 2 survey report	Proposed export cable corridors	Environmentaal and benthic survey including seabed sediment and benthic sampling	Natural Power Ltd	2023 (II)
Review of completed XOCEAN (2022) survey	Proposed export cable corridors	Review and reanalyses of XOCEAN (2022) geophysical survey	Hydrofix Ltd	2023

[5] As reported within the consent applications and supporting EIA for the BBWF.

7.7. Baseline Environment

23. The baseline characterisation provides a description of physical features in the marine environment which are expected to become influenced by the Marine Scheme. These features include the local seabed, adjacent coastline, metocean (tides, currents and waves) and properties of the water column (turbidity, temperature and salinity where available). This description set out in section 7.7.1 helps to establish the reference condition against which the potential physical effects of the development are assessed.

24. In addition, the baseline represents the offshore physical environment and seabed conditions that are expected to prevail without any development taking place and with consideration of a suitable duration to cover construction, operation and maintenance, and decommissioning phases. The description of the future baseline without any development occurring is summarised in section 7.7.2.

7.7.1. Overview of Baseline Environment

7.7.1.1. DESIGNATED SITES

25. Designated sites relevant to the offshore physical environment and seabed conditions in the vicinity of the Marine Scheme are shown in Volume 4, Figure 7.4 and described in Table 7.5. The Marine Scheme directly intersects four designated sites, including Firth of Forth Banks Complex Nature Conservation Marine Protected Areas (ncMPA) (JNCC, 2014); Northumberland Shore Site of Scientific Interest (SSSI) (Natural England, 1992b), Berwick to St Mary's MCZ) (designated for common eider only6, and not discussed further in this chapter) and Coquet to St Mary's MCZ (Defra, 2016a). The Offshore Physical Environment and Seabed Conditions Study Area intersects a further three sites, specifically Farnes East MCZ (Defra, 2016b); Creswell and Newbiggin Shores SSSI and Geological Conservation Review (Natural England, 1992a); and Tynemouth to Seaton Sluice SSSI and Geological Conservation Review (GCR) (Natural England, 1992b), the details of which are presented in Table 7.5.

26. Although the Marine Scheme presently overlaps three protected sites the degree of direct interaction between the Marine Scheme and these designated sites will be subject to the finalisation of the Offshore Export Cable Route by the Applicant. Any interaction between a designated site and the Marine Scheme has also been assessed fully through a Marine Conservation Zone (MCZ)/ Marine Protected Area (MPA) assessment which is provided as an accompanying document to the Marine Licence applications submitted to MD-LOT and the MMO.

[6] Please refer to the MPA and MCZ Assessment for further details – as explained above, this MCZ is designated for the common eider only and is not considered within the physical environment and seabed conditions chapter.

Table 7.5 Designated Sites and Relevant Qualifying Interest Features for the Physical Processes

Designated Site	Distance	Relevant Qualifying Interest Feature(s)	Location / Jurisdiction
Firth of Forth Banks Complex ncMPA	0.00 km (Overlaps with Marine Scheme)	• Offshore subtidal sands and gravels; • Shelf banks and mounds; and • Quaternary of Scotland – moraines;	Scotland
Northumberland Shore (Site of Special Scientific Interest) SSSI	0.00 km (Overlaps with Marine Scheme)	• Sandy bays separated by rocky headlands with wave-cut platforms; • Estuarine intertidal mudflats; and • Estuarine intertidal saltmarsh.	England
Coquet to St Mary's MCZ	0.00 km (Overlaps with Marine Scheme)	• Low energy tidal rock • Moderate energy intertidal rock • High energy intertidal rock • Intertidal mixed sediments • Intertidal coarse sediments • Intertidal sand and muddy sand • Intertidal mud • Intertidal under boulder communities • Peat and clay exposures • Moderate energy infralittoral rock • High energy infralittoral rock • Moderate energy circalittoral rock • Subtidal coarse sediment • Subtidal sand • Subtidal mixed sediments • Subtidal mud	England
Farnes East MCZ	0.18 km WSW	• Moderate energy circalittoral rock • Subtidal coarse sediment • Subtidal mixed sediments • Subtidal sand • Subtidal mud	England
Cresswell and Newbiggin Shores SSSI and GCR (GCR code 2938) (containing Sandy Bay GCR (GCR code 2025))	0.86 km WNW	• Sandy bay • Earth Heritage – • Littoral Sediment	England
Tynemouth to Seaton Sluice SSSI and GCR	6.6 km SSE	• Geological cliff exposures • Geological foreshore exposures	England

7.7.1.2. GEOLOGICAL AND GEOMORPHOLOGICAL

7.7.1.2.1. BATHYMETRY AND MORPHOLOGY

27. The water depths across the Offshore Physical Environment and Seabed Conditions Study Area are provided from EMODnet and are supported by a combination of survey datasets which are available under the European Inspire Directive and site-specific geophysical survey as introduced in section 7.6.2. The bathymetry across the Offshore Physical Environment and Seabed Conditions Study Area ranges from approximately 100 m below Lowest Astronomical Tide (m LAT) at isolated points within the Offshore Export Cable Corridor just beyond the 12 nm limit to less than 30 m LAT at the proposed Landfall location (EMODnet, 2021; ADMIRALTY Marine Data Portal). Characterisation of the present bathymetry and morphology across the Marine Scheme is discussed in relation to the regional waters in which they occur in the sections below.

Scottish Waters

28. The Marine Scheme covering the BBWF array area is located within Scottish waters, while the Offshore Export Cable Corridor is predominantly located in English waters as discussed below.

Specific to the BBWF array area within the Marine Scheme, water depth varies between 39 m and 68 m LAT (BBWFL, 2022a). The average depth within the Marine Scheme which overlaps the BBWF array area was generally recorded as being 50 m and 60 m LAT, Volume 4, Figure 7.5.

29. The seabed within the Offshore Physical Environment and Seabed Conditions Study Area is influenced by the presence of large-scale morphological bank features, including the Marr Bank and the northern part of Berwick Bank. These features are defined as Shelf Banks and Mounds which form part of the First of Forth Banks Complex (BBWFL, 2022a; 2022b). Slopes within the BBWF array area within the Marine Scheme, vary with respect to the morphological bank bedforms.

English Waters

30. The majority of the Marine Scheme is located in English waters. The bathymetry varies across the Marine Scheme geophysical survey area as demonstrated in Volume 4, Figure 7.5. The shallower depths measured at approximately 50 m to 60 m LAT, while the deepest depth was recorded at approximately 80 m to 110 m LAT within the Marine Scheme. Within the extents of the Marine Scheme, more up to date understanding was obtained from the site-specific geophysical survey (XOCEAN, 2022) and reanalyses completed by Hydrofix (2023), which were both based on high-resolution MBES survey as well as Unmanned Surface Vehicle (USV) bathymetric data in intertidal and low water areas. Site-specific survey, seabed depths and morphological understanding is summarised in Volume 4, Figure 7.6. Generally, the presence of the varying morphological bedforms, along with the asymmetry and orientation with respect to the flow, all indicate that these bedforms are actively evolving in relation to the flow regime.

31. Geophysical surveys within the survey corridors, indicate the presence of megaripples and sandwaves as summarised in (Volume 4, Figure 7.6) (XOCEAN, 2022; Hydrofix, 2023). Megaripples present vary significantly in size throughout the geophysical survey cable corridors. Megaripples observed in L05 (as illustrated in Volume 4, Figure 7.2), which is located at the most northern section of the export cable corridor, where water depths are approximately between 52 m LAT and 80 m LAT have a wavelength of up to 10 m and height of up to 0.2 m (Hydrofix, 2023). Also present are sandwaves, with a wavelengths of around 130 m and bedform height of around 0.5 m. The megaripples and sandwaves have a crest orientation of predominantly northeast to southwest, with some megaripples orientated northwest to southeast (Hydrofix, 2023). Less defined bedforms are present intermittently across survey corridor L07, although where coherent are considered to be megaripples, with wavelength and height of 50 m and 0.7 m respectively (Hydrofix, 2023). Other bedforms include striations with wavelength and heights of 90 m and 0.1 m respectively.

32. Across survey corridor L12 (as illustrated in Volume 4, Figure 7.6), located approximately 40 km from the BBWF array area, where water depths are approximately between 64 m LAT and 104 m LAT a variety of morphological bedforms are observed (XOCEAN, 2022; Hydrofix, 2023). Also present were geological rock ridges comprising of outcropping Quaternary rock expected to consist of the Wee Bankie Formation. The Wee Bankie Formation comprises over-consolidated sandy and gravelly till with interbeds of fluvial sand and pebbly sand, with occasional accumulations of coarse sand and gravel. It is also expected to contain significant volumes of cobbles and boulders (Hydrofix, 2023). Mobile morphological bedforms within the L12 survey corridor mainly comprised sandwaves with wavelengths of around 200 m and heights of up to 2.8 m, with a crest orientation of northeast to southwest (Hydrofix, 2023).

33. Plate 7.1 displays the bathymetric profile transect along survey corridor L11 (as illustrated in Volume 4, Figure 7.2), located offshore approximately 40 km from the BBWF array area along the export cable corridor within the Marine Scheme.

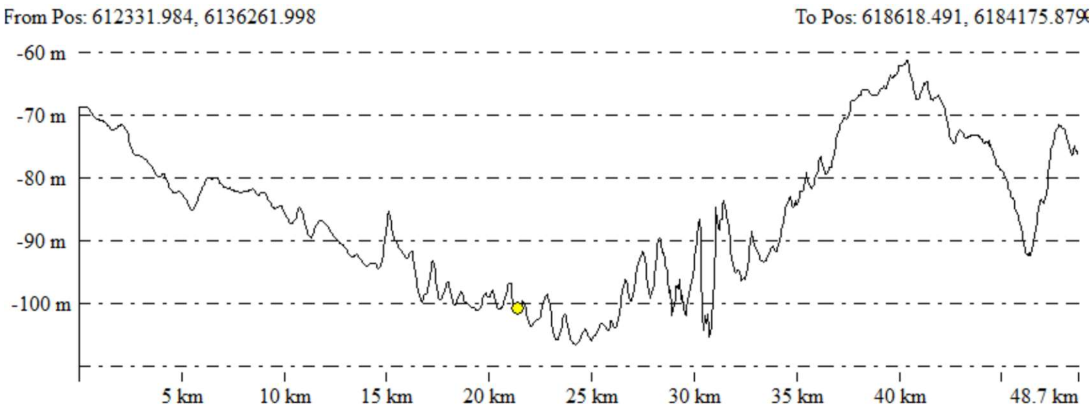

Plate 7.1 L11 bathymetry profile showing changes in elevation.

34. Across the geophysical survey corridor L15, poorly formed bedforms (no dimensions are available) with the presence of extensive dredging scars (Hydrofix, 2023). Towards the Landfall, a transect profile along survey corridor L16 (as illustrated in Plate 7.1), presents the most nearshore area of the site-specific survey, extending from the Landfall at Cambois, Northumberland to approximately 3.75 km offshore. The shallowest depth here was observed to be -1.94 m m LAT (i.e. inter tidal) and the deepest point to be approximately 26.5 m LAT, as shown in Plate 7.1 Based on the Hydrofix interpretation of survey data from this survey corridor, no significant bedforms are identified within survey corridor L16 (Hydrofix, 2023).

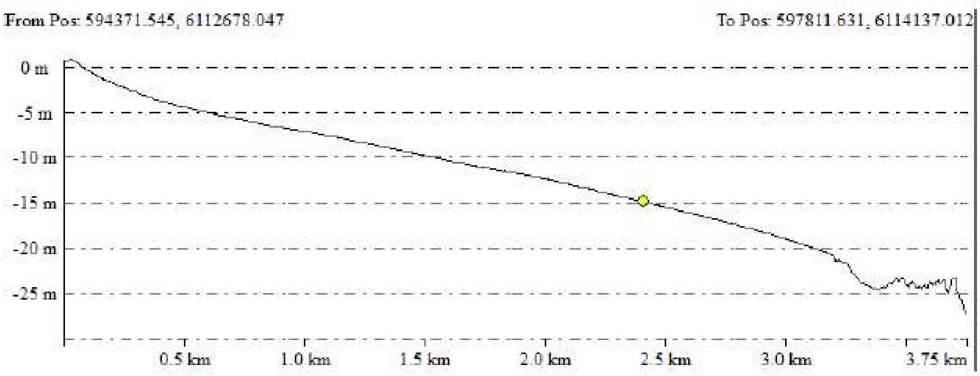

Plate 7.2 L16 bathymetry profile showing changes in elevation.

7.7.1.2.2. BEDROCK AND QUATNERARY GEOLOGY

35. The basic structural framework of bedrock geology within the North Sea is primarily a result of Upper Jurassic/Lower Cretaceous rifting, with partial control from older structural elements (Norwegian Petroleum Directorate, 2020).

Scottish Waters

36. Geology within the Marine Scheme within Scottish waters, covering the BBWF array area and a small part of the Offshore Export Cable Corridor comprises Mesozoic interbedded sedimentary sandstone (Volume 4, Figure 7.7). Geophysical surveys within the Marine Scheme, in survey corridor L05, did not identify any bedrock or Quaternary rock. Instead, loose Holocene sediment (representative of the bank formations) was said to occur at depths of up to and greater than 7 m (XOCEAN, 2022). There is no evidence of outcropping rock within the Marine Scheme, within Scottish waters.

English Waters

37. Within English waters, two bedrock lithologies broadly characterise the Marine Scheme and Offshore Physical Environment and Seabed Conditions Study Area based on BGS (2020). This comprises Palaeozoic sedimentary rock of the Coal Measures Group (extending 6.5 km east of the proposed Landfall area), indicating the potential for coal within the unit. Further offshore, and extending a further 67 km east, is the occurrence of a Mesozoic interbedded unit comprising of Permian mudstone. The BGS (2020) also identifies the potential for three unnamed igneous (magmatic) intrusions (Carboniferous to Permian), approximately between 1 km and 5 km from the shoreline which intersect with the Marine Scheme. These intrusions are known to outcrop onshore at Alnwick approximately 30 km north of the Marine Scheme. Although the recent geophysical survey identified outcropping Palaeozoic sedimentary bedrock in the Landfall area (within survey corridor L16, as illustrated in Volume 4, Figure 7.6), it did not note the presence of any coal fissures or igneous intrusions exposed at the seabed surface (XOCEAN, 2022), however, there is noted to be a coal exposures within the Onshore Scheme. The Landfall area extending from the shoreline comprises heavily faulted geology in an easterly trending direction is present extending approximately to a maximum of 17 km from the shoreline (BGS, 2020). An area of rock and hard substrate (defined as rock or clasts > 64 mm within 0.5 m of the seabed) extends approximately 8.7 km east of the proposed Landfall site (Volume 4, Figure 7.7).

38. Regional mapping of the Offshore Physical Environment and Seabed Conditions Study Area indicated the Quaternary geology to be typically made up of diamict (poorly sorted substrate of terrestrial origin) Quaternary deposits (i.e. glacial till), punctuated with regions of firm to hard mud, sand and gravel and undifferentiated deposits. Outcropping ridges of Quaternary rock are observed within the geophysical survey corridors, including in L12, L15 and L16 (XOCEAN, 2022; Hydrofix, 2023). These deposits range in thickness from less than 5 m to between 30 m and 50 m.

39. The composition of the shallow geology within the Marine Scheme was interpreted during the geophysical survey (XOCEAN, 2022). The majority of the Marine Scheme was dominated by Holocene sediment deposits which were mainly 0-7 m thick with coarser sediments sitting below this unit. Immediately seaward of the Landfall area at Cambois, outcropping Quaternary rock was observed which extended approximately 4 km offshore (XOCEAN, 2022; Hydrofix, 2023). This is supported by the BGS regional mapping indicating quaternary deposits of 0-5 m extend to approximately 6 km offshore, whilst the majority of the Marine Scheme deposits are between 5-20 m.

7.7.1.2.3. SEABED SEDIMENT

40. The interpretation of the geophysical survey provides a description of the seabed sediments derived from backscatter and compared to and complemented by the British Geological Survey (BGS) Seabed Folks classification. The sediment type was classified as either:

- Mud: Low acoustic reflectivity with no real texture; mainly sandy mud and muddy sand;
- Fine Sand: Low acoustic reflectivity with a relatively smooth texture; predominately muddy sand, slightly gravelly muddy sands, gravelly muddy sand, sand, slightly gravelly sand and gravelly sand;
- Coarse Sand: Low to medium acoustic reflectivity with areas of mixed sediments common; gravelly muddy sand, gravelly sand, slightly gravelly sand and sandy gravel;
- Fine Gravel: Medium acoustic reflectivity with areas of mixed sediments common and coarse texture in places; sandy gravel and gravelly sand; and
- Outcrop with veneer sediment: High acoustic reflectivity with rock texture in backscatter and lower acoustic signal in between (XOCEAN, 2022).

41. PSA of sediment samples acquired during environmental and benthic surveys (Natural Power, 2023) as introduced in section 7.6.2, indicate sediments predominantly have a large composition

of sand. More specifically, the composition comprises medium, fine and very fine sand, with a mean grain size range of 250-500 µm, 125-250 µm and 63-125 µm, for medium, fine and very fine sand respectively. The most frequent sediment classification is muddy sand, with 38 of the 58 samples being of this sediment type (Natural Power, 2023). The percentage composition of different sediment fraction from the 58 sampled locations across the Marine Scheme (Volume 4, Figure 7.3) is summarised in Table 7.6.

42. Interpretation of PSA data can be considered to be more reliable as this is often used to ground truth geophysical backscatter data. The PSA information from across the Marine Scheme provides a greater degree of resolution than is represented by the surveyed backscatter, and therefore provides a better representation of the sediment classification.

Table 7.6 Summary of seabed sediment characterisation based on 58 sampled locations across the Marine Scheme from Natural Power (2023)

	GRAVEL	SAND	MUD
Minimum	0.00%	31.24%	4.23%
Maximum	52.29%	93.26%	58.52%
Mean	5.99%	72.96%	21.05%
Median	0.24%	77.39%	17.78%

43. Characterisation of the seabed sediment is again distinguished by the regional waters in the sections below, based on the available backscatter and PSA data.

44. As described in section 7.6.2, site-specific surveys completed for the BBWF have been used to provide supporting baseline information for the Marine Scheme EIA; Plate 7.3 below provides a summary of the sediment composition from PSA at sampling locations within the BBWF array area.

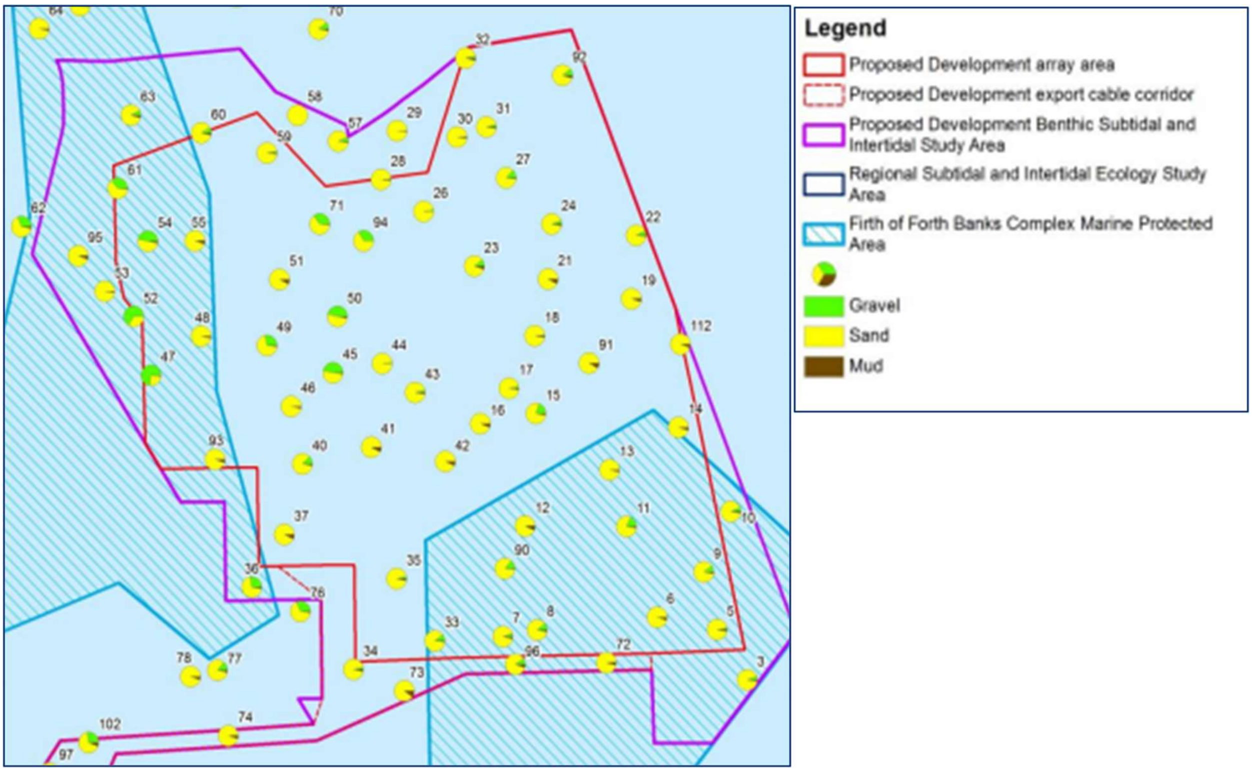

Plate 7.3 Sediment Composition (from PSA) at Each Benthic Grab Sample Location

Scottish Waters

45. Across the BBWF array area, seabed sediment from regional mapping indicate the dominance of sand (Volume 4, Figure 7.8). although geophysical interpreted sediment indicate the presence of hard substrates, mixed sediment and muddy sediment (Plate 7.3; BBWFL, 2022b).

46. Within the Offshore Export Cable Corridor, within the Marine Scheme in Scottish waters, the majority of the surveyed area indicates regions of muddy sand (XOCEAN, 2022; Hydrofix, 2023), characterised by primarily fine sand with small proportions of coarse sand and fine gravel sediment, as demonstrated in Volume 4, Figure 7.9 (Natural Power, 2023). The broad characterisation of seabed sediment from backscatter and PSA interpretation are broadly aligned with regional mapping from the BGS (BGS, 2022) (Volume 4, Figure 7.8).

English Waters

47. Geophysical survey corridors L05, L07 and L12 (as illustrated in Volume 4, Figure 7.8) located in English waters have been re-interpreted, with results presented in Hydrofix (2023). Within the survey corridors, sediment is predominantly muddy sand, with a mixture of muddy sand, gravelly muddy sand, muddy sandy gravel, sandy gravel and gravelly muddy sand also being present within the survey corridor L07 Hydrofix (2023). In corridor there is the additional outcropping Quaternary rock, contributing cobbles and boulders.

48. At the Landfall, within the L16 geophysical survey corridor (as illustrated in Volume 4, Figure 7.6), seabed sediments interpreted from backscatter were considered to be of two distinct types based on Hydrofix (2023):

- Up to and in proximity to the Landfall exit, the seabed comprises predominantly sand with isolated instances of outcropping Quaternary rock; and
- Beyond the Landfall exit, from about 15 m LAT and deeper, the L16 survey corridor comprises outcropping Quaternary rock, with patches of sandy mud.

49. PSA data of samples in this region confirm the presence of fine sand in proximity to the Landfall exit as illustrated in Volume 4, Figure 7.9 (Natural Power, 2023). The outcropping Quaternary rock, interspersed with muddy sand continues for much of the Marine Scheme within the geophysical survey corridor L15.

7.7.1.3. WAVE AND WIND CLIMATE

50. Throughout the North Sea, strong winds can occur with wave heights depending greatly on fetch limitations and water depths effects. Waves in the northern North Sea can be generated by local winds (i.e. wind waves) or travel into the region having been generated elsewhere in the Atlantic Ocean (i.e. swell waves). The mean annual wave height within the Offshore Physical Environment and Seabed Conditions Study Area ranges from approximately 1.17 m at the proposed Landfall location to approximately 1.59 m within the offshore extent of the Offshore Export Cable Corridor. There is a seasonal variation in the mean annual wave height, with spring and winter mean annual wave heights ranging from 0.85 – 1.05 m and 1.43 – 2.07 m respectively (ABPmer, 2008). However, in some cases extreme wave conditions (greater than 4 m) can be experienced from the entire eastern sector (0º to 180º) (HR Wallingford, 2012).

51. As part of the Cefas WaveNet network of buoys across the UKCS, one is installed in the Firth of Forth, near the northern extent of the Marine Scheme, in a water depth of 65 m chart datum (CD) and another installed at Newbiggin, near the Cambois landfall, from 2013 until present. The timeseries of wave properties is unavailable from for the Firth of Forth buoy, however, a graphical review of the significant wave heights between June 2022 and June 2023, indicate an average significant wave height of around 1 m, and maximum of 6.5 m associated with a storm event in November / December 2022, although the peak significant wave heights are typically less than 3 m (Cefas, 2023). The mean peak period is around 6.7 seconds and peak wave direction is from the east to northeast.

52. Timeseries of wave data is available to download for the Newbiggin buoy, which has been operational from August 2008 to the present, with information accessed through the National Network of Regional Coastal Monitoring Programmes. The Newbiggin buoy is located approximately 3.5 km north of the proposed Landfall location, within the Offshore Physical Environment and Seabed Conditions Study Area, in a water depth of 18 m CD. Since commissioning, the significant wave height (i.e., the mean wave height of the highest third of all waves) reached a maximum of 6.3 m in the early months of 2018, associated with a storm event (Cefas, 2022).

53. A wave rose summarising the wave conditions from the Newbiggin wave observation site is presented in Plate 7.4, for the years between 2013 and 2021 (National Network of Regional Coastal Monitoring Programmes, 2022). In 2022, the significant wave height was greatest in December, reaching 1.34 m, and lowest in August, with a maximum of 0.5 m. The peak wave period was greatest in January reaching 11.7 seconds and was lowest in August reaching 6.0 seconds (National Network of Regional Coastal Monitoring Programmes, 2022). The significant wave height on average in 2022 was 0.92 m with an average peak wave period of 7.8 seconds (National Network of Regional Coastal Monitoring Programmes, 2022). The dominant wave direction based on observations is waves approaching from the north-northeast to northeast, at just under 26% of the time and a secondary approach direction from the southeast, approximately 12% of the time.

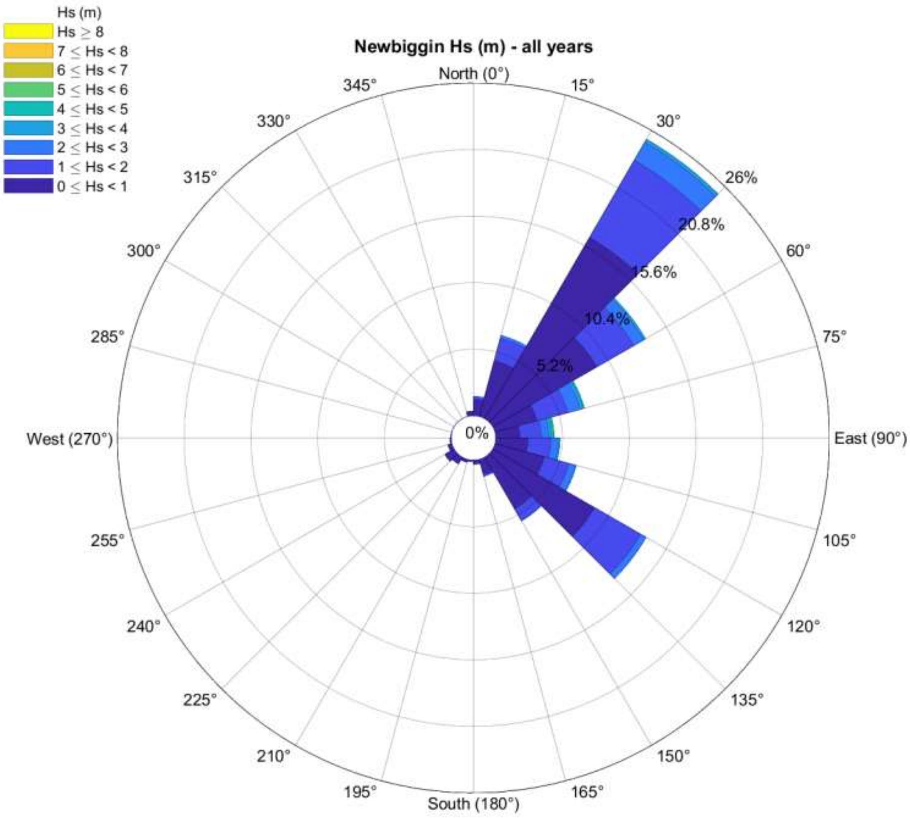

Plate 7.4 Wave rose from the Newbiggin buoy, for observations between 2013 and 2021 (National Network of Regional Coastal Monitoring Programmes, 2022)

54. As part of the BBWF EIA, wave modelling was undertaken of the BBWF array area which forms part of the Marine Scheme Offshore Physical Environment and Seabed Conditions Study Area (BBWFL, 2022b). For the modelling, the 22-year ECMWF Operational Wave model database was used. Plate 7.5 shows the wave and wind roses in the centre of the BBWF array area. This shows the dominant approach from the north-northeast directional sector, in line with observations from the Newbiggin wave buoy (Plate 7.4). Within the BBWF array area, Plate 7.5 shows that the north-northeast directional sector also contains the largest contribution of waves reaching a significant wave height between 1 and 2 m. The wave rose also indicates there is sufficient fetch from multiple directions to enable the development of local waves, with smaller significant wave heights.

55. Plate 7.5 also shows the wind rose for the same location in the BBWF array area, which was analysed on the same sectoral basis as the wave data to provide an indication of the return period wind speed. Across the Offshore Physical Environment and Seabed Conditions Study Area, the mean wind speed ranges from approximately 5.46 to 9.73 m/s, with evidence of seasonal variations. Throughout the summer months, the mean wind speed ranges from 5.28 to 7.22 m/s, with mean wind speed throughout the winter months ranging from 6.42 to 11.51 m/s (ABPmer, 2008).

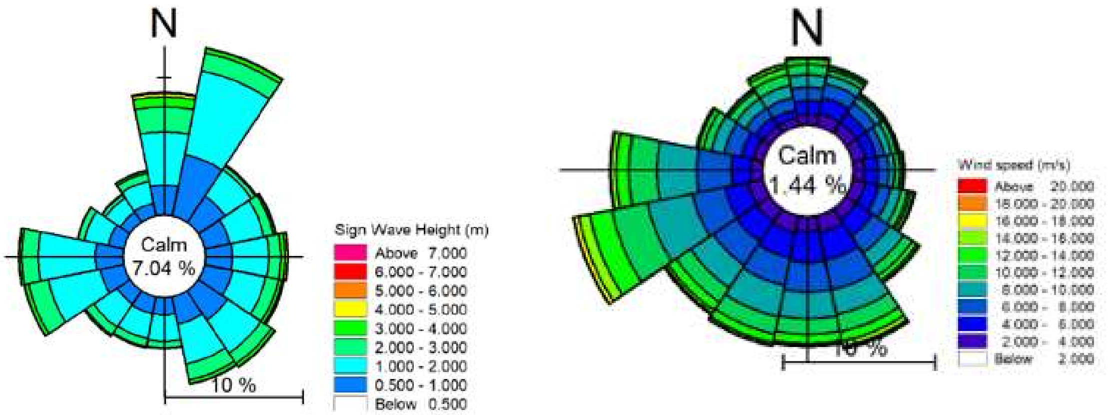

Plate 7.5 Wave rose (left) and wind rose (right) for the BBWF array area – 22 Year ECMWF (BBWFL, 2022

56. Further modelled information from the BBWF EIA is included in Plate 7.6, which shows the wave roses at the model boundaries surrounding the BBWF array area (BBWFL, 2022b). This indicates a shift from the north-northeast dominance at the array area to a northerly dominance further offshore. This sector also shows the dominant wave height is again between 1 and 2 m. However, there is also an increase in the proportion of waves with significant wave height 2 m and above.

57. Consideration of the potential extreme wave properties across the BBWF area and part of the Marine Scheme are illustrated in Plate 7.7 and Plate 7.8 below, for the 1:1-year and 1:20-year return period events respectively, both modelled from a northerly (000o) direction. Plate 7.6 shows a increase in the significant wave height in the offshore direction. Although not directly represented below, the immediate Landfall of the Marine Scheme is likely to be on the order of 0.6 to 1.2 m, before quickly increasing to between 3.0 to 3.6 m a few kilometres offshore from the coast. For the majority of the Marine Scheme and covering the BBWF array area significant wave heights of between 5.4 to 6 m are modelled to be the dominant 1:1-year significant wave height (Plate 7.7)). Even larger significant wave heights are modelled associated with the 1:20-year return period event, with significant wave heights between 6.6 – 7.8 m being present across the majority of the Marine Scheme and BBWF array area.

58. Plate 7.8 would also suggest the potential shoaling effect on larger return period waves from the sandbanks within the Firth of Forth Complex. Further modelling results presented in the BBWF EIA (BBWFL, 2022a) and Appendix 7.1: Physical Processes Technical Report of the BBWF Offshore ES (BBWFL, 2022b) demonstrate that wave climates from north easterly (045º) and easterly (090º) directions give rise to lower wave heights for the same return period than that presented in Plate 7.7 and Plate 7.8.

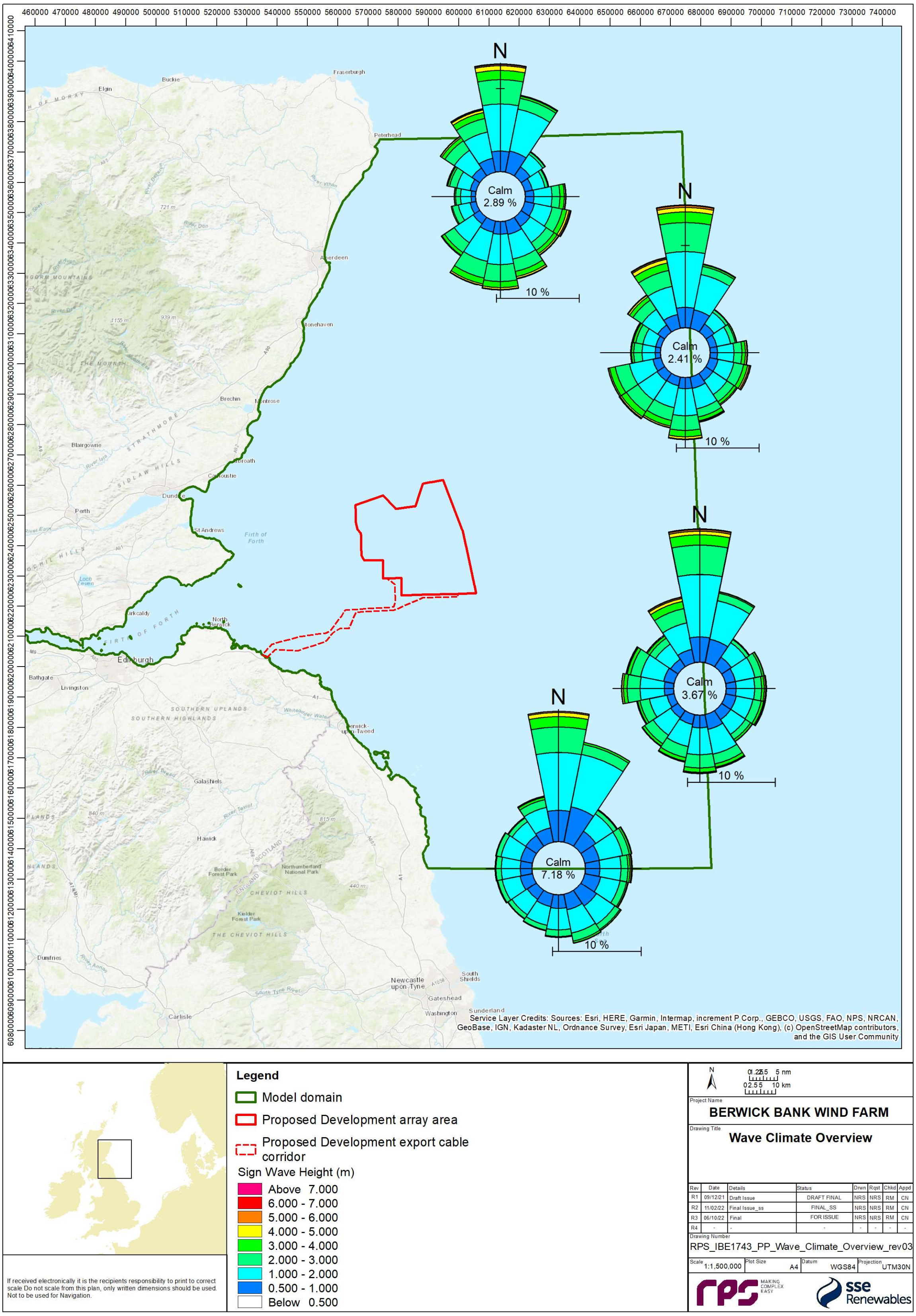

Plate 7.6 Wave roses for model boundaries – 22 Year ECMWF dataset (BBWFL, 2022b)

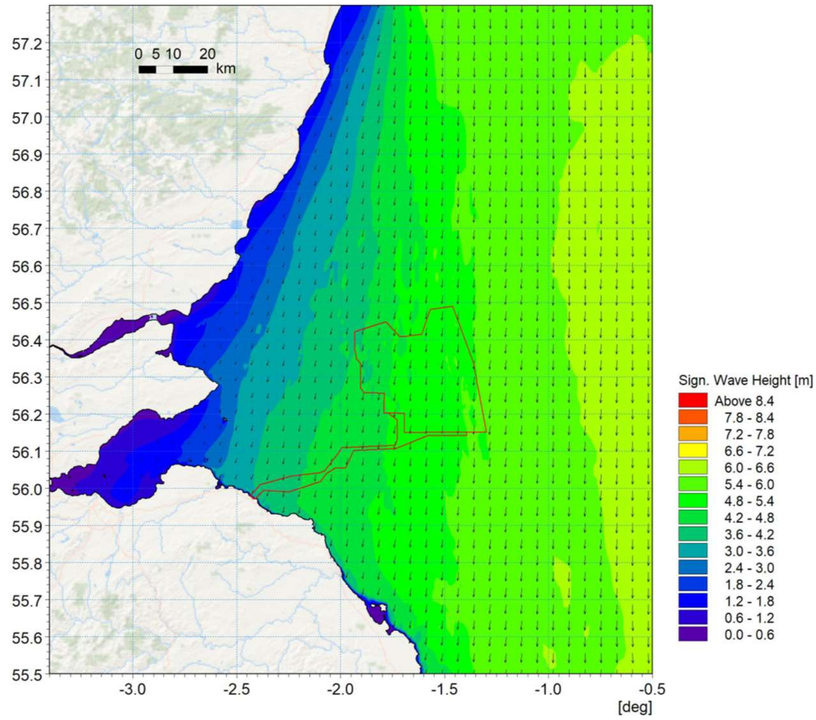

Plate 7.7 Wave climate 1:1 year storm from 000° at mid-tide (BBWFL, 2022b).

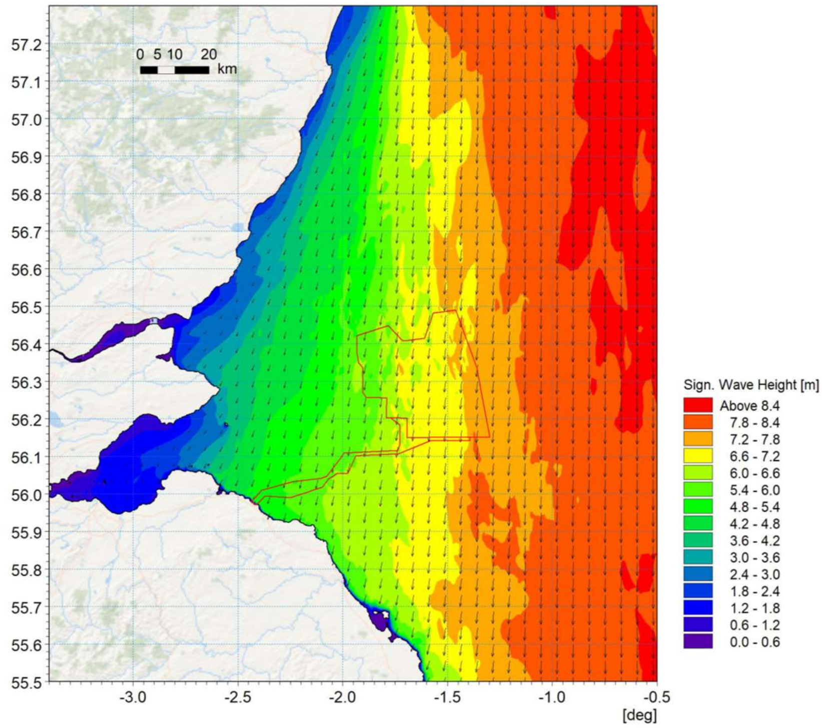

Plate 7.8 Wave climate 1:20 year storm from 000° at mid-tide (BBWFL, 2022b).

7.7.1.4. TIDAL LEVELS AND CURRENTS

59. The tidal range varies across the Offshore Physical Environment and Seabed Conditions Study Area. The main variation in local water levels is due to tidal influences. The National Tidal and Sea Level Facility (NTSLF) provides monitoring of real time and historic tidal gauge information. The nearest national tidal gauge to the Landfall is located in North Shields, in north-east England. The tidal gauge is located south of the Landfall, approximately 14 km from the Marine Scheme. Plate 7.9 shows the tidal levels for a month period (01 March 2022 to 31 March 2022). The period of observations in 2022 covers a month, which spans two spring-neap cycles. Astronomical predictions are shown in red and are highly comparable to the observations. Table 7.7 displays the water levels for the same tidal gauge located in North Shields. The spring range is shown to be approximately 4.5 m while the neap range is approximately 2 m. This is supported by the tidal levels presented in Table 7.7 which show the mean spring tidal ranges and mean neap tidal ranges to be in the same region.

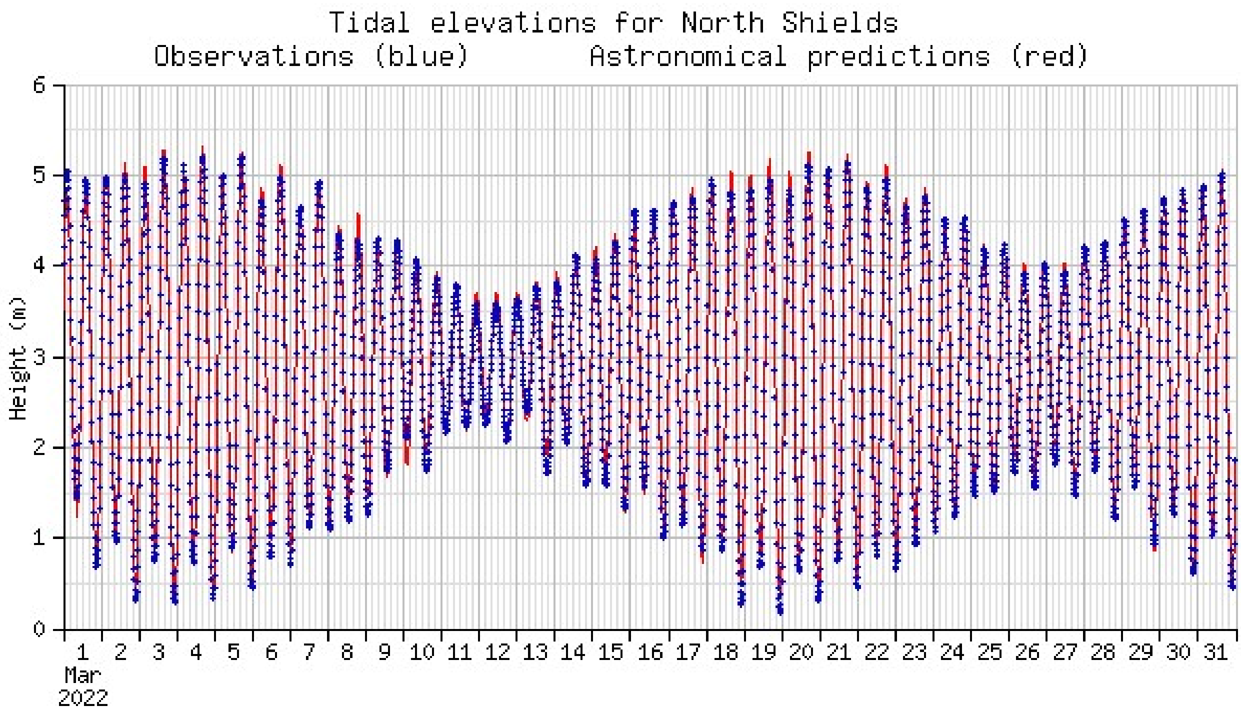

Plate 7.9 Tidal elevation for North Shields

Table 7.7 Tidal levels for North Shields (55° 0.444'N, 1° 26.388'W) (NTSLF, 2023).

Water Level	Acronym	Tidal Levels (m)
Highest Astronomical Tide	HAT	5.73 m
Mean High Water Springs	MHWS	5.12 m
Mean High Water Neaps	MHWN	4.08 m
Mean Low Water Neap	MLWN	1.90 m
Mean Low Water Springs	MLWS	0.73 m
Lowest Astronomical Tide	LAT	0.00 m
Highest for 2023	H for 2023	5.66 m
Lowest for 2023	L for 2023	0.05 m
Mean Spring Range	MSR	4.39 m
Mean Neap Range	MNR	2.18 m

60. Water levels according to the UKHO Admiralty Total Tide (ATT) service are provided in Table 7.8 for the proposed Landfall location and for a point further offshore, within the Marine Scheme, which demonstrate a reduction in water levels in the offshore direction. At the proposed Landfall area, the mean spring range is approximately 4.2 m, and the mean neap range is 2.2 m (UKHO, 2019). This aligns with the modelled tidal predictions presented in ABPmer's Atlas of UK Marine Renewable Energy (ABPmer, 2008) which show the mean spring range to be 4.14 m, and the neap range to be approximately 2.11 m. Both modelled tidal ranges support the observed data provided from NTSLF (2023) for the North Shields tidal gauge.

Table 7.8 Tidal ranges for the Marine Scheme (ATT, 2022)

Water Level	Acronym	Water Level (m) from LAT	
		Landfall (55 ° 07' N 01° 29' W)	Offshore (56 ° 10' N 0° 50' W)
Highest Astronomical Tide	HAT	5.6	3.8
Mean High Water Springs	MHWS	5.0	-
Mean High Water Neap	MHWN	3.9	-
Mean Sea Level	MSL	2.89	0.9
Mean Low Water Neap	MLWN	1.7	-
Mean Low Water Springs	MLWS	0.8	-
Lowest Astronomical Tide	LAT	0	-0.2

61. Across the Offshore Physical Environment and Seabed Conditions Study Area, the average annual spring peak flow is approximately 0.59 m/s: ranging from approximately 0.57 m/s at the Landfall area to 0.60 m/s throughout much of the Offshore Physical Environment and Seabed Conditions Study Area (ABPmer, 2008). The average annual mean neap peak flow across the offshore physical environment and seabed conditions study area is approximately 0.28 m/s. Mean neap flows at the Landfall area reach approximately 0.24 m/s and 0.30 m/s (ABPmer, 2008) within the

Offshore Physical Environment and Seabed Conditions Study Area as shown in Volume 4, Figure 7.10. The tidal excursion distance per tide is estimated to be about 5 km, with the full excursion extent associated with flood and ebb being 10 km (Volume 4, Figure 7.10). According to ATT spring current speeds at the Landfall location reach a maximum of 0.3 m/s on the spring tide and reach 0.2 m/s on a neap tide. Offshore, current speeds are predicted to also reach 0.36 m/s on a spring tide and 0.15 m/s on a neap tide as detailed in Table 7.9.

Table 7.9 Admiralty total tide predictions for the Marine Scheme Landfall location (tidal diamond SN020G 55 ° 06’ N 1° 27.5’ W) and offshore location (tidal diamond SN020H 55 ° 04.5’ N 1° 16.9’ W) (ATT, 2022))

	Marine Scheme Landfall			Tidal diamond Offshore		
Tidal Hour	Direction (°)	Spring Rate (m/s)	Neap Rate (m/s)	Direction (°)	Spring Rate (m/s)	Neap Rate (m/s)
-6	344	0.2	0.1	340	0.3	0.2
-5	318	0.1	0.1	339	0.2	0.1
-4	240	0.1	0.1	195	0.1	0.1
-3	210	0.2	0.1	184	0.2	0.1
-2	188	0.3	0.2	176	0.3	0.2
-1	168	0.3	0.1	166	0.4	0.2
HW	162	0.2	0.2	159	0.4	0.2
+1	157	0.2	0.1	157	0.2	0.1
+2	135	0.1	0.1	020	0.1	0.0
+3	015	0.2	0.1	355	0.2	0.1
+4	006	0.3	0.2	350	0.4	0.2
+5	002	0.4	0.2	345	0.4	0.2
+6	349	0.3	0.1	341	0.4	0.2

62. As part of the BBWF EIA, tidal and current modelling was undertaken of the tidal flows within the BBWF array area which overlaps the Marine Scheme, which forms part of the Offshore Physical Environment and Seabed Conditions Study Area (BBWFL, 2022b).

63. Plate 7.10 illustrates tidal patterns during peak flood on a spring tide whilst Plate 7.11 illustrates the ebb tide. across the BBWF array area which overlaps the Marine Scheme, and model domain that intersects the northern part of the Marine Scheme Offshore Export Cable Corridor, the tidal current floods to the south and ebbs to the north. The flows are relatively weak with tidal current speeds typically between 0.5 m/s and 0.6 m/s during peak flood, with ebb currents being of a similar magnitude (BBWFL, 2022b). Across the Offshore Export Cable Corridor within the Marine Scheme, the tidal flows are of the same magnitude between 0.5 m/s and 0.6 m/s during peak flood, with ebb current being of a slightly smaller magnitude between 0.4 m/s and 0.6 m/s.

64. Based on the range of available tidal current speeds across the Marine Scheme, the more conservative approach of faster flow speeds, i.e. ranging between 0.2 m/s and 0.6 m/s, are applied to inform further analyses completed for this assessment. This includes the estimation of sediment transport potential in section 7.7.2.5, the analyses of construction sedimentation and plume effects in section 7.12.1 and potential for flow blockage from installed cable protection under the operational phase in section 7.12.2.

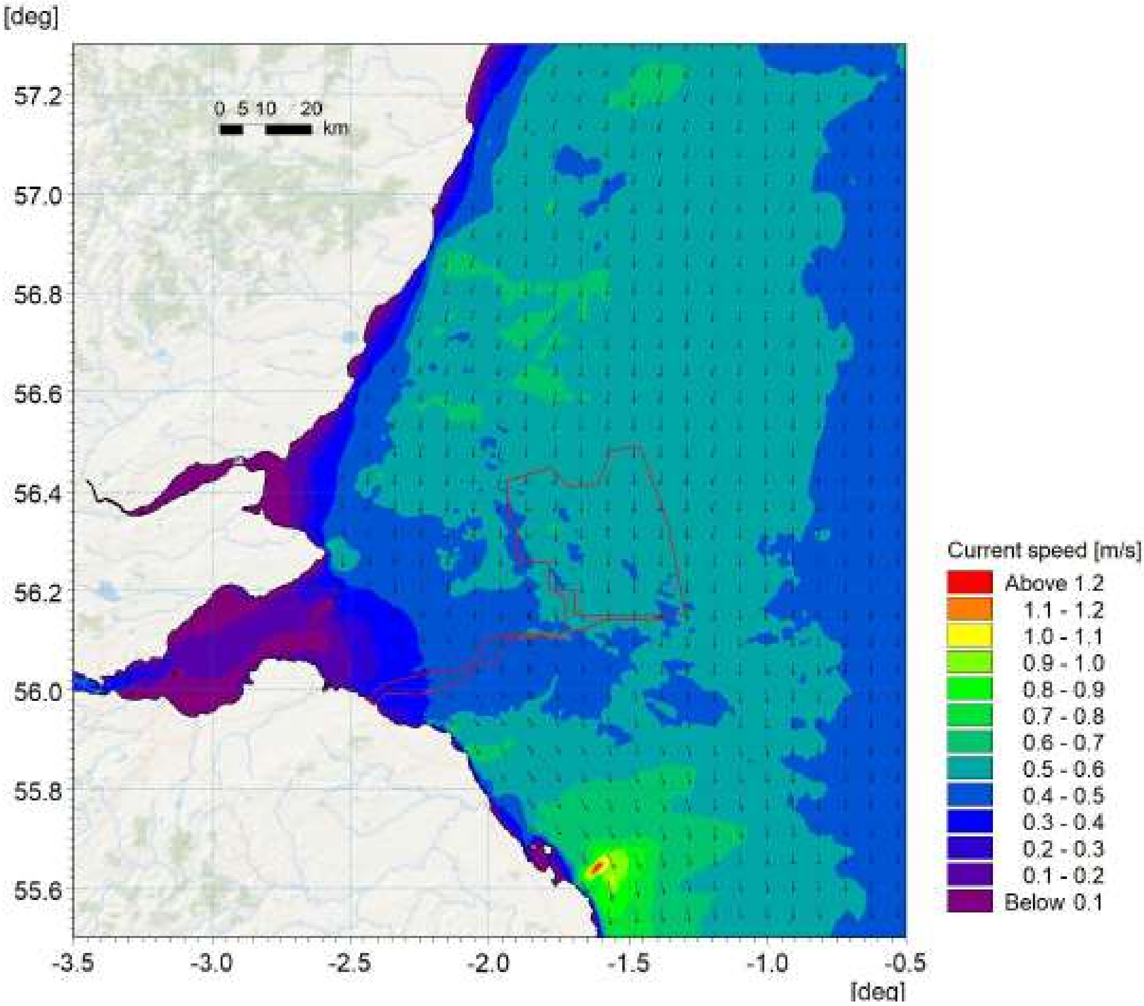

Plate 7.10 Tidal flow patterns – peak flood (HW-1 hour) (BBWFL, 2022b).[7]

[7]Tidal flow pattern data taken from separate EIA carried out for the BBWF (BBWFL. 2022) and therefore only the BBWF array area and Branxton connection are depicted. For further details related to the relationship between the BBWF and the Marine Scheme, please refer to Volume 1, Chapter 1: Introduction and Volume 1, Chapter 5: Project Description.

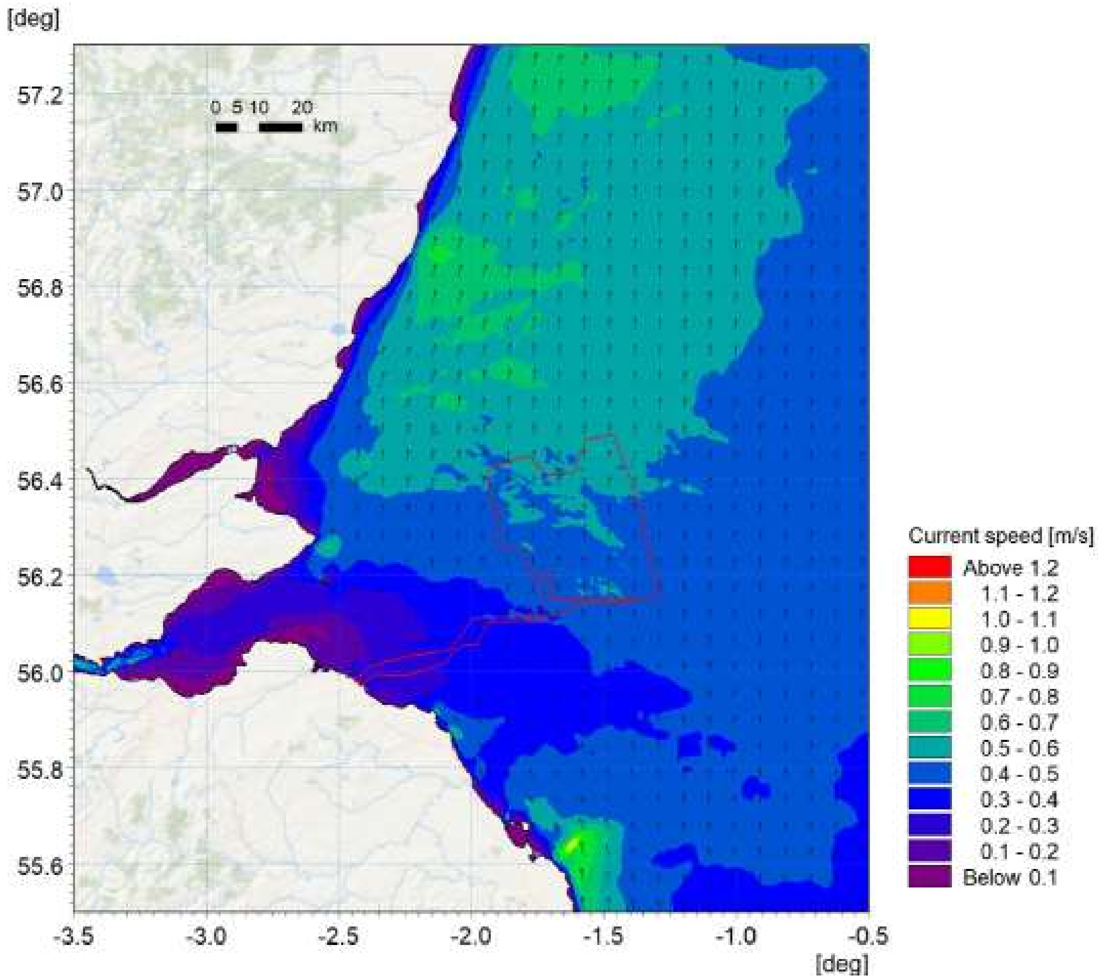

Plate 7.11 Tidal flow patterns – peak ebb (LW-1 Hour6) (BBWFL, 2022b).

65. Within the Marine Scheme, the residual current speeds are low. As residual currents are the net flow over a full tidal cycle, these have the potential to drive sediment transport. As part of the BBWF EIA, modelling was undertaken of the BBWF array area which overlaps the Marine Scheme, which forms part of the Offshore Physical Environment and Seabed Conditions Study Area to determine the residual currents (BBWFL, 2022b). For the tidal current alone, the residual current speeds are low within the BBWF array area which overlaps the Marine Scheme, and the model domain that intersects the northern part of the Marine Scheme as illustrated in Plate 7.12. In particular, Plate 7.12 demonstrates residual flow speeds in the order of 0.04 to 0.08 m/s (BBWFL, 2022b). The low tidal residuals are therefore interpreted to result in low sediment transport rates across the Marine Scheme.

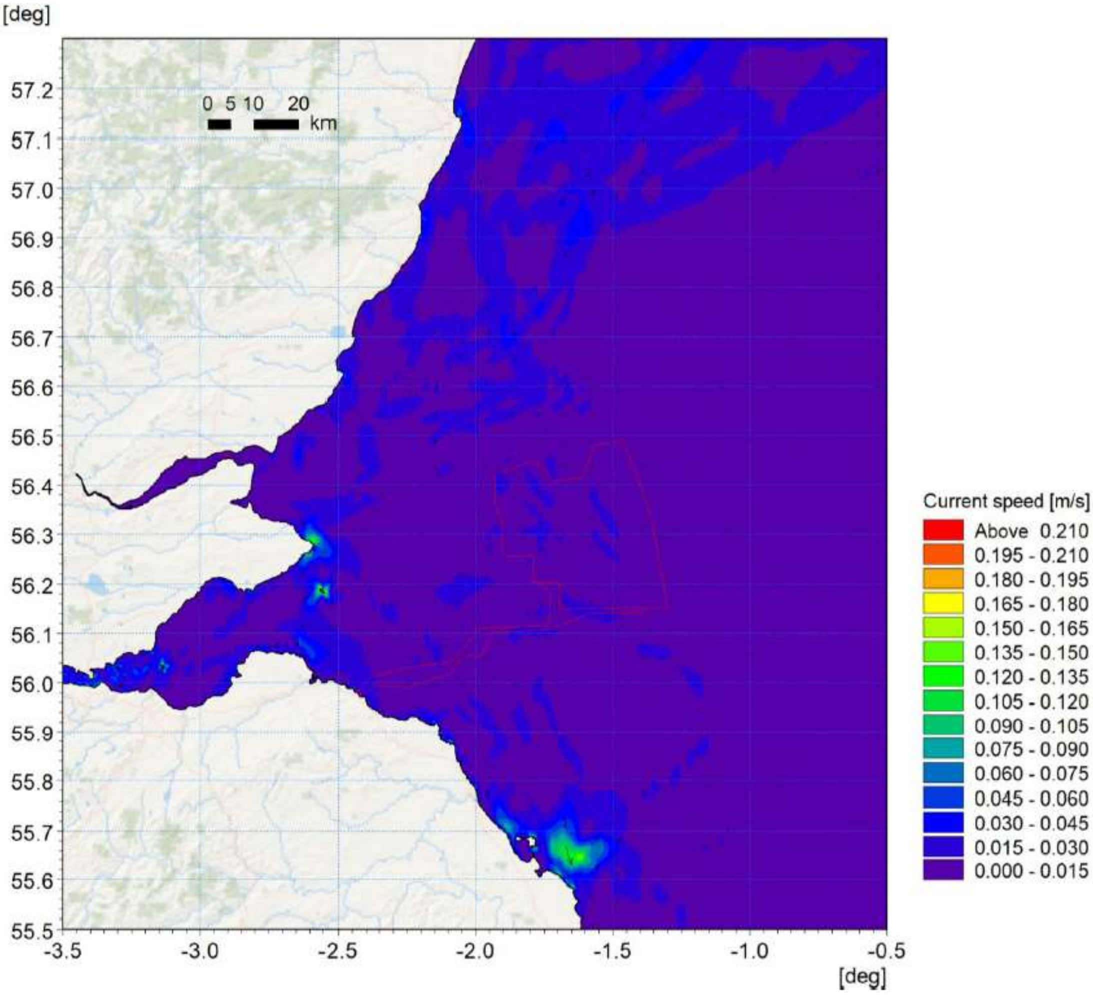

Plate 7.12 Residual current spring tide (BBWFL, 2022b)

7.7.1.5. SEDIMENT TRANSPORT REGIME

7.7.1.5.1. COARSE SEDIMENT

66. Coarser sediments (i.e. sands and gravels) typically move as bedload transport in response to waves and tides. Using the water levels extracted from the NTSLF (2023) and a time series of current data from the BODC (1980), at a location approximately 14 km south of the Marine Scheme, the mobility potential was calculated representative of the Offshore Physical Environment and Seabed Conditions Study Area during a spring-neap period. Water levels from the NTSLF (2023) were selected during 1980 from the North Shields tidal gauge. The observed time series of current data from the BODC was also selected for a time period in 1980 to ensure consistency. Mean current speeds for the assessed spring-neap time series were approximately 0.24 m/s. The location of the datasets is in water depths of approximately 33 m, based on a fine sand seabed with a mean grain size of 175 µm. The calculation of the sediment transport potential was based on formulae from Soulsby (1997).

67. Table 7.10 shows the mobility, as a percentage of time for the different sediment sizes as a result of currents only. Smaller sediment sizes, encompassing fine sand, medium sand and coarse sand, were all mobile at some point during a tidal cycle. These sediments were mobile on both spring and neap tides however, on the lowest neaps during the tidal cycle these sediments were not mobile. Larger grain sizes, larger than very fine gravel were never mobile (Table 7.10).

Table 7.10 Sediment mobility potential

Seabed sediment	Fine Sand	Medium Sand	Coarse Sand	Very Fine Gravel	Fine Gravel	Medium Gravel
Sediment size (mm)	0.175	0.35	0.63	3	6	11
Currents only	32%	24%	10%	0%	0%	0%
	Mobile spring and peak neap tides, not mobile at lowest neaps	Mobile spring and peak neap tides, not mobile at lowest neaps	Mobile spring tides only	Not mobile	Not mobile	Not mobile

68. As detailed in section 7.7.1.4, residual currents are low, interpreted to result in low levels of sediment transport in general. The BBWF EIA (BBWFL, 2022b) modelled for seabed response to varying tidal and wave conditions, including storm events. The modelling results indicated that the seabed within the BBWF array area could change within a tidal cycle. Bed levels decline along ripples at certain locations in the BBWF array area during the flood tide but increase to previous levels following the return tide (BBWFL, 2022b). At peak currents, changes in bed levels can be in the order of a fraction of a millimetre per day which indicates that the bed area is mobile however it is considered stable as shown in Plate 7.13 This is shown to also be a similar case for the Marine Scheme Offshore Export Cable Corridor, whereby bed levels decline along ripples during the flood tide but increase to previous levels following the return tide (BBWFL, 2022b). At peak currents, changes in bed levels are shown to be in the region of fraction of a millimetre per day which suggests that the bed area is mobile however it is considered stable. However, compared to the BBWF array area, the Marine Scheme Offshore Export Cable Corridor indicates slightly lower levels of changes in bed levels across both flood tide and ebb tide as shown in Plate 7.13

69. During storms approaching from the north generated from the modelling, the residual current and subsequent sediment transport increases during flood tides, which are enhanced by the wave climate. By comparison, changes in bed level peak tide suggest rates of change for both flood and ebb tide as shown in Plate 7.14.

70. Net drift at Cambois and Blyth is to the south, with an estimated 994 – 1,684 m^3/year of sediment being transported in a southward direction, dependent on tidal conditions (Scarborough Borough Council, 2017). This is in-keeping with net drift conditions along much of the Northumberland coast.

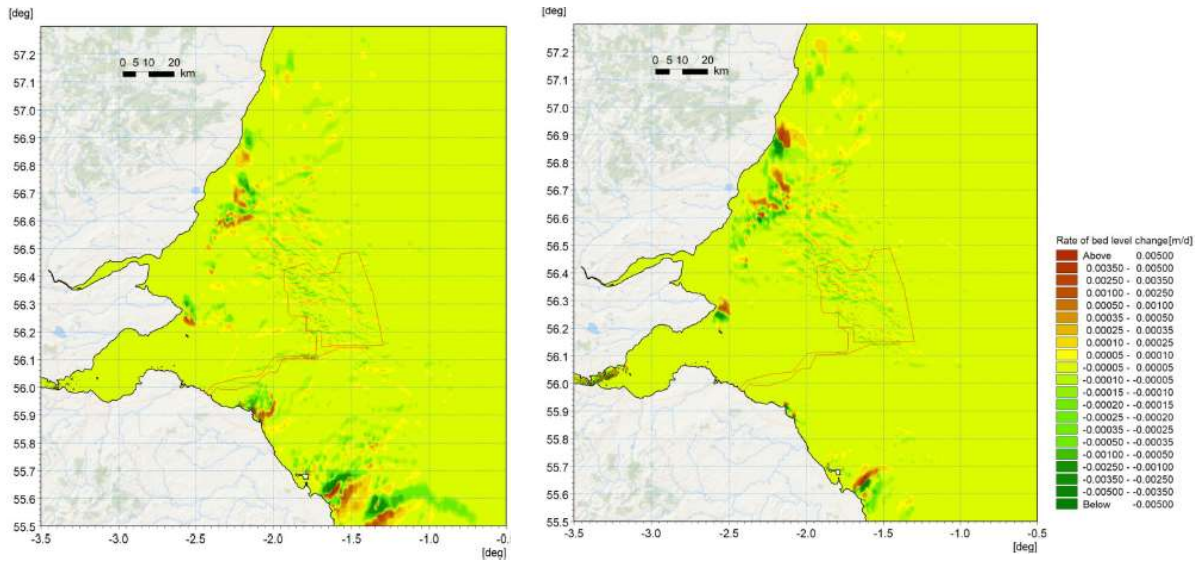

Plate 7.13 Rate of bed level change – peak flood tide (left) and peak ebb tide (right) (BBWFL, 2022b)

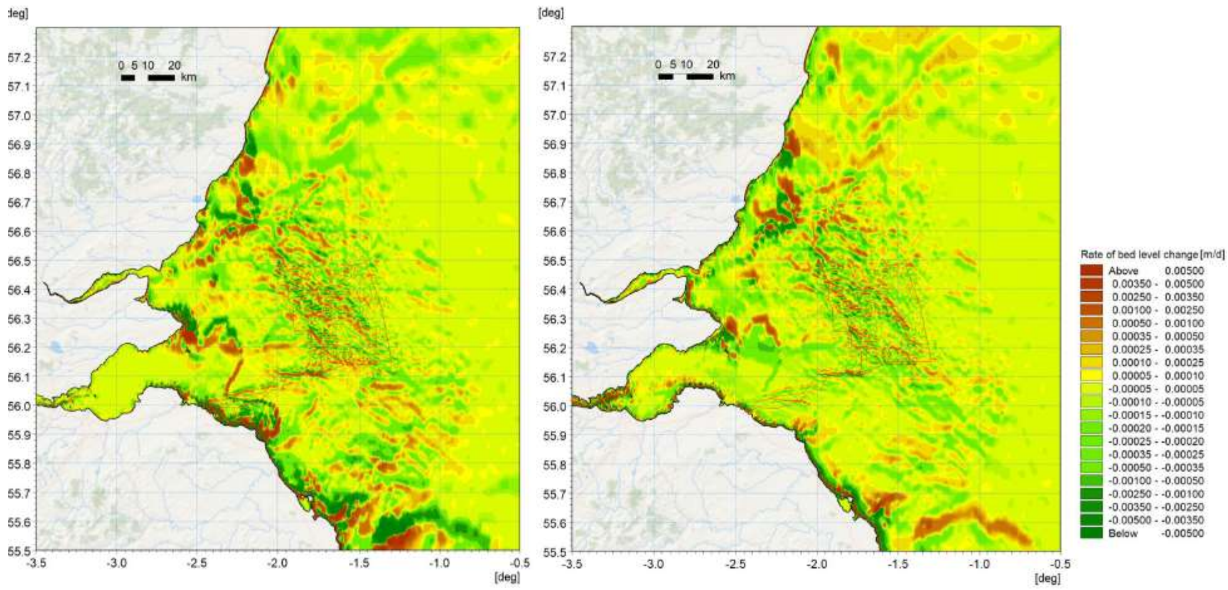

Plate 7.14 Rate of bed level change – peak flood tide with 1:1 year storm from 000º (left) and peak ebb tide with 1:1 year storm from 000º (right) (BBWFL, 2022b)

7.7.1.5.2. SUSPENDED SEDIMENTS

71. Suspended sediment concentrations (SSC) in the water column are principally governed by tidal currents, with fluctuations observed across the spring-neap cycle and across the different tidal stages (high water, peak ebb, low water, peak flood). SSC are also intensified during wind-driven storm events throughout the water column. During these high-energy storm events, SSC can increase considerably, both near the seabed and extending into the water column. Following storm events, SSC levels will gradually decrease to baseline conditions, regulated by the ambient regional tidal regimes. The seasonal nature and frequency of storm events in the central North Sea, therefore, support a broadly seasonal pattern for SSC levels.

72. No site-specific suspended sediment information is available for the Marine Scheme, nor would it be considered necessary to obtain for a project such as the Marine Scheme. This approach is also consistent with pre-application discussions and the approach to the assessment agreed through the Scoping exercise (section 7.5), while the methodology for the impact assessment is discussed in section 5.10). However, sampling has been conducted at an offshore station for Seagreen 1, which is located approximately 5 km north of the Marine Scheme. Sampling conducted in March and June 2011 indicated Total Suspended Solids (TSS) to be low in the order of < 5 mg/l with a maximum of 10 mg/l in March 2011 (Fugro, 2012).

73. For more generalised SSC conditions, the Cefas Climatology Report 2016 (Cefas, 2016) and associated dataset provides the spatial distribution of average non-algal Suspended Particulate Matter (SPM) for the majority of the United Kingdom Continental Shelf (UKCS). In the Offshore Physical Environment and Seabed Conditions Study Area the non-algal SPM around the Offshore Export Cable Corridor was estimated to be on average 0 mg/l to 1 mg/l between 1998 and 2015 (Volume 4, Figure 7.11). This is attributed to a lack of seabed sediment mobility, low levels of coastal erosion and remoteness to any large river or estuary source of fine sediment. Higher levels of SSC are experienced more frequently in the winter months. (Cefas, 2016) (Table 7.19).

7.7.1.6. COASTAL MORPHOLOGY – ENGLISH WATERS

74. The characterisation of the coastal morphology relates only to English waters (this is on the basis that the Marine Scheme in Scottish waters is entirely offshore – i.e. beyond the 12 nm limit – and there is therefore no potential for impact pathways with coastal morphology). The coastal morphology is described within the context of coastal cells and sub-cells. These cells are defined by common patterns in local coastal processes. The Landfall at Cambois will be located within Cell 1 in Management Area 21 – Spital Point to Blyth East Pier. The North East Observatory (2022) provides the most up to date information regarding the coastal morphology of the Landfall site.

75. The Northumberland Coast including the coastline covered by the Marine Scheme and the Offshore Physical Environment and Seabed Conditions Study Area is repeatedly monitored by the Northumberland County Council (2022). Information acquired from topographic monitoring along the Marine Scheme frontage indicate that in Cambois Bay, beach profiles in the north of the survey area are at higher levels compared to those in the south, suggesting a south-north movement of sediment or a greater input of sediment (possibly from the River Wansbeck) in the north of the survey area (Northumberland County Council (2022). This is supported by SMP 2 survey which suggests net drift is towards the south with 1,684 and 994 m^3/yr at MWHS and MLWS respectively (Northumbrian Coastal Authority Group, 2009).

76. From ongoing monitoring of the Northumberland Coast, recent cliff top surveys have identified most of the cliff tops to be relative stable with localised small sections of erosion which are located within the Marine Scheme. The most significant erosion occurs in the centre of the Cambois Bay opposite the carpark in the dune cliffs, where up to 12 m of erosion has occurred since 2009 and 2021. The north and south of the bay have more typical retreats of the north coast of England of between 3 – 7 m since 2009 to 2021 (Northumberland County Council (2022).

77. South of the immediate Landfall location, at Blyth south beach, the dunes have generally demonstrated a long-term trend of stability. Beach profiles exhibit a seasonal cross-shore movement of beach berms, characteristic to summer and winter beach cross-shore profiles (Northumberland County Council (2022). A site visit in December 2022 as illustrated in Plate 7.15 demonstrate a wide shallow profile beach.

78. Overall, the available monitoring and site information indicates a relatively stable coastal frontage along the proposed Landfall. Although localised pockets of erosions are identified to occur along the Northumberland coast, these are not directly within the proposed Landfall extent.

79. The ongoing monitoring as summarised above is supported by information from EMODnet (2021) which indicates the majority of the Landfall area is stable with areas of accretion towards the south (Volume 4, Figure 7.12). The zone of erosion is in relation to the spit immediately north of Blyth which indicates levels of erosion which is expected from that type of landform.

Plate 7.15 Landfall at Cambois Bay, with photos taken at low water, (top) view to the east, out to sea across the beach, (bottom) view south towards the Port of Blyth, demonstrating dunes backing the beach at Cambois

7.7.2. Future Baseline Scenario

80. The EIA Regulations require that 'a description of the relevant aspects of the current state of the environment (baseline scenario) and an outline of the likely evolution thereof without implementation of the project, as far as natural changes from the baseline scenario can be assessed with reasonable effort, on the basis of the availability of environmental information and scientific knowledge' is included within the Marine Scheme EIA. A description of the future baseline conditions in the absence of the Marine Scheme has contained within this section, with the described changes relevant to both Scottish and English waters.

81. The current baseline description provides an accurate reflection of the state of the existing environment. The earliest possible date for the start of construction is Q4 2026, with an expected operational lifetime of 35 years after the commissioning of the Marine Scheme, and therefore there exists the potential for the baseline to evolve from the time of the assessment and the time of impact. Exclusive of the short-term or seasonal fluctuation, changes to the baseline in relation to offshore physical environment processes and seabed conditions typically occur over an extended period of time.

82. The baseline environment for the Offshore Physical Environment and Seabed Conditions Study Area is not static and will exhibit a certain degree of natural variability over time. Such changes will occur with or without the Marine Scheme being in place.

83. The following sections provide a qualitative description of the evolution of the baseline environment, on the assumption that the Marine Scheme is not undertaken, using available information and scientific knowledge of the physical environment and seabed conditions.

7.7.2.1. CLIMATE CHANGE

84. The major issue likely to influence the physical environment and seabed conditions into the future is the impact of climate change. Climate change is predicted to modify existing weather patterns, increase average temperatures which has a resultant impact on the baseline conditions including sea levels, tides, currents, wave climate and wind climate. The United Kingdom Climate Projections 2019 (UKCP18) and marine report (Palmer *et al.,* 2018), provide up to date climate change projections for the UK. The main UKCP18 projects of interest to the offshore physical environment and seabed conditions are presented in the following sections.

7.7.2.2. GEOLOGICAL AND GEOMORPHOLOGICAL

7.7.2.2.1. BATHYMETRY AND MORPHOLOGY

85. The most significant change for bathymetry would be due to morphological features and megaripples present on the seabed. As detailed in section 7.7.1.2.1, the morphological features are understood to be active and evolving, so there is the potential for these features to continue to be evolve into the future in line with the tidal forcing.

7.7.2.2.2. BEDROCK AND QUATNERARY GEOLOGY

86. There will be no change to the sub-surface sediment and geology across the Marine Scheme into the future as climate change effects are unable to alter sub-surface geological units. The underlying sub-surface sediment and geology cover the Offshore Physical Environment and Seabed Conditions Study Area which has been the case for millennia and will continue to be so.

7.7.2.2.3. SEABED SEDIMENT

87. Seabed sediments are expected to remain the same into the future as there is limited sediment transport across the Marine Scheme physical environment and seabed conditions study are as discussed in section 7.7.1.2.3. However, it is possible for more sediment input into the Marine Scheme as a result of increased erosion of the coastline from elsewhere along the Northumberland coast. This is expected to remain the same seabed sediment type.

7.7.2.3. WAVE AND WIND CLIMATE

88. Due to naturally high inter-annual variability in the wave climate and low confidence in future climate change projections, there is presently no clear consensus on future wave climates affecting the north coast of United Kingdom (Wolf *et al.*, 2020). It is also predicted that there will be an overall reduction in significant wave height, combined with an increase in the mean annual maximum wave height by 0.5 m (i.e. larger waves less frequently) and that wave heights to the north of the UK will increase as a result of a retreating Arctic sea ice (Wolf *et al.*, 2020). Changes in future wind and wave conditions are provided in 'Flood Risk Assessments: Climate Change Allowances (Environment Agency, 2022).

89. Plate 7.16shows difference plots for the projected change in mean significant wave weight and annual maxima. There is 75% change that future conditions will be different to past records where three is no observed masking (grey). Blue indicates a net reduction, while red indicates an increase. In the Offshore Physical Environment and Seabed Conditions Study Area, Plate 7.16indicates a slight reduction in average wave heights. This information is reinforced by predictions by Wolf *et al.*, (2020). Changes in future wind and wave conditions are provided in Environment Agency (2016), 'Flood Risk Assessments: Climate Change Allowances (Environment Agency, 2022).

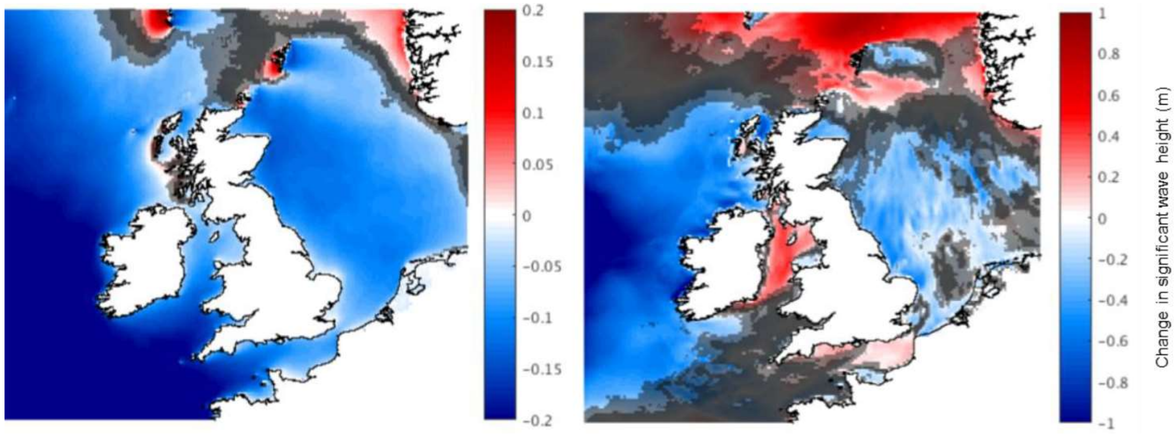

Plate 7.16 Projected change in mean significant wave height at end of 21st Century for (left) mean significant wave height and (right) annual maxima (Palmer et al., 2018).

7.7.2.4. TIDAL LEVELS AND CURRENTS

90. UK Climate Projections (UKCP) provides details of climate change projections for mean sea level at sites around the UK coastline. The projections extend to 2100 for various scenarios (representative concentration pathways, RCP). Based on the 50th percentile for low (RCP 2.6) and high emission (RCP 8.5) scenarios, an illustrative change in mean sea level after 35 years would be between +0.15 to +0.22 m (average annual rates of sea level rise of 4 to 6 mm/year). With the rise in relative sea-level, albeit at relatively low level within the Offshore Physical Environment and Seabed Conditions Study Area, this is likely to result in a landward advance of high water and may lead to increased coastal erosion (Horsburgh *et al.,* 2020) along more erodible shorelines.

91. As well as climate change, isostatic (glacial) rebound from the last Ice-Age is continuing to adjust some land and seabed levels. The northern part of the UK, where the Marine Scheme is located is subject to negative uplift between around 0 to -0.8 mm/year, as shown in Plate 7.17, thereby marginally reducing the rate of sea level rise.

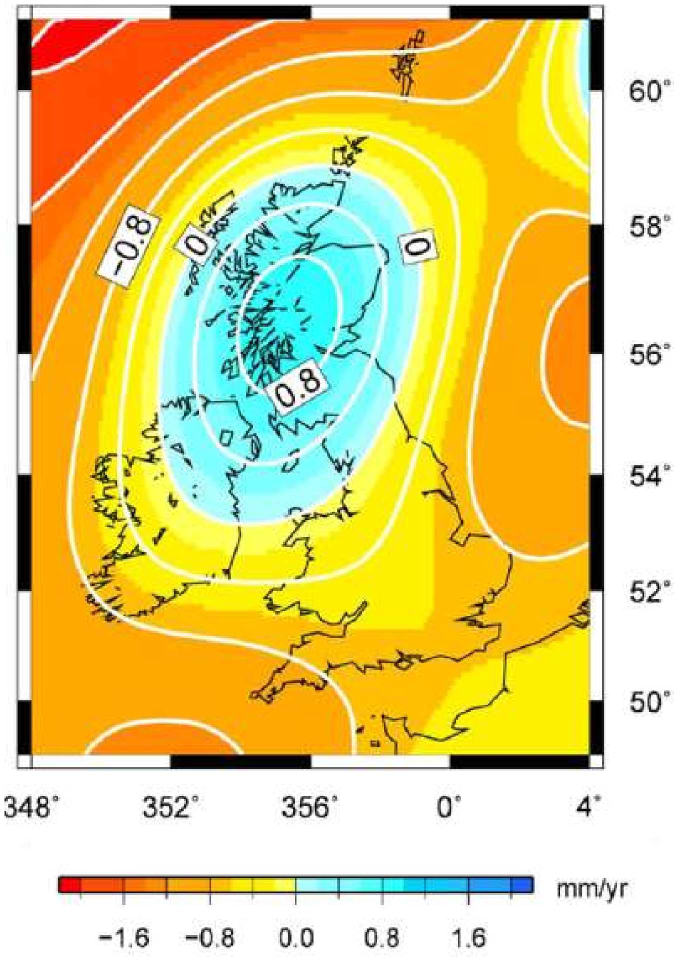

Plate 7.17 Predicted isostatic uplift rate (Bradley et al. 2011).

92. Despite the potential for relative sea level rise, resulting in higher tidal levels across the Offshore Physical Environment and Seabed Conditions Study Area there is not expected to be any change to tidal flows into the future. The tidal range is expected to stay the same, with increases occurring to both the lowest and highest tidal levels. At the same time, the tidal properties through the Marine Scheme are expected to stay the same, because the tidal regime is associated with much larger regional scale tidal movement.

7.7.2.5. SEDIMENT TRANSPORT REGIME

93. Given that there is not expected to be any changes to the regional scale tidal properties, and only natural variation to the wave climate in response to climate change is likely to occur, there is not anticipated to be any variation to the sediment transport characteristics into the future.

7.7.2.6. COASTAL MORPHOLOGY

94. With regards to the influence of climate change on coastal environments, trends in coastal erosion and accretion may also be altered as a result of sea level rise and changes to local sediment

transport processes. Sea-level rise is expected to contribute to coastal erosion, and it is assessed that 17 % of the UK coastline is currently experiencing erosion. In addition to sea-level rise, coastal erosion results from many factors, including reduced sediment supply, storms and anthropogenic disturbance (Masselink *et al*., 2020).

95. Specific to the Landfall, the Northumberland and North Tyneside Shoreline Management Plan 2 identified Cambois to have an erosion potential between 10 and 40 m over the next 100 years, while Blyth Beach is estimated to have an erosion potential of between 20 and 60 m over the next 100 years based on no further measures of erosion prevention (Northumbrian Coastal Authority Group, 2009).

96. Any changes that may occur during the design life span of the Marine Scheme should be considered in the context of both greater variability and sustained trends occurring on national and international scales in the marine environment.

7.7.3. Data Assumptions and Limitations

97. Complementary evidence has been collated from various sources to support the development of the baseline characterisation. Whilst a robust overall understanding is achieved from a qualitative description, some data gaps in local quantification of measured flows, waves, suspended sediment concentrations and the sediment transport regime do remain, which therefore places reliance on existing models to provide these details. The approach to baseline was developed and agreed with stakeholders during the pre-application process and agreed through the formal Scoping exercise. The approach followed is also consistent with that which has been adopted for comparable subsea transmission projects.

98. The use of desktop studies within the same region of the Marine Scheme provides a further basis of understanding which has been used within this Marine Scheme ES to form an acceptable basis of describing the Marine Scheme.

7.8. Scope of the Assessment

7.8.1. Impacts Scoped into the Assessment

99. The following impact pathways have been scoped into the assessment, as agreed through the Scoping process and follow up consultation with stakeholders and consultees[8]:

- Change to seabed levels and sediment properties due to installation of Offshore Export Cables (C & D);
- Increases to SSC due to installation of export cables (C & D);
- Impact on designated features within the designated sites due to installation of Offshore Export Cables (C & D);
- Change to coastal landfall morphology (C & D);
- Potential changes to the tidal, wave and sediment transport regimes as a result of blockage effects from cable protection measures (O&M); and
- Potential introduction of scour (including edge scour) (O&M).

[8] C = Construction, O&M = Operation and maintenance, D = Decommissioning

100. The impact assessment methodology for the offshore physical environment and seabed conditions is undertaken using the well-established source-pathway-receptor approach. The sources of effects are Marine Scheme activities. The pathway for effect can be categorised as either:

- **Seabed loss / alteration** – long-term effects from the Offshore Export Cable;
- **Seabed disturbance** – short-term effects during the construction and decommissioning phases which can lead to increased turbidity and subsequent deposition; or
- **Blockage and scour** – medium to long-term effects from the introduction of cable protection (if required), which could locally modify flow and wave energy transmission or introduce barriers to sediment transport pathways.

101. The capacity for these effects to translate over a wider area (in this case by the extent of the Offshore Physical Environment and Seabed Conditions Study Area) relates to the Marine Scheme physical processes which can develop a pathway, e.g. tidal advection or wave energy transmission. Methods of assessment have applied a variety of bespoke analytical spreadsheet tools which are supported by available survey and model data. Where other physical features may be impacted by these effects, they are then considered by this topic as physical environment and seabed conditions receptors, for example, the offshore seabed environment or coastal morphology. Some effects may also be relevant to receptors from other ES chapters, and where this is the case, the impacts are considered by the associated chapter. For example, smothering effects of sediment plumes on marine benthos are considered in Volume 2, Chapter 8: Benthic Subtidal and Intertidal Ecology and the influence of sediment plumes on fish ecology or marine mammals, considered in Volume 2, Chapter 9: Fish and Shellfish Ecology and Volume 2, Chapter 11: Marine Mammals.

102. The Scoping Opinion provided by MD-LOT necessitates the consideration of nearby operational projects with respect to the Marine Scheme. Operational projects, across Scottish and English waters, within the applied study area include cables, renewables, port and coastal developments and telecommunication infrastructure. All of the operational projects are considered as part of the baseline, so the completed impact assessment in relation to the Marine Scheme, includes due consideration of the operational Projects.

7.8.2. Impacts Scoped Out of the Assessment

103. No impact pathways were scoped out of the assessment, as agreed with key stakeholders through consultation following receipt of the Scoping Opinion from MD-LOT (MD-LOT, 2023) and MMO (MMO, 2023) and February and March 2023 respectively, and Scoping Advice (Table 7.2) received from stakeholders.

7.9. Key Parameters for Assessment

7.9.1. Maximum Design Scenario

104. The maximum design scenario(s) summarised here have been selected as those having the potential to result in the greatest effect on an identified receptor or receptor group. These scenarios have been selected from the details provided in Volume 2, Chapter 5: Project Description. Effects of greater adverse significance are not predicted to arise should any other development scenario, based on details within the PDE (e.g. different infrastructure layout), to that assessed here, be taken forward in the final design scheme.

105. Given that the maximum design scenario is based on the design option (or combination of options) that represents the greatest potential for change, confidence can be held that development of any alternative options within the design parameters will give rise to no worse effects than assessed in this impact assessment. Table 7.11 presents the maximum design scenario for potential impacts

on offshore physical environment and seabed conditions during construction, operation and maintenance and decommissioning.

106. Site preparation works, in advance of construction, are predicted to commence in Q4 of 2026 and will continue until all installation activities have ceased. Landfall construction is expected to occur between Q4 of 2027 until Q4 of 2028. Export cable installation is expected to begin in Q3 2028 and is expected to last until Q4 of 2029. All activities associated with the Marine Scheme are predicted to conclude by the end of 2029. Until detailed design of the Marine Scheme is progressed and further refined pre-construction, this programme for the Marine Scheme as a whole is indicative and is subject to further refinement, but is used to inform assessment of construction phase impacts for the Marine Scheme.

Table 7.11 Maximum design scenario specific to offshore physical environment and seabed conditions impact assessment

Potential Impact	Maximum Design Scenario	Scottish waters and English waters	Justification
Construction and Decommissioning			

Change to seabed levels and sediment properties due to installation of export cables
 	
Increases to SSC due to installation of export cables
	Offshore Export Cable properties:
	• Number of Offshore Export Cables within Offshore Export Cable Corridor: 4
	• Maximum length per Offshore Export Cable: 180 km
	• Maximum total length all Offshore Export Cables: 720 km
	• Maximum total width of Offshore Export Cable corridor: 1 km
	
	Site preparation:
	
	Cable route clearance activities:(all cables): Include pre-lay grapnel run (PLGR), boulder clearance, route preparation where sandwaves are encountered / pre-sweep, sea trials (as required), cables and pre-installation
	
	Cable route clearance:
	• Assumes use of boulder clearance plough with 25 m wide footprint per cable.
	
	Seabed levelling:
	• Maximum seabed levelling and disturbance width: 25 m per Offshore Export Cable
	• Average levelling height: 5 m
	• Maximum area for seabed levelling: 3.6 km^2
	• Maximum volume for seabed levelling: 10,800,000 m^3
	• Seabed levelling method: Pre-sweeping by MFE
		In Scottish waters:
		• Four Offshore Export Cables, with maximum length per cable of 40 km and total length of 160 km for all Offshore Export Cables.
		• Cable route clearance: Boulder clearance plough with 25 m wide footprint per cable.
		• Seabed levelling: Maximum area of 0.8 km2 and volume of 2,400,000 m3.
		• Cable installation: Up to 4 km^2 disturbance for all Offshore Export Cables based on 25 m disturbance width per cable.
		• Cable protection:
		  • Maximum cable protection length per Offshore Export Cable of 6 km and 24 km for all Offshore Export Cables;
		  • Maximum cable protection footprint per Offshore Export Cable of 0.06 km2 and 0.23 km2 for all Offshore Export Cables; and
		• There are no cable crossings in Scottish waters.
		
		In English waters:
		• Four Offshore Export Cables, with maximum length per cable of 140 km
			There is the potential for localised changes to the seabed as a result of pre-installation activities (including seabed preparation) and cable installation. This has the potential to result in pathways for impacts on other environmental, biological and human receptors.
			
			There is the potential for sediment changes related to the installation of the export cables including potential sediment disturbance and an increase in suspended sediments to have impacts on other receptors (for example, Water and Sediment Quality, Benthic Subtidal and Intertidal Ecology, and Fish and Shellfish Ecology).
			
			Increased sedimentation associated with installation and decommissioning works may lead to smothering of slow moving or sessile species (e.g. Ocean Quahog). Localised changes in sediment type which may also potentially impact seabed dependent species (e.g. Herring spawning). Any potential impacts associated with increased SSC and redeposition are anticipated to be highly localised and temporary.
			
			For the above reasons it is considered that there is a potential pathway with significant impacts on other receptors (for example, Water and Sediment Quality, Benthic Subtidal and Intertidal Ecology, and Fish and Shellfish Ecology) during installation and

Potential Impact	Maximum Design Scenario	Scottish waters and English waters	Justification

	• Indicative seabed levelling rate (Pre-sweeping by MFE): 100 m/hr;
	
	Installation:
	
	• Burial technique: Ploughs (displacement and/or non-displacement), jetting machines, mechanical trenchers, MFE
	• Cable laying approach: Simultaneous cable lay and burial, Surface lay and post-lay burial and use of Pre-trenching.
	• Minimum target burial depth: 0.5 m
	• Maximum target burial depth: 3 m
	• Maximum trench width: 2.5 m
	• Maximum width seabed disturbance from installation tool (m): 25 m
	• Total area of seabed disturbance for export cable route: 18 km^2
	• Indicative cable installation rates (jet trencher and MFE): 150 m/hr;
	
	Cable protection:
	
	• Cable protection material (type): rock installation/rock bags/concrete mattress/ cast iron cast / CPS system.
	• Maximum cable protection length per cable: 37.1 km
	• Total cable protection length all cables: 154.8 km
	• Maximum cable protection footprint per cable: 0.35 km^2
	• Total cable protection footprint all cables: 1.41 km^2
	• Cable protection height: 1.5 m
	• Cable protection width: 9.5 m
	
	Cable crossings (England only):
		and total length of 560 km for all Offshore Export Cables.
		• Cable route clearance: Boulder clearance plough with 25 m wide footprint per cable.
		• Seabed levelling: Maximum area of 2.8 km2 and volume of 8,400,000 m3
		• Cable installation: Up to 14 km^2 disturbance for all Offshore Export Cables based on 25 m disturbance with per cable.
		• Cable protection:
		  ◦ Maximum cable protection length per Offshore Export Cable of 31.1 km and 124.4 km for all Offshore Export Cables
		  ◦ Maximum cable protection footprint per Offshore Export Cable of 0.3 km2 and 1.18 km^2 for all Offshore Export Cables; and
		• Cable crossings:
		  ◦ Five crossings, consisting of rock dump/rock bags/concrete mattress/cast iron cast / CPS system.
		  ◦ Up to 0.05 km^2 of cable protection for five cable crossings
		• Landfall
		  ◦ Up to five exit pits, each 20 x 5 m, for up to four cable ducts (with one spare) due to trenchless cable installation at the Landfall
		  ◦ Minimum exit pit water depth (offshore): 10 m LAT
			decommissioning of the Offshore Export Cables and this impact is therefore scoped in.
			
			The precise duration of Landfall works and the period of time the exit pit and associated sediment storage berm may be in place cannot be confirmed until the landfall contractor is appointed, Therefore, a 3-month period is conservatively assumed in order to inform the impact assessment, based on a season.

Potential Impact	Maximum Design Scenario	Scottish waters and English waters	Justification
	• Number of crossings: 5 • Crossing material: Rock dump/rock bags/concrete mattress/cast iron cast / CPS system. • Crossing berm height: 2 m • Crossing berm width: 12.5 m • Crossing berm length: 200 m • Up to 0.05km2 of cable protection for five cable crossings **Construction programme:** 39 months **Landfall (England only):** • Trenchless technologies, such as HDD • Duct diameter: 0.3 – 3 m • Up to five exit pits, for up to four cable ducts (with one spare) due to trenchless cable installation at the Landfall • Volume of material released from HDD duct (per duct): 2,000 m^3 (up to 1,900 m^3 is estimated to be water and 100 m^3 is estimated to be solids); • Maximum subtidal exit pit dimensions per pit: 20 m length x 5 m width x 3 m depth • Minimum exit pit water depth (offshore): 10 m LAT • Maximum footprint per exit pit of 100 m^2 and 500 m^2 for all exit pits • Volume of excavated material per exit pit of 300 m^3 and 1,500 m^3 for all exit pits • Volume of material released from HDD duct per duct at 2,000 m^3 and 10,000 m^3 for all ducts.	• Maximum footprint per exit pit: 100 m^2 and 500 m^2 for all pits • Maximum volume of excavated material per exit pit 300 m^3 and 1,500 m^3 for all pits. • Volume of material released from HDD duct per duct at 2,000 m^3 and 10,000 m^3 for all ducts.	
Impact on designated features within the designated	As defined above for Change to seabed levels and sediment properties due to installation of export cables and increases to SSC due to installation of export cables impacts	In Scottish and English waters as defined above.	The Firth of Forth Banks Complex ncMPA, The Farnes East MCZ, and the Coquet to St. Mary's MCZ are all designated for a number of offshore physical features including subtidal

Potential Impact	Maximum Design Scenario	Scottish waters and English waters	Justification
sites due to installation of Offshore Export Cables			and intertidal habitats. There is the potential for activities relating to the pre-installation, construction and decommissioning phases of the Marine Scheme to impact these designated sites through direct and indirect pathways. These pathways include: direct seabed disturbance and loss; reduced water clarity (due to increased SSC) and potential smothering due to sediment deposition; changes to sediment transport changes to wave, tidal and sediment transport regimes.
Change to coastal landfall morphology	Landfall: As defined under Change to seabed levels and sediment properties due to installation of export cables and increases to SSC due to installation of export cables impacts.	In English waters only. Parameters as defined for the Landfall above.	Cable installation in coastal environments has the potential to disrupt coastal morphology with varying degrees of impact depending on cable installation and protection methods. A trenchless landfall method is being applied, however, protection may be installed leading to potential blockage effects.
Operation and Maintenance			
Potential changes to the tidal, wave and sediment transport regimes as a result of blockage effects from cable protection measures	Cable Protection: As defined under Change to seabed levels and sediment properties due to installation of export cables and increases to SSC due to installation of export cables impacts. Cable Crossing: As defined under Change to seabed levels and sediment properties due to installation of export cables and increases to SSC due to installation of export cables impacts. Maintenance: Annual inspections of the cable and any cable protection. Repair may include reburial and replacement / re-positioning of export cable protection.	In Scottish and English waters as defined above for: • Cable protection; and • Cable crossing	Impacts associated with operation and maintenance activities along the cable are likely to be limited to remediation activities. Rock placement as a source of cable protection at the Landfall and along the Offshore Export Cables may or may not be required during installation. Cable protection (which includes rock placement) will directly impact a limited area of seabed however the presence of cable protection may affect wider large-scale marine physical process pathways such that a change to local tidal, wave and sediment transport regimes is caused. This could result in delayed impacts on morphology and coastal receptors. However, additional protection volumes or berms during the O&M phase are expected to be negligible and within the margins

Potential Impact	Maximum Design Scenario	Scottish waters and English waters	Justification
			already defined within the maximum design scenario described above for the construction phase.
Potential introduction of scour (including edge scour)	Cable Protection: As defined under Change to seabed levels and sediment properties due to installation of export cables and increases to SSC due to installation of export cables impacts. Cable Crossing: As defined under Change to seabed levels and sediment properties due to installation of export cables and increases to SSC due to installation of export cables impacts.	In Scottish and English waters as defined above for: • Cable protection; and • Cable crossing	The intention is to bury the cable upon installation with scour protection to be used as and when required. This impact was scoped out in the Scoping Report (BBWFL, 2022c), however, following the Scoping Opinion (MMO, 2023) and Scoping Advice (Table 7.2) provided by stakeholders, the assessment includes the potential for development of secondary scour in locations where external cable protection may be used and the potential for scour developing in locations were burial depth was not adequately achieved. Therefore, this impact is assessed under the operational phase.

7.10. Methodology for Assessment of Effects

7.10.1. Overview

107. The offshore physical environment and seabed conditions assessment of effects has followed the methodology set out in Volume 2, Chapter 3: EIA Methodology. Specific to the assessment of offshore physical environment and seabed conditions, the following guidance documents have also been considered:

- Guidelines in the use of metocean data through the lifecycle of a marine renewables development (C666), (Cooper, et al., 2008);
- Coastal Process Modelling for Offshore Wind Farm Environmental Impact Assessment: Best Practice Guidance. COWRIE, 2009
- Guidance on Environmental Impact Statement (EIS) and Natura Impact Statement (NIS) Preparation for Offshore Renewable Energy Projects, (Barnes, 2017);
- Advice to Inform Development of Guidance on Marine, Coastal and Estuarine Physical Processes Numerical Modelling Assessments, (Pye, et al., 2017); and
- Guidance on Best Practice for Marine and Coastal Physical Processes Baseline Survey and Monitoring Requirements to inform EIA of Major Development Projects, (Brooks, et al., 2018).

7.10.2. Impact Assessment Criteria

108. Determining the significance of effects is a two-stage process that involves defining the magnitude of the potential impacts and the sensitivity of the receptors. This section describes the criteria applied in this chapter to assign values to the magnitude of potential impacts and the sensitivity of the receptors. The terms used to define magnitude and sensitivity are based on those which are described in further detail in Volume 2, Chapter 3: EIA Methodology.

109. The criteria for defining magnitude in this chapter are outlined in Table 7.12.

Table 7.12 Definition of terms relating to the magnitude of an impacts

Magnitude of Impact	Definition
High	Impact occurs over a large spatial extent resulting in widespread, long term or permanent changes in baseline conditions or affecting a large proportion of receptor population. The impact is very likely to occur and /or will occur at a high frequency or intensity.
Medium	Impact occurs over a local to medium extent, with short to medium term change to baseline conditions or affecting a moderate proportion of receptor population. The impact is likely to occur and/ or will occur at a moderate frequency or intensity.
Low	Impact is localised and temporary or short term, leading to detectable change in baseline conditions or noticeable effect on small proportion of receptor population. The impact is unlikely to occur or may occur but at low frequency or intensity.
Negligible	Impact is highly localised and short term with full rapid recovery expected to result in very slight or imperceptible changes to baseline conditions or receptor population. The impact is very unlikely to occur and if it does will occur at very low frequency or intensity.
No Change	No change from baseline conditions

110. The criteria for defining sensitivity in this chapter are outlined in Table 7.13 below.

Table 7.13 Definition of terms relating to the sensitivity of the receptor

Value (Sensitivity of the Receptor)	Description
Very High	Receptor is of very high importance and is protected under national and international legislation. Receptor with no capacity to accommodate a particular effect and no ability to recover or adapt.
High	Receptor is of very high importance and is protected under national and international legislation. Receptor with very low capacity to accommodate a particular effect with low ability to recover or adapt.
Medium	Receptor is of high importance and is protected under national and international legislation. Receptor with moderate capacity to accommodate a particular effect with moderate ability to recover or adapt.
Low	Receptor is of moderate importance, but with no associated designations. Receptor has some tolerance to accommodate a particular effect and a high ability to recover or adapt.
Negligible	Receptor of low importance, with no associated designations. Receptor is generally tolerant and can accommodate a particular effect without the need to recover or adapt.

111. The significance of the effect upon the offshore physical environment and seabed conditions is determined by correlating the magnitude of the impact and the sensitivity of the receptor, as outlined in Table 7.14 below. An effect with a significance of minor or less, is considered not significant in EIA terms, whereas an effect with a significance of moderate or greater is considered significant in EIA terms.

Table 7.14 Matrix used for the assessment of the significance of the effect

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

7.11. Measures Adopted as part of the Marine Scheme

112. As part of the Marine Scheme design process, a number of measures have been proposed to reduce the potential for impacts on the offshore physical environment and seabed conditions (see Table 7.15). These include measures which have been incorporated as part of the Marine

Scheme's design (referred to as 'designed in measures') and measures which will be implemented regardless of the impact assessment (referred to as 'tertiary mitigation'). As there is a commitment to implementing these measures, they are considered inherently part of the design of the Marine Scheme and have therefore been considered in the assessment presented in section 7.12 below (i.e. the determination of magnitude and therefore significance assumes implementation of these measures). These measures are considered standard industry practice for this type of development.

Table 7.15 Measures adopted as part of the Marine Scheme (designed in measures & tertiary mitigation)

Mitigation Measure	Justification	Applicable Jurisdiction
Route Selection and Avoidance.	The Marine Scheme has been specifically refined to avoid interactions with key designations, environmental sensitivities, and notable inshore fishing grounds as far as reasonably practicable. On the approach to the Landfall at Cambois, the route has been selected to minimise the footprint within European Sites. Nearshore routes with greater levels of interactivity with European Sites along the English and Scottish coast have been de-selected. Further detail on this is provided in Volume 2, Chapter 6: Route Appraisal and Consideration of Alternatives	Scottish and English waters
Micro-routeing within the Marine Scheme.	Micro-siting within the Marine Scheme will be carried out to help avoid or minimise interactions with localised engineering and environmental constraints identified during pre-construction surveys.	Scottish and English waters
Cable protection.	The use of cable protection will be minimised as far as practicable, and only used where required. Additional external cable protection (e.g. rock placement) will only be used where the minimum target burial depth cannot be achieved, for example in areas of hard ground or at third-party crossings. This will be informed by outputs from the Cable Burial Risk Assessment completed by the installation contractor(s) prior to the commencement of installation. Rock utilised in berms will be clean with low fines. Use of graded rock and 1:3 profile berms at areas of rock protection will reduce potential fishing gear snagging risk.	Scottish and English waters
Cable burial depth.	Cables will be buried to a minimum target depth of 0.5 m and only protected using external protection (e.g., rock berms) where minimum target burial depth is not achieved or at third-party crossings. Application of target cable burial depth will reduce the potential for cable exposure from interactions between metocean regimes (e.g. wave, sand, and currents) and will reduce interaction with fishing gear. Cable burial also reduces risk of interference with magnetic position fixing equipment.	Scottish and English waters
Shipboard Oil Pollution Emergency Plan (SOPEP).	All vessels to be used as part of any phase of the Project will adopt a waste management plan in line with the requirements set out as part of the International Convention for the Prevention of Pollution from Ships (MARPOL) and the SOPEP.	Scottish and English waters
Vessel best-practice / MARPOL.	Compliance with MARPOL regulations and best-practice protocols to prevent and manage incidents of accidental release of marine contaminants.	Scottish and English waters

Mitigation Measure	Justification	Applicable Jurisdiction
Pose Little or No Risk (PLONOR) substances.	During trenchless installation activities at Landfall, there will be an interface between the sea and the drilling fluids used to create the exit pits at the breakouts. Small quantities of drilling fluids may be discharged to the marine environment, however best practice mitigation will be implemented to reduce the amount of drill mud / cuttings released in the event of a release. To limit environmental damage, only biologically inert PLONOR listed drilling fluid will be used.	English waters
Landfall construction.	Trenchless techniques, such as Horizontal Directional Drilling (HDD) will be used at the Landfall for the construction of the Marine Scheme. Works associated with Landfall construction activities will avoid any works in the intertidal environment and will reduce the potential for sediment disturbance.	English waters

7.12. Assessment of Impacts

113. The potential impacts arising from the construction, operation and maintenance and decommissioning phases of the Marine Scheme are listed in Table 7.11 along with the maximum design scenario against which each impact has been assessed.

114. An assessment of the likely significance of the effects of the Marine Scheme on offshore physical environment and seabed conditions receptors caused by each identified impact is given below. Where applicable, consideration is given to which regional water the potential impacts apply, distinguishing between Scottish and English waters as relevant. Where no such distinction is applied, the impacts apply to both Scottish and English waters.

7.12.1. Potential Effects During Construction

7.12.1.1. CHANGE TO SEABED LEVELS AND SEDIMENT PROPERTIES

115. A number of different aspects of the Marine Scheme have the potential to have an effect on seabed levels and sediment properties. Any effects due to changes to seabed levels and sediment properties would be initiated during the Marine Scheme construction phase and may continue throughout the operational phase (i.e. with the potential to introduce blockage effects as assessed accordingly) until decommissioning removes the feature. These activities will cause seabed disturbance (resulting in changes to suspended sediment concentrations), which will then be deposited, resulting in changes to the seabed levels and sediment properties which is categorised as the loss or alteration of the seabed.

116. The following activities may cause changes to seabed levels and sediment properties:

- Seabed preparation, including boulder clearance and sandwave clearance;
- Cable installation and trenching; and
- Cable construction at Landfall.

7.12.1.1.1. CHANGES TO SEABED LEVELS

117. This section considers the varying pathways for changes to seabed levels to occur associated with the different construction activities. Changes to seabed levels associated with construction, will arise through the direct activity, such as boulder clearance, seabed levelling, cable laying and trenching, introduction of subsea infrastructure (including Offshore Export Cables and protection) and the deposition of sediment which has been disturbed during construction activities. The maximum design scenario (Table 7.11) sets out a total disturbance footprint of 18 km^2, which is approximately 3% of the Marine Scheme, although the nature and degree of the actual disturbance within this footprint would be variable. Impacts relating to the presence of subsea infrastructure, such as blockage, are assessed under the operation phase.

118. Completed modelling with respect to the BBWF indicated that sedimentation associated with construction activities would mostly be within 100 m of the disturbance activity, with deposition thicknesses between 0.5 m and 0.75 m and finer sediments which develop into a plume having a deposition thickness between 5 mm and 10 mm (BBWFL, 2022a; 2022b).

7.12.1.1.2. SEABED PREPARATION (CLEARANCE AND SEABED LEVELLING)

119. As detailed in section 7.9.1, seabed includes boulder clearance and seabed levelling along the cable corridor. The main techniques anticipated for boulder clearance are boulder ploughing and boulder grabs. Boulder clearance will result in some minor disturbance to the seabed corresponding to the direct site of the clearance activity. However, this removal of boulders is a discrete activity

which will not result in overall changes to seabed levels, as boulders would be relocated to adjacent areas where similar features may exist. Consequently, this activity is not likely to give rise to significant effects and is therefore not considered further in the context of changes to seabed levels. Boulder clearance will be considered in section 7.12.1.1.4 and 7.12.1.2.1 in relation to changes to sediment properties and increases in SSC, respectively.

120. Depending on the exact seabed conditions and presence of morphological bedforms along the route, further site preparation, specifically, seabed levelling may be required in some places to ensure suitably flat and stable conditions for installation of the Offshore Export Cables. This can be performed using varying methods and based on the disturbance mechanisms associated with the different seabed preparation options summarised in the Marine Scheme design, MFE is considered to provide the worst-case impacts. MFE has the potential for displacing relatively large volumes of sediment near the seabed. There is no anticipated requirement for dredgers to clear sandwaves via removal of the sediment onto a vessel with associated deposit elsewhere outside of the Offshore Export Cable Corridor, hence the trailing suction hopper dredger (TSHD) option is not considered. As set out previously as part of the Scoping Report (BBWFL, 2022c), the Applicant is aware of the licensing and supporting characterisation requirements in the event dredging were to be required at a later stage based on additional or new information. In this event, the Applicant would adhere to the relevant sample plan and analysis process (via MD-LOT / MMO approved sampling laboratories). At this stage, no dredging is assumed to be required nor has it been assessed.

121. As outlined in Table 7.11, in areas with bedforms, seabed levelling of around 5 m could occur over a total footprint of 3.6 km^2 (i.e. 0.8 km^2 and 2.8 km^2 in Scottish and English waters respectively). Of the total volumes to be cleared, a large proportion (on average over 90%) would fall directly to the seabed during the active phase of deposition, leaving only a small proportion (i.e. approximately less than 10%) to form a plume as assessed in the impact to changes to SSC (section 7.12.1.2.1). The method for determining the deposition of sediment in the wake of seabed levelling by MFE accounts for the activity, as the disturbance occurs at the seabed and will be transient and continuous as the MFE moves. As MFE occurs at the seabed, local flows have been taken into account, which range between 0.2 m/s and 0.6 m/s (section 7.7.1.4). Heights of 5 m, 10 m and 15 m above the seabed are used to represent the height which sediment could be ejected up to during the clearance.

122. As detailed in section 7.7.1.2.3, the seabed sediment in the Marine Scheme is predominantly classified as muddy sand, with large composition of fine sand, although medium and coarse sand are also prevalent with areas of fine gravel sediment. Therefore, this range in sediments across the Marine Scheme is considered in the analyses, with the following sediment composition percentages used to scale the disturbance volumes:

- Fine gravel: 6%; and
- Sand: 73%
- Coarse sand: 6%
- Medium sand: 17%; and
- Fine sand 50%.

123. The remaining 21% is considered to represent fine sediment (including silts and muds), which would develop into a plume, rather than fall directly to the seabed during the active phase of deposition.

124. The potential seabed levelling volumes are as summarised in Table 7.11, and are scaled by the proportion of the sediment type, in determining the potential sediment deposition thickness for the respective sediment type. Results of the estimated deposition characteristics associated with MFE clearance activities is summarised in Table 7.16, where the deposition thicknesses and extents vary according to flow speeds and sediment size. In Table 7.16, sedimentation extent and deposition thickness are inversely linked and presents the different theoretical sediment deposition

scenarios based on the flow and seabed sediment properties. Based on the scaled disturbance volumes for each sediment type under the 5 m disturbance height assumption, the deposition thickness ranges from approximately 0.11 m to 0.9 m, with a deposition extent of 4.7 km^2 and 0.7 km^2 respectively (i.e. for fine sand and fine gravel respectively). Larger sediments and slower flow speeds result in thicker deposits, but cover a smaller area, with thinner deposits associated with smaller sediment and faster flow speeds covering a larger area. Based on the higher disturbance height of 15 m, the deposition thickness ranges approximately between 0.04 m and 0.3 m, with a deposition extent of 4.7 km^2 and 1.6 km^2 respectively, again for fine sand and fine gravel.

125. As detailed in section 7.7.1.2.3, the mixed sediments across the Marine Scheme consisting of fine sand to gravelly sediment as well as boulders mean the disturbance activities will result in non-uniform sedimentation. The areas of coarser seabed will result in sedimentation largely close to the disturbance site, whereas the areas of finer sediments such as the sandy sediments will result in sedimentation being spread on a wider range and therefore less thickness. Based on sediment composition within the disturbed sediment volumes, there is the potential for the cumulative deposition of varying sediment types. However, the cumulative deposition thickness may be a combination of the varying sediment types at varying flow speeds and disturbance height. Therefore, Table 7.16 illustrates the range of possible deposition outcomes, where ultimately, the actual deposition thickness and extent will fall somewhere within the range for each sediment type, given the flow and sediment characteristics across the Marine Scheme.

Table 7.16 Estimated sedimentation extent and deposition thickness, associated with the seabed levelling volumes across the Marine Scheme using MFE

Current speed (m/s)	Disturbance height (m)	Deposition thickness (m)	Area Marine Scheme (km^2)	Area English Waters (km^2)	Area Scottish Waters (km^2)	Deposition thickness (m)	Area Marine Scheme (km^2)	Area English Waters (km^2)	Area Scottish Waters (km^2)	Deposition thickness (m)	Area Marine Scheme (km^2)	Area English Waters (km^2)	Area Scottish Waters (km^2)	Deposition thickness (m)	Area Marine Scheme (km^2)	Area English Waters (km^2)	Area Scottish Waters (km^2)
		Fine Gravel				**Coarse Sand**				**Medium Sand**				**Fine Sand**			
0.2	5	0.9	0.74	0.58	0.17	0.6	1.54	1.20	0.34	0.6	1.56	1.21	0.35	0.34	1.56	1.21	0.35
0.4	5	0.4	1.49	1.16	0.33	0.3	3.09	2.40	0.69	0.3	3.11	2.42	0.69	0.17	3.11	2.42	0.69
0.6	5	0.3	2.23	1.74	0.50	0.2	4.63	3.60	1.03	0.2	4.67	3.63	1.04	0.11	4.67	3.63	1.04
0.2	10	0.4	1.49	1.16	0.33	0.3	1.56	1.21	0.35	0.3	1.56	1.21	0.35	0.17	1.56	1.21	0.35
0.4	10	0.2	2.98	2.32	0.66	0.2	3.11	2.42	0.69	0.1	3.11	2.42	0.69	0.09	3.11	2.42	0.69
0.6	10	0.1	4.47	3.48	0.99	0.1	4.67	3.63	1.04	0.1	4.67	3.63	1.04	0.06	4.67	3.63	1.04
0.2	15	0.3	1.56	1.21	0.35	0.2	1.56	1.21	0.35	0.2	1.56	1.21	0.35	0.11	1.56	1.21	0.35
0.4	15	0.1	3.11	2.42	0.69	0.1	3.11	2.42	0.69	0.1	3.11	2.42	0.69	0.06	3.11	2.42	0.69
0.6	15	0.1	4.67	3.63	1.04	0.1	4.67	3.63	1.04	0.1	4.67	3.63	1.04	0.04	4.67	3.63	1.04

7.12.1.1.3. CABLE INSTALLATION

126. As detailed in section 7.9.1, the preferred method of cable protection is to bury the cable along the majority of the Offshore Export Cable Corridor. Where cable burial is possible, one or more of jet trenching, MFE, mechanical trenching, and cable ploughs will be used. Whilst burial is the preferred method of cable protection, the possibility of burial depends on seabed conditions within the Offshore Export Cable Corridor. Of the possible cable burial methods, MFE is determined to be the worst-case scenario, due to the potential for displacing relatively large volumes of sediment near the seabed. The maximum design scenario associated with cable installation in summarised in Table 7.11.

127. Due to the more targeted nature of trenching, the MFE disturbance height has been assumed to be lower than the seabed levelling, therefore disturbance heights of 1 m, 5 m, and 10 m are used in the analyses. The deposition analysis again takes into account a range of flow speeds (0.2 m/s, 0.4 m/s and 0.6 m/s), in addition to the range of sediments, as are known to occur in the Marine Scheme. The analyses again scales the disturbed sediment volumes by the percentage composition for the varying sediment types. The results of the deposition analysis for MFE cable trenching are shown in Table 7.17.

128. With increasing disturbance height, the dispersion distance increases. This is as expected, the greater the disturbance height, the further sediment will be dispersed and, in the case of finer sediments these will be subject to water flows further afield. Based on the scaled disturbance volumes for each sediment type, under the highest disturbance height of 10 m and fastest flow speeds of 0.6 m/s, fine sand can travel up to 600 m from the location of the activity, with an associated deposition thickness of 0.01 m (Table 7.17). Generally, the thickness of fine sand deposits are always less than 0.2 m. For larger sediments, like fine gravel, the deposition thickness ranges from 0.02 m to 0.65 m varying in relation to the flow speed and disturbance height (Table 7.17).

129. As described in section 7.7.1.2.3, although the most frequent sediment classification is muddy sand, the PSA classification of seabed sediment across the Marine Scheme indicates the sediment is not uniform and have varying composition of the gravels, sands and muds (Table 7.6), with sand regarded as the dominant sediment fraction. Near the Landfall, the PSA samples are almost entirely sand (at over 90% sediment composition), while the rest of the Marine Scheme varies between 30% to 70% sand. In approximately 20% of the PSA samples, there is a higher degree of gravels, with these sample locations occurring throughout the Marine Scheme, in both Scottish and English waters. Based on the sediment composition within the disturbed sediment volumes, there is the potential for the cumulative deposition of varying sediment types. However, the cumulative deposition thickness may be a combination of the varying sediment types at varying flow speeds and disturbance height. Therefore, just as Table 7.17 demonstrates the range of possible outcomes of deposition for the varying sediment types associated with cable installation using MFE, the actual deposition thickness and dispersion extent will be somewhere within the range, given the flow and sediment characteristics across the Marine Scheme.

130. The inclusion of cable or crossing protection within the Marine Scheme has the potential to change seabed levels and as such is only considered on this basis under the construction phase. Assessment due to the presence of infrastructure, including protection, with the potential to introduce blockage effects or edge scour, is addressed under the operation phase. Should cable protection be required, the protection would be installed to a berm height of 1.5 m, over a maximum footprint of 1.5 km^2 (0.23 km^2 1.18 km^2 for Scottish and English waters respectively), (Table 7.11). For crossings, up to five cable crossings are expected, up to a berm height of 1.5 m, over of 0.013 km^2, which are all located in English waters.

Table 7.17 Deposition thickness associated with cable installation by MFE

Current Speed (m/s)	Disturbance height (m)	Downstream dispersion distance (m) Fine gravel	Deposition thickness (m)	Downstream dispersion distance (m) Coarse sand	Deposition thickness (m)	Downstream dispersion distance (m) Medium sand	Deposition thickness (m)	Downstream dispersion distance (m) Fine sand	Deposition thickness (m)
0.2	1	0.7	0.65	1.4	0.46	4.0	0.43	20.0	0.26
0.4	1	1.4	0.33	2.9	0.23	8.0	0.21	40.0	0.13
0.6	1	2.1	0.22	4.3	0.15	12.0	0.14	60.0	0.09
0.2	5	3.4	0.13	7.1	0.09	20.0	0.09	100.0	0.05
0.4	5	6.9	0.07	14.3	0.05	40.0	0.04	200.0	0.03
0.6	5	10.3	0.04	21.4	0.03	60.0	0.03	300.0	0.02
0.2	10	6.9	0.07	14.3	0.05	40.0	0.04	200.0	0.03
0.4	10	13.8	0.03	28.6	0.02	80.0	0.02	400.0	0.01
0.6	10	20.7	0.02	42.9	0.02	120.0	0.01	600.0	0.01

7.12.1.1.4. CABLE LANDFALL

131. The Offshore Export Cable will be installed through trenchless techniques from an onshore location to an offshore exit location expected to occur at around 10 m LAT. To facilitate the trenchless installation, exit pits will be excavated for which the maximum design scenario is summarised in Table 7.11. Up to five pits (four plus a spare) may be excavated to a maximum depth of 3 m, over a total area of 500 m^2, associated with a total excavated volume of 1,500 m^3. Excavated material would be temporarily stored alongside the exit pits as sediment berms, with a temporary but maximum height of up to 1.5 m. The sediment berms would be used to backfill the pits on completion of drilling. Therefore, the exit pits and sediment berms are only likely to be present for a period of up to 3-months, before the seabed is reinstated. Once the pits have been backfilled some rock coverage could be required for protection. It is anticipated that the pit protection would have a maximum berm height of 1.5 m as applied elsewhere within the Marine Scheme.

132. As part of the cable Landfall up to five bores could be used as summarised in Table 7.11. At each exit pit up to 2,000 m^3 of PLONOR fluid could be released at pop out, comprising approximately 1,900 m^3 of water and 100 m^3 of solids (i.e. bentonite), for which medium silt is applied as a proxy. Based on a near-bed release height of 0.5 m, deposition thickness associated with the solids could be up to 0.05 m per exit pit, associated with a release during the slowest neap flows.

7.12.1.1.5. CHANGES TO SEDIMENT PROPERTIES

133. Changes to sediment properties may arise during construction due to any of the Marine Scheme activities, including boulder clearing, excavation of exit pits, seabed levelling, trenching and installation of the cables, crossings and associated, all within the 18 km^2 total Marine Scheme disturbance footprint (Table 7.11). Each of these activities have the potential to change seabed sediment properties and are therefore considered below.

134. As a seabed preparation activity, boulder clearance could occur across the Marine Scheme area, with the potential to change the local characterisation of the seabed. The geophysical surveys of the Marine Scheme identified boulders throughout the BBWF array area and Offshore Export Cable Corridor (section 7.7.2.2). The movement of boulders would inherently change the characterisation of the immediate area. However, the boulders would only be moved a short distance away from the immediate site of the cable route, to within locations where boulders are already present. Therefore, the relocation of boulders would not ultimately change the character of the seabed across the wider area.

135. The potential disturbance and deposition footprints associated with seabed levelling are discussed in relation to changes to seabed levels in section 7.12.1.1.1. The disturbance footprint from seabed levelling equates to approximately 3.6 km^2, with sediment deposition occurring over an area of 1.8 km^2, a proportion of which would overlap with the disturbance area. Trenching and deposition associated with trenching would be within the seabed levelling footprint in coincident areas, or in addition elsewhere.

136. Compared to seabed sediments (section 7.7.2.2.3), the Quaternary geology across the Marine Scheme occurs at depths of approximately 7 m below the seabed in the nearshore areas and between 5 and 20 m further offshore within the Marine Scheme (section 7.7.2.2.2). Cable burial is to occur to a maximum burial depth of 3 m below the seabed. Therefore, cable burial activities are not expected to reach any subsurface geology or introduce any new or alternative of sediment types, into the Marine Scheme, beyond that which occurs as the seabed sediment.

137. Sediment deposition associated with levelling and or trenching would typically be within tens to hundreds of metres of the activity, with a deposition thickness of less than 1 m, as presented in Table 7.16 and Table 7.17 and discussed in section 7.12.1.1.1. Therefore, the disturbance and deposition of sediment would not ultimately lead to a change in sediment type or properties, as

sediment would largely be deposited in proximity to the disturbance and would be of the same sediment type.

138. With respect to the installation of cable and crossing protection, the maximum design scenario (Table 7.11) indicates that the protection used could include rock, rock bags, concrete mattress, cast iron cast or CPS system. Each of these would lead to a change of seabed sediment properties, the larger proportion of which would occur in English waters.

139. In terms of the cable Landfall, the exit pits could have a maximum depth up to 3 m. As described in section 7.7.2.2.3, Quaternary geology and other geological substrates occur at depths of greater than 7 m. Therefore, the exit pits would only be excavating sediment that makes up the surficial sediment with no change to the sediment type and composition. As the trenchless methodology is to remove and process drill cuttings and recycle drilling fluids on land, only a small volume of drilled sediment with drilling fluid will be released at the exit, which will not introduce any changes to the seabed sediment properties. As detailed within Table 7.11, for a total of five bores, this is anticipated to be a maximum of 10,000 m^3, of which 9,500 m^3 is estimated to be comprised of water and 500 m^3 is estimated to be comprised of solids. The released solids would be a mixture of the subsurface geology and bentonite.

140. The subsurface geology near the Landfall duct popout, could comprise sandstone or Holocene units, similar to the surficial sediment. As described in section 7.7.1.2.2 and based on the geophysical and shallow geology survey data, there are no igneous intrusions or coal fissures outcropping within the Marine Scheme, including at the Landfall, although there is the outcropping Palaeozoic sedimentary unit belonging to the Coal Measure Group (XOCEAN, 2022; Hydrofix, 2023). Therefore, the material being released at the exit would be expected to be of similar properties to the existing seabed sediment. For the bentonite, although this could be different to the seabed sediment it is a PLONOR material, with similar consistency to silt, only a small volume would be released and deposited, after which it would form part of the sediment transport regime.

7.12.1.1.5.1. Magnitude of impact

141. Section 7.12.1.1.1 details the changes to seabed levels, primarily as a result of sedimentation. This includes the sediment that will be deposited directly at the seabed from seabed preparation, cable trenching and installation of cable and crossing protection. Deposition thickness per the activities described throughout section 7.12.1.1.1 is typically less than 1 m. The spread of deposition can extend between tens to hundreds of metres, but this only corresponds to a thin layer of deposit (i.e. only 0.1 m), as the relationship between extent and thickness are inversely correlated. On the whole, deposition associated with construction activity will affect a very small proportion of the Marine Scheme. The theoretical deposition values presented are indicative of the potential range in change to seabed level.

142. The mixed sediments across the Marine Scheme mean the disturbance activities will result in non-uniform sedimentation. The areas of coarser seabed will result in sedimentation largely close to the disturbance site, whereas the areas of finer sediments such as the sandy sediments will result in sedimentation being spread on a wider range and therefore less thickness.

143. The deposition of sediment will be transient along the Offshore Export Cables, with the thickest areas of sedimentation located closest to the area of disturbance activity, decreasing in thickness with increasing distance. Sedimentation in relation to natural settling velocity of the region, once deposited will form part of the sediment transport regime as described in section 7.7.1.5.

144. Based on the assessment presented in section 7.12.1.1.4, introduction of new of relocation existing sediment substrate is not considered to ultimately lead to a large change in sediment properties or characteristics across the Marine Scheme. As described for the seabed sediment (section 7.7.2.2.3) the Marine Scheme is diverse with a range of varying seabed sediment and clast sizes. Therefore, any effects associated with the Marine Scheme would largely be in keeping with the varied nature

of the seabed environment and any deposited seabed sediment would be indiscernible from the existing seabed sediment. Furthermore, any contribution of sediment deposition from a sediment plume will be minimal, due to the low proportion of sediment within the plume. Sediments deposited as a result of a plume, though more far reaching, will be rapidly incorporated into the local sediment transport regime.

145. Based on the completed analyses, the disturbance and loss/alteration pathways of the seabed, leading to changes in seabed levels and seabed properties are varied as presented above. The impact is predicted to be of local spatial extent, short to long term duration, and high reversibility, the magnitude is therefore considered to be low.

7.12.1.1.5.2. Sensitivity of the receptor

146. The impact to the seabed receptor relates to the potential change to seabed levels and sediment type associated with construction activities. The seabed within the Marine Scheme covers a number of protected sites which may be sensitive to changes in seabed levels and changes to seabed properties as a result of the installation of the Offshore Export Cables. Protected sites which are designated for geomorphological, geological, and sedimentary features of the seabed are the Firth of Forth Banks Complex ncMPA within Scottish waters, and Northumberland SSSI, Coquet to St Mary's MCZ, Farnes East MCZ, Creswell and Newbiggin Shores SSSI and GCR, Tynemouth to Seaton Sluice SSSI and GCR, which are all in English waters. The changes to seabed levels and changes to seabed properties identified are localised and composed of native material which may be deposited through sedimentation therefore the structure and function of the seabed is of low vulnerability and has the capacity to recover.

147. Due to the seabed containing features which are protected under national and international legislation and a low capacity to accommodate and moderate ability to recover from the impacts of changes to seabed levels and seabed properties, the sensitivity of the seabed is therefore considered to be medium.

7.12.1.1.5.3. Significance of the effect

148. Based on the completed analyses, the potential changes in seabed levels and seabed properties predicted to be of local spatial extent, long term duration, continuous and high reversibility. It is predicted that the impact will affect the receptor directly, with a low magnitude. The seabed receptor within the Marine Scheme is considered to be of medium sensitivity. The effect will, therefore, be of **minor** adverse significance for the Marine Scheme as a whole, which is not significant in EIA terms.

7.12.1.1.5.4. Secondary mitigation and residual effect

149. Given that there are no likely significant effects in EIA terms, secondary mitigation is not required.

7.12.1.2. INCREASES TO SUSPENDED SEDIMENT CONCENTRATIONS (SSC)

150. A number of different aspects of the Marine Scheme have the potential to have an impact on SSC. This impact relates to short-term and localised increases in SSC associated with seabed disturbance during the Marine Scheme construction and decommissioning activities. Marine Scheme activities likely to result in seabed disturbance leading to increases in SSC include site preparation activities (which includes boulder clearance and seabed levelling) and cable installation through trenching and cable Landfall activities. This impact applies to the water column and coastal receptors. Increases in SSC associated with installation of cable protection are considered to be less than that associated with levelling or trenching. Should installation of cable protection occur concurrently with levelling or trenching it is considered that the effects would be minimal in comparison. Therefore, the following assessment focusses on the methods with the potential to generate the worst case impacts.

151. Based on the sediment properties within the Marine Scheme, only a very small percentage of the sediment bulk will form a plume, on average across the Marine Scheme, this is approximately less than 10%. The majority of sediments (i.e. the remaining 90%) will fall directly to the seabed within a relatively short distance from the disturbance site as assessed in section 7.12.1.1.1. Increases in SSC associated with the active deposition phase are not directly quantified, but are considered to be several orders of magnitude greater (i.e. over thousands of mg/l), than the background levels of <5 mg/l characteristic to the Marine Scheme (section 7.7.1.5.2). However, these high concentrations, would only be within tens of metres of the disturbance. The high SSC would also only be short-lived, in the order of minutes and reduce very quickly with increasing distance from the disturbance site as the sediment quickly settles to the seabed. Therefore, SSC associated with the active deposition are unlikely to give rise to significant effects and are therefore not assessed further. Instead the SSC likely to occur based on the fine sediment fraction that would develop into a sediment plume, is considered in more detail with respect to the potential plume extent and duration. The potential plume associated with the fine sediment fraction is assessed analytically, based on the sediment settling velocity, with respect to the range of flow speeds of 0.2 m/s to 0.6 m/s (section 7.7.1.4) that are characteristic to the Marine Scheme.

7.12.1.2.1. INCREASES IN SSC FROM SEABED PREPARATION

152. The initial offshore activity during the construction phase of the Marine Scheme is seabed preparation. This is required to remove obstacles that might interfere with efficient cable burial and / or to provide a level seabed for the Offshore Export Cables. The construction activities with the potential to cause sediment disturbance leading to increases is SSC are boulder clearance and seabed levelling.

153. As described in section 7.12.1.1.1 above, boulder clearance in discrete areas will take place across the Marine Scheme to ensure cable lay can occur safely and effectively. While the boulder clearance activity has been assessed in the context of changes to the local sediment properties, the act of removing the boulders a short distance from the cable corridor is a very low level of mechanical disturbance of short-term duration. The act of boulder removal could lead to a slight increase in bed roughness in the immediate locality of the activity, however this is not sufficient to generate a plume of any description. This is considered to be the same should a boulder plough be applied, as disturbance effects would only be near seabed as the plough drags on the seabed. The expectation would be that any disturbed sediment would immediately fall to the seabed. Consequently, boulder clearance is not likely to give rise to significant effects and is not considered further within the context of changes to SSC.

154. Conversely, seabed levelling (MFE considered as worst-case) as a seabed preparation activity does have the potential to generate a sediment plume. Seabed levelling using MFE is expected to occur at a rate of around 100 m/hr, based on the tool disturbance footprint of 25 m, average levelling height of 5 m, a conservative release rate of 520 kg/s is applied in the analysis, based on the proportion of sediment likely to develop into a plume. The instantaneous increase in SSC which could result in a plume would only occur in the immediate vicinity of disturbance activity, although much smaller and reduced sediment concentrations could advect over larger distances. Due to the release rate and disturbance mechanism, it is estimated that SSC could locally increase by hundreds of thousands of mg/l, in very close proximity to the disturbance site. However, the high instantaneous SSC would reduce quickly with increasing distance from the disturbance, so that at its widest extent would generally be less than 10 mg/l. Based on the settling velocity for silt of 0.0001 m/s, and disturbance height of 5 m, silt sediment could remain in suspension for nearly 14-hours before settling back to the seabed. Based on a flow speed of 0.2 m/s sediment could be moved up to a total distance of 10 km. However, based on the duration, the sediment is expected to move in relation to the flow (either flood or ebb) before turning associated with the changing tide. Therefore, the maximum movement in any one direction is considered to relate to the mean annual

tidal excursion extent, which is approximately 5 km (in one direction and 10 km for both flood and ebb) (section 7.7.1.4).

155. The maximum design scenario indicates that the larger proportion of clearance is to occur in English waters (i.e. 2.8 km^2 in English waters compared to 0.8 km^2 in Scottish waters), therefore the impact would occur over a longer time frame in English waters compared with Scottish waters.

7.12.1.2.2. INCREASES IN SSC FROM CABLE INSTALLATION

156. Of the possible cable burial methods that could potentially be applied, MFE is determined to be the worst-case scenario. This is due to MFE having the potential for displacing relatively large volumes of sediment close to the seabed. The amount of sediment disturbed at a trenching rate of 150 m/hr based on a trench width of 2.5 m and depth of 3 m, across a unit metre would be 1,125 m^3 per hour or 0.31 m^3 per second. Based on the trench dimensions and proportion of sediment likely to develop into a plume properties, a conservative sediment release rate of 47 kg/s is assumed for the cable installation through MFE for the Marine Scheme.

157. As described for seabed levelling operations above, the instantaneous increase in SSC which could result in a plume would only occur in the immediate vicinity of the trenching activity, with much smaller and reduced sediment concentrations advecting over larger distances. It is estimated that SSC could locally increase by tens of thousands of mg/l, in very close proximity to the trench, with the SSC again reducing with increasing distance from the disturbance. Again, it is estimated that by the widest extent of the plume, the SSC would generally be less than 10 mg/l.

158. Based on the settling velocity for silt of 0.0001 m/s as applied for seabed levelling, and disturbance height of 1 m associated with trenching operations, silt sediment could remain in suspension for only a short duration at nearly 3-hours before settling back to the seabed. Based on a flow speed of 0.2 m/s, sediment could be moved up to a total distance of 2 km, within the tidal ellipse extent. This means that for trenching operations, any plume as a result of the cable installation would largely return to background levels during the same phase of the tide, only moving a relatively short distance in relation to the flow direction. Therefore, any sediment disturbed as a result of MFE that has the potential to form a plume would be extremely transient, and due to the current flow regime within the Marine Scheme sediment would settle out, returning the SSC back to ambient concentrations after a short duration.

159. The orientation of the plume would be in relation to the flow axis with respect to the Offshore Export Cable orientation, which would therefore be variable across the Marine Scheme. In proximity to the Landfall at the coast, the sediment plume from trenching would largely be parallel to the coast in line with the tidal flow axis as illustrated in Plate 7.10 and Plate 7.11. Based on the short duration of the plume (of up to 3-hours) and the transit distance (of up to 2 km), only a very small proportion of the plume may extend to the coast, with the highest concentration magnitudes remaining close to the disturbance site at 10 m LAT and deeper. Should the plume extend to the coast in relation to the flow axis, the SSC would be in the order of tens of mg/l, having being dissipated associated with the natural dispersion with the flow.

160. As a larger proportion of the cable will be within English waters, the increases in SSC will occur over a longer time frame only in terms of the cable length to be installed (i.e. 560 km in English waters compared to 120 km in Scottish waters). Irrespective of being in Scottish or English waters, the impact will be transient as cable installation progresses.

161. Modelling was undertaken as part of the BBWF EIA to determine the increases in SSC as a result of the Offshore Export Cables from the BBWF array area (BBWFL, 2022a). Average levels of SSC increased to between 50 mg/l and 500 mg/l across the plume extent (noting that this is not inclusive of the instantaneous maxima likely to occur at the disturbance site) as a result of Offshore Export Cable installation, where circa 400,000 m^3 of material may be mobilised. These levels dropped to background levels on the slack tide. Confirming the deposition of fine sediment within the same

tidal phase as determined analytically. Therefore, in the context of the Marine Scheme, it is not anticipated that increases in SSC would be of sufficient magnitude to alter the hydrodynamic regime or offshore bank or beach morphology. Peak currents within the BBWF array area are of a similar magnitude to the Marine Scheme Offshore Export Cables. Therefore, it can be predicted that any changes in SSC as a result of the BBWF Offshore Export Cables will be of a similar magnitude to the changes in SSC within the Marine Scheme as a result of cable installation.

7.12.1.2.3. INCREASES IN SSC FROM CABLE LANDFALL

162. Increases in SSC associated with cable Landfall relate only to English waters, due to the Landfall location. To aid exit, temporary exit pits and associated sediment storage berms will be created at a minimum water depth of 10 m LAT. As the requirement is to retain as much sediment as possible, the pits are to be mechanically excavated, with the sediment side-cast into berms adjacent to the pit. Based on the sediment disturbance mechanism, it is assumed that the sediment release associated with the pit excavation and sediment side-casting would be similar or less than that associated with trenching. Therefore, the same characterisation of the potential plume described for cable installation in section 7.12.1.2.2 is also applicable here. During pit excavation and side-casting, SSC would locally increase by tens of thousands of mg/l, in very close proximity to the pit and berm, with the SSC again reducing with increasing distance from the disturbance. It is estimated that by the widest extent of the plume, the SSC would generally be less than 10 mg/l. The same disturbance height of 1 m is assumed for the Landfall works and therefore, any fine sediment that develops into a plume would remain in suspension for only a short duration at nearly 3-hours and move up to a total distance of 2 km, based on a flow speed of 0.2 m/s.

163. With respect the trenchless technology duct popout at Landfall, as described in Table 7.11, up to 2,000 m^3 (comprising 1,900 m^3 water and 100 m^3 solids) per duct could be released. Increases in SSC associated with this would be on the order of hundreds of thousands of mg/l at the release site and decrease with increasing distance from the release in line with dissipation and dilution with flows and wave action. The potential extent could be up to 3 km based on the fastest flow speeds through the Marine Scheme, with a maximum duration of approximately 1.4-hours. It is again estimated that by the widest extent of the plume, the SSC from the duct release would generally be less than 10 mg/l. Each duct would be installed sequentially, so there would not be coincidence of multiple releases.

164. As described for trenching and Landfall operations, increases in SSC associated with the works and the highest concentrations will mostly be parallel to the coast due to the orientation of the flow axis. However, a small proportion may extend to the coast at the plume extents, SSC magnitudes at the plume extents are only expected to be on the order of tens of mg/l based on the dissipation and dilution in the flow.

165. It is assumed that the exit pit(s) and sediment storage berms could be in place for up to 3-months. During this time, the berm would be subject to natural sediment transport processes by flows and waves. The characterisation of the sediment (section 7.7.1.2.3) and sediment transport regime within the Marine Scheme as presented in section 7.7.1.5, is applicable here in terms of understanding the transport potential of sediment contained within the sediment storage berms. Available PSA information from the site-specific surveys indicate that the closest samples to the Landfall (Volume 4, Figure 7.9), comprise sand, where the largest composition is of fine sand (with a mean grain size of 63 – 250 µm), making up approximately 70% – 90% of the sediment fraction. For the same sediment samples, silt (which is the sediment that would develop into a plume) comprises between 6% – 8% of the sediment fraction, while gravel is typically less than 1%.

166. On the basis of the sediment fractions in proximity to the Landfall works and the sediment transport regime, silt and sand sediment is likely to be winnowed out from the berms during the 3-month period the berm is in place. This is because analyses of the sediment transport potential indicate that fine sand would be mobilised in relation to flows only approximately a third of the time during

spring – neap tidal cycle, while sediment up to medium sand would be mobilised up to a quarter of the time over the same period (Table 7.10). As gravels typically make up less than 1% of the sediment fraction in the samples at the Landfall, only a small proportion of the sediment is likely to remain immobile to flows. The presented assessment is on the basis of flows only, whereby currents have demonstrated the ability to amplify the sediment transport potential in terms of picking up material to then be transported by the flow. With the contribution of waves, sediment is likely to be mobile for longer periods of time than with flows in isolation. With the sand fraction being winnowed out (based on the berm height of 1.5 m), the sediment would settle back to the seabed within tens of metres from the berm and in minutes based on the sediment settling velocity for fine sand. Medium and coarse sand would settle out over a shorter distance and duration.

167. With respect to the silt sediment fraction being winnowed out from the sediment berm, the material could develop into a plume that extends from the berm. The plume extent and dissipation duration associated with the sediment berm while in-situ would likely have the same properties as described above for the Landfall works and trenching works near the Landfall. However, as the silt sediment fraction is finite, so will the sediment source into any plume. It is not possible to state the exact period (during the approximate 3-months which the berm could be in-situ) over which a plume could form and dissipate in relation to the sediment berm as this is based on the proportion of the silt sediment fraction and the rate at which it is released from surrounding coarse grains. However, it is likely that a sediment plume could repeatedly occur and dissipate over several flood – ebb tidal cycles until the silts have all been winnowed out from the berm. After which, no plume would occur with the berm in-situ. SSC magnitudes associated with this process would be variable spatially and temporarily but it is estimated that concentrations would be generally less than 100 mg/l at the berm and reducing further with distance. Based on the tidal flow axis and plume extents, some SSC could reach the coast, but as described previously, dissipation processes would mean concentrations of less than 10 mg/l are likely.

7.12.1.2.4. MAGNITUDE OF IMPACT

168. The results of the increases in SSC detailed above show that although the instantaneous increases in concentration are very high at several orders of magnitude above representative background concentrations of <5 mg/l, the high concentrations would be only in the immediate vicinity of disturbance activities and would be very transient. The largest plume extent and duration is assessed to occur with respect to seabed levelling, where the plume could transit over a cumulative distance of up to 10 km (although it would turn with the tide, only advecting the distance associated with the tidal ellipse of around 2.5 km), and last for nearly 14-hours, covering both the flood and ebb tidal phases of a single tide. However, this activity will be fairly localised and intermittent across the Marine Scheme, occurring only in the isolated locations where seabed levelling is required. Therefore, the scale of impact although longer is still temporary, transient and fairly localised, in that for the worst case, the plume lasts less than a day and just over a flood-ebb tidal cycle and only advects a maximum distance associated with the tidal ellipse. The fact that only a small proportion of sediments will enter into suspension to develop into a plume in the first place, with the seabed levelling and trenching activities, contributes to the short duration and relatively localised plume.

169. The impact from increases in SSC is predicted to be of local spatial extent, only of short-term duration, continuous and high reversibility, and therefore, the magnitude is considered to be low.

7.12.1.2.5. SENSITIVITY OF THE RECEPTOR

170. The impact to the water column and coast receptors relates to disturbance to these receptors. Although the Marine Scheme overlaps with designated sites in Scottish and English waters, it is noted that none of the designated interest features relate to water column properties, but instead geological, geomorphological and sedimentological features, which do occur along the coast.

However, increases in SSC are not likely to impact these qualifying features beyond the potential deposition of sediment, already considered in section 7.12.1.2.6. Based on the absence of designated interest features directly relating to the water column and the recoverability following any increases in SSC, the sensitivity is considered to be low.

7.12.1.2.6. SIGNIFICANCE OF THE EFFECT

171. Based on the completed analyses, increases in SSC are predicted to be of local spatial extent, short term duration, continuous and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore considered to be low. The water column receptor within the Marine Scheme is considered to be of medium sensitivity. The effect will, therefore, be of **negligible to minor** adverse significance, for the Marine Scheme as a whole, which is not significant in EIA terms.

7.12.1.2.7. SECONDARY MITIGATION AND RESIDUAL EFFECT

172. Given that there are no likely significant effects in EIA terms, secondary mitigation is not required.

7.12.1.3. IMPACT ON DESIGNATED FEATURES WITHIN THE DESIGNATED SITES

173. A number of designated sites intersect the Offshore Physical Environment and Seabed Conditions Study Area, as listed in Table 7.5. The designated interest features mainly comprise geological, geomorphological and sedimentological features and based on their properties, the pathway for impacts relates to the potential for changes to seabed levels and sediment properties from construction activities within the Marine Scheme, as assessed in section 7.12.1.

7.12.1.3.1. MAGNITUDE OF IMPACT

7.12.1.3.1.1. Firth of Forth Banks Complex ncMPA

174. The seabed within the Marine Scheme contains a number of protected sites. The Marine Scheme and Offshore Physical Environment and Seabed Conditions Study Area directly overlaps with the Firth of Forth Banks Complex ncMPA (Volume 4, Figure 7.4). The Marine Scheme area of overlap within the designated site is approximately 361 km^2, equating to approximately 26% of the designated site. The Firth of Forth Banks Complex ncMPA is a composite site with Berwick and Marr Banks lying within the Marine Scheme in Scottish waters, whilst Scalp and Montrose Banks, and the Wee Bankie lie within the wider Offshore Physical Environment and Seabed Conditions Study Area. These banks are comprised of the following designated features: offshore subtidal sands and gravels, shelf banks and moulds and moraine formations. Both offshore subtidal sands and gravels are Priority Marine Features (PMFs) in Scotland's seas and considered of conservation importance. The Firth of Forth Banks Complex ncMPA is also designated for the protection of Shelf banks and mounds as large-scale features, which are considered to be significant to the health and biodiversity of the wider Scottish sea, and the Wee Bankie Key Geodiversity Area.

175. The Firth of Forth Banks Complex ncMPA may be susceptible to changes in seabed levels, changes to seabed properties and changes to SSC. Approximately 16.3 km of the Offshore Export Cables (within the Marine Scheme) is located within the designated site, so based on the disturbance footprint of 25 m per cable for four cables, up to a total of 1.6 km^2 would be directly disturbed, which equates to 0.1% of the designated site. The disturbance would be entirely within Scottish waters.

176. As detailed in sections 7.12.1.1.1 and 7.12.1.1.4 (in relation to changes to seabed levels and sediment properties respectively), the sedimentation identified would mostly be localised to the disturbance and composed of native material. Sedimentation from active deposition would be transient along the Offshore Export Cables, with the thickest areas of sedimentation located closest

to the area of disturbance activity, decreasing in thickness with increasing distance. Whereby sedimentation from active deposition will be in relation to settling velocity of sediment within the Marine Scheme (i.e. predominantly fine sand), and once deposited will form part of the sediment transport regime. Deposition from the plume extent would again result in deposition within the designated site and beyond, however, this would be only millimetres of deposition that would largely be indiscernible from the background and natural variation.

177. As seabed levelling will be mostly required in locations with bedforms, which could coincide with the Marine Scheme area that overlaps with or is in close proximity to the Firth of Forth Banks Complex ncMPA. Table 7.16 demonstrates that for seabed levelling deposition thickness based on clearance within Scottish waters could range between 0.1 m and 0.9 m (for the lowest disturbance height), which would occur over an area between 1 km^2 and 0.6 km^2 respectively, a proportion of which may overlap the ncMPA. With respect to any potential deposition within the ncMPA associated with clearance activities within English waters, a much smaller deposition area could overlap the ncMPA, however, this would be a much smaller area and lower thickness than suggested above due to the increased distance from the disturbance. With respect to trenching, the deposition thickness ranged between 0.1 m and 0.7 m (for the lowest disturbance height) (Table 7.17), with deposition occurring within tens of metres, therefore deposition associated with trenching is less likely to reach the ncMPA. As deposition would be in proximity to the disturbance and the designation includes sandwave bedforms with variable height, the direct disturbance will not alter the properties of the designated site, so a low magnitude is considered to apply to the Firth of Forth Banks Complex ncMPA.

7.12.1.3.1.2. Northumberland Shore SSSI

178. The Northumberland Shore SSSI is located in English waters and is designated for sandy bays separated by rocky headlands with wavecut platforms, estuarine intertidal mudflats and estuarine intertidal saltmarsh (Natural England, 1992b). Although the Marine Scheme at Landfall directly overlaps this designated site as illustrated in Volume 4, Figure 7.4, it should be noted that trenchless technologies are being applied for the Landfall, with the minimum exit depth being completely subtidal at approximately 10 m LAT. Therefore, it is the case that the trenchless method will completely pass under this designated site, with the exit being beyond the seaward boundary of the SSSI, with no direct disturbance to this site. The footprint of the Marine Scheme within the designated site is approximately 0.23 km^2, equating to approximately 1% of the designated site. Although 0.18 km of the Offshore Export Cables (within the Marine Scheme) overlaps the SSSI, the cables would be drilled beneath the site, without any direct impact. As such the only potential impacts on the SSSI would be indirect, for example sediment deposition.

179. The site and units relating to geological, geomorphological and sedimentological features is considered to be in favourable condition based on recent surveys in 2009 (Natural England, 2009). Deposition associated with construction activities as a result of active deposition as discussed throughout section 7.12.1.1.1, could result in sedimentation locally where the Offshore Export Cables will be buried as well as the methodology for the installation of the Offshore Export Cables at Landfall. Seabed levelling is not considered to be required within the part of the Marine Scheme that intersects this protected site. Therefore, the main activities likely to introduce an impact is in relation to change in bed levels as a result of deposition in relation to cable installation and Landfall works, including the excavation of exit pits and the popout from the trenchless technology duct, in the subtidal region (i.e. at depths greater than 10 mLAT).

180. The deposition thickness ranged between 0.1 m and 0.7 m (for the lowest disturbance height) for the different sediment types, based on their percentage composition, with the cumulative deposition thickness being a combination of the varying sediment types at varying flow speeds and disturbance heights (Table 7.17). The change in seabed levels as a result of trenching deposition would be transient along the Offshore Export Cables, with the thickest areas of sedimentation located closest to the area of disturbance activity, decreasing in thickness with increasing distance.

Deposition from the trenchless technology popout release would at worst be up to 0.05 m, as described in paragraph 132. Sedimentation from active deposition in relation to natural settling velocity of the region, once deposited will form part of the sediment transport regime. Deposition in terms of the plumes from trenching and Landfall works would result in deposition within the protected site and beyond, however this would be only millimetres of deposition that would largely be indiscernible from the background and natural variation.

181. The excavation of the exit pits would temporarily alter seabed levels as assessed further in section 5.12.1.4, due to the presence of the exit pits and associated sediment berms. However, the seabed is to be reinstated following completion of Landfall works, thereby returning the seabed levels to its original state.

182. There is not expected to be any change to sediment properties, as the only sediment largely being deposited, would be that disturbed in the vicinity. Therefore, mainly on the basis of the cable installation or Landfall operations altering seabed levels by a very low margin over a small proportion of the designated site, a low magnitude is again considered to be applicable to this Northumberland Shore SSSI.

7.12.1.3.1.3. Creswell and Newbiggin Shores SSSI and GCR

183. The Creswell and Newbiggin Shores SSSI and GCR is located in English waters, and is designated for sandy bays, littoral sediment and geological designations of earth heritage which is considered to contain exposures of the Northumberland Coalfield of Middle Carboniferous strata (Natural England, 1992a). The site is located within the Offshore Physical Environment and Seabed Conditions Study Area, located directly north of the Marine Scheme at Landfall but does not overlap with the Marine Scheme. During surveys carried out in 2012, the protected site was identified as in favourable condition (Natural England, 2012). The Offshore Physical Environment and Seabed Conditions Study Area was defined by the tidal excursion extent (section 7.3), therefore there is potential for connectivity between the protected site and the proposed construction activities in the Marine Scheme.

184. Deposition associated with construction activities as a result of active deposition as discussed throughout section 7.12.1.1.1, could result in sedimentation locally where the Offshore Export Cables will be buried as well as the Landfall methodology. This would be transient along the Offshore Export Cables, with the thickest areas of sedimentation located closest to the area of disturbance activity, decreasing in thickness with increasing distance. Sedimentation from active deposition in relation to natural settling velocity of the region, once deposited will form part of the sediment transport regime. Deposition from the plumes from trenching and Landfall works could result in deposition within the protected site, however, this would be only millimetres of deposition that would largely be indiscernible from the background and natural variation. Consequently, the Marine Scheme is not anticipated to affect the integrity of the SSSI and GCR and a negligible magnitude is applied.

7.12.1.3.1.4. Coquet to St Mary's MCZ

185. The Coquet to St Mary's MCZ is located in English waters and is designated for both geomorphological and geological coastal features and offshore features such as intertidal and subtidal sediments (Defra, 2016a; Natural England, 2019). The Marine Scheme directly overlaps this designated site at Landfall as illustrated in Volume 4, Figure 7.4, with an area of 4.5 km^2, equating to approximately 2.3% of the designated site. Approximately 3.9 km of the Offshore Export Cables (within the Marine Scheme) is located within the designated site. Based on the disturbance footprint of 25 m per cable for four cables, approximately 0.4 km^2 would be directly disturbed, in addition to the 500 m^2 from the footprint of the exit pits, which equates to 0.2% of the designated site. No feature condition status is available for the MCZ at the time of writing, although supplementary advice exists for each interest feature.

186. The designated site is potentially sensitive to activities which negatively affect properties of the interest feature, sediment deposition and natural physical process on the site. This means the site may be susceptible to changes in seabed levels, changes to seabed properties and changes to SSC associated with construction activities. No bedforms are described within the MCZ and the site-specific geophysical survey did not highlight the presence of any bedform features, thereby suggesting levelling unlikely to be necessary within the designated site. Therefore, the main construction activity likely to introduce impacts is through cable installation trenching operations. Deposition associated with cable installation and Landfall works as discussed in section 7.12.1.1.1, could result in sedimentation locally where the Offshore Export Cables will be buried. This would be transient along the Offshore Export Cables, with the thickest areas of sedimentation located closest to the area of disturbance activity, decreasing in thickness with increasing distance. Whereby sedimentation from active deposition will be in relation to settling velocity of sediment within the Marine Scheme (i.e. predominantly fine sand), and once deposited will form part of the sediment transport regime. Table 7.17 demonstrates that the deposition thickness ranged between 0.1 m and 0.7 m (for the lowest disturbance height) for the different sediment types, based on their percentage composition, with the cumulative deposition thickness being a combination of the varying sediment types at varying flow speeds and disturbance heights associated with trenching. Deposition from the trenchless technology popout release would at worst be up to 0.05 m (paragraph 132). Although further deposition could occur associated with the plumes from trenching and Landfall works, the deposited material would be only millimetres of deposition that would largely be indiscernible from the background and natural variation.

187. With respect to the excavation of trenchless exit pits at the Landfall, these would be temporary, with the seabed reinstated. As described for the seabed sediment (section 7.7.2.2.3) the Marine Scheme is diverse with a range of varying seabed sediment and clast sizes. Therefore, the project related effects would largely be in keeping with the varied nature of the seabed environment and any deposited seabed sediment would be indiscernible from the existing seabed sediment. There is not expected to be any change to sediment properties, as the only sediment being deposited would be that disturbed within the site. Therefore, mainly on the basis of the cable installation trenching operations altering seabed levels by a low margin over a small proportion of the designated site, a low magnitude is considered to be applicable to this Coquet to St Mary's MCZ.

7.12.1.3.1.5. Farnes East MCZ

188. The Farnes East MCZ is characterised by offshore subtidal geological and geomorphological features notably, moderate energy circalittoral rock and subtidal sediments consisting of coarse, mixed sediments, mud and sand (Defra, 2016b; JNCC, 2017). The site is located in English waters, approximately 11 km from the Northumberland Coast, located within the Offshore Physical Environment and Seabed Conditions Study Area, directly adjacent to the Marine Scheme (Volume 4, Figure 7.4). The features that form part of the MCZ are maintained in favourable condition except for subtidal mud, which is in recover to favourable condition. The shallower areas of the site, in the west largely, consist of subtidal coarse sediment and subtidal mixed sediments, while the eastern half of the site is dominated of subtidal sand.

189. The MCZ is located directly adjacent to the Marine Scheme, which means there is potential for direct connectivity between the protected site and the proposed construction activities in the Marine Scheme. Although the designated site characterisation did not describe the presence of bedforms within the MCZ (JNCC, 2017), the site-specific geophysical survey indicated the presence of bedforms in survey corridor L12 (Volume 4, Figure 7.2 and section 7.7.1.2.1), particularly within the Marine Scheme that is directly adjacent to this designated site.

190. There is therefore the potential that seabed levelling could be completed within the Marine Scheme in the area adjacent to the designated site. Should seabed levelling be completed in this area, deposition could extend between tens to hundreds of metres from the works, based on the settling velocity of the sediment present within the Marine Scheme (i.e. predominantly fine sand) (section

7.12.1.1.3). Therefore, deposition from disturbance occurring within the Marine Scheme could extend into the designated site, although it is expected that the majority of the disturbed sediment would be deposited within Marine Scheme boundary. In any instance, the deposition thickness would reduce with increasing distance from the disturbance activity, with a deposition thickness of less than 0.1 m for distances over 100 m from the disturbance activity (Table 7.17), so any deposition within this designated site would be minimal. Deposition associated with construction activities would be transient along the Marine Scheme, with the thickest areas of sedimentation located closest to the area of disturbance activity, decreasing in thickness with increasing distance (section 7.12.1.1.1). Once deposited, the sediment will form part of the sediment transport regime. Deposition from the plumes from trenching could also result in deposition within the MCZ, however, this would be only millimetres of deposition that would largely be indiscernible from the background and natural variation.

191. As described for the seabed sediment (section 7.7.1.2.3) the Marine Scheme is diverse with a range of varying seabed sediment and clast sizes. Therefore, the project related effects would largely be in keeping with the varied nature of the seabed environment and the any deposited seabed sediment would be indiscernible from the existing seabed sediment. There is not expected to be any change to sediment properties, as only the only sediment being deposited, would be that disturbed in the vicinity. Therefore, mainly on the basis of the cable installation trenching operations potentially altering seabed levels by up to 0.1 m over a very small proportion of the designated site, a low magnitude is considered to be applicable to this Farnes East MCZ.

7.12.1.3.1.6. Tynemouth to Seaton Sluice SSSI and GCR

192. Tynemouth to Seaton Sluice SSSI and GCR located within England is designated for geological features. These include geological cliff exposures and geological foreshore exposures (Natural England, 1989). The site is located approximately 9 km south from the Landfall area and half of the designated site is located within the Offshore Physical Environment and Seabed Conditions Study Area. The area contains exposures of coal and mudstones horizons at the surface. The two geological features are considered to be in favourable maintained conditions and not considered to be exposed to any negative pressures, based on assessments completed in 2011 (Natural England, 2011). The Offshore Physical Environment and Seabed Conditions Study Area was defined by the tidal excursion extent (section 7.3), therefore there is some possibility for connectivity between the protected site and the proposed construction activities in the Marine Scheme.

193. The influence of the Marine Scheme as a result of active deposition is predicted to result in sedimentation locally around the construction activities and therefore no connectivity between the Marine Scheme and the protected site is anticipated. As a result of passive deposition from the sediment plume, the influence of the Marine Scheme has a maximum distance of half the extent of the tidal ellipse in the direction of the tidal flow which is approximately 2.5 km. With regards to the sediment deposition from plumes from trenching and Landfall works, these factors are not likely to affect the geological feature of the site. Furthermore, at distance of 9 km south of the Marine Scheme, changes in local wave, flow and sediment transport regimes are not anticipated to have any connectivity with the Marine Scheme and the protected site. Therefore, a negligible magnitude is considered applicable to this designated site.

7.12.1.3.2. SENSITIVITY OF THE RECEPTOR

194. The impact to the designated features within the designated site relates to the potential changes in seabed levels and sediment properties. The worst-case impact is associated with the seabed preparation and cable installation both offshore and at Landfall which has the potential to impact the designated features within the designated sites. The seabed within the Marine Scheme is designated for a number of protected sites which may be sensitive to changes in seabed levels and changes to seabed properties as a result of the installation of the Offshore Export Cables. Protected sites which are designated for geomorphological, geological and sedimentary features of the

seabed include the Firth of Forth Banks Complex ncMPA, Northumberland Shore SSSI, Coquet to St Mary's MCZ, Farnes East MCZ, Creswell and Newbiggin Shores SSSI and GCR, Tynemouth to Seaton Sluice SSSI and GCR.

195. The changes to seabed levels and changes to seabed properties identified are localised and composed of native material which may be deposited through sedimentation therefore the structure and function of the seabed is of low vulnerability and recoverable. Changes to SSC as a result of passive deposition from sediment plumes is anticipated to not affect any of the geological, geomorphological and sedimentological features within the designated sites. Deposition from the plume extent could result in deposition at the protected site, however, this would be only millimetres of deposition that would largely be indiscernible from the background and natural variation. Due to the seabed containing features which are protected under national and international legislation and a low capacity to accommodate and moderate ability to recover from the impacts of changes to seabed levels and seabed properties, the sensitivity of the seabed therefore considered to be medium.

7.12.1.3.3. SIGNIFICANCE OF THE EFFECT

196. Based on the completed analyses, the potential changes in seabed levels impacting designated features are predicted to be of local spatial extent, long term duration, continuous and high reversibility. It is predicted that the impact will affect the receptor directly. For the Creswell and Newbiggin Shores SSSI and GCR and Tynemouth to Seaton Sluice SSSI a negligible magnitude is applied.

197. A low magnitude is applied to the remaining designated sites, namely the Firth of Forth Banks Complex ncMPA, Coquet to St Mary's MCZ, Farnes East MCZ and Northumberland Shore SSSI. Designated interest features within the site are noted as being sensitive to changes in seabed level, and the construction activities are demonstrated to result in sedimentation of less than 1 m across a small area of overlap with the designated sites.

198. The seabed receptor, which is a designated feature, within the Marine Scheme is considered to be of medium sensitivity due to the presence sites designated under national and international legislation.

199. Therefore, the effect will at worst be of **minor** adverse significance for the Firth of Forth Banks Complex ncMPA located within Scottish waters, The same **minor** adverse significance is also applicable to the Coquet to St Mary's MCZ, Farnes East MCZ and Northumberland Shore SSSI all located within English waters. For the above designated sites, the effect is considered not significant in EIA terms, noting that the effect will be only over a very limited proportion of each designated site. For the Creswell and Newbiggin Shores SSSI and GCR and Tynemouth to Seaton Sluice SSSI designated sites, which are both located in English waters, the effect will be of **negligible to minor** adverse significance, which is not significant in EIA terms.

7.12.1.3.4. SECONDARY MITIGATION AND RESIDUAL EFFECT

200. Given that there are no likely significant effects in EIA terms, secondary mitigation is not required.

7.12.1.4. CHANGE TO COASTAL LANDFALL MORPHOLOGY – ENGLISH WATERS

201. The Cambois Landfall is an open bay fronted by a beach backed by dunes. The coastal characterisation discussed in section 7.7.1.6 identified the coastline as being stable.

202. Potential changes to the Landfall morphology can arise as a result of cable Landfall activities at the coast. As detailed in Table 7.11, the Landfall methodology is for trenchless techniques, with the excavation of up to five (four plus one spare) exit pits, to aid the Landfall exit, at a subtidal depth of

10 m LAT. Potential deposition from the trenchless technology popout release would at worst be up to 0.05 m, which would be mostly indiscernible from the surrounding seabed, so the main potential for changes are associated with the excavation of exit pits. The exit pits would be up to 20 m in length (orientated offshore), by 5 m wide and 3 m deep. Depending on ground conditions, it is possible that a single pit for all ducts may be considered, leading to a minimum 20 m wide pit, extending 20 m offshore. Up to 300 m^3 could be excavated from each pit, up to a total of 1,500 m^3 (should five be excavated). The excavated sediment would be deposited alongside the pits in temporary sediment storage berms, with a maximum height of up to 1.5 m and width of 9.5 m. Based on installation programme (and the assumptions set out in section 7.9.11 above) the exit pits and sediment storage berms could be in place for three months until the completion of trenchless techniques works, when mechanical backfilling would occur. There is therefore the potential for both the pits and berms in the nearshore for a period of time, so the worst case is assessed on the basis that the exit pits (separately or grouped into one single pit) and sediment berms are present and have the potential to interact with the local flow and wave regime.

203. The average wave period characteristic to the Landfall area informed by observations from the Newbiggin wave buoy (in a water depth of 18 m CD) is 7.8 seconds (section 7.7.1.2). The wavelength associated with the wave period is approximately 95 m, and at the exit depth of 10 m LAT, the waves would be in a breaking regime, as the wave begin to shoal on feeling the seabed. Therefore, the presence of the temporary exit pit(s) and sediment storage berms could interact with the wave regime.

204. In terms of the exit pit(s), these would locally increase the water depth by up to 3 m. The increase in water depth would not ultimately affect the wave regime as the increase in depth would still be within a breaking wave regime based on the wave period and wavelength for the average waves characteristic to the Landfall (section 7.7.1.2). In terms of the sediment berms, as noted above, the sediment berms could be up to 1.5 m high and 9.5 m wide, to account for the excavated volumes from each pit, each respective berm would be about 35 m long. As the pits and berms would be orientated offshore, so perpendicular to the coastline and wave approach direction, the influence of the berm on the approaching waves is to locally increase wave shoaling where the berm is present. In terms of influence on flows, the increased depths associated with the exit pits(s), would not alter or influence flows. For the sediment berms, the height of 1.5 m is not high enough to disrupt water levels either side of the berm, therefore, there the flow will not be disrupted and there will not be any change to flow speeds.

205. Therefore, beyond the immediate proximity to the exit pit(s) and sediment berms, there will be no interruption to flows and only locally increased shoaling to waves in close proximity to the berms. The localised changes to waves are not enough to alter the morphology of the coastline or the littoral drift that occurs along this frontage in relation to the regional north to south sediment transport section pathway (7.7.1.2).

7.12.1.4.1. MAGNITUDE OF IMPACT

206. The pathway for potential changes to the morphology of the coastline is introduced above. It notes that there will ultimately be no changes to flows, with localised increase to wave shoaling where the temporary sediment storage berms are located. The orientation of the exit pit(s) and sediment berms are perpendicular to the coastline and wave approach. Therefore, the coastal frontage likely to be influenced by the localised changes to waves is minimal, and at worst would be marginally larger than the sediment berm width. It is estimated that the exit pits and berms could be in position for up to three-months, before being mechanically backfilled and the seabed reinstated, so the potential changes to waves locally would be temporary.

207. Overall, the impact is predicted to be of local spatial extent, short-term duration, continuous during the three-month period and high reversibility on completion of the Landfall installation. The impact is not predicted to ultimately lead to changes to the coastal morphology of Cambois Bay, due to the

small-scale and localised nature of the exit pit(s) and sediment berms. There is however, the potential for localised changes to waves as a result of the sediment berms, so the magnitude is therefore considered to be low.

7.12.1.4.2. SENSITIVITY OF THE RECEPTOR

208. The Marine Scheme Landfall directly overlaps the Coquet to St Mary's MCZ and Northumberland Shore SSSI, which are both designated for geological, geomorphological and sedimentological features under national and international legislation. Due to the seabed and coast containing designated features, with a low capacity to accommodate and moderate ability to recover from the impacts of changes, the sensitivity is considered to be medium.

7.12.1.4.3. SIGNIFICANCE OF THE EFFECT

209. The impact to coastal morphology is predicted to be of local spatial extent, short term duration, during the three-month period when works are ongoing and high reversibility on completion of the Landfall installation. Therefore, the magnitude is therefore considered to be low. The coast receptor within the Marine Scheme is considered to be of medium sensitivity due to the presence of designated features. The effect will, therefore, be of **minor** adverse significance, for the Marine Scheme in English waters which is not significant in EIA terms.

7.12.1.4.4. SECONDARY MITIGATION AND RESIDUAL EFFECT

210. Given that there are no likely significant effects in EIA terms, secondary mitigation is not required.

7.12.2. Potential Effects During Operation and Maintenance

7.12.2.1. POTENTIAL CHANGES TO THE TIDAL, WAVE AND SEDIMENT TRANSPORT REGIMES AS A RESULT OF BLOCKAGE EFFECTS FROM CABLE PROTECTION MEASURES

211. Potential changes to the tide and wave regime may occur when infrastructure, in the case of the Marine Scheme, the cable and crossing protection on the seabed has the capacity to locally block the incident flows and waves. These changes can have associated consequences on the water column, seabed and coast, due to blockage effects. The scale of any blockage relates to the cross-sectional area of the infrastructure on the seabed and their protruding heights. The potential changes to flows and waves and the onward impact to sediment transport regimes within the Marine Scheme are presented below.

7.12.2.1.1. CHANGES TO FLOWS

212. The total footprint of cable and crossing protection estimated to be required across the Marine Scheme is 1.46 km^2 (0.23 km^2 1.23 km^2 for Scottish and English waters respectively) (Table 7.11). Protection would have a maximum height of 1.5 m and width of 9.5 m, while crossing protection have a maximum elevation of 2 m, with a width of 12.5 m, these would protrude into the water column with a submerged cross-sectional profile.

213. The potential obstruction of protection to flows at varying depths along the Marine Scheme was investigated based using empirical formulae on determining the depth-averaged flow speed above a submerged near-bed structure from the Construction Industry Research and Information Association (CIRIA) rock manual (CIRIA, 2007). The data used in the calculations included:

- Water depths at a mid-tide state at the Landfall, mid-depth and deepest depth across the Marine Scheme (i.e. 10 m LAT, 50 m LAT and 100 m LAT respectively);

- Water levels and spring and neap flow speeds as presented in section 7.7.1.4; and
- A discharge coefficient of one, which is relevant for a vertical closure, subcritical flow (CIRIA, 2007), which is characteristic of the site conditions with a protection in place.

214. Results of the completed analyses are summarised in Table 7.18 and demonstrate at all water depths where protection could be installed, there is no discernible change to water levels upstream or downstream of the protection berm, consequently, there is no alteration to flow speeds. At all water depths, the presence of the cable and crossing protection would be indiscernible across the Marine Scheme.

Table 7.18 Downstream flow speed changes due to remedial cable protection

Location	Analysed water depths (m LAT)	Flow speed (m/s)[1]		Spring [2]		Neap [2]	
		Spring	Neap	Downstream flow speed	Percentage change	Downstream flow speed	Percentage change
Landfall (English waters)	10	0.6	0.2	0.6	No Change	0.2	No Change
Mid-depth Marine Scheme (Scottish and English waters)	50	0.6	0.2	0.6	No Change	0.2	No Change
Deepest depth Marine Scheme (Scottish and English waters)	100	0.6	0.2	0.6	No Change	0.2	No Change

[1]: Flow speed across the Marine Scheme, informed by the baseline characterisation (section 7.7.1.4).

[2]: Assessed changes to flow speeds as a result of the 1.5 m high and 9.5 m wide cable and crossing protection.

7.12.2.1.2. CHANGES TO WAVES

215. Wave energy is transmitted through a water body as an oscillatory motion which is strongest at the sea surface but reduces exponentially over depth. Long-period swell-waves transmit the greatest amount of wave energy and with a deeper influence through a water body compared to short-crested wind-waves which transmit most of their energy close to the sea surface.

216. Offshore locations of the Marine Scheme are located within a deep water wave regime, moving towards a transitional wave and shallow water breaking wave regime on approach to the Landfall. As detailed in section 7.7.1.2, the waves approach predominantly from the NNE direction. Under the deep water wave regime, which occurs along the majority of the Marine Scheme, the cable and crossing protection are not going to be felt by the wave and will not have any impact on the progression of the wave (both swell and local waves). For the characteristic wave period of 7.8 seconds and associated wavelength of 95 m, the transitional wave regime is estimated to occur from depths of around 48 m LAT, with a shoaling and breaking wave regime taking over at depths of around 14 m LAT and shallower. The presence of cable and crossing protection at depths associated with a transitional wave regime means that theoretically the wave could begin to feel the protection. However, the actual profile of the protection berm at 9.5 m at its widest and 1.5 m at its highest, is very small and in reality would be largely indiscernible in the context of a

progressing wave train that is on a much larger scale at tens to hundreds of metres. Furthermore, any protection would be in short distinct areas, noting that the berms would not be present along the entire Offshore Export Cable Corridor. Therefore, the presence of any protection within the water depths associated with the transitional wave is not considered to cause any changes to wave or increase shoaling.

217. In terms of locations in the shallow water and breaking wave regime (i.e. at depths of around 14 m LAT and shallower), the presence of the protection would locally increase the seabed height by up to 1.5 m. As noted in the maximum design scenario, the shallowest depth which protection could occur is at 10 m LAT, associated with the exit. Therefore, for the few metres of subtidal depth (i.e. between 10 m LAT and approximately 14 m LAT) the protection berm would interact with waves. However, as described for the transitional wave regime, the protection berms would be small distinct and infrequent features within the Marine Scheme. Wave progression is a meso-scale regional process, so the footprint of the protection in the context of the wave progression would be minimal. Should the wave interact with the seabed, the effect of the presence of the berm would be to very locally and very temporarily create additional drag on the wave as it progresses. Beyond the protection berm, the wave would recover and continue to propagate. The described drag effect would be akin to that from bedforms that are known to occur across the Marine Scheme. Therefore, even in the water depths associated with the shallow water and breaking wave regime, the presence of protection is not considered to ultimately affect or disrupt wave propagation (through reflection or diffraction processes). The small and intermittent footprint of the protection in locations where required within the Marine Scheme, would also not lead to wave energy dissipation for the same reason that waves would recover in the lee of the protection berms and continue to travel to eventually completely break at the coast.

7.12.2.1.3. CHANGES TO SEDIMENT TRANSPORT

218. This impact considers the potential for changes to the sediment transport regime, based on the pathways by which the changes might occur as a result of the Marine Scheme. The pathways that have been identified and discussed in the following sections are as follows:

- Changes to the wave and tide regime with resulting onward modification of sediment transport, either as bedload or in suspension;
- Blockage effect from cable and crossing protection on the seabed; and
- Increases in suspended sediment associated with the Offshore Export Cables.

7.12.2.1.4. CHANGES TO SEDIMENT TRANSPORT AS A RESULT OF CHANGES TO WAVE AND TIDE REGIME

219. Sediment transport is dependent on tidal flow and wave properties, which drive the potential for sediment mobility as introduced in section 7.7.1.5. Based on the results assessed for potential changes to flows and waves, discussed in sections 7.12.2.1.1 and 7.12.2.1.2 respectively, the presence of cable and crossing protection on the seabed does not ultimately impact the tidal and wave regimes across the Marine Scheme. With no change to waves and tides, there is not anticipated to be onward changes to the sediment transport regime as a result of the Marine Scheme.

7.12.2.1.5. CHANGES TO SEDIMENT TRANSPORT AS A RESULT OF BLOCKAGE FROM REMEDIAL CABLE PROTECTION

220. Current speeds across the Marine Scheme as described in section 7.7.2.4 are in the region of 0.2 m/s to 0.6 m/s on the neap and spring tides respectively. The shallowest depths within the Marine Scheme at which remedial cable protection could be placed would be at the exit, at depths of

around 10 m LAT. The worst-case height and coverage of protection would be 1.5 m and 0.2 % of the Marine Scheme, in water depths ranging between 10 m LAT and over 100 m LAT.

221. The sediment mobility potential (Table 7.10) demonstrates that for the different sediment sizes that occur across the Marine Scheme, only a small proportion would be mobilised based on baseline conditions, with sediment moving as a result of bedload transport. Of the amount available for transport, only a small proportion could theoretically be trapped within the protection, and the exact amount would vary in relation to the tidal processes, wave properties and sediment grain size. There would be an increasing dependence on current driven transport (with associated reduction in wave energy contribution) with increasing depth along the Marine Scheme. Any changes to tidal processes could therefore have a greater effect on the transport regime, so the potential for varying current speeds and any onward effects on suspended sediment transport was investigated.

222. As demonstrated in the assessment for potential changes to tides (section 7.12.2.1.1) above, the presence of protection does not alter water levels downstream of the protection. Therefore, there is no large scale change to flow properties, which is still the case at the shallowest location within the Marine Scheme (Table 7.18). With no variation in tidal flow speeds, the sands and gravels that comprise the majority of the seabed sediment across the Marine Scheme would not be disrupted and still be transported. At the same time, any silt sediment would remain in suspension. However, it is recognised that locally, in proximity to the protection structure, the protection could temporarily act as a blockage to sediment movement. The protection would be a porous structure, therefore sediment transported as bedload could potentially be trapped within the voids of the protection, meaning the structure would initially act as a localised sink for coarser sediments. This effect, however, would only be temporary and in the short-term, for the localised area of seabed where the protection is present, based on observations of beach groynes where sediment entrapment is the primary purpose. With time and as the voids within the protection fills or colonises with benthic communities, sediment previously deposited locally, would bypass, pass through or overtop the protection. The protection structure is therefore unlikely to cause any hindrance to the transport of coarse sediment in the medium to long-term.

223. Waves observed across the Marine Scheme would exert an almost constant influence on the seabed at the potential shallowest placement of protection (i.e. around 10 m LAT) and locations under the shallow water wave breaking regime, (section 7.12.2.1.2) potentially moving sand sediment. As described above in relation to flows, the protection would be a porous structure, thereby trapping sediment moved in relation to flows and waves, again meaning the structure would initially act as a localised sink for coarser sediments. It is again considered that this effect would only be temporary and in the short-term, for the section of the protection where wave action interacts with the seabed. As the voids fill and sediment bypassing begins, sediment would continue to be transported with the protection in place, with the protection unlikely to cause any hindrance to the transport of coarse sediment in the medium to long-term.

7.12.2.1.6. CHANGES TO SEDIMENT TRANSPORT AS A RESULT OF INCREASES IN SUSPENDED SEDIMENT

224. Although no changes to the wave and tide regime are anticipated (sections 7.12.2.1.1 and 7.12.2.1.2), increases in suspended sediment may occur due to repairs during the operational phase of the Marine Scheme. Although it is not possible to exactly quantify the increase in suspended sediment, it is anticipated that the sediment disturbance would be relatively minimal compared to the volumes assessed associated with construction activities (section 7.12.1). For any disturbance that occurs, it would be short-term during repair operations and transient along the Offshore Export Cables and within a few metres of the seabed vertically. As described for the construction impact assessment in section 7.12.1, it is anticipated that the coarser fraction within the disturbed sediment would quickly be redeposited back on the seabed, whilst the silt fraction (i.e. the finer sediment, section 7.12.1.2.4) may be advected away by the near-bed flow. It is noted that SPM levels across the Marine Scheme are generally low at below 1 mg/l (section 7.7.1.5.2). Any

disturbance would remain near-bed and is not expected to alter water column sediment concentrations above background levels that would be expected with the tidal flow.

7.12.2.1.7. MAGNITUDE OF IMPACT

225. The potential changes to the tidal, wave and sediment transport regimes as a result of blockage effects from cable and crossing protection measures within the Marine Scheme is assessed to be minimal. The presence of cable and crossing protection on the seabed does not ultimately impact the local wave and tidal regime across the Marine Scheme. With no change to waves and tides, there is not anticipated to be onward changes to the sediment transport regime as a result of the Marine Scheme. However, it is noted that in the short-term the protection berm could act as a localised sink, with disruption to sediment transport processes, but in the medium to long-term, sediment would bypass the protection berm. This process could occur at all depths, where flows are the primary sediment transport mechanism, but would be more pronounced in the shallowest water depths where the shallow water breaking wave regime are considered to occur and waves contribute to sediment transport processes. Therefore, the impact is predicted to be of local spatial extent and short-term duration (until sediment by-passing begins) but continuous, with sediment by-passing occurring in the medium to long-term in line with the protection being present. The magnitude is therefore considered to be low for the Marine Scheme as a whole.

7.12.2.1.8. SENSITIVITY OF THE RECEPTOR

226. The potential changes to the tidal, wave and sediment transport regimes as a result of blockage effects from cable and crossing protection measures relate to the seabed and coast receptor. As the Marine Scheme directly overlaps a number of designated sites designated for geological, geomorphological and sedimentological features under national and international legislation, with a low capacity to accommodate and moderate ability to recover from the impacts of changes, the sensitivity is considered to be medium.

7.12.2.1.9. SIGNIFICANCE OF THE EFFECT

227. Based on the completed analyses, the impacts to the seabed and coast as a result of changes to the tidal, wave and sediment transport regimes as a result of blockage effects from cable and crossing protection measures is minimal. The impact is predicted to be of local spatial extent and short-term duration (until sediment by-passing begins) but continuous, with sediment by-passing occurring in the medium to long-term in line with the protection being present. It is predicted that the impact will affect the receptors directly, so the magnitude is therefore considered to be low. The seabed and coast contain designated sites with designated geological, geomorphological and sedimentological interest features, so medium sensitivity is applied. The effect will, therefore, be of **minor** adverse significance, for the Marine Scheme as a whole, which is not significant in EIA terms.

7.12.2.1.10. SECONDARY MITIGATION AND RESIDUAL EFFECT

228. Given that there are no likely significant effects in EIA terms, secondary mitigation is not required.

7.12.2.2. POTENTIAL INTRODUCTION OF SCOUR (INCLUDING EDGE SCOUR)

229. Based on the embedded mitigation for the burial of the Offshore Export Cables, and installation of external cable and crossing protection where necessary at the construction stage, thereby negating the development of scour in the first place, it was proposed to scope out this potential impact in the Scoping Report (BBWFL, 2022c). However, following comments received from stakeholders (in particular Cefas) and within the Scoping Opinion (MMO, 2023), this impact has been taken forward into the impact assessment. In particular Cefas requested the consideration of the potential for secondary (edge) scour as a result of the applied protection. Cefas noted that as protection can be

a localised blockage to flow, resulting in the development of scour with respect to the cable and crossing protection (Table 7.2).

7.12.2.2.1. PATHWAY FOR THE INTRODUCTION OF SCOUR

230. The analyses for the potential edge scour properties around the cable protection is based on empirical formulae as presented in Petersen (2014) and Petersen *et al.,* (2015a; 2015b). In the above studies, the edge scour properties primarily relate to the rock size applied, which normalises the scour depth. Key assumptions applied are as follows:

- Mean grain size of 350 μm, representative of fine sand characteristic to the Marine Scheme as determined from PSA analyses (section 7.7.1.5.1);
- At the time of writing the average size of rock is not available so a nominal grain size of 67 mm representative of boulders is applied;
- Water levels and spring and neap flow speeds as presented in section 7.7.1.4;
- Water depths of 10 m LAT, 50 m LAT and 100 m LAT as applied for blockage calculations; and
- Independent variable coefficients taken from Petersen (2014) and a friction factor of 0.5 based on a median value between 0 and 1.

231. Based on the applied water depths, the assumed rock size and the representative spring and neap flow speeds that occur across the Marine Scheme, there is little to no development of edge scour. With the application of faster flow speeds of around 1 m/s, which are not representative of the Marine Scheme, the potential for edge scour is still only centimetres, which would be indiscernible from the natural variation.

232. Overall, with the described potential effect of the protection acting as a localised sink in the short-term and sediment bypassing occurring in the medium to long-term, the potential for edge scour is considered unlikely with respect to the representative environmental conditions characteristic to the Marine Scheme.

7.12.2.2.1.1. Magnitude of impact

233. Based on the potential for edge scour calculated in line with empirical formulae, there is considered to be little to no potential for edge scour based on the assumed rock size in relation the water depths and flow speeds that occur across the Marine Scheme. Therefore, the impact is considered to be negligible for the Marine Scheme as a whole.

7.12.2.2.1.2. Sensitivity of the receptor

234. The potential introduction of scour, in particular edge scour from cable and crossing protection measures relates to the seabed receptor. As the Marine Scheme directly overlaps a number of designated sites designated for geological, geomorphological and sedimentological features under national and international legislation, with a low capacity to accommodate and moderate ability to recover from the impacts of changes, the sensitivity is considered to be medium.

7.12.2.2.1.3. Significance of the effect

235. Based on the completed analyses, the impacts to the seabed based on the potential introduction of scour is minimal, so the magnitude is therefore considered to be negligible. The seabed and coast contain designated sites with designated geological, geomorphological and sedimentological interest features, so medium sensitivity is applied. The effect will, therefore, be of **negligible** significance, for the Marine Scheme as a whole, which is not significant in EIA terms.

7.12.2.2.1.4. Secondary mitigation and residual effect

236. Given that there are no likely significant effects in EIA terms, secondary mitigation is not required.

7.12.3. Effects During Decommissioning

237. At the end of the operation and maintenance phase of the Marine Scheme, the options for decommissioning works will be reviewed, taking into consideration constraints (e.g., safety and liability) and the potential environmental impacts associated with decommissioning works.

238. The principal options for decommissioning include:

- Leaving the cable in-situ, trenched;
- Leaving the cable in-situ and providing additional protection;
- Remove sections of the cable that present a risk to other sea users; and
- Remove the cable entirely.

239. Should complete removal of the Offshore Export Cables be required, the significance of effect is considered to result in similar impacts to those assessment as part of the construction phase of the Marine Scheme. Impacts are anticipated to be of similar or lower magnitude to the construction phase (depending on the decommissioning option selected). Complete removal of the Offshore Export Cables represents the most significant adverse effects, and therefore if the other decommissioning options were to be progressed, they would have no more significant adverse effects. It is also assumed that the receptor sensitivities will not materially change over the life-cycle of the Marine Scheme as a result the sensitivity of the receptor is considered to be medium to the features being protected under national and international legislation.

240. Based on the potential change in seabed level and sediment properties, increases in SSC, impacts to designated features or change to coastal morphology associated with decommissioning activities, the magnitude of the impact is deemed to be low, associated with the worst case determined for construction activities. The presence of designated sites with geological, geomorphological or sedimentological interest features, which directly overlap the Marine Scheme mean that a medium sensitivity is applicable. The effect will, therefore, be of **minor** adverse significance, for the Marine Scheme as a whole, which is not significant in EIA terms.

7.13. Proposed Monitoring

241. No offshore physical environment and seabed conditions monitoring to test the predictions made within the assessment of likely significant effects on offshore physical environment and seabed conditions is considered necessary.

7.14. Cumulative Effects Assessment

7.14.1. Methodology

242. The Cumulative Effects Assessment (CEA) takes into account the impact associated with the Marine Scheme together with other relevant plans, developments and activities. Cumulative effects are therefore the complete set of effects arising from the Marine Scheme together with the effects from a number of different developments, on the same receptor or resource. Please see Volume 2, Chapter 3: EIA Methodology for detail on CEA methodology.

243. The developments selected as relevant to the CEA presented within this chapter are based on the results of a screening exercise and the development of a 'long list' of cumulative developments relevant to the Marine Scheme (see Volume 3, Appendix 3.4). Each development has been considered on a case by case basis for screening in or out of this chapter's assessment based on data confidence, effect-receptor pathways and the spatial/temporal scales involved based on defined zone of influence, to create the 'short list' as summarised in Table 7.19. A 10 km zone of influence was applied to the Marine Scheme, which is equivalent to the Offshore Physical

Environment and Seabed Conditions Study Area, to inform the cumulative developments list, to try capture potential overlapping maximum excursion extents from the nearby developments. This approach was agreed during Scoping and further consultation and technical engagement undertaken with consultees, as detailed in Table 7.2. Projects considered as part of the CEA are shown in Volume 4, Figure 7.13.

244. The 'short list' has taken into account the study area, as described within section 7.3 and depicted in Volume 4, Figure 7.1. Developments have been considered where there is a spatial or temporal overlap with the Marine Scheme and its programme. For the avoidance of doubt, the 'short list' does not include any currently operational developments – these have been considered as part of the baseline characterisation.

245. The specific projects scoped into the CEA for offshore physical environment and seabed conditions are outlined in Table 7.19.

246. Of the developments listed in Table 7.19, the Northumberland Energy Park (Phase 3) is in very early planning stages and no publicly available information on development details have been identified. Furthermore, the timeline is uncertain. Overall, whilst it has been considered for the CEA no meaningful assessment can be derived from its inclusion in the CEA and therefore it is not considered further for assessments.

247. It should be noted that the Marine Scheme and BBWF overlap both spatially (within the BBWF array area) and temporally (with regards to construction, operation and maintenance and decommissioning). As the Marine Scheme and BBWF are both being progressed by the Applicant, it is expected that both developments will be jointly coordinated using the same Marine Coordination Centre for all phases of each development.

Table 7.19 List of other developments considered within the CEA for the offshore physical environment and seabed conditions

Development / Plan	Jurisdiction	Status	Distance from Marine Scheme (km)	Description of Development / Plan	Dates of Construction (If Applicable)	Dates of Operation (If Applicable)	Overlap with the Marine Scheme
BBWF	Scottish waters	In planning	0	Offshore wind farm	2025-2033	2033 onward (35 year operational life)	Construction phase of Marine Scheme overlaps with development's timeline and spatially. O&M and decommissioning phases will also overlap.
Blyth Demonstrator Offshore Wind Farm - Phase 2	English waters	Consented	1	Offshore wind farm (floating)	Complete by 2025	Current lease secured until 2050	The Offshore Physical Environment and Seabed Conditions Study Area overlaps with development spatially. Overlap will be with the Marine Scheme construction and O&M phase.
Eastern Green Link 1	Scottish and English waters	In planning	0	Transmission infrastructure	2024-2027	2027 onward (~50 year operational life)	Construction phase of Marine Scheme overlaps with development spatially. O&M phases will overlap.
Eastern Green Link 2	Scottish and English waters	In planning	3	Transmission infrastructure	2026-2029	2029 onward (~40 year operational life)	Construction phase of Marine Scheme overlaps with development timeline. O&M phases will overlap.
Blyth Demonstration Phase 2 (and 3) Cable Corridor	English waters	Consented	0	Transmission infrastructure	Complete by 2025	Assumed to be consistent with Blyth Demonstrator Offshore Wind Farm - Phase 2	Marine Scheme overlaps with development spatially. Overlap will be with the Project construction and O&M phase.
Seagreen 1	Scottish waters	Under Constructio n	5	Offshore wind farm	2022 to 2023	2023 onward (25 year operational life)	No direct spatial overlap with Marine Scheme, only overlap in relation to O&M timescales.

Development / Plan	Jurisdiction	Status	Distance from Marine Scheme (km)	Description of Development / Plan	Dates of Construction (If Applicable)	Dates of Operation (If Applicable)	Overlap with the Marine Scheme
Inch Cape OFTO	Scottish waters	In planning	10	Transmission infrastructure	2022 to 2025	2025 onward (50 year operational life)	No direct spatial overlap with Marine Scheme, although construction and O&M phases may overlap.

7.14.2. Cumulative Effects Assessment

248. An assessment of the likely significance of the cumulative effects of the Marine Scheme with nearby projects on the offshore physical environment and seabed conditions receptors arising from each identified impact is given below.

249. The following sections summarise the nature of the potential cumulative effects for each potential stage of the Marine Scheme.

250. The following impacts have been taken forward for the cumulative assessment:

- Construction and Decommissioning:
  - Changes to seabed levels and changes to seabed properties due to cable installation;
  - Increases to SSC due to installation of export cables;
  - Impact on designated features within the designated sites due to installation of Offshore Export Cables; and
  - Change to coastal Landfall morphology.
- Operation and Maintenance:
  - Potential changes to the tidal, wave and sediment transport regimes as a result of blockage effects from cable protection measures; and
  - Potential introduction of scour.

251. It is appropriate to consider the Landfall area in further detail in the context of the Cambois Connection Onshore Scheme. Based on the maximum design scenario for the Marine Scheme, a trenchless technique, such as HDD, will be deployed to bring the Offshore Export Cables ashore via ducts that will be installed from a point landward of MHWS to an exit point at least 250 m seaward of MLWS, thus completely bypassing the intertidal area. All construction works and infrastructure associated with the Onshore Scheme will be above MHWS, and landward of the dune system on Cambois beach, and therefore there is no potential for any direct interaction with the intertidal area. Given there will be no construction works associated with the Onshore Scheme within the intertidal area, there is no potential for any direct effects on physical processes nor seabed conditions. Therefore, the Onshore Scheme is not considered further within this CEA. Further detail on the Onshore Scheme is provided in Volume 2, Chapter 5 Project Description.

7.14.2.1. POTENTIAL EFFECTS DURING CONSTRUCTION

7.14.2.1.1. CHANGES TO SEABED LEVELS AND SEDIMENT PROPERTIES

252. Changes to seabed levels and sediment properties will be affected by activities in the Marine Scheme. As presented in the impact assessment for changes to seabed levels and sediment properties, for construction activities, the activities may alter seabed depths to levels set out within the maximum design scenario (i.e. up to 5 m for levelling, 3 m for trenching, 3 m for the exit pits and 0.05 m for trenchless technology ducts at Landfall). In terms of the potential change in levels and sediment properties, for seabed preparation, the deposition extent associated with the majority of the sediment bulk can be up to an area around the disturbance, that in the worst case could be up to 4.7 km^2 within the Marine Scheme, to a deposition thickness of 0.1 m. In terms of trenching, deposition associated with the majority of the sediment bulk can extend up to a distance of 600 m, with a deposition thickness of a few centimetres. With respect to the potential plume for both construction activities, deposition from the plume could extend over 2.5 km, but the deposition thickness is more likely to be on the order of millimetres and would be undiscernible from the surrounding seabed. On the whole, deposition associated with construction activities will affect a very small proportion of the Marine Scheme.

253. Based on the timing of nearby projects summarised in Table 7.19, there is the potential for changes to seabed levels and sediment properties impacts to cumulatively occur associated with a number of marine renewables, cables and coastal development projects, including the BBWF, Blyth Demonstrator Offshore Wind Farm Phase 2 (which is a floating wind farm), Eastern Green Link (EGL) 1, Eastern Green Link (EGL) 2, and Blyth Demonstration Phase 2 Cable Corridor. Similar to the assessed changes for the Marine Scheme, nearby projects are expected to have impacts on a scale to or less than that determined for the Marine Scheme. Given the distance of the nearby projects from the Marine Scheme, impacts could coalesce leading to further changes in seabed levels. The deposition of sediment is expected to be transient associated with the Marine Scheme and along with the nearby developments, with the thickest areas of sedimentation located closest to the area of disturbance activity, decreasing in thickness with increasing distance. Sedimentation will occur in relation to the natural settling velocity of the sediment present and once deposited will form part of the sediment transport regime and be reworked in line with transport processes. As determined for the Marine Scheme, there is not expected to be any changes to sediment properties, as the same deposition mechanisms are expected to apply to all projects. Therefore, similar sediments are expected to be deposited in close proximity to the disturbance site, the sediment composition and type remaining the same.

254. It is particularly noted that there is direct overlap between the Marine Scheme and BBWF with construction works associated with both projects being completed concurrently. Based on the assessed impacts of the BBWF as presented in BBWFL (2022a), effects would be short-lived and of an extent that is largely within the BBWF, while impacts associated with the Marine Scheme would be on a smaller scale and less than that assessed for the BBWF. However, there is the potential for a marginal cumulative increase in seabed levels associated with cumulative deposition effects, with the deposition being largest in proximity to the disturbance, should any construction occur in close proximity for both projects. The potential for cumulative increase in seabed level mainly applies within the BBWF area, which is already noted as having a variable seabed due to the presence of bedforms (BBWFL, 2022a). Therefore, any cumulative deposition would not be uncharacteristic to the seabed, with the Marine Scheme only contributing a smaller proportion.

7.14.2.1.1.1. Magnitude of impact

255. There is not considered to be any change to the magnitude assessment for the potential change to seabed levels and sediment properties associated with the cumulative project, as the impact is predicted to be of local spatial extent, short to long term duration, continuous and high reversibility, although the impact will directly affect the seabed receptor. The magnitude is therefore considered to be low.

7.14.2.1.1.2. Sensitivity of receptor

256. Due to the seabed containing features which are protected under national and international legislation and a low capacity to accommodate and moderate ability to recover from the impacts of changes to seabed levels and sediment properties, the sensitivity of the seabed therefore considered to be medium.

7.14.2.1.1.3. Significance of effect

257. Based on the completed analysis, the results of the cumulative impact from changes to seabed levels and sediment properties are expected to be local within the region of 1 km from the activity of disturbance. As a result, the cumulative impacts are anticipated to be limited. Overall, the magnitude of the cumulative effect is deemed to be low and the sensitivity of the receptor is considered to be medium. The cumulative effect in terms of the Marine Scheme with nearby plans, projects and developments will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

7.14.2.1.1.4. Secondary mitigation and residual effect

258. Given that there are no likely significant effects in EIA terms, secondary mitigation is not required.

7.14.2.1.2. INCREASES TO SUSPENDED SEDIMENT CONCENTRATIONS (SSC)

259. Increases in SSC are predicted to occur associated with Marine Scheme construction activities (section 5.12.1.2). Worst case plume extents were assessed to occur in relation to seabed preparation, with plumes being present for up to 14-hours, so just over one flood-ebb tidal cycle. Magnitudes were largest in closest proximity to the disturbance, reducing with increasing distance from the disturbance site. Overall increases to SSC were assessed to be minor adverse significance, which is not significant in EIA terms due to the short duration, localised and highly transient nature of the impact.

260. In the context of the nearby projects, Table 7.19 indicates that there are a number of projects with the potential for cumulative effects to SSC associated with construction activities. Should construction for the project(s) coincide, there is the potential for SSC plumes to coalesce based on the distance between the Marine Scheme and nearby projects. Should construction activities with the development of plumes coincide, there could be localised increases in SSC magnitudes beyond that determined for the Marine Scheme, based on varying release rates associated with the project activities and the nature of the material being released. However, it is more likely the increases in SSC magnitudes would primarily be driven by the nearby project (i.e. not the Marine Scheme), for example in the case of any drilling in relation to the BBWF. It is also important to note that for several of the third-party projects with potential for cumulative effects, they are complex, multi-faceted developments with complicated offshore programmes meaning the potential for simultaneous operations are highly unlikely. By way of example, the Marine Scheme crosses both EGL 1 and the Blyth Demonstration Phase 2 Cable Corridor at single locations along the length of the Offshore Export Cables, therefore, the probability of a simultaneous installation programme for both the Marine Scheme and the nearby project is very small.

261. Although plume magnitudes may be driven by the nearby projects, plume extents are expected to be similar to that described for the Marine Scheme and would at worst coincide with the local tidal excursion extent of several kilometres. However, based on the nature of the construction activity, the plume duration could be longer than that assessed for the Marine Scheme. Nonetheless, given the tidal regime along the Marine Scheme, plume durations are not expected to exceed several tidal cycles, with the main impact being from the nearby project activities (e.g. such as drilling) rather than the seabed levelling or trenching described for the Marine Scheme. Similar to the assessed increases in SSC for the Marine Scheme, it is expected that any increases associated with construction of the identified nearby projects would be largest at the point of disturbance and reduce with increasing distance. In line with the flow conditions in the Marine Scheme, increases in SSC would reduce (by several orders of magnitude) in a short period of time due to dilution and dispersion. Should sediment plumes coalesce, increases in SSC from the cumulative projects (i.e. with the Marine Scheme), are expected to be short-term and transient, with a high degree of recoverability. SSC levels would quickly return to background levels within a few hours of cessation of the installation or construction activity and associated disturbance.

262. The cumulative project with the maximum extent of temporal and spatial overlap is the BBWF, given that the Marine Scheme wholly overlaps with the BBWF array area boundary and construction programmes also overlap. Based on the information presented in the BBWF EIA, seabed preparation and construction activities including foundation installation (for turbines and OSPs/OCSPs) and installation of inter-array, interconnector and export cable, will result in increased SSCs.

263. Suspended sediment modelling was undertaken for BBWF. The modelling determined that the SSC would be highest in the immediate vicinity of the activity. For instance, releases associated with

wind turbine generator drilling showed the SSC within the plume was less than 5 mg/l and dropped to even lower levels within a very short distance, typically less than 500 m. Plumes dissipated within a few tidal cycles (BBWFL, 2022).

264. For cable installation as part of BBWF, a comparable activity to those associated with the Marine Scheme, the BBWF modelling outputs indicated average SSC along the route ranged between 50 mg/l and 500 mg/l. Associated average sedimentation peaks at 0.5 mm to 1.0 mm. One day after cessation of operations this maximum increased to 10-30 mm. However, it was noted that this deposition only accounts for a very small area and deposition thicknesses are considerably reduced with distance from the location of cable installation (BBWFL, 2022).

265. The supporting environmental documentation for the Scotland England Green Link 1/Eastern Link 1 development predicted a maximum extent of SSC (i.e. a plume) would reach 1.4 km from the site of disturbance. Comparatively, coarse sand (typical of the majority of the sediments along the development cable route), were expected to travel up to 200 m. Additionally, the environmental appraisal report anticipated that measurable change in SSC will be limited to the bottom 5 m of the water column (National Grid and Scottish Power, 2022).

266. The supporting environmental documentation for the Eastern Green Link 2 development predicted that most sediment types would settle within approximately 1.5 km from the point of disturbance. The exception to this is fine silts (which form a very small proportion of the sediment at the Eastern Green 2 locations) which may remain in suspension for several days, settling on the seabed at up to 4.3 km from the point of disturbance. Therefore, the environmental appraisal report concludes that there will be no significant increases in SSC at a distance beyond 1.5 km (National Grid and SSEN, 2022).

267. Equivalent information is not available for the Blyth Demonstrator Offshore Wind Farm - Phase 2 and the Blyth Demonstration Phase 2 (&3) Cable Corridor developments. However, it can be assumed that the impact from these developments would be less than, or equal to, the BBWF outputs.

268. As the BBWF findings indicate, suspended sediment is readily reincorporated to the local sediment transport regime (over the course of a few tidal cycles; BBWFL, 2022). With the exception of BBWF, cumulatively, it is unlikely that there will be considerable spatial or temporal overlap between the Marine Scheme and these other developments that would result in elevated cumulative SSC.

269. Should activities coincide between multiple developments, as is likely between the Marine Scheme and BBWF, elevated SSC will last a matter of hours to days. Deposition thicknesses associated with increased SSC as part of BBWF in combination with the Marine Scheme will be on the scale of centimetres and will generally be highly localised to the site of disturbance.

7.14.2.1.2.1. Magnitude of impact

270. There is not considered to be any change to the magnitude assessment for the potential increases in SSC, as the impact is predicted to be of local spatial extent, short to long term duration, continuous and high reversibility. The magnitude is therefore considered to be low.

7.14.2.1.2.2. Sensitivity of receptor

271. It is noted that none of the designated sites have physical interest features relating to water column properties, but instead relate to geological, geomorphological and sedimentological features, which do occur along the coast. Increases in SSC are not likely to impact these qualifying features beyond the potential deposition of sediment. Based on the absence of designated physical interest features directly relating to the water column and the recoverability following any increases in SSC, the sensitivity is considered to be low.

7.14.2.1.2.3. Significance of effect

272. Based on the completed analyses for the Marine Scheme impact assessment, the disturbance to the water column and coast, leading to increases in SSC, is predicted to be of local spatial extent, short term duration, continuous and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore considered to be low. The coast receptor within the Marine Scheme is considered to be of medium sensitivity. The cumulative effect in terms of the Marine Scheme with nearby projects will, therefore, be of negligible to minor adverse significance, which is not significant in EIA terms.

7.14.2.1.2.4. Secondary mitigation and residual effect

273. Given that there are no likely significant effects in EIA terms, secondary mitigation is not required.

7.14.2.1.3. IMPACT ON DESIGNATED FEATURES WITHIN THE DESIGNATED SITES

274. There is potential for cumulative impacts on designated features within the designated sites from nearby projects and the Marine Scheme. Due to the location of the nearby developments, the same designated sites are applicable to the Marine Scheme as the other nearby projects. The assessment of potential impacts from the Marine Scheme assessed the potential for significant effects in EIA terms, primarily on the basis of the potential sedimentation associated with construction activities (i.e. seabed levelling and trenching).

275. In the context of cumulative impacts, the potential for cumulative change to seabed levels and sediment properties is assessed in section 7.14.2.1.1.3, which indicated that based on the timing of project activities, there is the potential for changes to seabed levels and sediment properties impacts to cumulatively occur associated with a number of projects, including the BBWF, Blyth Demonstrator Offshore Wind Farm Phase 2, EGL 1, EGL 2 and Blyth Demonstration Phase 2 Cable Corridor.

276. Assessed cumulative impacts are marginally larger (only in the case of changes to seabed levels associated with the BBWF) or at the same scale than that determined for the Marine Scheme. Given the distance of the nearby projects from the Marine Scheme, impacts could coalesce leading to further increases in seabed levels (i.e. for the area of direct overlap between the Marine Scheme and BBWF) and as described above in section 5.14.2.1.1.

277. The deposition of sediment is expected to be transient associated with the Marine Scheme and along with the nearby projects, with the thickest areas of sedimentation located closest to the area of disturbance activity, decreasing in thickness with increasing distance. Sedimentation will occur in relation to the natural settling velocity of the sediment present and once deposited will form part of the sediment transport regime and be reworked in line with transport processes. As determined for the Marine Scheme, there is not expected to be any changes to sediment properties, as the same deposition mechanisms are expected to apply to all projects. Therefore, similar sediments are expected to be deposited in close proximity to the disturbance site, the sediment composition and type remaining the same.

7.14.2.1.3.1. Magnitude of impact

278. The magnitude of impact is likely to mostly arise as a result of the Marine Scheme due to the proximity of the Marine Scheme to the designated sites for the coastal designated sites, while for the Firth of Forth Banks Complex ncMPA, impacts could arise as a result of the Marine Scheme and BBWF. In terms of the Marine Scheme impact assessment an impact magnitude of medium was determined for the Firth of Forth Banks Complex ncMPA, Coquet to St Mary’s MCZ, Farnes East MCZ and Northumberland Shore SSSI. The magnitude was determined on the basis of the Marine Scheme either directly overlapping or being immediately adjacent to the designated sites, with the interest features noted as being sensitive to changes in seabed levels and sediment

properties and with the potential for deposition of less than 1 m. In the context of the cumulative projects, a low magnitude is again considered to be applicable.

279. In terms of the Marine Scheme impact assessment, a negligible magnitude was determined due to the intervening distance between the Marine Scheme and the Creswell and Newbiggin Shores SSSI and GCR and Tynemouth to Seaton Sluice SSSI. It is on this same basis a negligible magnitude is considered applicable as the Marine Scheme would contribute little to no impacts to these designated sites from that from the nearby projects.

7.14.2.1.3.2. Sensitivity of receptor

280. The seabed within the Marine Scheme and nearby projects is designated for a number of protected sites which are designated for geomorphological, geological and sedimentary features of the seabed including the Firth of Forth Banks Complex ncMPA, Northumberland SSSI, Coquet to St Mary's MCZ, Farnes East MCZ, Creswell and Newbiggin Shores SSSI and GCR, Tynemouth to Seaton Sluice SSSI and GCR.

281. Due to the seabed containing features which are protected under national and international legislation and a low capacity to accommodate and moderate ability to recover from the impacts of changes to seabed levels and seabed properties, the sensitivity of the seabed is therefore considered to be medium.

7.14.2.1.3.3. Significance of effect

282. As assessed for the Marine Scheme in isolation, the potential changes in seabed levels impacting designated features is predicted to be of local spatial extent, long term duration, continuous and high reversibility. It is predicted that the impact will affect the receptor directly. For the Creswell and Newbiggin Shores SSSI and GCR and Tynemouth to Seaton Sluice SSSI a negligible magnitude is applied due to the intervening distance. However, a low magnitude is applied to the remaining designated sites, namely the Firth of Forth Banks Complex ncMPA, Coquet to St Mary's MCZ, Farnes East MCZ and Northumberland Shore SSSI. Designated interest features within the site are noted as being sensitive to changes in seabed level, and the construction activities are demonstrated to result in sedimentation of up less than 1 m. The seabed receptor within the Marine Scheme is considered to be of medium sensitivity due to the presence sites designated under national and international legislation.

283. BBWF and the Marine Scheme both overlap with the Firth of Forth Banks Complex ncMPA. It was identified in the BBWF EIA (BBWFL, 2022), in terms of the Firth of Forth Banks Complex ncMPA, the limited and localised changes to hydrography seen in relation to the Berwick Bank and Scalp and Wee Bankie parts of the ncMPA, would not result in changes to the hydrodynamic regime or sediment composition. The structure of the offshore subtidal sands and gravels would remain unchanged. Similarly, shelf, banks and mound features would remain stable and supporting hydrodynamics processes remain unaffected. It was concluded that potential cumulative effects to the Firth of Forth Banks Complex ncMPA would be negligible.

284. The planned construction period for the Marine Scheme overlaps with the operation and maintenance periods for the Blyth Demonstrator Offshore Wind Farm – Phase 2 and the Blyth Demonstrator Phase 2 (&3) Cable Corridor developments. The Blyth Demonstrator Phase 2 (&3) Cable Corridor overlaps with the MCZ for approximately 4 km and overlaps with the Marine Scheme at the southern landfall approach. The Demonstrator Offshore Wind Farm – Phase 2 is located approximately 1 km from the Marine Scheme and is entirely a floating windfarm development. As determined for the Marine Scheme, there is not expected to be any changes to the seabed levels or sediment composition within the Coquet to St Mary's MCZ, as the same deposition mechanisms are expected to apply to all projects. As such, it can be reasonably expected that SSC generated by the Blyth Demonstration Phase 2 (&3)) Cable Corridor works would fall out of suspension quickly, depositing in close proximity to the maintenance activities and thus within an area of similar

sediment composition. Likewise, any plume created would be similarly localised and temporary to that of the Marine Scheme.

285. There was no risk identified to any of the intertidal or subtidal habitat features of the MCZ. Any SSC generated by maintenance works to the Blyth Phase 2 & 3 cable or offshore wind farm would be expected to be of no greater extent to that of the Marine Scheme construction works.

286. Therefore the cumulative effect in terms of the Marine Scheme with nearby projects will at worst be of minor adverse significance for the Firth of Forth Banks Complex ncMPA, Coquet to St Mary's MCZ, Farnes East MCZ and Northumberland Shore SSSI, which is not significant in EIA terms. For the Creswell and Newbiggin Shores SSSI and GCR and Tynemouth to Seaton Sluice SSSI designated sites, the cumulative effect in terms of the Marine Scheme with nearby projects will be of **negligible to minor** adverse significance, which is not significant in EIA terms.

7.14.2.1.3.4. Secondary mitigation and residual effect

287. Given that there are no likely significant effects in EIA terms, secondary mitigation is not required.

7.14.2.1.4. CHANGE TO COASTAL LANDFALL MORPHOLOGY – ENGLISH WATERS

288. This impact relates only to English waters, in particular the Cambois Bay frontage, where the Landfall is proposed. As assessed for the Marine Scheme in section 7.12.1.4.3, Landfall activities, particularly the excavation of temporary exit pits and associated sediment storage berms are only like to have localised and temporary influence on waves, with no disruption to flows. The localised and temporary influence to waves are not likely to lead to changes in the coastal morphology. The nearby projects near the Landfall for which there is the potential for cumulative effects includes the Blyth Demonstrator Offshore Wind Farm Phase 2 and Blyth Demonstration Phase 2 Cable Corridor. Both of these projects are noted as also landfalling within the Marine Scheme Landfall area, so depending on the timing of the project activities and the methods for cable Landfall, there is the potential for cumulative impacts.

289. Information available from the two potential cumulative projects indicate a broad range of methods for cable Landfall, with the potential to introduce impacts to the coast beyond what is applicable to the Marine Scheme. In particular, application documents suggest the cable Landfall methods consented for previous phases of the Blyth Demonstrator Offshore Wind Farm, which all seem to entail open cut trenching (OCT). The implementation of OCT across the intertidal would have greater impacts than those arising from the installation methodologies being considered for the Marine Scheme. Therefore, with respect to potential for cumulative impacts with the above projects, the main impacts would be from the other cable projects, rather than the Marine Scheme, with the Marine Scheme contributing very little to the overall cumulative impact.

7.14.2.1.4.1. Magnitude of impact

290. The impact associated with the Marine Scheme is predicted to be of local spatial extent, short-term duration, continuous during the three-month period and high reversibility on completion of the Landfall installation. The impact is also not predicted to ultimately lead changes to the coastal morphology of Cambois Bay, due to the small-scale and localised nature of the exit pit(s) and sediment berms. There is however, the potential localised changes to waves as a result of the sediment berms, so the magnitude is therefore considered to be low. The Landfall methodology for the Marine Scheme is such that there should not be any physical or direct interaction between the Marine Scheme and the landfall operations planned for the Blyth Demonstration Phase 2 Cable Corridor projects. The only pathway for effects is through hydrodynamic connectivity, where the impacts from the cumulative projects would be substantially greater than that from the Marine Scheme. Without further detail on the cable landfall methodology for the Blyth Demonstrator Offshore Wind Farm Phase 2 and Blyth Demonstration Phase 2 Cable Corridor projects, it is assumed that the intertidal and seabed would be reinstated following any cable landfall works for

the cumulative project . On the basis that the impacts from the cumulative projects should be short-duration, localised and reversible, the magnitude is considered to be low for the Marine Scheme and the cumulative projects.

7.14.2.1.4.2. Sensitivity of receptor

291. The cumulative projects landfall (i.e. the Marine Scheme and Blyth Demonstration Phase 2 Cable Corridor) directly overlap the Coquet to St Mary's MCZ and Northumberland Shore SSSI, which are both designated for geological, geomorphological and sedimentological features under national and international legislation. Due to the seabed and coast containing designated features, with a low capacity to accommodate and moderate ability to recover from the impacts of changes, the sensitivity is again considered to be medium.

7.14.2.1.4.3. Significance of effect

292. The impact to coastal morphology based on the cumulative projects, is predicted to be of local spatial extent, short term duration, with a high reversibility. This is particularly the case for the Marine Scheme, with the impacts from the other nearby projects considered to be similar or less than that determined for the Marine Scheme, the magnitude is therefore considered to be low. The coast receptor is considered to be of medium sensitivity due to the presence of designated features. The cumulative effect in terms of the Marine Scheme with nearby projects will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

7.14.2.1.4.4. Secondary mitigation and residual effect

293. Given that there are no likely significant effects in EIA terms, secondary mitigation is not required.

7.14.2.2. POTENTIAL EFFECTS DURING OPERATION AND MAINTENANCE

7.14.2.2.1. POTENTIAL CHANGES TO THE TIDAL, WAVE AND SEDIMENT TRANSPORT REGIMES AS A RESULT OF BLOCKAGE EFFECTS FROM CABLE PROTECTION MEASURES

294. Assessment of effects to changes to the tidal, wave and sediment transport regimes in relation to the Marine Scheme in isolation (section 7.12.2), is considered to be minor as a result of the Marine Scheme. There are a number of nearby developments which need to be considered cumulatively, as summarised in Table 7.19 (this is focused upon projects which are still to be constructed but would be operational in line with the Marine Scheme, noting that as described above, nearby projects which are already operational are considered part of the baseline and within the assessment completed for the Marine Scheme). There is therefore the potential for the nearby Projects to act cumulatively with the Marine Scheme during shared operational periods with respect to changes to tide, wave and sediment transport regime from blockage resultant from nearby cables, floating or seabed structures and associated protection measures.

295. The closest projects for which there is a direct overlap with the Marine Scheme are BBWF (in planning), EGL 1 (in planning) and the Blyth Demonstration Phase 2 Cable Corridor (consented). Adjacent to the Marine Scheme are further projects which are still be constructed but would likely be operational over the same period as the Marine Scheme, as detailed in Table 7.19. There is therefore, the potential for cumulative impacts, associated with operations, repairs or maintenance works. The nearby projects can be grouped according to whether they are developments represented by structures (i.e. including offshore wind farm and port and coastal developments) or cables with associated protection berms (i.e. including transmission and telecommunication infrastructure), based on the development description provided in Table 7.19.

296. Any blockage to tidal and wave properties from the directly overlapping or adjacent projects of BBWF, Blyth Demo Phase 2 offshore wind farm and Seagreen 1 structures are considered to be localised to the development. With respect to the Blyth Demonstration Phase 2 offshore wind farm,

this will involve five floating structures that do not ultimately block the progression of flows or waves. With respect to the BBWF with fixed structures, the relative separation of the foundation structures are such that the development as a whole is unlikely to cause a blockage to the progression of flows and waves as presented in BBWFL (2022). The Seagreen 1 offshore wind farm is approximately 5 km from the Marine Scheme, with the potential for blockage effects being less than that described for the BBWF. Overall, it is considered that there is little to no pathway for connectivity between the offshore wind farm structures and Marine Scheme and is therefore unlikely to give rise to significant effects so these nearby projects are not considered further.

297. There is however, the potential for cumulative impacts from the cables and associated external protection measures from relevant projects, including those from the nearby offshore windfarm developments and power cables. The nearby projects include BBWF, EGL1, EGL2, Blyth Demonstration Phase 2 Cable Corridor and Inch Cape OFTO. With respect to the cables and any associated external protection, it can be assumed that the potential changes to the tidal, wave and sediment transport regimes as a result of blockage are of a similar nature to the Marine Scheme, on the basis that similar protection would be applied. As a result, it is not anticipated that there would be any cumulative changes to the tidal regime as the assessment of blockage effects in relation to the protection proposed for the Marine Scheme demonstrated no disruption to flows conditions.

298. With respect to waves, the assessment in relation to the Marine Scheme identified the potential for highly localised effects on waves, in terms of additional drag over the protection berm. However, due to the small scale footprint of the protection, it was not considered to ultimately lead to a change or disruption to the propagating wave, with no loss in wave energy. Furthermore, the wave would recover in the lee of the protection berm to finally break at the coast. The same is considered to be applicable to the nearby projects. Information on the location of protection berms is not available from the nearby projects, but applying the same assumptions of size, extent and minimum depth, the same processes as described for the Marine Scheme can be considered to be applicable to the nearby projects. Ultimately, there is not considered to be any changes to the changes to the wave regime.

299. With respect to the potential for changes to sediment transport, as there is no change to flows or waves there is not considered to be any onward changes to the sediment transport potential. In terms of the potential for blockage to sediment transport, the presence of the berm on the seabed at the outset will act as a localised sink, with time and as the voids fill, sediment would ultimately bypass the protection berm with no change in the medium to long-term sediment transport regime. As determined for the Marine Scheme, the same is again considered to be applicable to any protection berms applied to the operational cumulative projects. The same is considered to apply between the cumulative BBWF and Marine Scheme should protection be applied in relation BBWF structures and cables and the Offshore Export Cable within the Marine Scheme.

7.14.2.2.1.1. Magnitude of impact

300. The results of the cumulative assessment in terms of the changes to the tidal, wave and sediment transport regimes indicated no further impact to the tidal and wave regime and as a result to anticipated change to the sediment transport regime. The cumulative impact is predicted to be of local spatial extent, short to long term duration, continuous and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is, therefore, considered to be low.

7.14.2.2.1.2. Sensitivity of receptor

301. The potential changes to the tidal, wave and sediment transport regimes as a result of blockage effects from cable and crossing protection measures relate to the seabed and coast receptor. As the Marine Scheme directly overlaps a number of designated sites designated for geological, geomorphological and sedimentological features under national and international legislation, with

a low capacity to accommodate and moderate ability to recover from the impacts of changes, the sensitivity is considered to be medium.

7.14.2.2.1.3. Significance of effect

302. Based on the completed analyses, the impacts to the seabed and coast as a result of changes to the tidal, wave and sediment transport regimes as a result of blockage effects from cable and crossing protection measures is minimal. The impact is predicted to be of local spatial extent and short-term duration (until sediment by-passing begins) but continuous, with sediment by-passing occurring in the medium to long-term in line with the protection being present. It is predicted that the impact will affect the receptors directly, so the magnitude is therefore considered to be low. The seabed and coast contain designated sites with designated geological, geomorphological and sedimentological interest features, so medium sensitivity is applied. The cumulative effect in terms of the Marine Scheme with nearby projects will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

7.14.2.2.1.4. Secondary mitigation and residual effect

303. Given that there are no likely significant effects in EIA terms, secondary mitigation is not required.

7.14.2.2.2. POTENTIAL INTRODUCTION OF SCOUR (INCLUDING EDGE SCOUR)

304. The assessment of the potential for scour associated with the Marine Scheme was determined to be negligible on the basis that protection would be installed as necessary at the construction stage to negate the introduction of scour. Furthermore, based on the analyses for potential scour, it was estimated that edge scour associated with the protection is unlikely to develop based on the applied properties in relation to the flow speeds that occur within the Marine Scheme. In terms of the potential for cumulative impacts, it again relates to the nearby projects as summarised in Table 7.19 and discussed in section 5.14.2.2.1.

305. With respect to the direct overlap between the Marine Scheme and BBWF offshore, or with the EGL1 and Blyth Demonstration Phase 2 Cable Corridor in the nearshore or at landfall. The potential concurrent requirement for external protection would in reality be at a crossing, and it is noted that no crossings are planned for the BBWF inter-array or export cables. There would be no direct overlap between the Marine Scheme with the Inch Cape OFTO, so it is not considered further for this potential cumulative impact.

306. The Marine Scheme could have up to five crossings all in English waters, with the Offshore Export Cable definitely crossing the EGL1 cable. As described in the maximum design scenario (Table 7.11), berm crossings are to be applied, to protect and also negate the development of scour.

307. With respect to the Marine Scheme, there is a demonstrated negligible potential for scour. Should scour develop in relation to the nearby projects, it would all be localised to the respective projects and not act cumulatively.

7.14.2.2.2.1. Magnitude of impact

308. Based on the completed assessment for the Marine Scheme and the same berm design applied to crossings with nearby projects, the impact is considered to be negligible.

7.14.2.2.2.2. Sensitivity of receptor

309. The potential introduction of scour, in particular edge scour from cable and crossing protection measures relates to the seabed receptor. As the Marine Scheme directly overlaps a number of designated sites designated for geological, geomorphological and sedimentological features under national and international legislation, with a low capacity to accommodate and moderate ability to recover from the impacts of changes, the sensitivity is considered to be medium.

7.14.2.2.2.3. Significance of effect

310. The impacts to the seabed based on the potential introduction of scour is minimal, so the magnitude is therefore considered to be negligible. The seabed and coast contain designated sites with designated geological, geomorphological and sedimentological interest features, so medium sensitivity is applied. The cumulative effect in terms of the Marine Scheme with nearby projects will, therefore, be of **negligible** significance, which is not significant in EIA terms.

7.14.2.2.2.4. Secondary mitigation and residual effect

311. Given that there are no likely significant effects in EIA terms, secondary mitigation is not required.

7.14.2.3. POTENTIAL EFFECTS DURING DECOMMISSIONING

312. At the end of the operation and maintenance phase of the Marine Scheme, the options for decommissioning works will be reviewed, taking into consideration constraints (e.g. safety and liability) and the potential environmental impacts associated with decommissioning works.

313. The principal options for decommissioning include:

- Leaving the cable in-situ, trenched;
- Leaving the cable in-situ and providing additional protection;
- Remove sections of the cable that present a risk to other sea users; and
- Remove the cable entirely.

314. Should complete removal of the Offshore Export Cables be required, the significance of effect is considered to be similar to that experienced during the construction phase of the Marine Scheme. Based on the timing of the nearby project summarised in Table 7.19, there is the potential for cumulative effects associated with decommissioning activities. However, as assessed for the cumulative projects in relation to construction activities (section 5.14.2.1), impacts are anticipated to be of similar or lower magnitude to the construction phase (depending on the decommissioning option selected for the Marine Scheme and nearby projects).

315. Complete removal of the Offshore Export Cables associated with the Marine Scheme represents the most significant adverse effects, and therefore if the other decommissioning options were to be progressed, they would have no more significant adverse effects. For the nearby projects, the same is considered to apply, with complete removal equating the same impacts as described for construction. It is also assumed that the receptor sensitivities will not materially change over the life-cycle of the cumulative projects, as a result the sensitivity of the receptor is considered to be medium to the features being protected under national and international legislation.

316. Overall, the magnitude of the impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The cumulative effect in terms of the Marine Scheme with nearby projects will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

7.15. Inter-Related Effects

317. Inter-related effects are the potential effects of multiple impacts, affecting one receptor or a group of receptors. Inter-related effects include interactions between the impacts of the different stages of the Marine Scheme (i.e. interaction of impacts across construction, operation and maintenance and decommissioning), as well as the interaction between impacts on a receptor within a Marine Scheme stage. A description of the likely inter-related effects arising from the Marine Scheme on Offshore Physical Environment and Seabed Conditions Study Area is provided below.

318. For the offshore physical environment and seabed conditions, the following potential impacts have been considered within the inter-related assessment:

- Changes to seabed levels and changes to seabed properties due to cable installation;
- Increases to SSC due to installation of export cables;
- Impact on designated features within the designated sites due to installation of Offshore Export Cables;
- Change to coastal Landfall morphology;
- Potential changes to the tidal, wave and sediment transport regimes as a result of blockage effects from cable protection measures; and
- Introduction of scour (including edge scour).

319. Table 7.21 lists the inter-related effects (Marine Scheme lifetime effects) that are predicted to arise during the construction, operation and maintenance, and decommissioning of the Marine Scheme. As previously noted, effects on the Offshore Physical Environment and Seabed Conditions also have the potential to have secondary effects on other receptors and these are fully assessed in the topic specific chapters. These receptors are:

- Benthic Subtidal and Intertidal Ecology;
- Fish and Shellfish Ecology; and
- Offshore and Intertidal Ornithology;
- Marine Mammals;
- Marine Archaeology and Cultural Heritage; and
- Other Sea Users.

Table 7.20 Summary of potential likely significant inter-related effects on the environment individual effects occurring across the construction, operation and maintenance and decommissioning phases of the Marine Scheme

Description of Impact	Phase C	Phase O	Phase D	Potential Likely Significant Inter-Related Effects
Changes to seabed levels and sediment properties due to cable installation	✓	✓	✓	Changes to seabed levels and sediment properties during the construction and decommissioning phases of the Marine Scheme would also occur during the operation and maintenance phase. For example, sediment would be deposited that would form part of the sediment transport regime throughout the operation and maintenance phase.
Increases to SSC due to installation of export cables	✓		✓	Increases in SSC during the construction and decommissioning phases of the Marine Scheme would not extend into the operation and maintenance phase. Sediment plumes generated during construction are shown to dissipate relatively rapidly, and certainly will have done so by the time Project operation is achieved.
Impact on designated features within the designated sites due to installation of Offshore Export Cables	✓	✓	✓	Impact on designated features during the construction and decommissioning phases of the Marine Scheme would extend into the operation and maintenance phase. Sediment plumes generated during construction are shown to dissipate relatively rapidly, and certainly will have done so by the time Project operation is achieved. However, deposition of sediment and the resulting changes in seabed levels would continue throughout the operation phase as the deposited material becomes part of the sediment transport regime.
Change to coastal Landfall morphology	✓	✓	✓	Changes to the coastal Landfall morphology as a result of Landfall installation works are likely to only occur for the construction phase. As the seabed is to be reinstated on completion of the works, there would be no further alteration to the coastal morphology.
Potential changes to the tidal, wave and		✓	✓	Changes to tidal currents and wave climate due to blockage from cable and crossing protection relate to the same infrastructure within the construction,

Description of Impact	Phase C	Phase O	Phase D	Potential Likely Significant Inter-Related Effects
sediment transport regimes as a result of blockage effects from cable protection measures				operation and decommissioning phases. The decommissioning phase structures are only those remaining bed structures, such as cable protection, not possible or practical to be removed, thus resulting in a lesser magnitude of the same impact.
Potential introduction of scour (including edge scour)		✓	✓	The potential introduction of scour would only start in the operational phase and extend into the decommissioning phase. However, as assessed this is considered unlikely to develop.
Receptor Led Effects				
Seabed receptor: During principally the operation and maintenance phase increased SSCs and associated deposition on physical features may occur due to maintenance activities on the Offshore Export Cables; this would coincide with changes to tidal, wave and sediment transport as a result of blockage effects from cable protection measures. Maintenance activities are sporadic, with the impacts predicted to be of local spatial extent, short term duration and intermittent. Due to the presence of designated sites with sedimentological, geological or morphological interest features, the receptor is considered to have a medium sensitivity. However due to the recoverability of the seabed and limited duration and magnitude of most impacts, at worst a low impact magnitude was considered to apply, resulting in at worst a minor adverse significance, which is not be significant in EIA terms.				

320. These inter-related effects as described above are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phases. Therefore, these inter-related effects would not be significant in EIA terms.

7.16. Transboundary Effects

321. There is no potential for transboundary impacts upon the offshore physical environment and seabed conditions receptors due to construction, operation and maintenance and decommissioning of the Marine Scheme. The potential impacts are localised and are not expected to affect other EEA states. Therefore, transboundary effects for the offshore physical environment and seabed conditions receptors do not need to be considered further.

7.17. Summary of Impacts, Mitigation Measures, Likely Significant Effects and Monitoring

322. Information on the offshore physical environment and seabed conditions within the Offshore Physical Environment and Seabed Conditions Study Area was collected through desktop review, site surveys, consultation and desktop analytical assessments. Table 7.21 presents a summary of the potential impacts, mitigation measures and the conclusion of likely significant effects in EIA terms in respect to the offshore physical environment and seabed conditions. The impacts assessed include:

- Construction and decommissioning; and
  - Change to seabed levels and sediment properties due to installation of export cables;
  - Increases to SSC due to installation of export cables;
  - Impact on designated features within the designated sites due to installation of Offshore Export Cables; and

    - Change to coastal Landfall morphology.

- Operation and maintenance:
    - Potential changes to the tidal, wave and sediment transport regimes as a result of blockage effects from cable protection measures; and
    - Potential introduction of scour (including edge scour).

323. Overall, it is concluded that there will be no significant effects arising from the Marine Scheme during the construction, operation and decommissioning phases.

324. Table 7.22 presents a summary of the potential cumulative impacts, mitigation measures and the conclusion of likely significant effects on the offshore physical environment and seabed conditions in EIA terms. The cumulative effects assessed are the same as that assessed for the Marine Scheme in isolation. Overall, it is concluded that there will be no significant cumulative effects arising from the Marine Scheme alongside other developments/plans during the construction, operation and decommissioning phases.

325. For the assessed impacts, the conclusions apply to both Scottish and English waters, with the exception of the potential change to coastal morphology, which only applies to English waters.

Table 7.21 Summary of potential likely significant environmental effects, mitigation and monitoring

Description of Impact	Phase C/I	Phase O	Phase D	Magnitude of Impact	Sensitivity of Receptor	Significance of Effect	Secondary Mitigation	Residual Effect	Proposed Monitoring
Change to seabed levels and sediment properties due to installation of export cables									
Scottish and English waters	✓	×	✓	Low	Medium	Minor (not significant)	None required above embedded mitigation measures.	Minor (not significant)	Not considered necessary
Increases to SSC due to installation of export cables									
Scottish and English waters	✓	×	✓	Low	Low	Negligible to Minor (not significant)	None required above embedded mitigation measures.	Minor (not significant)	Not considered necessary
Impact on designated features within the designated sites due to installation of Offshore Export Cables									
Scottish and English waters	✓	×	✓	Low	Medium	Minor (significant)	None required above embedded mitigation measures.	Minor (not significant)	Not considered necessary
Change to coastal Landfall morphology									
English waters only	✓	×	✓	Low	Medium	Minor (not significant)	None required above embedded mitigation measures.	Minor (not significant)	Not considered necessary
Potential changes to the tidal, wave and sediment transport regimes as a result of blockage effects from cable protection measures									
Scottish and English waters	×	✓	×	Low	Medium	Minor (not significant)	None required above embedded mitigation measures.	Minor (not significant)	Not considered necessary
Potential Introduction of scour (including edge scour)									
Scottish and English waters	×	✓	×	Negligible	Medium	Negligible to Minor (not significant)	None required above embedded mitigation measures.	Minor (not significant)	Not considered necessary
Effects during decommissioning									

Description of Impact	Phase C/I	O	D	Magnitude of Impact	Sensitivity of Receptor	Significance of Effect	Secondary Mitigation	Residual Effect	Proposed Monitoring
Scottish and English waters	×	×	✓	Low	Medium	Minor (not significant)	None required above embedded mitigation measures.	Minor (not significant)	Not considered necessary

Table 7.22 Summary of likely significant cumulative environment effects, mitigation and monitoring

Description of Impact	Phase C/I	O	D	Cumulative Effects Assessment Tier	Magnitude of Impact	Sensitivity of Receptor	Significance of Effect	Secondary Mitigation	Residual Effect	Proposed Monitoring
Change to seabed levels and sediment properties due to installation of export cables	✓	×	✓		Low	Medium	Minor (not significant)	None required above embedded mitigation measures.	Minor (not significant)	Not considered necessary
Increases to SSC due to installation of export cables	✓	×	✓		Low	Low	Negligible to Minor (not significant)	None required above embedded mitigation measures.	Minor (not significant)	Not considered necessary
Impact on designated features within the designated sites due to installation of Offshore Export Cables	✓	×	✓		Low	Medium	Minor (significant)	None required above embedded mitigation measures.	Minor (not significant)	Not considered necessary
Change to coastal Landfall morphology	✓	×	✓		Low	Medium	Minor (not significant)	None required above embedded mitigation measures.	Minor (not significant)	Not considered necessary
Potential changes to the tidal, wave and sediment transport regimes as a result of blockage effects from cable protection measures	×	✓	×		Low	Medium	Minor (not significant)	None required above embedded mitigation measures.	Minor (not significant)	Not considered necessary

Description of Impact	Phase C/I	Phase O	Phase D	Cumulative Effects Assessment Tier	Magnitude of Impact	Sensitivity of Receptor	Significance of Effect	Secondary Mitigation	Residual Effect	Proposed Monitoring
Potential Introduction of scour (including edge scour)	×	✓	×		Negligible	Medium	Negligible to Minor (not significant)	None required above embedded mitigation measures.	Minor (not significant)	Not considered necessary
Effects during decommissioning	×	×	✓		Low	Medium	Minor (not significant)	None required above embedded mitigation measures.	Minor (not significant)	Not considered necessary

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