



Rampion Offshore Wind Farm



ES Section 7 – Benthos and Sediment Quality

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7 BENTHOS AND SEDIMENT QUALITY

7.1 Introduction

7.1.1 This section of the Environmental Statement (ES) presents an assessment of the potential impacts on the benthic (seabed) environment that might arise from construction, operation and decommissioning of the proposed Rampion Offshore Wind Farm (“the Project”). The assessment has been made using data from field surveys, desk-based information and consultations.

7.1.2 This section addresses the following topics:

- Assessment methodology;
- An overview of the baseline (benthic habitats and species, and sediment quality in the area of the proposed offshore wind farm and export cable route);
- An account of potential impacts on the benthic environment, together a summary of residual impacts in tabular form.

7.1.3 Throughout offshore site and cable route selection, emphasis has been placed on avoiding areas of seabed that have nature conservation interests, such as protected areas.

7.1.4 This assessment includes both the intertidal (landfall) and subtidal (offshore) environments that the offshore wind farm and its associated offshore cables may impact. Terrestrial (onshore) nature conservation interests are covered in Section 24 - Ecology and are not considered further here. Information on sediments is briefly summarised in this Section, although this is covered in more detail in Section 6 - Physical Environment.

7.2 Legislation and Policy Context

National Policy Statements

7.2.1 National Policy Statements (NPS) provide the primary basis on which the Secretary of State is required to make its decision. The following paragraphs provide detail from sections of the NPSs considered relevant to the assessment of impacts on the subtidal environment including benthos as a result of the Project.

- 7.2.2 The Overarching NPS for Energy (EN-1) (July 2011) sets out in Section 5.3 policy in relation to energy developments and biodiversity and geological conservation.
- 7.2.3 The NPS for Renewable Energy Infrastructure (EN-3) provides policy relating to Renewable Energy projects including offshore wind farms, and paragraphs 2.6.58 to 2.6.71 of EN-3 set out offshore wind-specific biodiversity policy.
- 7.2.4 Specific considerations that apply to the effect of offshore wind energy infrastructure proposals on the subtidal environment including benthos as set out below.
- 7.2.5 Paragraph 2.6.113 states that *“Where necessary, assessment of the effects on the subtidal environment should include:*
- *loss of habitat due to foundation type including associated seabed;*
 - *preparation, predicted scour, scour protection and altered sedimentary processes;*
 - *environmental appraisal of inter-array and cable routes and installation methods;*
 - *habitat disturbance from construction vessels’ extendible legs and anchors;*
 - *increased suspended sediment loads during construction; and*
 - *predicted rates at which the subtidal zone might recover from temporary effects.”*
- 7.2.6 Paragraph 2.6.114 states that *“If it is proposed to install offshore cables to a depth of at least 1.5 m below the sea bed, the applicant should not have to assess the effect of the cables on subtidal habitat during the operational phase of the offshore wind farm”.*
- 7.2.7 In the context of Decision Making, the following paragraphs are relevant:
- 2.6.115 which states that *“The conservation status of subtidal habitat is of relevance to the Secretary of State”.*
 - 2.6.116 which states that *“The Secretary of State should be satisfied that activities have been designed taking into account sensitive subtidal environmental aspects.”*
 - 2.6.117 which indicates that *“Where adverse effects are predicted, when reaching a judgement, the Secretary of State should consider the extent to which the effects are temporary or reversible.”*

- 2.6.118 which proposes that *“Where it is proposed that the offshore export cables are armoured and buried at a sufficient depth to minimise heat effects (as described in paragraph 2.6.76 of EN-3); the effects of heat on sensitive species from cable infrastructure during operation are unlikely to be a reason for the Secretary of State to refuse to grant consent for a development.”*

7.2.8 Insofar as mitigation is concerned, paragraph 2.6.119 states that *“Construction and decommissioning methods should be designed appropriately to minimise effects on subtidal habitats, taking into account other constraints. Mitigation measures which the Secretary of State should expect the applicants to have considered may include:*

- *surveying and micro-siting of the export cable route to avoid adverse effects on sensitive habitat and biogenic reefs;*
- *burying cables at a sufficient depth, taking into account other constraints, to allow the seabed to recover to its natural state, and;*
- *the use of anti-fouling paint might be minimised on subtidal surfaces, to encourage species colonisation on the structures.”*

7.2.9 Moreover, paragraph 2.6.120 indicates that *“Where cumulative effects on subtidal habitats are predicted as a result of the cumulative effects of multiple cable routes, it may be appropriate for applicants for various schemes to work together to ensure that the number of cables crossing the subtidal zone is minimised and installation/decommissioning phases are coordinated to ensure that disturbance is reasonably minimised.”*

Water Framework Directive (WFD)

7.2.10 The WFD (2000/60/EC) establishes a framework for an integrated approach to the protection, improvement and sustainable use of Europe's water bodies, and requires all member states to achieve good ecological and chemical status of their water bodies (including coastal waters up to 1 nautical mile (nm) offshore) by 2015.

7.2.11 Under the WFD, the Environment Agency (EA) is responsible for monitoring water quality and reports the data against Environmental Quality Standards (EQS).

Marine Strategy Framework Directive (MSFD)

7.2.12 The European Commission Marine Strategy Framework Directive (MSFD) came into force on 15 July 2008 and was transcribed into UK law by the Marine Strategy Regulations 2010. The MSFD aims to achieve Good Environmental Status (GES) in European seas by 2020 and fits with UK Government's vision for clean, healthy, safe, productive and biologically diverse seas. The jurisdiction of the MSFD overlaps with the 'coastal waters' of the WFD.

- 7.2.13 Key requirements of the MSFD are establishment of a monitoring programme to measure progress toward GES (by July 2014), and establishment of a programme of measures for achieving GES by 2016.
- 7.2.14 Marine spatial planning (MSP) is expected to contribute to GES targets, and aims to ensure a sustainable future for coastal and offshore waters through managing and balancing the many activities, resources and assets in the UK marine environment.
- 7.2.15 The framework for MSP is the UK Marine Policy Statement. The Marine and Coastal Access Act 2009 divides the UK marine areas into 11 marine planning regions. It was announced in August 2012 that the south coast (which covers the entirety of the Project site) will be the second area to benefit from a marine plan, commencing with stakeholder engagement in early 2013. E.ON intends to engage fully with this process.

Protected Sites

- 7.2.16 There are a number of sites that include the benthic environment as a key feature of nature conservation designations in the area of the Project. These are covered in detail in Section 9 - Nature Conservation but can be summarised as:
- Special Areas of Conservation (SAC); designated under the Habitats Directive and of international importance. Excluding supratidal habitats, seven Annex I marine habitats are listed as occurring in the UK (JNCC, 2012), i.e. shallow sandbanks, estuaries, intertidal mud and sandflats, coastal lagoons, large shallow inlets and bays, reefs, and submarine structures made by leaking gases. Of these, only 'reefs' are considered to be both present (or have high potential of occurring) and have the potential to be impacted by the proposed development. The definition of 'reefs' includes both bedrock and stony (e.g. subtidal chalk) and biogenic (e.g. blue mussel, or *Sabellaria spinulosa*) structures, both of which are of relevance to the proposed development. Potential reefs (including both stony and biogenic reefs) recorded in the 2011 benthic survey (see Appendix 7.2) were subject to reef definition criteria; of these, only 1 location (blue mussel reef, close inshore on the export cable corridor) could be confirmed as a 'reef' based on the information available;
 - Marine Conservation Zones (MCZs); proposed under the Marine and Coastal Access Act 2009, and of national importance. MCZs are discussed in detail in Section 9 - Nature Conservation. Recommended MCZs (rMCZs) are under consideration by Government and are likely to be officially designated in 2013. A network of rMCZs has been identified based on the principles outlined in the ecological network guidance (ENG) by a Regional Stakeholder Group (RSG). Features proposed to be designated for protection by MCZs are all listed in the ENG and comprise 'broad-scale habitats', which comprise groups of species together into types of marine habitat; and 'Features of Conservation Interest (FOCI)', which comprise specific species and habitat for

which more detailed data are available. Habitat FOCI of relevance to the study area include blue mussel (*Mytilus edulis*) beds, littoral chalk communities, Ross worm (*Sabellaria spinulosa*) reefs, subtidal chalk, and subtidal sands and gravels. The list of benthic FOCI species includes native oysters (JNCC, 2011). Blue mussel beds are proposed as a FOCI for two nearby rMCZs (Kingmere, and Beachy Head East and West). In addition, the broader eastern English Channel region is important for subtidal chalk, and it is proposed as a FOCI for two nearby rMCZs (Kingmere, and Beachy Head East and West);

- Biodiversity Action Plans (BAPs); a non-statutory designation for habitats and species in need of protection, to be enacted at a local level. Further details of BAP habitats are provided in Section 9 – Nature Conservation, but of particular relevance to the proposed development are the following: blue mussel beds on sediment; Ross worm *Sabellaria spinulosa* beds; subtidal chalk; peat and clay exposures; and subtidal sands and gravels;
- Marine Sites of Nature Conservation Importance (MSNCIs); Non-statutory SNCIs are found throughout the UK for protection of sites of county importance. East and West Sussex County Council, and Brighton and Hove City Council, are unusual in England in designating Marine SNCIs (MSNCIs); and
- Voluntary Marine Conservation Areas (VCMAs); non-statutory.

Scoping and consultation

7.2.17 Initial consultation on the Project was carried out via the Rampion Offshore Wind Farm Scoping Document (E.ON/RSK, September 2010). Responses received are presented in the Infrastructure Planning Commission (IPC) Scoping Opinion report (IPC, October 2011).

7.2.18 The information, advice and comments received during the scoping process with regard to benthic issues is summarised in Table 7.1. This table also identifies where in the text the responses are addressed.

Table 7-1: Scoping and consultation responses

Date	Consultee	Summary of issues	Where addressed
11/10/10	East Sussex County Council	Potential increases in biodiversity from turbine colonisation should be carefully considered and explained	7.5.25
11/10/10	East Sussex County Council	Intertidal survey data from Sussex Shoresearch should be included if possible.	Seasearch/Shoresearch data was requested and obtained from the Booth Museum but is mostly related to areas outside the wind farm and cable corridor (see section 7.4.10). Only two data points

Date	Consultee	Summary of issues	Where addressed
			were from the intertidal zone in the broad area of the landfall.
12/10/10	Havant Borough Council	Impacts to marine & coastal wildlife such as siltation and benthic disturbance should be considered.	7.5, particularly the section on Construction.
12/10/10	Natural England	Discussion with NE regarding details of surveys (e.g. drop-down video for reefs) is required	The MMO consulted with both NE and Cefas prior to their approval of the survey scope in Feb 2011
		Limited information on landfall location	An intertidal survey of the landfall location was undertaken. Details of the landfall are provided in 7.4.1 and Appendix 7.1.
	Natural England, MMO	Additional data sources (e.g. South Coast REC) should be considered. All references cited should be listed in the ES.	Data sources are listed in 7.3.1.1; References are provided in 7.9.
	Natural England	Reference to Annex I habitats should be included	These are covered fully in Section 9 Nature Conservation
		Potential chalk reef habitat along cable route should be treated as an Annex I habitat and taken into account in impact assessment/mitigation	These are covered fully in Section 9 Nature Conservation
		Potential habitat loss through cable and scour protection should be considered	These potential impacts are considered in Section 7.5.
		Benthic survey methodology should consider potential for biogenic reefs and use image-based techniques for grabbing	Imaging was used on the offshore benthic survey to avoid accidental damage by grabbing.
		Benthic survey information should be reviewed with reference to NE/JNCC guidance on Features of Conservation Interest (FOCIs) in MCZs	These are covered in Section 7.4 and Section 9 Nature Conservation
		ES needs to be site-specific as cables etc may run through the chalk reef areas – indirect impacts should also be assessed.	The exact route of the export cable was not available at the time of writing the ES; a route corridor has been identified. Impacts are considered in 7.5.
		A Phase 2 habitat survey of the landfall should be included	A Phase 2 intertidal survey was performed in May 2011; results are presented in 7.4.1 and Appendix 7.1
	MMO	MMO unable to advise on benthic	MMO were consulted on the

Date	Consultee	Summary of issues	Where addressed
		survey methodology [at Scoping stage] as no details provided. Underwater imagery would be the preferred method where grabs are not possible.	benthic survey design and a scope agreed, prior to it taking place. Drop-down photography was included in the offshore benthic survey.

7.2.19 The scope of the assessment was modified accordingly to take account of the above consultee responses and the opinions of the IPC, the findings of which were reported in the Draft ES and subject to stakeholder consultation.

Formal Pre-application Consultation

7.2.20 As detailed in Section 5 – EIA Methodology, an extensive programme of engagement has been undertaken with regard to the Project, details of which are provided in the Consultation Report for the Project (Document 5.1). This included publication of the Draft ES as part of the Section 42 and Section 48 consultation in June 2012.

7.2.21 Key consultees (i.e. Natural England; Marine Management Organisation; Sussex Inshore Fisheries and Conservation Authority (IFCA); Sussex Wildlife Trust) provided responses to the draft ES on benthos and sediment quality. These responses, and the modifications subsequently made to the final ES, were as follows:

- The description of the extent of benthic habitats of conservation interest (e.g. blue mussel reefs, subtidal chalk and *Sabellaria spinulosa* reefs) reported in the draft ES was not deemed to be sufficient to assess potential impacts, and responses to the draft ES included requests for an integrated habitat map that drew together data from both the broad-scale geophysical survey (conducted by Osiris in 2010) and the point-sampling methodology of the benthic survey (conducted by Emu in 2011). As a result, EMU Limited were commissioned to produce an integrated, predicted habitat map to a methodology agreed in consultation with the Sussex Inshore Fisheries and Conservation Authority (IFCA) (teleconference between RSK, Emu and Sussex IFCA, 14 September 2012). The maps and further details of the methodology used, are presented in this Section and Figures 7.7 and 7.8; The results of these studies were then used to inform detailed consultation with the relevant agencies regarding the need for micro-siting of the turbines and cable route to avoid sensitive features;
- More refined estimates of areas of benthic habitat loss (and the habitats in which these would be located) were requested. In response, refined project description data and habitat data (as above) were cross-referenced to determine more accurate estimates.
- Natural England proposed that any arisings from installation of foundation piles by drilling should be disposed of at a licensed site;

- Sussex IFCA requested a stronger association was made between benthic habitats/species and underlying sediments/geology.
- Other comments on issues such as expansion or clarification of draft ES text; expansion of text on contaminated sediments; and alteration of text on invasive species/new habitat, have also been noted and incorporated.

7.3 Assessment Methodology

Establishment of Baseline Environment

Desk-based assessment

7.3.1 Prior to design of surveys, data were collated from a number of sources to establish the broad baseline of the area and identify possible constraints, such as sensitive habitats. A number of sources of information were used, with key references including (but not limited to):

- South Coast Regional Environmental Characterisation (REC) (James *et al.*, 2010); and the Marine Aggregate Levy Sustainability Fund (MALSF) synthesis study in the central and eastern English Channel (James *et al.*, 2011)
- Publicly available information from regulators and stakeholders on benthic environments and designations (e.g. JNCC, Sussex IFCA, Balanced Seas Marine Conservation Zone (MCZ) project, Sussex Biodiversity Partnership, local councils etc).
- Data purchased from Sussex SeaSearch (observations by trained divers) for an 'area of search' in the broad vicinity of the wind farm site. In response to the draft ES consultation response from the Sussex IFCA, this was supplemented by further records provided by the IFCA, which had a high degree of confidence associated with them (R. Clark, Sussex IFCA, pers. comm. 14 September 2012)

Field surveys

7.3.2 Surveys specifically designed to characterise the benthic environment in and around the Project area were approved by the Marine Management Organisation (MMO). Benthic sampling covered the Project site, the wider Zone, a "tidal envelope" (i.e. the area over which sediment released during construction might be re-distributed over a single tidal cycle), a corridor for the export cable route, and stations outside the anticipated zone of any potential influence, to ensure that adequate information was collected on the surrounding environment. Surveys performed were as follows

- Intertidal ecology: Marine ecologists from RSK Environment Ltd conducted an ecological survey of the intertidal habitat around the proposed cable landfall on 18-19 of May 2011. This survey included a Phase 1 habitat survey to

document broad habitat types and features of interest that were visible, as well as sampling sediment with a 0.01m² hand-core for analysis of benthic invertebrates, particle size, total organic carbon and a range of contaminants. Details are presented in Appendix 7.1. In addition, a botanical survey of the onshore cable route included maritime vegetation on the uppermost areas of the shore, and details are included separately in Section 24 (Onshore) Ecology.

- Subtidal: several surveys contributed to forming an understanding of the subtidal environment including:
 - *Geophysical survey*: Osiris Projects Ltd undertook an offshore geophysical survey of the wind farm site and cable export route over May-August 2010 using the vessels *Lia* and *Freja*. This survey identified broad-scale sediment types, bedforms, and areas of interest for further investigation (such as possible biogenic reefs) by the benthic surveys (Osiris, 2010)
 - *Geophysical survey*: Osiris also undertook an additional geophysical survey of some of the deeper areas of the Project site in September 2011, using the same vessels.
 - *Benthic surveys* were undertaken by Emu Ltd on board the survey vessel Discovery. The main survey took place from 15 - 19 of April 2011 and sampled 59 stations in and around the Project area. EMU used grabs (0.1m² Day, 0.1m² Hamon, 0.04m² Shipek as appropriate to conditions) to collect sediment for analysis (of benthic invertebrates, particle size, total organic carbon, and contaminants), and drop-down photography to record habitats and visible epifauna at each station. In addition, the drop-down photography survey investigated 6 transects that were tentatively identified from the geophysical survey as potentially being reefs formed by the honeycomb worm *Sabellaria spinulosa*. However, the survey did not record any *Sabellaria* reef structures within the Project area. At the request of the MMO a further survey was conducted on 10 and 11 July 2011 at 17 stations using a 2m scientific beam trawl to collect epifauna (fauna either attached to, or living on, the seabed surface). Details of both the benthic and 2m beam trawl surveys are presented together in Appendix 7.2. The location of benthic survey stations is presented in Figure 7.1.

7.3.3 As noted above, responses to the draft ES included requests for an integrated habitat map that drew together data from both the broad-scale geophysical survey (conducted by Osiris in 2010) and the point-sampling methodology of the benthic survey (conducted by Emu in 2011), in order to better define the location and extent of habitats in the survey area (and therefore better assess potential impacts). As a result of this request, Emu Ltd were commissioned to produce an integrated map to a methodology agreed in consultation with the Sussex IFCA

(teleconference between RSK, Emu and Sussex IFCA, 14 September 2012). As different seabed types (such as mud, rock or rippled sand) have different appearances or ‘signatures’ on side-scan sonar (SSS) images, this was performed by experienced personnel scrutinising SSS maps and demarcating areas with similar signatures (for example rippled sand). This was then cross-referenced with ‘ground-truthed’ data, i.e. direct observations or samples of the seabed, which was mostly derived from either grab and/or photo evidence from the benthic survey (supplemented by some Seasearch records). This point-location ground-truth data was then extrapolated out to the boundaries of the distinct SSS signature, to produce a predicted habitat map (Figure 7.6 and 7.7). This process was assisted by the design of the benthic survey, which specifically aimed to sample the major seabed types recorded by the geophysical survey.

Identification and Assessment of Impacts and Mitigation Measures

- 7.3.4 All biotopes and habitats referred to in this section are consistent with the Marine Habitat Classification for Britain and Ireland system documented by Connor *et al.* (2004).
- 7.3.5 Impacts were identified and assessed based on expert judgement and taking into account the Institute of Ecology and Environmental Management’s “Guidelines for ecological impact assessment in Britain & Ireland: Marine and Coastal” (IEM, 2010), which were specifically developed for marine and coastal environments and species. When assessing potential impacts or changes to benthic environments and species, the following factors were considered:
- Magnitude/extent: the size or amount of impact – such as the area of seabed directly or indirectly impacted;
 - Duration: the length of time before recovery is complete. The duration of the activity causing the impact may be much less than the duration of the impact itself, for example if the benthic community is sensitive and takes a long time to recover;
 - Reversibility: whether irreversible (permanent) or reversible (temporary);
 - Timing and frequency: e.g. whether the impact occurs once, or is repeated, or only occurs in a certain season.
- 7.3.6 The sensitivity of different benthic habitats and species were also considered as part of the impact assessment (Table 7.2). Sensitivity is based on two aspects. The first is expert assessment from the Marine Life Information Network (MarLIN, 2010), which classifies biotopes and habitats according to their tolerance to, and recoverability from, certain impacts. The second aspect incorporates the importance of the habitat in terms of its nature conservation value, i.e. whether it has a protected status.

Table 7-2: Sensitivity of benthic receptors

Sensitivity	Rationale
High	Biotores classed by MarLIN as “Very high/High” sensitivity to the impact under consideration An internationally or nationally designated site or candidate site designated for benthic features (SAC, MCZ)
Medium	Biotores classed by MarLIN as “Moderate” sensitivity to the impact under consideration ‘Potential Annex I Habitat’ (e.g. subtidal chalk) BAP priority habitats and species Regionally designated sites of benthic interest (MSNCIs, VMCAAs) MCZ FOCI habitats and species (not as part of a rMCZ)
Low	Biotores classed by MarLIN as “Low” “Very low” or “Not sensitive” to the impact under consideration Common and widespread benthic habitats/species

7.3.7 The magnitude of impact was assessed according to the criteria presented in Table 7.3.

Table 7-3: Magnitude of impact

Magnitude	Definitions
Large	The interest features of internationally designated sites (SAC, MCZs) are degraded or destroyed to such an extent that the designation is compromised. Activities predicted to occur and affect receptors continuously over the long term, and during sensitive life stages. Recovery, if it occurs, would be expected to be long term i.e. 10 years following the cessation of activity. Impacts not limited to areas within and adjacent to the development.
Medium	The quality and availability of habitats and species are impacted to the extent that the population or habitat experiences change in number or range. Activities predicted to occur and affect receptors regularly and intermittently, over the medium to short term and during sensitive life stages. Recovery expected to be medium term timescales i.e. 5 years following cessation of activity. Impacts largely limited to the areas within and adjacent to the development.
Small	The quality and availability of habitats and species experience some limited degradation. Disturbance is within the range of natural variability. Activities predicted to occur intermittently and irregularly over the medium to short term. Recovery expected to be short term i.e. 6-months to one year following cessation of activity. Impacts limited to the area within the development.

Negligible	Disturbance is within the range of natural variability. Activities predicted to occur occasionally and/or for a short period. Recovery expected to be relatively rapid i.e. less than ~ 6 months following cessation of activity. Impacts limited to the area within the development.
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Significance of Residual Impacts

- 7.3.8 The overall significance of residual impacts was determined by combining sensitivity of the receptor (Table 7.2) and the magnitude of the impact (Table 7.3) as presented in Table 7.4.

Table 7-4: Significance of impact

Magnitude	Sensitivity		
	High	Medium	Low
Large	Major	Major/ Moderate	Moderate
Medium	Major/Moderate	Moderate	Minor
Small	Moderate	Minor	Minor
Negligible	Minor	Negligible	Negligible

Uncertainty and Technical Difficulties Encountered

- 7.3.9 A small number of positions where benthic survey stations were proposed needed to be relocated due to the presence of hard substrate or fishing gear. Full details are provided in Appendix 7.2.
- 7.3.10 It should be noted that some benthic habitats can vary significantly in their distribution and abundance over time. As such, the data collected in the characterisation surveys presented here (collected in 2010/2011) may be subject to change by the time that the Project is constructed.

7.4 Environmental Baseline

Water Framework Directive (WFD)

- 7.4.1 Currently, the coastal waters in the landfall area are classified as a 'heavily modified water body' of 'moderate' ecological status.

Intertidal

- 7.4.2 Details of the intertidal survey are presented in Appendix 7.1. A summary of key points is provided below. For details of maritime vegetation recorded on the upper shore, refer to Section 24 - Terrestrial Ecology.

Habitats

- 7.4.3 The desk-based study did not identify any features of particular interest for the landfall. From information gathered during the survey, the intertidal environment can be summarised as being a flat shingle bank on the uppermost shore (backed by the A259 Worthing – Brighton road) that slopes steeply to a flat, sandy beach, which comprises the majority of the mid- and lower intertidal. Rock and wooden groynes are found on the upper part of the beach, and the lower shore has patchy sand-covered cobbles overgrown with macroalgae (Figure 7.2).



Figure 7.2: The export cable landfall at low tide (view from the upper shore to seaward)

- 7.4.4 Sediments on the upper intertidal were dominated by gravel, while those at mid- and lower shore stations comprised medium sand. Fine sediment of $<63\ \mu\text{m}$ was either absent or present in only very low ($\sim 0.01\%$) quantities.
- 7.4.5 Benthic communities were typical of those expected for sand and gravel shorelines, with abundance and species richness being relatively low. Upper shore benthic communities were dominated by turbellarians and nematodes worms, with some terrestrial arthropods also recorded. Mid- and lower-shore communities were broadly similar and mostly comprised small polychaetes and crustaceans associated with clean sand. No rare, unusual or protected benthic invertebrates of conservation interest were recorded.
- 7.4.6 The biotope survey recorded habitats that are widespread, extensive and typical along the Sussex and English Channel coast.

Habitats of conservation interest

- 7.4.7 No intertidal BAP priority habitats were recorded during the intertidal survey in May 2011. Further details of habitats of conservation in interest in the intertidal and coastal environment are presented in Section 9 - Nature Conservation.

Sediment quality

- 7.4.8 In general, concentrations of contaminants in sediments were not of concern. Tributyltin and total petroleum hydrocarbons (TPHs) were below detection limits across the survey area. For polycyclic aromatic hydrocarbons (PAHs), these were below detection limits at the majority of sample points. Exceptions to this were elevated levels on the upper shore, which are likely to be associated with vehicle emissions from the road. However, PAH concentrations were generally considered not to be of concern. For metals, concentrations were not of particular concern with the exception of a single sample point on the western side of the lower shore (WRL), which may be a result of an isolated pollution event. This station had concentrations of copper, nickel and particularly chromium that exceeded internationally recognised criteria (Environmental Canada Probable Effects Level (PEL)). This station is within the planned working area for landfall operations.

Subtidal

Desk-based assessment

- 7.4.9 Information from the literature indicates that sediments in the broader Project area are dominated by mixed sediments, coarse occasional sands, finer sediment, and areas of bedrock (including chalk), either exposed or covered by a thin veneer of sediment, present. The geophysical survey showed gravelly sands to be important across the Project site, with sand and sandy gravel dominating in the export cable corridor.
- 7.4.10 Biological communities recorded from the area are generally complex and patchy, although coarse sediment biotopes tend to be prevalent. While a wide variety of biotopes have been recorded, the high level habitats (according to the classification of Connor *et al.*, 2004) of SS.SCS (sublittoral sand), SS.SSa (sublittoral coarse sediments) and SS.SMx (sublittoral mixed) are common in the region. This seabed habitat diversity is also known to give rise to a varied sessile and mobile epifauna.

Infauna

- 7.4.11 A total of 399 macrofaunal species represented by 4,289 individuals were recorded from the grab sample locations (including individuals recorded as present/absent). The principal taxonomic groups present were the Annelida with 115 species, the Crustacea and Bryozoa (57 species each), Mollusca (41), Cnidaria (24), Porifera (11) and the Echinodermata with 9 species. The remaining

taxonomic groups, including sipunculids, nemerteans, ascidians and turbellarians comprised 5 or less species each.

7.4.12 Based on statistical analysis the following infaunal groups, the distribution of which is presented in Figure 7.4, were established:

- **Group B** was located in the outer perimeter of the survey area (Reference and Tidal Envelope sites) and to the northwest and west of the Zone and Cable Route respectively. The fauna is typical of mixed sand, gravel and silt based communities, with a fauna comprising species found in the sandier components (*Echinocyamus pusillus*), siltier sediments (*Lumbrineris* spp.) and coarser sediments including gravels (*Pomatoceros* spp). The closest recognised biotope that describes this community is SS.SCS.CCS.MedLumVen, (*Mediomastus fragilis*, *Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel) although the large numbers of *Echinocyamus pusillus* are greater than typically recorded in this biotope.
- **Group I** was the most commonly recorded biotope within the Project site. This cluster supported a smaller range of species than Group B, although mean abundance was similar. The dominant species are typically found in sandy communities and the group is best described by the biotope SS.SSa.CFiSa.EpusOborApri (*Echinocyamus pusillus*, *Ophelia borealis* and *Abra prismatica* in circalittoral fine sand).
- **Group A** The inshore sites to the east of the Cable Route corridor supported the most sandy sediments, with a fauna typically comprising mobile crustacean species, such as *Bathyporeia* spp. and the relatively robust *Magelona* species, which were the dominants for these sites. No clear fit to any biotope was possible with this species assemblage, although the higher-level SS.SSa.IFiSa classification was appropriate (Infralittoral Fine Sand).
- **Group J**: appears to represent an intermediate community between B and I, with a much reduced diversity and abundance of individuals. The fauna are typical of coarse sands, including the robust venerid bivalve, *Spisula elliptica*, and the disturbance tolerant polychaete, *Ophelia borealis*. Both of these species were also found in abundance at several sites included within clusters I and B. The sites from this cluster were found scattered throughout the area in all zones, with the exception of the Cable Route area. The most representative biotope is SS.SSa.CCS (Circalittoral Coarse Sand).

Epifauna

7.4.13 Information on encrusting and mobile epifauna was based on review of three datasets: analysis of colonial and encrusting epifauna in grab samples, analysis of video and still photography images, and the 2m scientific beam trawl. This variety of sampling gave rise to a wide number of biotopes being recorded, presented in detail in Appendix 7.2. These can be summarised as follows:

- **Grab samples:** The colonial and encrusting epifauna were well represented across the region with bryozoans the most evident, with *Schizomavella auriculata* and *Aspidelectra melolontha* dominating. These two species typified the sites from the two principal groups identified in the multivariate analysis. The former was associated with a high diversity group found over the coarser mixed sediments, while the latter was associated with more unstable sediments. The distribution of these clusters mirrored the infaunal groupings. An intermediate cluster was also identified for the colonial and encrusting epifauna, with representatives of both faunal groups.
- **Video:** A total of 14 biotopes or biotope complex level descriptions were identified from the video analysis, and these broadly followed the distribution of communities sampled by grab (both in- and epifauna). The most frequently present was SS.SSa.IFiSa.IMoSa (infralittoral mobile sand). The biotope complex level description of SS.SCS.CCS (circalittoral coarse sediment) was also frequently encountered along with the biotope SS.SCS.CCS.PomB (*Pomatoceros triqueter* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles).
- **2m scientific beam trawl:** In general, the distribution of community types broadly followed the other benthic surveys. Motile epifauna recorded was dominated by the common starfish *Asterias rubens*, which occurred in all samples. Other taxa occurring in high frequencies of samples (ca. >80%) were:
 - Crustaceans (hermit crabs *Pagurus bernhardus* and *P. prideaux*, swimming crab *Liocarcinus holsatus*, spider crabs *Macropodia* spp., and shrimp *Crangon allmanni*);
 - Echinoderms (in addition to *A. rubens*: brittlestars *Ophiura albida*, *Ophiothrix fragilis*, and the sea urchin *Psammechinus miliaris*).
- However, abundance of most of these was relatively low, with the only individual (i.e. not colonial) organisms occurring in large numbers being *O. albida* and *P. miliaris*. Beam trawl clusters fell into two main, distinct groups:
 - Cluster D: the most commonly recorded assemblage, with high abundance and diversity; fauna indicative of mixed sediment, including encrusting epifauna, ophiuroids, *P. miliaris*. Distributed across the survey area in a line going E-W, including the top of the zone.
 - Cluster C: a community typical of mobile sediment with relatively low diversity and abundance, with weever fish *Echiichthys vipera* and shrimp *Crangon allmanni*. Largely restricted to the Zone.

7.4.14 Different communities of slightly lower abundance and diversity were recorded at stations on the inshore cable route.

Habitats of conservation interest

7.4.15 The location of features of conservation interest recorded in the subtidal benthic survey are presented in Figure 7.4. These can be summarised as:

- A blue mussel *Mytilus edulis* reef was recorded by drop-down photography at a single station in the inshore part of the export cable route corridor (Figure 7.5). A further blue mussel reef was also recorded just to the east of the cable route corridor;
- Subtidal chalk (and areas of 'hard substrate/rock' identified by the predicted habitat map which may include subtidal chalk) was also recorded at several locations across the export cable corridor, as well as to the west of the corridor; and in the easternmost tidal envelope;
- A single station in the export cable corridor fell within the BAP habitat 'sheltered muddy gravels';
- A single distant reference station) was identified as having clay bedrock with burrowing piddocks;
- Seasearch records reported chalk bedrock and mussels (not necessarily a reef) from within and outside the cable route corridor.



Figure 7.5: Image of a blue mussel reef (*Mytilus edulis*) in the shallow subtidal on the inshore cable route, recorded in the 2011 benthic survey.

7.4.16 The conservation status of these habitats is discussed in Section 9 - Nature Conservation.

Alien invasive species

7.4.17 The slipper limpet *Crepidula fornicata* is a filter-feeding gastropod mollusc originating from North America that is abundant in the English Channel and generally limited to waters of <30m. Large numbers can entirely carpet the

seabed and modify the local environment by increasing the fine sediment content of the seabed with pseudo-faeces (James *et al.*, 2010). As expected, the benthic survey found the biotope SS.SMx.IMx.CreAsAn (*Crepidula fornicata* with ascidians and anemones on infralittoral coarse mixed sediment) within the shallower waters of the export cable corridor. No other invasive species were recorded in the benthic survey.

Predicted habitat map

7.4.18 Figures 7.6 and 7.7 present the integrated (i.e. geophysical cross-referenced with benthic data) habitat map for the cable route corridor and offshore wind farm, respectively. It should be noted that geophysical information was only available for the central part of the export cable corridor (the southeastern and southwestern margins have not yet been surveyed).

7.4.19 Table 7.5 presents the extent of predicted habitat types in the cable route corridor, based on Figure 7.6.

Table 7-5: Extent of predicted habitat types in the export cable route corridor

Habitat	Estimated area of this habitat in the export cable route corridor (m ²)	% of seabed in the export cable route corridor this habitat covers
Infralittoral mobile clean sand with sparse fauna SS.Ssa.IFiSa.IMoSa	5,908,000	7.1
Infralittoral muddy sand SS.Ssa.IMuSa	24,030,000	28.9
Circalittoral coarse sediment SS.SCS.CCS	28,401,000	34.2
Circalittoral coarse/mixed sediment SS.SCS.CCS/SS.SMx.CMx	1,913,000	2.3
Mixed Hard substrate/rock	2,479,000	3.0
Mixed sediments with emergent bedrock and potential mussel bed	4,249,000	5.1
<i>Area with no seabed classified</i>	16,030,000	19.3
<i>Total</i>	83,010,000 m²	100

7.4.20 In the cable route corridor, key features of the predicted habitats are:

- Muddy sand (SS.SSa.IMuSa) dominates the southern half of the cable route corridor; whereas coarse sediments (SS.SCS.CCS) dominate in the northern half;
- Clean mobile sand with sparse infauna is restricted to patches in the southwest and central-northwestern part;
- Mixed hard substrate/rock is found mainly as linear patches in the central and southern part of the corridor;

- The most inshore 2km of the cable route corridor were identified as having potential to support mussel beds.

7.4.21 Table 7-6 and Table 7.7 present the extent of predicted habitat types in the Rampion offshore wind farm site (based on Figure 7.7) for a full and a compressed turbine layout scenario, respectively (see Section 2a.4).

Table 7-6: Extent of predicted habitat types in the Rampion offshore wind farm (full scenario)

Habitat	Estimated area of this habitat in the Rampion site (m ²)	% of seabed in the Rampion site this habitat covers
Infralittoral mobile clean sand with sparse fauna SS.SSa.IFiSa.IMoSa	52,125,000	37.5
Circalittoral coarse sediment SS.SCS.CCS	8,340,000	6.0
Circalittoral coarse/mixed sediment SS.SCS.CCS/SS.SMx.CMx	67,137,000	48.3
Mixed hard substrate/rock	3,058,000	2.2
Sand veneer over hard substrate (SS.SSa.IFiSa.IMoSa)	8,062,000	5.8
<i>Area with no seabed classified</i>	278,000	0.2
<i>Total</i>	139,000,000 m²	100

Table 7-7: Extent of predicted habitat types in the Rampion offshore wind farm (compressed scenario)

Habitat	Estimated area of this habitat in the Rampion site (m ²)	% of seabed in the Rampion site this habitat covers
Infralittoral mobile clean sand with sparse fauna SS.SSa.IFiSa.IMoSa	19,646,000	20.9
Circalittoral coarse sediment SS.SCS.CCS	5,170,000	5.5
Circalittoral coarse/mixed sediment SS.SCS.CCS/SS.SMx.CMx	65,894,000	70.1
Mixed hard substrate/rock	3,008,000	3.2
<i>Area with no seabed classified</i>	282,000	0.3
<i>Total</i>	94,000,000 m²	100

7.4.22 In the wind farm area (full scenario), key features of the predicted habitats are:

- The vast majority of the zone is composed of two main seabed habitats: mobile clean sand with sparse fauna (SS.SSa.IFiSa.IMoSa) in the south and southwestern part, and coarse/mixed sediment (SS.SCS.CCS/SS.SMx.CMx) in the north and western part. There is also an area of coarse sediment (SS.SCS.CCS) along the eastern boundary.

- Hard substrate (e.g. exposed bedrock) is mainly concentrated within a relatively small area in the centre of the zone. There is also an area of sand veneer over hard substrate along the central part of the southern boundary.
- For the compressed scenario, the relative extent of mobile clean sand with sparse infauna is almost halved, with a resulting significant increase in the relative proportion of coarse/mixed sediment. The relative contribution of mixed hard substrate/rock (potentially including subtidal chalk) also increases slightly, from 2.2 to 3.2%.

Sediment quality

7.4.23 Concentrations of contaminants were classed according to Cefas' Guideline Action Levels for the Disposal of Dredged Material (Cefas, 2012). Concentrations below Action Level 1 are generally considered to be of no concern, while those above Level 2 are considered unsafe for sea disposal. Action Levels recorded during the survey are presented in Table 7.8 and Figure 7.6.

7.4.24 No concentrations exceeding Level 2 were recorded for any contaminant. A total of 11 stations recorded concentrations of metals between Action Levels 1 and 2 (arsenic at all 11 sites, chromium at four, and nickel at one). Four of these stations were located in areas outside the development area where seabed will not be disturbed, but seven stations lie either within the cable route corridor or the windfarm. However, for all of those stations in the development area with concentrations between Levels 1 and 2, none approached the Level 2 concentrations. The concentrations recorded in the survey are therefore not considered to be of particular concern.

Table 7-8: Levels of contaminants recorded in sediments within the Project area that exceeded CEFAS Action Level 1.

	Arsenic	Chromium	Nickel
CEFAS Action Level 1	20	40	20
CEFAS Action Level 2	100	400	200
Station			
Cable route corridor			
CR1.1	37.8	117.8	<Action Level 1
CR7	28.9	<Action Level 1	<Action Level 1
Wind farm			
WF2	20.7	<Action Level 1	<Action Level 1
WF4	51.4	<Action Level 1	<Action Level 1
WF7	37.0	50.7	54.6
WF11	26.9	55.2	<Action Level 1
WF13	21.0	<Action Level 1	<Action Level 1

NB All units are mg/kg, and results for each sample are normalised to total organic carbon

7.5 Predicted Impacts

- 7.5.1 In line with the use of the “Rochdale Envelope” (see Section 5 – EIA Process), the assessment in this section has been based on a development scenario that is considered to be the worst case in terms of impacts to the benthic environment. Table 7.9 lists the components of the design of the marine part of the project that could influence the magnitude of impacts. The realistic worst-case scenario in terms of seabed take is presented in Section 2a - Offshore Project Description.

Table 7-9: Wind farm design features and their influence on the Rochdale envelope for benthos and sediment quality

Design feature	Design options
Wind farm site layouts	Array layout (full or compressed) may affect the area of impact to certain benthic habitats.
Wind turbines	The size and therefore number of turbines selected for the final design affects the number of foundations, which then influences the worst case in terms of seabed take (see Foundations below as well).
Foundations	The greatest seabed area taken per turbine (including scour protection) is from gravity bases and suction caissons. Monopiles and gravity bases create the greatest volumes of spill from drilling and seabed preparation.
Offshore substation	Unlikely to have an influence on the worst case unless located close to UKBAP or Annex I habitat (given that substations are a the hub of the cabling requirements)
Cables	Reduced length of cabling will produce lower impact on benthos from installation and EMF during operation. Routing of cable to avoid UK BPA and Annex I habitats. Choice of route influences burial potential and scour protection requirements.
Construction and installation	Choice of cable installation methods could affect magnitude of impacts.
Decommissioning	Decisions on the level of seabed disturbance will be heavily influenced during the array design and foundation selection. Decisions on the degree of material left in situ at the end of the project’s life will also influence the degree of impact on benthos.

Construction

Direct disturbance – turbine foundation (and scour protection) installation footprint

- 7.5.2 Section 2a - Offshore Project Description provides descriptions of the various types of turbine foundation which are being considered for the Project. Several designs will require piles to be driven into the seabed; where ground conditions dictate, drilling may also be required. Other designs such as the gravity base and suction caissons require a relatively large area of seabed to be prepared in advance of their installation. The different foundation types have limitations on their applicability both in terms of the size of turbine which they can support and

the depths of water in which they can be used (more information on this subject is presented in Section 2a).

- 7.5.3 In addition, scour protection may be required around some types of turbine foundations (see Section 2a).
- 7.5.4 All of the above installation activities will result in the mortality of all benthos immediately underneath this 'footprint' by compaction, injury or burial. This impact will be permanent for the lifetime of the Offshore Project. All biotopes that are affected will be equally impacted, as recovery will not be possible.
- 7.5.5 As discussed in Section 2a, the realistic worst-case scenario (identified as being the 100 foundation scenario) of direct habitat loss from the footprint of turbine foundations and scour protection will be 523,000 m².
- 7.5.6 To determine more accurately in which habitats these areas would be contained, indicative turbine positions were plotted against the predicted habitat map (Figure 7.7) for the two potential worst-case options in terms of seabed take, i.e. a 175 turbine full, hexagonal arrangement, and a 175 turbine compressed hexagonal scenario. From this, the number of turbine foundations to fall within each predicted habitat was estimated, the results of which are presented in Table 7.10.

Table 7-10: The number of turbine foundations that are estimated (based on indicative positions) to fall within each predicted habitat type, for two different scenarios.

Habitat	Number of turbine foundations	
	Full, hexagonal (Option E)	Compressed, hexagonal (Option G)
Infralittoral mobile clean sand with sparse fauna SS.SSa.IFiSa.lmoSa	59	40
Circalittoral coarse sediment SS.SCS.CCS	12	9
Circalittoral coarse/mixed sediment SS.SCS.CCS/SS.SMx.CMx	91	118
Mixed hard substrate/rock	3	7
Sand veneer over hard substrate (SS.SSa.IFiSa.lMoSa)	9	0
<i>Area with no seabed classified</i>	1	1
<i>Total</i>	175	175

- 7.5.8 For the majority of seabed habitats (see below for habitats of conservation interest) potential impacts are assessed as minor, based on the data presented in Table 7.10 (impacts are considered to be similar for both scenarios);
- Overall sensitivity is considered to be low for the vast majority of habitats, which are reported as common and widespread in the area (e.g. James *et al.*, 2011). In addition, the total worst-case estimate of impacted seabed is 523,000m², which represents just 0.38% of the total seabed within the

boundary of the full scenario of the wind farm area (and 0.56% of the compressed scenario).

- Magnitude is considered to be medium (at worse), as impacts will be restricted to within the development.

7.5.9 Impacts to benthic species and habitats of conservation interest from turbine foundation installation are considered below. Note that, in all cases, sensitivity is considered to be medium (given e.g. BAP status):

- Native oyster: While the presence of this species in the development area is confirmed from survey data (see Section 8 – Fish and Shellfish Ecology), it is not possible to determine its population density. As adults are sessile and generally present as isolated individuals, it is possible that some individuals present in the foundation footprint will be destroyed. However, based on the fact that the footprint represents only 0.38-0.56% of the wind farm area (which is in itself part of a much wider distribution), and that this species has high potential to colonize other suitable habitat locally (through spawning with abundant, wide-ranging pelagic eggs and larvae), the loss of some individual organisms is likely to be within the range of natural variability. Magnitude is therefore predicted as negligible (i.e. impacts limited to within the development), giving overall impact of minor significance.
- Blue mussel beds: Although these were recorded in and next to the inshore cable route, no blue mussel beds or reefs were recorded in the wind farm area. However, these habitats can be ephemeral and naturally establish in suitable conditions, as well as experience natural loss due to the action of e.g. predators or storms. As such, there is the potential for them to occur in the wind farm. If blue mussel beds were present, they would be destroyed under the permanent footprint of turbine foundations. With a medium magnitude (i.e. reduction limited to the development and not affecting any sites designated for this habitat), overall potential significance is considered to be moderate.
- Subtidal chalk: 'Mixed hard substrate/rock habitats' (which may include subtidal chalk) were identified by the predicted habitat map as representing a predicted 2.2-3.2% of the total seabed area within the wind farm; based on data presented in Table 7.10, approximately 3-7 turbine foundations could be located in it, which would represent a permanent loss of some of this habitat. Magnitude (medium) and overall impact (moderate) are similar to that for blue mussel beds.
- *Sabellaria spinulosa* beds: Although *Sabellaria* aggregations are likely to occur in the area, the surveys did not confirm their presence in the wind farm. As with blue mussel beds, *Sabellaria spinulosa* aggregations can be ephemeral and therefore there is the potential for them to occur in the wind farm and be destroyed by installation of permanent turbine foundations. Magnitude

(medium) and overall impact (moderate) are similar to that for subtidal chalk and blue mussel beds.

- 7.5.10 As noted, some turbine foundations may require drilling. While some finer sediment from drilling will be dispersed by currents along the seabed, most drill arisings (such as those from rock) will, unless removed, remain around the drilling location and either not be dispersed or take much longer to disperse.

Direct disturbance – jack-up vessel spud can footprint

- 7.5.11 As the footprint of the spud can will be located immediately next to the turbine foundation, it is likely that the range of habitats affected (and the concentration of impacts within a given habitat) by this impact will be similar to that estimated Table 7.10, for example in that circalittoral coarse/mixed sediment (SS.SCS.CCS/SS.SMx.CMx) and clean sand with sparse fauna (SS.SSa.IFiSa.IMoSa) will be the habitats most commonly affected.
- 7.5.12 In soft sediment (e.g. gravel, sand) the placement of the spud cans onto the seabed, and the subsequent ‘jacking-up’ of the vessel’s weight onto these, will result in the mortality of nearly all benthic organisms underneath this footprint. Mortality will occur through direct crushing or loss of access to oxygenated seawater from the seabed surface. Although the depth to which the spud cans penetrate the sediment will depend on the type of substrate, it is likely that the entire benthic community, including the deepest-burrowing species, will be impacted.
- 7.5.13 In both soft- and hard-substrate examples, some more mobile organisms (such as shrimps) may escape from the area, by detecting the spud can as it is lowered towards the seabed.
- 7.5.14 As discussed in Section 2a, the realistic worst-case scenario of direct habitat loss from the footprint of jack-up vessel footprint (using the illustrative example of the MPI *Discovery installation vessel*) will be 236,399m². This represents approximately 0.17% of the wind farm site (full scenario) or 0.25% (compressed scenario).
- 7.5.15 Each spud can deployment will last for a maximum of a few days. Impacts are therefore temporary, and benthic communities will start to re-establish immediately following spud can removal with immigration of organisms (including eggs and larvae).
- 7.5.16 For the majority of seabed habitats (see below for habitats of conservation interest) the overall significance of this impact is considered to be minor-negligible. This is based on low sensitivity for the majority of habitats (i.e. common and widespread), combined with a magnitude ranging from negligible (i.e. MarLIN recoverability of ‘very high’; full recovery within 6 months; see Table 7.12) to medium (i.e. MarLIN recoverability of ‘moderate’; full recovery between 5-10 years; see Table 7.12), but always limited to within the development.

7.5.17 Potential impacts to benthic species and habitats of conservation interest from the footprint of spud cans are considered below. As for turbine foundations, sensitivity is medium for all of the below:

- Native oyster: As for turbine foundations, it is possible that some individuals present in the spud can footprint will be destroyed although the impact of this is likely to be minimal; the impact will only be temporary, and once the vessel is redeployed elsewhere then the seabed will become available for colonization by this species. With this negligible magnitude, overall impact will be minor.
- Blue mussel beds: Although no blue mussel beds were recorded or predicted in the wind farm area they could potentially occur and therefore be destroyed by the spud can footprint. The MarLIN assessment for recoverability for *Mytilus edulis* beds on sediment is high (i.e. 'Full recovery will occur but will take many months (or more likely years) but should be complete within about five years'; MarLIN, 2008), i.e. a magnitude of medium; giving an overall impact of moderate.
- Subtidal chalk: Recoverability of similar scoured rock habitat from substratum loss is reportedly also high (Tyler-Walters, 2008a); the temporary impact will have a medium magnitude, giving an overall impact of moderate.
- *Sabellaria spinulosa* beds: Although not recorded in the surveys, these could occur in the wind farm site. Recoverability of *S. spinulosa* habitat from substratum loss is reportedly high (Marshall, 2008); the temporary impact will have a medium magnitude, giving an overall impact of moderate.

7.5.18 There may also be impacts to benthos from vessel anchor scars left immediately after construction. Although likely to affect a much smaller area, these would be expected to have a similar, temporary impact to spud can footprints.

Direct disturbance – inter-array and export cable

7.5.19 For safety reasons, inter-array and export cables will either be buried in the seabed, or if this is not possible, they will be protected by covering them with concrete mattresses. Burial will be achieved by using one or more of the following techniques: a) burial into soft sediment using ploughing or jetting techniques, allowing for sediment to backfill the trench; or b) trenching (where a trench is excavated through an area of harder material); this technique will however only be used in exceptional circumstances. Cable burial will be the preferred method of protection as sediment which fills the trench above the cable is typically suitable for re-colonisation by benthos. Burial is therefore likely to present a temporary impact to benthic organisms.

7.5.20 From experience on other UK offshore wind farm developments, it is acknowledged that it can sometimes be difficult to achieve the full level of cable burial specified in the design, due to factors such as local ground conditions or

scouring. In the case of unsuccessful burial, it will be necessary to ensure safe cable protection by use of mattresses or rock protection at a later date.

- 7.5.21 In the nearshore area, the export cable(s) may be laid by a barge that moves by pulling on anchors that are placed by anchor handling vessels. Removal of these anchors may result in the deposit of lumps of consolidated sediment (where clay is present) on the seabed, however geophysical surveys indicate that such sediments are not present in the Offshore Project area (see Section 6 – Physical Environment).
- 7.5.22 These activities will impact the benthos by causing mortality, injury and displacement of benthic organisms. The impact will be temporary for the majority of the cable route where the cable is buried, but permanent for where the cable is covered with mattresses or rock.
- 7.5.23 The estimated realistic worst-case scenario in terms of benthic habitat loss (assuming mattresses are used)/disturbance (if cables are buried) from both cable installation, and turbine foundations (including scour protection), is presented in Table 7.11.

Table 7-11: Summary of estimated realistic worst-case scenarios for area of benthic habitat loss/disturbance as a result of construction of the Project

Aspect	Total maximum area of habitat loss/disturbance (m ²)	Wind farm site (full scenario)	Cable route corridor
		139,000,000 m ²	83,010,000 m ²
		Maximum %age of the existing seabed in that area that will be impacted	
Turbine foundation (and scour protection) footprint	523,000	0.38	N/A
Jack-up vessel spud-can footprint	236,399	0.17	N/A
Inter-array cable installation/protection	2,300,000	1.67	N/A
Export cable installation/protection	920,000	N/A	1.11
Total	3,979,399	2.22	1.11

NB Crown Estate Round 3 Zone 6 has a total area of 267km²; therefore, the total percentage of that area affected by turbines, spud can footprint and inter-array cabling is 1.14%

- 7.5.24 For the inter-array cable, a maximum of 2,300,000m² will be impacted, representing 1.67% of the wind farm area. As the detailed route of these cables has not yet been selected, it is not possible to determine exactly which habitats (and therefore the extent of these) will be impacted, although they will likely be the same or similar to those presented for turbine foundation impacts (Table 7.10).

- 7.5.25 In order to assess the significance of impact from inter-array cable installation, MarLIN assessments of sensitivity to, and recoverability from, substratum loss were considered for broad habitats that were recorded from the development area, for which MarLIN data is available (Table 7.12). It should be noted that MarLIN assessments are not available for all biotope types; in such cases, assessments for broader/similar biotopes were used.

Table 7-12: Sensitivity to, and recoverability from, substratum loss (i.e. cable installation) to broad benthic habitats both recorded in the development area and for which MarLIN data is available.

Habitat	Sensitivity	Recoverability
Sublittoral coarse sediment SS.SCS.CCS (Groups B&J)	Low-Moderate	High-very high
Sparse fauna on mobile coarse sediment SS.SCS.ICS	Moderate	High
Sublittoral/infralittoral mixed sediment SS.SMx.CMx/Imx	Moderate	Moderate-high
Infralittoral fine sand SS.SSa.IfSa	Low-Moderate	High-Very high
Infralittoral muddy sand SS.SSa.ImuSa	Moderate	Moderate-High
Sublittoral mussel beds SS.SBR.SMus	Moderate	High
Epifauna on scoured rock CR.HCR.Xfa	Moderate	High

- 7.5.26 Inter-array cabling will mostly affect two habitats: coarse/mixed sediments, and mobile sand with sparse infauna. Worst-case sensitivity for the majority of habitats can be considered as medium. This can be combined with a magnitude varying from negligible (i.e. 'very high' MarLIN recoverability; full recovery within 6 months) to medium (i.e. 'moderate' MarLIN recoverability; full recovery between 5-10 years), but always limited to within the development. Overall, the significance of impacts from inter-array cable installation varies from moderate (for more sensitive habitats) to negligible (for less sensitive habitats).
- 7.5.27 For species and habitats of conservation interest, the overall impacts from inter-array cable installation, which will be largely temporary, are considered to be similar to that from the footprint of the spud cans, i.e. negligible for native oyster; and moderate for blue mussel beds, subtidal chalk, and *Sabellaria spinulosa* aggregations.
- 7.5.28 For the export cable, a maximum of 920,000m² will be impacted, representing 1.11% of the area of the export cable route corridor. However, this area of impact will be spread along a narrow, linear corridor and not occur in a single area. As noted before, the southeastern and southwestern margins of the cable route corridor have not yet been surveyed; it is therefore not possible to predict habitat type. However based on the predicted habitat mapping for the majority of the cable route corridor (Figure 7.6 and Table 7.5) muddy sand, coarse

sediment, and mobile sand with sparse infauna habitats will be the most commonly impacted. As a band of mixed sediments with emergent bedrock and potential mussel bed covers almost the entire width of the most inshore section of the cable route, it is almost certain that this habitat has the potential to be impacted. As noted previously, the cable routing will avoid hard seabed conditions where possible, making it less likely that the 'mixed hard substrate/rock' (i.e., those that are potentially subtidal chalk) habitat predicted in the area will be impacted.

7.5.29 For the export cable (and with reference to Table 7.12), worst-case sensitivity for the majority of habitats can be considered as medium, with magnitude varying from negligible (i.e. 'very high' MarLIN recoverability; full recovery within 6 months) to medium (i.e. 'moderate' MarLIN recoverability; full recovery between 5-10 years), but always limited to within the development. Overall, the significance of impacts from installation of the export cable is therefore between moderate (for more sensitive habitats) and negligible (for less sensitive habitats).

7.5.30 Potential pre-mitigation impacts from installation of the export cable for species and habitats of conservation interest are as follows (noting that all are considered 'medium' sensitivity):

- Native oyster: this species may occur in the cable route corridor; however, as for other direct disturbance impacts, overall impact will be of negligible significance based on negligible magnitude.
- Blue mussel beds/reefs: the anticipated pre-mitigation impact could be of moderate significance, based on medium magnitude. Impacts will be mostly temporary (except where the matting has to be used) and limited to within the development, and recovery is 'high' (i.e. full recovery expected within 5 years; MarLIN 2008).
- Subtidal chalk: the anticipated impact will be of moderate significance, based on medium magnitude. Impacts will be temporary (except where the matting has to be used) and limited to within the development, and recovery of a similar habitat is 'high' (i.e. full recovery expected within 5 years; Tyler-Walters 2008a).
- *Sabellaria spinulosa* aggregations: there were indications from the 2010 geophysical survey that *S. spinulosa* aggregations may have been present in the survey area; the 2011 benthic characterisation survey included drop-down camera work to identify such aggregations, however, none were recorded. If *Sabellaria* aggregations are present in the export cable corridor, the anticipated pre-mitigation impact could be of moderate significance, based on medium magnitude. Impacts will be temporary and limited to within the development, and recovery is 'high' (i.e. full recovery expected within 5 years; Marshall 2008).

Increased suspended sediment & smothering

7.5.31 Increases in suspended sediment concentration will arise from construction activities, most notably through installation of turbine foundations, installation of inter-array and export cables, and the deployment and retrieval of anchors (from anchor handling tugs). Changes to suspended sediment, and changes in the thickness of seabed sediment, as a result of Project construction activity was modelled by ABPMer (2012). The worst case scenario for generation of suspended sediment during foundation installation was considered to be the use of monopiles, which needed to be drilled into the seabed. In summary, the modelling predicted:

- Installation of the realistic worst-case foundation option (monopiles) could elevate suspended sediment concentrations, but this was only considered a minor impact given its limited spatial effect and temporary time-scales. Maximum suspended sediment concentrations of up to 200mg/L might occur in slack water conditions for a period of a few hours, but this would be limited to an area of approximately 0.5km. Suspended sediment concentrations would be elevated above background levels by no more than 5mg/L following completion of foundation installation, and these levels would be expected to rapidly disperse. To place these in perspective, natural suspended sediment levels in the area are known to be 35mg/L (storm events, near-seabed), 5-9mg/L (surface, winter) and 1-3mg/L (surface, summer);
- Away from the immediate vicinity of the foundation structures, bed level changes are likely to be extremely small (any scour will be limited in extent, and any deposition will be shallow); and
- The nearshore area close to the export cable landfall could potentially experience elevated suspended sediment concentrations in the immediate vicinity of works, although these will be rapidly diluted away from the works, and only be temporary.

7.5.32 Sediment spoil produced from the installation of any turbine foundation will be deposited on the seabed in the nearby area. As calculated in Section 2a, the realistic worst-case volume of spoil that could be produced is 167,451m³.

7.5.33 These impacts may affect benthic organisms in two main ways, both of which are likely to be exacerbated if a significant portion of the sediment is composed of fine (<63µm) material:

- Clogging of gill and feeding structures; and
- Direct smothering.

7.5.34 However, impacts are considered to be ameliorated by a number of factors:

- Biota in the area are adapted to relatively high levels of turbidity and sediment deposition, both from naturally high levels and other anthropogenic sources such as aggregate extraction activities. Biotopes very similar to those recorded in both the intertidal and subtidal have been assessed by MarLIN as having sensitivities to both increased suspended sediment and smothering ranging from “not sensitive” to “low sensitivity” (Table 7.13);
- Based on samples from the 2011 benthic survey from both inter- and subtidal areas, the majority of the surface sediment that will be disturbed during construction activities will consist either of sand (63µm-2mm) or gravel (>2 mm), with low proportions of fine sediment at only a few sites (Appendix 7.2);
- Currents will disperse sediment widely, so that smothering will be limited to very small areas; and
- Sediment will be gradually deposited (and dispersed) through the period of the installation schedule, and will persist as a temporary impact for installation only.

7.5.35 The significance of the worst-case scenario for these impacts is considered to be minor, based on low sensitivity, and small magnitude of impact (i.e. some limited degradation; recovery expected within 1 year; impacts limited to within the development).

Table 7-13: MarLIN sensitivity of benthic habitats found in the development area, to the impacts of increased suspended sediment and smothering

Broad habitat type	Impact type	
	Increased suspended sediment	Smothering
<i>Intertidal</i>		
LS.Sa*	Not sensitive-Very low	Not sensitive-Low
<i>Subtidal infauna</i>		
SS.SCS.CCS (Group B)	Not sensitive-Very low	Very low-Low
SS.SSa.CFiSa.EpusOborApri (Group I)	Not sensitive-Low	Not sensitive-Very low
SS.SSa.IfSa (Group A)	Not sensitive-Very low	Not sensitive-Low
SS.SSa.CCS (Group J)	Not sensitive-Low	Not sensitive-Very low

*NB MarLIN assessments are not available for all biotope types, or for these broader classifications. The nearest relevant biotope types have been used.

7.5.36 For species and habitats of conservation importance, MarLIN sensitivity to increases in suspended sediment, and subsequent predicted impact, is as below:

- Native oyster: “not sensitive” (Jackson and Wilding, 2009); no impact predicted.

- Blue mussel beds: “not sensitive” (MarLIN, 2008); no impact predicted.
- Subtidal chalk: “low” sensitivity for a similar habitat (Tyler-Walters, 2008a); combined with small magnitude, a minor impact predicted;
- *Sabellaria spinulosa* aggregations: “not sensitive” (Marshall, 2008); no impact predicted.

Suspension of contaminated sediment

7.5.37 Disturbance and resuspension of contaminated sediment during construction could result in contaminants being redistributed and made biologically available to benthic organisms. Benthic organisms recorded in the development area will vary widely in their tolerance and sensitivity to contamination. Some examples are:

- Native oyster *Ostrea edulis* is considered to have sensitivities to contamination ranging from very high (synthetic compounds), high (metals), to very low (hydrocarbons)(Jackson and Wilding, 2009);
- Edible mussel *Mytilus edulis* is considered to have low sensitivity to all three of these types of contamination (Tyler-Walters, 2008b);
- The biotope most similar to the ‘Group B’ infaunal biotope found across the survey area, (*Mediomastus fragilis*, *Lumbrineris* spp. and venerid bivalves in circalittoral coarse and or gravel; SS.SCS.CCS.MedLumVen) is reported as having moderate sensitivity to all three of these contamination types (Rayment, 2008).

7.5.38 Results from the intertidal and subtidal surveys indicate that most locations did not have contaminant concentrations of concern. However, a single station in the intertidal had contaminant levels above action limits (see section 7.4.2.6), and 11 stations in the subtidal, had contaminant levels between those generally considered of no concern (Cefas Action Level 1), and those of concern (Cefas Action Level 2).

7.5.39 Assuming that these areas of contamination sampled in 2011 are present when construction occurs, and that the small areas in which they occur are actually disturbed, sediment will be rapidly dispersed into the water column (for subtidal stations) or upon tidal inundation (for the intertidal station) and contaminant levels will be diluted to levels well below those that are of biological concern. Contaminants (including metals) tend to associate with fine (<63 µm) particles, which require low energy conditions to settle to the seabed; it is therefore likely that any contaminated particles will be widely dispersed to give an overall minor-negligible impact for both common habitats, and those species and habitats of conservation interest (based on low-high sensitivity of benthic biotopes to metal contamination, and negligible magnitude).

Introduction of non-native species

7.5.40 There is the potential for non-native marine species to be introduced, and become established, during the lifetime of the Project. Introduction could potentially occur during both construction (e.g. direct introduction of organisms on Project construction vessels) and operation (e.g. Project maintenance vessels; non-Project vessel traffic), and establishment could occur during operation. Issues regarding invasive species during both construction and operation are discussed in 'Operation' below.

Operation

Presence of new habitat

7.5.41 Installation of the Project will introduce a number of man-made structures into the marine environment. These will comprise:

- Turbine foundations: these will extend from the intertidal down to the seabed, presenting a smooth surface of concrete/steel.
- Scour protection around foundations: As noted in Section 2a, the realistic worst-case maximum extent of seabed that both turbine foundations and scour protection will cover will be 523,000m². However, as this surface will consist of rock and/or gravel material it will be three-dimensional and comprise a greater total surface area. As well as providing new surfaces for colonisation by sessile fauna, this rock/gravel material will also provide micro-habitat between spaces for colonisation by both sessile and mobile fauna.
- Cable protection (i.e. concrete mattresses/rock armour on inter-array and cable route): Inter-array cables would span a maximum of 230km, and the export cable would span a maximum of 92km (accounting for four separate cables up to 2 km each). The maximum (and highly improbable) engineering requirement would be for 10% of the lengths of a 10m wide area around the cables to be covered with concrete mattresses.

7.5.42 As with any man-made structure in the sea that is not treated with biocides, these structures will gradually develop an encrusting biota of sessile benthic fauna (e.g. bryozoans, hydroids, sponges, tube-dwelling polychaete worms, attached bivalve molluscs), which will provide microhabitat for mobile benthic fauna (e.g. amphipod and decapod crustaceans, mobile polychaetes, gastropod molluscs). Algae (seaweed) growth will also develop on structures in intertidal and shallow waters, where light levels are adequate for them to occur. The degree of development of any encrusting benthic community will vary based on a number of factors, including water depth, exposure to waves and currents and the type of man-made material present.

- 7.5.43 Presence of the turbines will change the benthic environment in the Project area, in that they will permanently introduce small areas of intertidal environment (i.e. the uppermost part of the turbine foundations) into the offshore area where the intertidal is not naturally present.
- 7.5.44 In the subtidal, it is likely that encrusting communities on man-made structures will be different in terms of species composition to those found in natural environments in the immediate area, such as expanses of soft sediment (e.g. sand). Although natural hard-substrate communities exist in the Project area (Seasearch 2009; James *et al.*, 2010; Williams and Clark, 2010), such as on chalk bedrock, these may be different to those that will form on anthropogenically introduced surfaces. In both cases, a permanent but highly localised alteration to the natural benthic environment will occur.
- 7.5.45 It is possible that the presence of new inter- and subtidal habitat may provide habitat for colonisation by non-native (alien) species. While some alien species can exist without causing widespread harmful effects, in some cases their abundance can increase to such an extent that local ecological conditions are changed, in which case they become known as alien invasive species. These may originate from sources such as planktonic larvae released from ballast water of shipping traffic in the English Channel, or from fouling of hulls or other submerged materials.
- 7.5.46 It is not anticipated that the presence of the new structures will significantly affect the distribution or abundance of the American slipper limpet *Crepidula fornicata*, as this is already abundant and widely distributed in the English Channel (James *et al.*, 2010). It is possible that submerged infrastructure has the potential to provide habitat for other species of invasive species. The carpet sea squirt (*Didemnum* sp.) is a rapidly-growing colonial organism that has been highlighted by the GB Non-native Species Secretariat (NNSS) as potentially highly damaging to native habitats, fisheries and aquaculture. First discovered in the UK in 2008, it has recently been recorded in the south east of England off the north coast of Kent (CEFAS 2011; NNSS 2012).
- 7.5.47 Overall, the significance of this impact is considered to be negligible, based on medium-low sensitivity (BAP and common/widespread benthic) and negligible magnitude. However, it is acknowledged that in the event that best practice does not prevent colonization of the wind farm by invasive species, this level of significance has the potential to increase.

Electro-magnetic Fields (EMF)

- 7.5.48 It is possible that electro-magnetic fields (EMF) emitted from both inter array and export cables into overlying seabed sediment and water have the potential to impact benthic communities. However, it is acknowledged that there is very little scientific information available on which to accurately base any assessment. Several groups of benthic invertebrates are known to be able to detect electric or magnetic fields, but in general the detection and effects of anthropogenic EMF

on them is poorly understood (Normandeau Associates *et al.*, 2011). MarLIN do not provide information on sensitivity of benthic habitats to EMF. While some preliminary work has suggested that EMF may cause behavioural changes in a species of crab under experimental conditions (Wilson & Woodruff, 2011), no direct evidence of impacts to invertebrates from undersea cable EMF exists (Normandeau Associates *et al.*, 2011). Electrosensitive invertebrate species that have had their sensitivity thresholds identified were predicted to be unimpacted by fields from undersea cables, although it was acknowledged that magnetosensitive species could be affected in close proximity to certain cable systems (Normandeau Associates *et al.*, 2011). No significant change to infaunal benthic communities was reported one year after installation of a buried HVDC cable in the Baltic Sea, from which the authors inferred that EMF was not a detectable source of impact (Andrulewicz *et al.*, 2003).

- 7.5.49 As there is little scientific certainty on impacts to benthos from EMF, the precautionary principle is applied, by using 'high' sensitivity. As it is considered highly likely that any effects of EMF on benthos (negative or otherwise), would be confined to the development itself, this gives a worst-case magnitude of small. Combined, these give a worst-case significance of moderate.

Presence of inter-array and export cables

- 7.5.50 Cables will be buried to a depth of at least 1m in sediment. As most benthic infaunal organisms are generally found within the top 30cm of sediment, or occasionally up to 60cm (Nybakken, 1988), it is not anticipated that even deep-burrowing species will be affected by the presence of the buried cable. Therefore, no significant impacts are anticipated during operation.

Temperature

- 7.5.51 Some of the heat emitted from the buried cable will be transferred to the surrounding environment, particularly sediment and interstitial water (i.e. water between sediment grains). There are little data available on temperature effects from operational wind farms, but the OSPAR Commission (2009) reported that the only known study, from Nysted in Denmark, found that sediment temperature did not increase more than 1.4°C at 20cm above a buried cable of 166MW capacity. OSPAR Commission (2009) also noted that heat loss from the cable was likely to be greater through coarse sediment compared to finer sands and muds, due to the greater interstitial spaces.
- 7.5.52 There is little scientific data available on the temperature effects of cables on benthos. Increased temperature could affect benthic organisms directly, for example by impaired physiology and reproduction; limited experimental data show that some organisms avoid areas of higher temperature, whereas other do not (OSPAR Commission, 2009). Temperature increases could also affect organisms indirectly, for example through increased bacterial activity and localised anoxic sediments, although these possible impacts are poorly understood (OSPAR Commission, 2009).

7.5.53 Actual potential temperature changes at the seabed will be heavily influenced by the depth of cable burial and the composition of the sediment above the buried cables. The cable will be buried to a depth of between 1 and 2 m, and the dominant sediments in the study area are sands and gravels. It is therefore likely that heat will disperse rapidly away from the cable, through relatively large interstitial spaces. Temperature increases in the top few centimeters of sediment, where the majority of the benthic infauna are located, are therefore likely to be marginal.

7.5.54 The NPS notes that for offshore export cables that are armoured and buried at a sufficient depth to minimise heat effects, the effects of heat on sensitive species from cable infrastructure during operation are unlikely to be a reason for the IPC to refuse to grant consent for a development. As such, the potential impacts of elevated temperature from cables are not considered further here as a potential impact to benthic communities.

Maintenance, repair and upgrade

7.5.55 As noted in the Project Description, it may sometimes be necessary to replace some of the larger components of the turbines in the event of failure or breakdown. As the size of some of these components is too large to be handled by normal service vessels, jack up barges or larger ships would need to be used, and as such there may be some limited impacts similar to those during the construction phase (e.g. of the jack-up vessel spud can footprint).

Decommissioning

7.5.56 After the operational life of the development it will be decommissioned. Activities carried out during this phase of the development, resulting in potential impacts to benthos may include the following:

- Removal of foundations (e.g. by cutting) prior to removal for onshore processing, which would result in mortality of organisms living on the foundations and a permanent loss of artificial habitat;
- Possible partial excavation of the seabed to allow e.g. cable cutting. This may result in localised, temporary mortality/injury/displacement of benthic organisms;
- Removal of scour protection materials, resulting in mortality of organisms and a permanent loss of artificial habitat;
- Cables that are not buried will be removed, using a water jetter or similar technology. This would result in similar impacts to that for cable installation, i.e. localised, temporary mortality/injury/displacement of benthic organisms. However, the extent would be more limited as only exposed cable would be removed.

7.6 Mitigation Measures

- 7.6.1 Mitigation measures are summarised in the impacts summary Table 17.14.

During Construction

Direct disturbance – turbine foundation (and scour protection) footprint

- 7.6.2 Impacts to benthos will be mitigated by minimising, as far as feasible, the requirements for foundations with a large ‘footprint’ and the use of scour protection.
- 7.6.3 To ensure that impacts to habitats of conservation importance are limited as far as possible, a pre-construction benthic survey of indicative turbine foundation locations will be conducted in the wind farm area to comply with established practice for a development of this type. Any areas of important habitat identified will be discussed in consultation with regulators, and options such as micro-siting of foundations to reduce impacts will be considered.
- 7.6.4 Any such micro-siting will be expected to considerably reduce impacts from the predicted, pre-mitigation moderate impact.

Direct disturbance – jack-up vessel spud can footprint

- 7.6.5 The jack-up vessel will routinely aim to minimise the number of ‘jack-ups’ (i.e. spud can deployments) as part of operational efficiency. As for turbine foundations above, areas of habitat of conservation importance (based on pre-construction surveys) will be avoided where possible, and in discussion with regulators. This will also be expected to considerably reduce impacts from the predicted, pre-mitigation moderate impact.

Direct disturbance – intra-array and export cable

- 7.6.6 Impacts to benthos will be mitigated by minimising, as far as feasible, a) the width of the cable ‘footprint’ disturbed by cable burial b) the requirement for mattresses/armour.
- 7.6.7 Routing of both the inter-array and export cables will aim to avoid areas of hard (i.e. rock) seabed where possible due to engineering requirements, which will also minimise impacts to subtidal chalk.
- 7.6.8 As for those noted above, impacts to habitats of conservation importance can be expected to be reduced based on discussion of the results of the pre-construction survey with regulators, and appropriate mitigation such as possible minor route deviations.

Increased suspended sediment

- 7.6.9 As worst-case impacts are assessed as minor, and are only temporary, no specific mitigation measures are proposed. However, where feasible, construction techniques that minimise sediment suspension will be used.

Suspension of contaminated sediment

- 7.6.10 As impacts are predicted as negligible, no mitigation is proposed.

During Operation*Presence of new habitat*

- 7.6.11 To avoid contamination with invasive species during both construction and operation liaison will take place with Natural England to ensure work is carried out with regard to suitable bio-security guidance, such as “Biosecurity for submerged structures” (Environment Agency, 2011). Relevant contractors (e.g. survey/maintenance/monitoring personnel) will be made aware of the requirement to immediately report key non-native species (including the carpet sea-squirt) to the non-native secretariat at DEFRA. It should be noted that the prevention and control of marine invasives is complex, requiring the co-operation of the large number of sea users from a variety of sectors to minimise risks. Prevention measures will aim to keep the magnitude of impacts (and therefore the overall impact) as negligible, although it is acknowledged that accidental introduction could potentially have more significant impacts.

EMF

- 7.6.12 Export cables will be buried between 1m and 2m and intra-array cables will be buried to a target depth of 1m and coated with insulating material that will minimise emissions of EMF into the marine environment. Although there is currently no direct scientific evidence of negative impacts to benthos from EMF, the latest research on this subject will be considered through the further design stages of the Project. Should any such studies identify negative impacts that require mitigation and can reasonably be mitigated, these will be discussed with the relevant regulators.

Presence of inter-array and export cables

- 7.6.13 As no significant impacts are predicted, no mitigation (other than target cable burial depth of 1m) is proposed.

During Decommissioning

- 7.6.14 In advance of decommissioning, impacts to benthos will be fully considered within an environmental options appraisal and appropriate mitigation measures will be proposed, based on the recognised best practice at the time and consultation with regulatory authorities. This assessment will take into

consideration Natural England's draft ES consultation response, i.e. that a) seabed structures should be removed and b) that any scour/cable protection materials used should be retrievable from the seabed. This mitigation factor will be a consideration in the design of the construction and operational phases.

7.7 Significance of Residual Effects

7.7.1 Residual impacts are summarised in Table 17.14.

7.7.2 Given the level of residual impacts summarised below, it is considered unlikely that the current WFD ecological status of coastal waters (nor future GES, in relation to the MSFD) will be negatively impacted.

During Construction

Direct disturbance – (permanent) turbine foundation (and scour protection) footprint

7.7.3 The residual significance of this impact for the majority of habitats, and for native oyster, is considered to be minor. For other habitats of conservation importance (e.g. blue mussel beds, subtidal chalk and *Sabellaria spinulosa* aggregations), the predicted pre-mitigation impact of moderate is expected to be considerably reduced based principally on avoidance. Final locations of turbines which appear to be within, or close to, habitats of conservation interest will be discussed with regulators following a pre-construction survey.

Direct disturbance – (mostly temporary): jack-up vessel spud can footprint; inter-array and export cable installation

7.7.4 The residual significance of these impacts for the majority of habitats is considered to be moderate-negligible, depending on the receptor. Impacts for native oyster are considered to be negligible. For other habitats of conservation importance the predicted pre-mitigation impact of moderate is expected to be considerably reduced based principally on avoidance.

Increased suspended sediment & smothering

7.7.5 Residual impacts for the majority of habitats, and subtidal chalk, are considered to be minor given the low sensitivity of the benthic communities present and the temporary, relatively small, and localised increases in suspended material which have been estimated from modelling. No residual impacts to native oyster, blue mussel beds; and *Sabellaria spinulosa* aggregations are predicted given that they are not considered sensitive to this impact.

Suspension of contaminated sediment

7.7.6 Residual impacts are considered to be negligible, based on the low levels (both in terms of area and elevated contaminant levels) of contaminated material which

have been recorded, and the temporary nature of resuspension (given rapid dispersal and dilution).

During Operation

Presence of new habitat

- 7.7.7 There will be a minor impact to the benthic ecosystem from the presence of new habitat, based on the low sensitivity of common and widespread benthic receptors, and the small-medium magnitude of impact. While the potential impact of invasive species (either direct introduction, or providing conditions for their establishment) could be significant (long-term and widespread effects, including on sensitive receptors), appropriate awareness, reporting and monitoring, agreed with Natural England, will significantly reduce this to a minor or negligible level.

EMF

- 7.7.8 As noted previously, there is no evidence of negative ecological impacts from this source; however, the best available current evidence suggests that a worst-case residual effect will be of moderate significance.

Presence of inter-array and export cables

- 7.7.9 It is predicted that there will be no significant residual impacts from this aspect.

During Decommissioning

- 7.7.10 Impacts to benthos will be fully considered at the time of decommissioning, using the best available information on the existing environment and proposed techniques. Potential impacts to benthos will be mitigated where possible; however impacts to benthos will need to be considered within the overall environmental options appraisal when the various decommissioning alternatives have been identified. It is therefore not possible to predict the levels of impacts to benthos from decommissioning, however the intention will be to reduce them as far as possible.

7.8 Cumulative Impacts

- 7.8.1 There is the potential for three main sources of cumulative impact to benthos with other developments and activities in the area, and these are considered below.

Aggregate extraction

- 7.8.2 Active aggregate extraction licence areas are located close to the Rampion wind farm, which may cumulatively affect benthos in two main ways:

- Extraction operations cause increased suspended sediment, and if these are occurring at the same time, and in a similar location, to Project activities that also increase suspended sediment (e.g. foundation/cable installation), there is the potential for a more significant, combined impact. Changes to seabed sediment thickness as a result of combined foundation installation and aggregate extraction works were modelled as part of the impact assessment (ABPMer, 2012). The modelling predicted that bed level changes of up to around 1 mm could occur; however, it was expected that this sediment would be widely remobilised. The addition of 1 mm of sediment is not anticipated to cause any significant impacts to benthos. ABPMer (2012) also considered that there was only a minimal potential for of any interaction between suspended sediment from export cable installation and aggregate extraction. The overall impact of this is considered to be negligible (biotopes of low sensitivity (e.g. *Mytilus edulis*, the main component of blue mussel beds, is considered 'not sensitive' to increases in suspended sediment; MarLIN, 2008), with negligible magnitude within natural variability limits).
- Removal of aggregate causes localised mortality, injury and displacement of benthos. This may affect the re-colonisation of benthic habitats impacted by the Project (for example through cable burial), by reducing the abundance of available organisms (or their planktonic larvae). However, the extent of this impact will be a minimal fraction of available, similar habitat locally, and the potential impact is considered to be not significant.

Commercial fisheries

- 7.8.3 Some types of commercial fishing in the area (particularly beam trawling and scallop dredging) cause mortality or injury to epibenthic invertebrates. This impact has the potential to combine with mortality/injury of invertebrates through Project installation activities (e.g. turbine/cable installation), to cause localised changes in abundance or diversity. However, these two impacts are unlikely to act in combination, as commercial bottom fishing will be either temporarily or permanently excluded from those areas where the Project's impact will have been greatest (i.e. around turbine foundations, or along the cable route).

Offshore wind farms

- 7.8.4 The planned Navitus Bay offshore wind farm, to the west of the Isle of Wight, has the potential to introduce a large number of artificial structures into the marine environment. Like the Rampion development, this is also likely to introduce areas of artificial intertidal environment (i.e. the turbine foundations) into the existing offshore environment.
- 7.8.5 It is possible that there may be potential for an increased, in-combination risk of alien species becoming established in the region once both Rampion and Navitus Bay are operational. This is because alien species can become established on artificial structures, as well as being able to out-compete native species in in

natural conditions. The presence of a large number of artificial structures (with a large combined surface area) may therefore present opportunities for settlement of alien species. This is particularly relevant as the English Channel is an area of very high shipping intensity, some of which may carry alien species as biofouling or in ballast. Establishment of an alien species on either wind farm (and subsequent spawning of planktonic larvae) therefore has the potential to affect the other wind farm (with subsequent settlement of these larvae).

Cables

- 7.8.6 The installation of the IFA2 interconnector cable, provisionally planned to connect landfalls in the Solent and Caen (France), may cause impacts to benthos. However, the locations of the landfalls (and the likelihood of a relatively direct route between these two points) will mean that impacts remain distant (at least 30km) from Rampion, and no cumulative impact is predicted.

Table 7-14: Summary of Residual Effects and Mitigation Measures

Aspect	Effect	Proposed Mitigation Measures	Sensitivity	Magnitude	Residual Effect
Construction Phase					
Turbine foundations (and scour protection) footprint	Direct worst-case disturbance of 523,000m ² (0.38-0.56% of wind farm area) Mortality of all benthos. Permanent loss of habitat.	Design will minimise the footprint of turbines and scour protection where possible. Pre-construction survey to inform final locations for turbines. Results to be discussed with regulators, and options such as micro-siting of turbine foundations to avoid sensitive habitats will be discussed.	Low (majority of habitats) Medium (native oyster; blue mussel beds; subtidal chalk; <i>Sabellaria spinulosa</i> aggregations)	Medium (majority of habitats) Negligible (native oyster) Medium (blue mussel beds; subtidal chalk; <i>Sabellaria spinulosa</i> aggregations)	Minor (majority of habitats) Negligible (native oyster) Moderate or less, pending mitigation (blue mussel beds; subtidal chalk; <i>Sabellaria spinulosa</i> aggregations)
Jack-up vessel spud-can footprint	Direct disturbance of 236,399 m ² (0.17% of full scenario wind farm area) Mortality of nearly all benthos. Temporary loss of habitat.	Number of jack-ups (spud can deployments) will be minimised as part of operational efficiency. Pre-construction survey to inform final locations for turbines. Results to be discussed with regulators, and options such as micro-siting of turbine foundations to avoid sensitive habitats will be discussed	Low (majority of habitats) Medium (native oyster; blue mussel beds; subtidal chalk; <i>Sabellaria spinulosa</i> aggregations)	Medium-Negligible (majority of habitats) Negligible (native oyster) Medium (blue mussel beds; subtidal chalk; <i>Sabellaria spinulosa</i> aggregations)	Minor-negligible (majority of habitats) Negligible (native oyster) Moderate or less, pending mitigation (blue mussel beds; subtidal chalk; <i>Sabellaria spinulosa</i> aggregations)

Aspect	Effect	Proposed Mitigation Measures	Sensitivity	Magnitude	Residual Effect
Installation of inter-array cables (and cable protection)	Direct worst-case disturbance of 2,300,000m ² . Mortality, injury and displacement. Temporary habitat loss (cable burial) Permanent habitat loss (under cable protection)	Pre-construction survey to inform micro-siting and avoidance of sensitive habitats.	Low-Medium (majority of habitats) Medium (native oyster; blue mussel beds; subtidal chalk; <i>Sabellaria spinulosa</i> aggregations)	Medium-negligible (majority of habitats) Negligible (native oyster) Medium (blue mussel beds; subtidal chalk; <i>Sabellaria spinulosa</i> aggregations)	Moderate-negligible (majority of habitats) Negligible (native oyster) Moderate or less, pending mitigation (blue mussel beds; subtidal chalk; <i>Sabellaria spinulosa</i> aggregations)
Installation of export cables (and cable protection)	Direct worst-case disturbance of 920,000m ² . Mortality, injury and displacement. Loss of habitat either permanent (under cable protection) or temporary (cable burial in sediment)	Pre-construction survey to ensure no sensitive habitats present in wind farm zone or along the cable route, or any that are present are avoided by the cables.	Moderate-negligible (majority of habitats) Medium (native oyster; blue mussel beds; subtidal chalk; <i>Sabellaria spinulosa</i> aggregations)	Medium-negligible (majority of habitats) Negligible (native oyster) Medium (blue mussel beds; subtidal chalk; <i>Sabellaria spinulosa</i> aggregations)	Moderate-negligible (majority of habitats) Negligible (native oyster) Moderate or less, pending mitigation (blue mussel beds; subtidal chalk; <i>Sabellaria spinulosa</i> aggregations)

Aspect	Effect	Proposed Mitigation Measures	Sensitivity	Magnitude	Residual Effect
Foundation/ cable installation	Increased suspended sediment and smothering (temporary), including worst-case volume of sediment spoil of 167,451 m ³	Techniques that minimise sediment suspension will be used where feasible.	Low (majority of habitats; subtidal chalk) Not sensitive (native oyster; blue mussel beds; <i>Sabellaria spinulosa</i> aggregations)	Small (majority of habitats; subtidal chalk) N/A (native oyster; blue mussel beds; <i>Sabellaria spinulosa</i> aggregations)	Minor (majority of habitats; subtidal chalk) N/A (native oyster; blue mussel beds; <i>Sabellaria spinulosa</i> aggregations)
Foundation/ cable installation	Suspension of contaminated sediment (temporary)	Any contaminants will be rapidly diluted to negligible levels, and widely dispersed.	Low-High	Negligible	Minor-negligible
Operational Phase					
Presence of new habitat	Permanent introduction of new structures and surfaces into the marine environment: turbine shafts and bases, scour protection and cable protection.	No specific mitigation measures are proposed.	Low	Medium	Minor
Presence of new habitat	Possible introduction/establishment of non-native species.	Best practice mitigation to be agreed with Natural England, and work to be carried out in accordance with this. Relevant contractors to be trained in identification of key invasive species. All records of carpet sea squirt to be reported to NNSS immediately.	Low-Medium	Negligible (potentially higher in the case of introductions that, despite best practice, occur)	Negligible (potentially higher in the case of introductions that, despite best practice, occur)

Aspect	Effect	Proposed Mitigation Measures	Sensitivity	Magnitude	Residual Effect
EMF	Possible responses, including negative impacts, by individual organisms or communities. However, very little scientific information is available to accurately base assessment on, and there is no evidence of impacts at the population level.	Burial of cable to target depth of 1 m; cable design features (insulation). Consideration of latest EMF/benthos research through development of Project, and discussion with regulators if necessary as and when this becomes available.	High	Small	Moderate
Presence of cable	Permanent physical barrier to benthos; however, considered to be negligible	Burial of cable to target depth of 1 m	N/A	N/A	None
Decommissioning Phase					
Effects from the decommissioning of the various wind farm components will be subject to a detailed assessment during the decommissioning planning study. This assessment will consider Natural England's draft ES consultation response, in that a) seabed structures, including foundations, should be removed upon decommissioning; and b) selection of scour and cable protection materials in the final design should favour those materials that can be more easily removed upon decommissioning (e.g. concrete mattresses, compared to rock armour).					

7.9 References

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