22 *OFFSHORE TRANSMISSION WORKS BENTHIC ECOLOGY*

22.1 INTRODUCTION

1. This section of the ES evaluates the likely significant effects of the OfTW on the benthic ecology. The assessment has been undertaken by CMACS Ltd and includes an assessment of cumulative effects.

2. This section of the ES is supported by the following documents:

- Annex 22A: Cable Route Benthic Technical Report.

3. This Section includes the following elements:

- Assessment Methodology and Significance Criteria;
- Baseline Conditions;
- Development Design Mitigation;
- Assessment of Potential Effects;
- Mitigation Measures and Residual Effects;
- Summary of Effects;
- Statement of Significance; and
- References.

4. The cumulative effects of the OfTW are assessed in Section 10: Benthic Ecology which assesses the Benthic Ecology effects of the Wind Farm

22.1.1 POLICY AND PLANS

5. The following guidance has been considered in this assessment:

- CEFAS, 2004. Offshore Wind Farms: Guidance note for Environmental Impact Assessment in respect of FEPA and CPA requirements, Version 2, June 2004;
- IEEM (2010). Guidelines for Ecological Impact Assessment in Britain and Ireland. Marine and Coastal;
- CEFAS, 2010. Strategic Review of Offshore Wind Farm Monitoring Data Associated with FEPA Licence Conditions; and
- Boyd, S.E. (2002) Guidelines for the conduct of benthic studies at aggregate dredging sites. U.K. Department for Transport, Local Government and the Regions, London and CEFAS, Lowestoft.

22.2 ASSESSMENT METHODOLOGY AND SIGNIFICANCE CRITERIA

6. Baseline information from site-specific surveys, desk studies and information received from statutory and non-statutory stakeholders following consultation has been used to inform this assessment of the proposed OfTW on the marine benthic habitats and species of the Moray Firth.

22.2.1 CONSULTATION

7. Responses to the Scoping Report issued to the statutory and non-statutory consultees for the Project are summarised in Table 22.1 and relate to the potential effects of the OfTW cable upon benthic habitats and species (see also Annex 5A: Summary of Consultation Responses to Offshore Wind Farm Scoping Report.

8. Scottish National Heritage (SNH), Marine Scotland (MS) and the Crown Estate (TCE) were also consulted with regard to the site-specific characterisation survey, including the methodology of this survey and the survey site locations. The agreed approach to the site-specific survey was a wide spread of survey sites extending beyond the OfTW planned route using a drop down camera to gather images and establish the presence of protected species/areas and delineate the extent of these areas where possible. Benthic grabs were also to be taken at specific location to analyse the physical and chemical characteristic of the sediments. These consultees were also contacted for sources of existing information, particularly regarding Priority Marine Features (PMFs).

Table 22.1 Summary of Consultation Undertaken

Consultee	Summary of Consultation Response	Project Response
SNH	Habitat loss/damage as a result of construction of the OfTW. Smothering effects to benthic species and habitats due to sediment mobilisation as a result of the OfTW and may also potentially release any buried contaminants into the suspension. Electromagnetic effects of the transmitting cables on the benthic communities from any thermal load or electro-magnetic fields (EMF) arising from the cables during operation.	Considered and assessed in section 22.5 Considered and assessed in section 22.5.2 and 22.5.4 Considered and assessed in section 22.5.8 and 22.5.9
MS	Map distribution of any horse mussels, *Modiolus modiolus*, recorded from the survey. Assess for Electromagnetic Field (EMF) field/thermal load on surrounding sediments, Potential changes in the sediments (loss of fines for example) should be considered as there is the potential for release of contaminants from disturbed sediments. Towed video used to collect data for cable route and analysed by a qualified benthic ecologist PSA and chemical analysis of sediments to be undertaken	See Annex 22A: Cable Route Benthic Technical Report. See section 22.5.8 and 22.5.9 See Annex 22A: Cable Route Benthic Technical Report and section 22.5 Discussed and closed out during characterisation survey methodology review and agreement- drop down camera to be used. Annex 22A: Cable Route Benthic Technical Report Undertaken. See Annex 22A: Cable Route Benthic Technical Report.
SEPA	The ES should assess risks of introduction of marine non-native species and biosecurity principally in terms of bringing ships and materials into the area.	Considered and assessed in section 22.5

22.2.2 GEOGRAPHICAL SCOPE OF ASSESSMENT

9. The Study Area for this assessment is the cable corridor which extends from the main Wind Farm Site, located on the Smith Bank, down to the Moray coastline at

Portgordon within Spey Bay. The extent of the Study Area is highlighted by the OfTW corridor shown in Figure 22.1.

10. The length of the OfTW corridor is approximately 65 km in length. The width of the corridor will vary depending on water depth, and is likely to be between 575 m and 1.54 km wide. It is expected that there will be a maximum of nine (combined into three groups of three) export power cables within this corridor. The cables will be either buried or protected using rock placement, rock net/gabion or mattressing.

11. Background information used to inform the assessment was collated from a site-specific characterisation survey undertaken along the Study Area (cable corridor) and the surrounding environment (both near-field and far-field locations) in June 2011. Full information from this survey is provided in the technical report included in Annex 22A: Cable Route Benthic Technical Report with a summation of the main findings from this survey reproduced here.

12. Information from a literature review was also used to provide background information to inform the assessment. The majority of the information available relates to the Smith Bank where the Wind Farm Site is located, however; some information relating to the inshore areas in the vicinity of the cable corridor is also available and considered here.

22.2.3 BASELINE SURVEY METHODOLOGY

13. A site-specific benthic survey was undertaken using a drop down camera and benthic grabs to sample the marine environment along the proposed route of the OfTW. The methodology and survey site locations were agreed with the statutory authorities (MS and SNH) through consultation and were designed specifically to identify any habitats and species which are PMFs, in addition to any protected or vulnerable habitats and species. The survey was completed in June 2011 and full results are provided in the technical report in Annex 22A: Cable Route Benthic Technical Report. A summary of the main findings are presented below in section 22.3.

22.2.4 ASSESSMENT METHODOLOGY

22.2.4.1 Worst case scenario

14. The following elements of the OfTW have been identified as the worst case for the receptor benthic species and habitats identified as being present along the cable corridor.

Method of Installation

15. Three possible methods of cable installation have been identified: cable plough, jet trencher and chain/wheel trench cutter. The proposed installation approach will be either simultaneous lay and bury whereby the cable is placed directly into a trench as it is formed or post lay where the cable is laid onto the seabed and trenched subsequently. In terms of the area of seabed affected, both the cable plough and the jet trencher will have a 'zone of influence' of approximately 12 m^2 per linear metre. The chain/wheel cutter has a smaller footprint of 11 m^2. However, the jet trencher is anticipated to cause a greater overall effect as the high

pressure water hoses inject water at high pressure to fluidise the seabed allowing the cable to sink. This leads to greater mobilisation of suspended sediments than the other methods with wider potential for effects on seabed habitats and fauna. The effect of cable installation by jetting on the suspension and resettlement of sediments has been assessed in Section 21: OfTW Physical Processes and Geomorphology. The extent and magnitude of effects from this assessment have been used to assess the effects upon the benthic ecology as a result of the OfTW.

16. The worst case scenario for installation method in relation to disturbance of the seabed would be the use of the jet trencher which would have a total zone of influence of 65000 m x 12 m = 778,000 m^2 (x3 for three cable trenches = 2.33 km^2).

Cable Protection

17. Where obstructions to trenching the cable occur e.g. obstacles on seabed or where insufficient burial depth has been achieved then additional cable protection may be required. This is likely to be by rock armouring or concrete mattressing.

18. For the OfTW it is anticipated that at least 55% of the cables will be buried to target depth (minimum 0.6 m) and the remainder protected by other means. The worst case scenario is considered to be as follows.

19. Worst case scenario for installation method would be the use of cable protection covering a total area of 260,000 m^2 habitat lost which is approximately 0.44 % of the total cable corridor area (see Table 22.4 for calculation).

Duration of Installation

20. The duration of cable installation is dependent upon the installation methods and plant to be used. The worst-case scenario in terms of the duration of effect on the benthic fauna and habitats would be three cable trenches with a construction timetable of 120 days for installation and 120 days for cable protecting equating to a 240 day construction timetable. This is considered to be relevant to effects of noise and increased suspended sediment concentrations on benthic species and habitats. As the cable landfall is to be installed by a directional drilling approach, this is not considered to effect upon the benthic communities in the OfTW corridor.

Number of Vessels

21. For benthic habitats the number of vessels anchoring, or jacking up, is of more relevance than the maximum number of vessels *per se*. Offshore (greater than 15 m water depth) it is expected that vessels will operate using Dynamic Positioning (DP) without direct interaction with the seabed (other than the actual cable installation). For the inshore sections several smaller boats may have to be used. Smaller vessels do not always have the ability to operate on DP so may have to anchor or jack up to hold position. The worst case therefore being inshore vessels required for cable installation using anchor rather than DP.

22.2.4.2 Assessment limitations

22. This assessment only considers sub-tidal benthic ecology. Intertidal ecology has not been considered here as no works on the shore are expected since directional drilling is to be used to install the cables to avoid effects to the Spey Bay SSSI.

23. The exact alignment of the cables within the proposed corridor has not yet been decided so an assessment of the benthic habitat within the entire cable corridor and surrounding area, as described by the site-specific survey, has been undertaken.

22.2.4.3 Significance criteria

24. The assessment has been carried out on several potential effects associated with both the construction activities and the operational effects of the OfTW. In deciding what potential effects should be assessed this assessment draws upon the experience of other wind farm developments across Europe and the UK, since there is now a considerable body of experience in this field, along with the consultations carried out with respect to the Wind Farm itself (as discussed in Section 5: Consultation).

25. The sensitivity of relevant receptors (species and communities), as described above, is defined as low, medium or high, taking into consideration criteria such as extent, rarity, protected status and importance to the wider community (e.g. as an important food source, provider of habitat).

26. The magnitude of any potential effects is described as small, medium or large, based on known sensitivity of the receptor to the worst case effects that are expected.

27. The significance of the effect is then assessed using both of the above factors, i.e. sensitivity of the receptor and the expected magnitude of the effect. The significance of the effect can thus be of negligible, minor, moderate or major significance. Details of the assessment methods are presented in Section 4: EIA Process and Methodology. Only those effects of moderate or major significance are considered to be significant in relation to the EIA Regulations.

22.3 BASELINE CONDITIONS

28. Four main habitat types associated with the different sediment types were recorded from the site-specific underwater camera survey (see Figure 22.1 and refer to Annex 22A: Cable Route Benthic Technical Report). Two of these (burrowed mud and fine-medium sand with shell fragments) dominated the Study Area.

22.3.1.1 Smith Bank

29. The OfTW route begins at the south east margin of the Beatrice main wind farm site (see Figure 22.1) located on Smith Bank, a bathymetric high in the Outer Moray Firth. Sediments recorded here from the site-specific survey were medium sands and gravels with varying amounts of shell fragments. It is assumed that these sediments will support benthic infaunal communities associated with gravelly seabeds. Little epifauna was recorded for this habitat from the camera survey.

22.3.1.2 *Outer Moray Firth*

30. From the Wind Farm, the middle section of the OfTW cable route passes through central parts of the Outer Moray Firth. Here the sediments are dominated by fine-medium sands and gravel with shell fragments, similar to the sediments found at Smith Bank but slightly finer. In the deeper central part of the Study Area in this section, sediments were classed as muds with evidence of high levels of bioturbation as evidenced by visible depressions, burrows and tracks left by marine organisms.

31. This burrowed mud habitat, present in the deeper central part of the Study Area, had very little visible epifauna but sea pens were observed at some sites and the larger burrows were indicative of those created by *Nephrops norvegicus*, although none were actually recorded during the survey. The habitat was identified as the biotope SS.SMu.CFiMu.SpnMeg- sea pens and burrowing megafauna in circalittoral mud albeit with a low density of sea pens. This habitat is listed as a PMF on the draft list for Scottish Territorial Waters (see Annex 22A: Cable Route Benthic Technical Report).

32. This biotope is typical of the deep mud habitats and has been recorded in many Scottish Sea Lochs (SNH, 2011). It has also been observed in the north-eastern Irish Sea and is considered as being fairly extensive in the deeper areas of the North Sea (Hill, 2008).

22.3.1.3 *Spey Bay*

33. The end of the OfTW cable route is located in Spey Bay on the central southern coastline of the Outer Moray Firth with the landfall being at Portgordon within the Spey Bay SSSI.

34. Inshore areas were mainly fine-medium sands and gravels. Further inshore, small patches of hard substratum such as cobbles, pebbles and gravel were present overlaying the sand (see Figure 22.1). This hard substratum supported encrusting epifauna and is considered to be a small patch of cobble reef dominated mostly by tubeworms and barnacles, bryozoans, hydroids and algae, and is ascribed to the biotope SS.SCS.CCS.Pomb *Pomatoceros triqueter* with barnacles, coralline algae and bryozoan crusts on unstable circalittoral cobbles and pebbles (but with slightly richer biological community than usually associated with this biotope). This biotope may be considered as being potential Annex I cobble reef after descriptions in Irving (2009).

35. The closest inshore sublittoral areas were composed of very clean fine sand with no visible epifauna.

22.3.1.4 *Sediment contamination*

36. Sediments from five locations along and around the OfTW route were investigated for evidence of contamination through testing for a suite of possible heavy metal and organic contaminants due to the history of oil and gas explorations and production activities in the Moray Firth. Organic contaminants (Polycyclic Aromatic Hydrocarbons (PAHs), n-alkanes, and total alkanes) were present at very

low levels or not detected. Barium was present at levels ranging from 133 to 273 mg kg^{-1}, and this is likely to have come from past drilling activities. All heavy metals were present at levels that were in all cases below Interim Sediment Quality Guidelines and CEFAS and Marine Scotland Action levels where these exist (see Annex 22A: Cable Route Benthic Technical Report).

22.3.2 IMPORTANCE OF RECEPTORS

37. The PMFs/Scottish Local BAPS identified from the baseline survey as being present within the OfTW corridor have been assessed by Marine Scotland in relation to their sensitivity to damage by wind farm development. This has been set out in Table 22.2 below. Additionally, no evidence of other potential Annex I habitats or Annex II species were recorded during the site-specific surveys and no eel grass was present within the cable route corridor and near-field and far-field sites within the Study Area. The assessment of effects of the OfTW on the benthic ecology has therefore been undertaken at the biotope/community level with sensitivity being assessed as a function of both intolerance and recoverability.

38. For effects likely to be less important to benthic invertebrates but still worthy of assessment, such as noise or EMF, the sensitivity is briefly discussed in the relevant section.

Table 22.2 National Priority Marine Features in Scottish waters known to occur in the Moray Firth and their sensitivity to damage by wind farm development (as assessed by Marine Scotland)

Habitat	Importance	Sensitivity as defined by MS	Seasonality	Sensitivity as defined for ES assessment
Mud habitats in deep water (>20-30m)	Support the priority benthic species sea pen.	Temporary damage along cable routes; reasonable likelihood of recovery.	None.	Low-Medium (where sea pens present)
Sublittoral sands and gravels	Support high species diversity and act as nursery grounds for flatfish. Distribution is widespread.	Temporary damage along cable routes; high chance of recovery	None for habitat as a whole; summer/autumn for spawning and nursery.	Low
Seagrass beds Not recorded within Study Area but present approx. 35km west	On sandy sediments in shallow waters sheltered from wave action. Known in Moray Firth.	Permanent loss in areas of increased scour. Highly susceptible to damage in construction areas and along cable routes. Susceptible to increased turbidity and smothering by sediment plumes during construction.	Turbidity effects are greatest during summer growth period.	High- but not included within the assessment as none recorded from Study Area and nearest presence over 1 tidal excursion away.

Habitat	Importance	Sensitivity as defined by MS	Seasonality	Sensitivity as defined for ES assessment
Additional habitat recorded from site-specific survey: Patches of encrusted cobble classed as Potential Annex I habitat.	Support encrusting species in areas of soft sediment, often with high species diversity in a small area. Limited in extent in Study Area.	Physically robust, being tolerant to a high degree of scour and elevated suspended sediment levels. Susceptible to smothering/ burial beneath several cm of sediment for long periods	None but encrusting flora and fauna greatest in summer months.	Low

39. Important habitats and species historically recorded from the Study Area and surrounding proximity include but are not necessarily limited to, the following.

40. Eelgrass, both *Zostera marina* and *Zostera noltii,* has been recorded as present within the sheltered area of Findhorn Bay located approximately 35 km directly west of the OfTW landfall site at Portgordon. Most of the rest of the north east coastline of the Moray Firth is regarded as being unsuitable for the formation of seagrass beds (NES LBAP, 1998). This habitat is rare and important for many juvenile marine species including species of commercial importance such as flat-fish. This habitat is potentially susceptible to secondary effects such as smothering from suspended sediments or anchor drag from construction traffic.

41. Deep muddy seabeds are found in the central areas of the Moray Firth (and recorded in the Study Area from the site-specific survey) provide an important habitat for many species. 'Mud habitats in deep water' is a priority habitat for the UK Biodiversity Action Plan (UK BAP), now taken forward by the Scottish Government as part of the Scottish Biodiversity Strategy. Deep mud habitats are also important for burrowing mega fauna such as *Nephrops norvegicus* which is a valuable commercial species.

42. Other species which populate such mud habitats within the Moray Firth are sea pens (Order: Pennatulacea) which are relatives of sea anemones and corals. The habitat 'mud and sea pens' is an OSPAR (Oslo-Paris convention for the protection of the marine environment of the North-East Atlantic) feature, an MPA (Marine Protected Area) search feature and a Scottish Priority Marine Feature (PMF). Mud habitats tend to be heavily bioturbated with many mounds and burrows which are also home to species such the mud shrimps *Callianassa subterranea* and *Calocaris macandreae*, and the angular crab *Goneplax rhomboides* which makes complex burrows, with interconnecting tunnels and side chambers. Sea squirts and burrowing brittlestars (*Amphiura spp*) may be abundant in places. The activities of all these animals help to aerate the mud, which would otherwise become anoxic (lacking in oxygen) just below the surface (SNH, 2011).

43. Rare marine species which have been recorded within the Moray Firth are detailed below.

44. The bivalve *Arctica islandica* has been historically recorded in the Moray Firth. This species is long lived and slow growing (not reaching maturity until 25 years of age) and, though robust, thought to be susceptible to physical damage. It is a PMF by SNH due to its long-lived nature, its susceptibility to physical disturbance, and its declining status in UK waters. This species is also present on the OSPAR list of Threatened and/or declining species. Virtually all records of this species, and certainly all records of higher abundances, are from areas outside of the Wind Farm area and proposed cable route corridor in the slightly deeper muddier sediments around the Beatrice oil platform, with just a single recent record on the south end of the Smith Bank close to the northern part of the OfTW route corridor.

45. The cold water coral *Lophelia pertusa* has been observed colonising several oil installations in the North Sea (Bell and Smith, 1999) and may occur on suitable substrates in the outer Moray Firth although no colonies of conservation interest are currently known.

46. Important species potentially able to form reef aggregations (biogenic reef) present in the Moray Firth include the horse mussel *Modiolus modiolus*, and the fan mussel *Atrina fragilis* (UK BAP, 2010). *M. modiolus* is common throughout the inner Moray Firth Horse mussel beds are OSPAR Threatened and/or Declining Species and are listed under Annex I of the Habitats Directive, although not specifically as 'biogenic reefs'. The fan mussel, *Atrina fragilis*, is protected under Schedule 5 of the Wildlife and Countryside Act 1981 and both *M. modiolus* beds and the fan mussel are also listed on the UK BAP.

47. *Sabellaria spinulosa* polychaete worms are well known for their reef-forming ability when they occur in very large numbers and the tubes clump together and form mounds which can act to stabilise finer sediments providing a consolidated habitat for epibenthic species. The *S. spinulosa* reef habitats of greatest nature conservation significance are those which occur on predominantly fine sediment or mixed sediment areas. These enable a range of epibenthic species and a specialised 'crevice' infauna, which would not otherwise be found in the area, to become established (UKBAP from JNCC, 2011). Although not recorded, it is possible that there are *Sabellaria* reefs as yet undiscovered within the Moray Firth (SNH, 2011). *Sabellaria* reef is a UKBAP Priority Habitat, OSPAR List of Threatened and/or Declining Species and Habitats (Region II – North Sea, Region III – Celtic Sea) and is Listed in Annex 1 of the Habitats Directive: Reefs, and as a feature of sandbanks which are covered by seawater at all time, large shallow bays and inlets, and Estuaries (Council Directive 92/43/EEC).

48. The blue mussel, *Mytilus edulis*, can also form dense beds or reefs which occur in the Moray Firth. Additionally, a particular form of mussel bed of high densities of juvenile blue mussels on pebbles, gravel and sand forming a thin bed with the fan worm, *Fabricia sabella*, along with other bivalve molluscs and worms, is found exclusively in the Moray Firth SAC area to the west of the proposed cable route (Scotland Marine Atlas, March 2011).

49. Biogenic reefs are particularly sensitive to any operations that cause physical damage and in particular demersal fishing operations, bait-digging, anchoring, coastal developments, chemical pollution and harvesting (Holt *et al*, 1998).

22.4 DEVELOPMENT DESIGN MITIGATION

50. Mitigation of effects for sublittoral and littoral marine species and habitats has been embedded into the design of the cable landfall operation by excluding the possibility of open trenching through the intertidal zone, in favour of a subterranean directional drilling process.

22.5 ASSESSMENT OF POTENTIAL EFFECTS

51. This section considers the effect of the OfTW on the identified benthic ecology receptors during the construction and operation and decommissioning phases of development.

22.5.1 CONSTRUCTION PHASE: DISTURBANCE OF THE SEABED AS A RESULT OF CABLE LAYING PROCESSES.

52. This assessment focuses on direct effects to benthic habitats and species as a result of cable installation. Effects will occur from the ploughing, trenching or jetting activities used to lay the cable and from anchors used by the installation vessels.

53. The jetting tool has been assessed as the worst-case scenario and the area of zone of effect from the jet tool has been calculated as 12 m^2 per linear metre in section 22.2.4.1. This area of zone of influence is the same for the trenching tool. The percentage of habitat this will affect within each of the identified areas of habitat along the cable route corridor has been calculated below in Table 22.3. This was calculated by overlaying the site-specific habitat data with the geophysical data obtained for the cable corridor (see Figure 22.1). Sedimentary boundaries were described and areas calculated using drawn polygons in ArcGIS (v10).

Table 22.3 Approximate Percentage of Habitat Affected by Installation of Cables within the Cable Corridor

Habitat	Area of Habitat within Cable Corridor	Area Affected by Installation	Percentage of Habitat within Cable Corridor Affected
Sand and shell fragments	24,837,933 m^2 (north end of corridor) 5,663,631 m^2 (south end of corridor)	(31,100 x12)x3= 1,119,600 m^2	3.67%
Burrowed mud	17,333,887 m^2	(16,500 x12)x3= 594,000 m^2	3.43%
Encrusted cobble and pebble interspersed with sand	9,095,609 m^2	(9000 x12)x3= 324,000 m^2	3.56%
Fine sand	2,206,651 m^2	(2,100 x12)x3= 75,600 m^2	3.43%

(Figures based upon three trenches and a zone of influence of 12 m^2 per linear metre for the installation tool)

54. The percentage of habitat directly affected by the cable installation process is considered as being very low, especially as it only takes into account the area of habitat affected within the proposed cable corridor itself and does not consider the extent of these habitats outside of this zone (which were identified as being present outside the corridor during the site-specific survey).

55. Physical damage to habitats and species would be experienced with presumed loss of epifauna and infauna from the affected areas. Following the disturbance of the sediments from the cable laying process, the subtidal habitats would be expected to recover with recolonisation of the disturbed sediments occurring via recruitment of macrofaunal species from adjacent undisturbed areas. Once the sediment stabilises, further species would then be expected to colonise allowing the eventual recovery of the biotope. The recovery of these subtidal areas by recruitment from the surrounding biotopes would be expected to be relatively rapid. The area of encrusted cobble towards the inshore end of the OfTW route would experience a greater magnitude of effect than the soft sediment areas which would be expected to recover relatively rapidly, although any sea pens within affected areas of the burrowed mud habitat would be expected to be lost.

56. The monitoring programmes at several UK offshore wind farms have been completed e.g. North Hoyle, Rhyl Flats, Burbo Bank (RWE npower Renewables, DONG Energy). These have all shown that the dominant species present before construction remain common post-construction with sites along export cable routes exhibiting no significant adverse effects on the benthic habitats.

57. The effect of cable laying activities is limited to a small area within the cable corridor and the spatial effect is assessed as being within the Study Area.

58. The effect of cable laying activities is expected to be temporary due to the rapid installation methods and will affect a limited area of the biotopes (see Table 22.3). The overall magnitude of this effect is therefore assessed as being small. Rapid colonisation by species from undisturbed habitat is expected to occur and the benthic habitats present are likely to recover rapidly and have been assessed as being of low sensitivity. However, because of the sensitivity of sea pens to direct physical disturbance and because burrowed mud is identified as a PMF and the area of encrusted cobble may be potential Annex I habitat, the sensitivity of these receptors has been assessed as being of Medium sensitivity. The overall assessment is a negative effect of minor significance, and is therefore not significant in terms of the EIA Regulations.

22.5.2 CONSTRUCTION PHASE: RISK OF INTRODUCTION OF NON-NATIVE SPECIES AS A RESULT OF CABLE INSTALLATION ACTIVITIES

59. The introduction of non-native marine species to the marine and estuaruine environments of the UK is usually associated with shipping/boating activity, either as a result of fouling on ships hulls or from larval or reproductive stages in ballast water. Serious examples of outbreaks of non-native species which have had biologically negative impact upon local marine environments are presently associated with ports, harbours and marinas e.g. carpet sea squirt, Didemnum vexillum in marinas along the south coast and in the Irish Sea e.g. Holyhead and the Chinese mitten crab, Eriocheir sinensis originally noted in the Thames Estuary where it was accelerating erosional processes of the banks, and is now reported around the UK. Some non-native species are introduced to UK waters by natural processes such as larval dispersal or juvenile stages e.g. seaweeds and shellfish which have migrated to the UK from French or Irish waters where they were first introduced. They may also have become established in the natural environment as a result of being introduced to the UK for aquaculture purposes e.g. Pacific oyster, Crassostrea gigas.

60. Although it is noted that the potential addition of large amounts of new hard substrates in UK territorial waters may increase the ability of invasive species to spread, there is no published or anecdotal evidence that the installation of large numbers of offshore platforms and pipelines in the North Sea in recent decades has led to such a spread of invasive species. There is to be relatively little new substrata introduced into the marine environment as a result of the OfTW (an assessment of the turbines and other new structures at the wind farm site has been undertaken separately). The cabling and all protection materials are to be manufactured specifically for the project and will be new to a marine environment (ensuring cross-contamination from other waters does not occur). It is currently unknown which vessels are to be used for the OfTW construction, however; it is likely that they will be either from UK or European Ports. The Construction Plan for the project will control the possibility that they may introduce non-native species to the environment e.g. control of vessel pumping/ballast water etc.

61. The magnitude of this impact is assessed as being negligible as there is currently no evidence in relation to transmission work construction, but there is a small possibility of occurrence. The nature of impact is unknown but in certain examples it has had a negative impact e.g. carpet sea squirt and Chinese mitten crab. This potential impact is therefore considered to be of negligible significance and not significant in terms of the EIA Regulations.

22.5.3 CONSTRUCTION PHASE: INCREASE IN SUSPENDED SEDIMENT CONCENTRATIONS AND DEPOSITION OF SEDIMENT AS A RESULT OF CABLE INSTALLATION ACTIVITIES

62. Installing the cables will disturb seabed sediments and increase the turbidity of surrounding waters. This may cause secondary effects to benthic invertebrate communities and the increased light attenuation will effect upon species dependent upon light for photosynthesis such as plankton and algae. Increased concentrations of suspended sediments will also affect filter feeding organisms such as sea pens, anemones and shellfish such as mussels (e.g. *Mytilus edulis*) through clogging and prevention of effective feeding, thereby affecting growth. Where sediments deposit out of the water column, they could also smother sessile organisms.

63. The physical processes assessment (see Section 21: OfTW Physical Processes and Geomorphology) has modelled and assessed the effects of cable installation on the different sediment types recorded along the cable route. The concentration of

suspended sediments and the resulting thickness and distance from effect of sediment deposition has also been assessed.

64. Cable installation in gravels or coarser sediments will have only a localised effect as material will be almost instantly deposited with the effect being confined to within a very small distance of the cable route (order of metres). The thickness of deposition has been assessed as between 0.24-2.7 m depending upon the height of ejection and current speed. Cable installation in sandy material will have a relatively high effect on suspended sediment concentration; however this effect will be short term (in the order of seconds to minutes) and will be localised to tens of metres. Cable installation in finer material (e.g. mud biotope) will also have a relatively high magnitude effect on suspended sediment concentration and this effect will persist for longer than for sands but will still be short term/intermittent due to the construction methods of cable laying. Effects will be more disperse (up to 1 tidal excursion) and accumulation in this habitat is assessed as being up to 0.1 cm (see Section 21: OfTW Physical Processes and Geomorphology). The magnitude of effect on benthic species is assessed as being small.

65. The purpose of cable burial is to achieve a certain depth of burial and thickness of sediment cover over the cable. The machines employed for this task are therefore designed to retain as much sediment in the trench profile as possible. The volume of sediment resuspension (and hence the effects on SSC and subsequent deposition thickness) will therefore be inherently minimised by these machines and further by application of good practice in their usage.

66. The surface sediments of the Moray Firth, especially the sandier areas are in a continuous cycle of re-suspension and deposition according to variations in the physical processes responsible for sediment transport. Benthic species present are all well adapted to such high-energy environments and therefore tolerant of intermittent disturbance or smothering (e.g. Kaiser and Spencer, 1996; Elliot *et al*, 1998; Jones *et al*, 2000). The deposition of intermittently released sediments such as sand and silt/mud particles will likely be tolerated by the resident infauna. This is because the faunal communities consist of species which naturally burrow through sediments, a reflection of the normal environment within which they exist. The sensitivity of these habitats is assessed as being low. However, it is possible that filter feeding organisms such as the sea pens recorded during the site-specific survey may be more susceptible to the elevated levels of suspended sediments so the sensitivity level is increased to medium.

67. The intermittent and temporary nature of the increases in suspended sediments from the cable laying construction, the relatively rapid dispersion of sediment plumes to background levels and the natural tolerance of the fauna in the area to such events means that the effects on benthic and planktonic communities are assessed to be negative and of minor significance, even when considering the worst-case scenario. This effect is therefore considered to be not significant in terms of the EIA Regulations.

22.5.4 CONSTRUCTION PHASE: EFFECTS OF ELEVATED NOISE LEVELS ON BENTHIC SPECIES

68. Marine invertebrates lack the anatomical features of fish or marine mammals which allow them to 'hear'. Instead, marine invertebrates respond to sound stimuli through the use of sensory organs known as chordotonal organs**,** which are an internal mechanoreceptor. These organs sense pressure, movement, and tension detecting vibrations that may be associated with sound.

69. Sound has few behavioural or physiological effects unless the organisms are very close (within metres) to a powerful noise source such as pile driving or seismic survey. For example, seismic exploration source noise levels are known to be in the order of 250 dB re 1µPa @ 1 m (Richardson *et al,* 1995) and it has been previously observed that noise sources of this intensity may have an effect upon marine invertebrates within ten metres of the source (McCauley, 1994; Brand and Wilson, 1996). Examples of these effects include polychaete species withdrawing to the bottom of their burrows or retracting their palps into their tubes, and bivalve species withdrawing siphons. The noise generated by the installation of the cables will not exceed noise levels generated by seismic exploration levels which initiate a reaction within tens of metres (cable trenching measured at North Hoyle gave a Source Level of 178 dB re 1 µPa @ 1 (Nedwell *et al*, 2004). The magnitude of this effect is assessed as being negligible.

70. The effects of noise generated during the OfTW cable installation are expected to have a negligible magnitude with a highly localised and temporary disturbance to benthic invertebrate species which have a low sensitivity to this disturbance. This effect is assessed as being of negligible significance. This effect is therefore considered to be not significant in terms of the EIA Regulations.

22.5.5 CONSTRUCTION PHASE: RELEASE OF SEABED CONTAMINANTS

71. Results of sediment contamination from the site-specific survey recorded very low levels of contaminants from the Study Area. Because of this, and the dispersive and dilutive nature of the receptor environment, it is concluded that the temporary and intermittent nature of the disturbance that may result means that the effects to benthic ecology are considered as being of negligible magnitude.

72. Elevated levels of sediments within the water column are likely to be transported within a tidal cycle of the disturbance and would be expected to resettle out of the water column over a relatively short period of time. Benthic receptors are assessed as having low sensitivity to this effect.

73. Due to the very low level of sediment contamination recorded across the Study Area, the intermittent disturbance of sediment and the small amounts disturbed, the potential for the release of contaminants during the cable installation phase is not predicted to adversely affect plankton or benthic communities along the OfTW cable route, the magnitude of this effect is assessed as being negligible and the significance of this effect is also assessed as negligible. This effect is therefore considered to be not significant in terms of the EIA Regulations.

22.5.6 CONSTRUCTION PHASE: POLLUTION/ SPILLAGE FROM CONSTRUCTION WORKS

74. Contaminants potentially (but unintentionally) released into the marine environment may include fuel, oil and lubricants from the vessels and plant associated with the cable installation phase of the project. Such contaminants have the potential to be toxic to macrobenthic communities should they be present in sufficient quantities.

75. The discharge of contaminants into the marine environment from vessels or plant would not be an intentional part of the construction phase and any such discharge would be accidental. However, because there is a small risk of disturbance to the benthic environment beyond the range of natural variability the magnitude of effect is assessed as being negligible. The sensitivity of receptors is assessed as low and the significance of effects is therefore assessed as being negligible. This effect is therefore considered to be not significant in terms of the EIA Regulations.

22.5.7 CONSTRUCTION PHASE: CABLE PROTECTION MEASURES WILL REDUCE BENTHIC HABITAT

76. Cable protection from rock armouring or mattressing is identified as a necessary practice for protecting the OfTW cables in places where they are not buried. Such protection will cover existing benthic habitat and species. Currently, it is unknown which sections, if any, will have additional protection. However, for the purpose of this assessment, a worst case scenario of 45% of the total cable length needing protection by mattressing (which covers a wider area than rock dumping) has been considered. The percentage of habitat lost to cable protection has been calculated and is provided in Table 22.4 below.

Table 22.4 Maximum percentage of habitat covered by cable protection

Approximate Area of Habitat within Cable Corridor. Assessed using GIS	Maximum Area Covered by Protection	Percentage of Total Habitat within Cable Corridor Affected
59,137,711 m^2	260,000 m^2	0.44%

77. The area of benthic habitat lost within the total area of the cable corridor is assessed as being very low. It is also expected that over time this new substratum will become colonised by benthic organisms as artificial structures placed into the marine environment provide a hard and stable substratum available for colonisation by a diverse range of benthic organisms such as seaweeds, mussels, barnacles, tubeworms, hydroids, sponges, soft corals and other invertebrates (Vella *et al*, 2001). Protection is most likely to be installed over coarser sediments and areas of compact sediment where trenching is not practical. Epifauna will re-colonise such areas using the hard surfaces of mattresses (or rock armour) as habitat. Potentially, the increased complexity offered by the mattress protection (or rock armour) may compensate for the habitat lost in areas of less coarse sediment but this would represent a change from existing infaunal dominated communities to epifaunal. The magnitude of effect is assessed as being negligible.

78. Organisms colonising the new substrates are expected to recruit from the surrounding water column/sediment and would be expected to be common to the local area (recruiting from other areas of hard substratum e.g. inshore cobble areas and offshore boulder fields) and none would be considered as being invasive. Potentially serious examples of invasive species are at present associated with mainly estuaries and ports and marinas and have been introduced as a result of shipping/boating activity e.g. the colonial ascidian, *Didemnum vexillum* found in marinas in North Wales and along the south coast and the Chinese mitten crab in the Thames Estuary and now recorded from estuaries around the UK.

79. Due to the very small area affected, even as a worst case scenario, the negligible magnitude of effect and the low to medium sensitivity of the receptors the significance of this effect is assessed to be negligible. This effect is therefore considered to be not significant in terms of the EIA Regulations.

22.5.8 OPERATION PHASE: EFFECT OF SCOUR ON BENTHIC COMMUNITIES

80. The presence of artificial structures on the seabed may cause variations in the local current velocity, potentially increasing erosion forces around the base of these structures resulting in scour or accumulations of sediments in areas of low sediment transport such as the mud habitats of the central part of the Moray Firth.

81. The sedimentary environment heavily influences marine benthic communities and any changes to sediment habitats are likely to affect infauna. Burrowing marine invertebrate infauna such as molluscs, worms and Crustacea would be affected the most by any loss of finer sediments through scour.

82. The potential for scour to occur has been assessed as part of the physical processes assessment presented in Section 21: OfTW Physical Processes and Geomorphology. This assessment concluded that cable protection measures would have no effect on the muddier sediments at the centre of the Moray Firth where transport rates are low (and where the PMF burrowed mud is located) and will not have a measureable effect on sediment transport elsewhere along the cable route beyond a short period of adjustment. The magnitude of effect is therefore assessed as being negligible and the sensitivity of the receptors are also assessed as being low. This effect is therefore assessed as being negligible. This effect is therefore considered to be not significant in terms of the EIA Regulations.

22.5.9 OPERATION PHASE: EFFECT OF ELECTROMAGNETIC FIELDS ON BENTHIC INVERTEBRATES

83. Submarine power cables will generate EMF in the surrounding seabed and water. Certain benthic species are understood to be magnetically sensitive and could therefore be affected by the magnetic component of EMF. It is assumed for this assessment that all cabling will be buried or covered by protection, thus removing the highest magnitude fields present at the cable surface from the marine environment.

84. Potentially sensitive groups include Crustacea such as crabs, shrimp and prawns and molluscs. It is currently not known which species could be affected but magnetic sensitivity has been demonstrated for Decapoda (*Crangon crangon*),

Isopoda (*Idotea baltica)* and Amphipoda *(Talorchestia martensii* and *Talitrus saltator)*. In all cases, magnetic sensitivity is understood to be associated with orientation and direction finding ability. If animals perceive a different magnetic field to the Earth's there is potential for them to become disorientated. Depending on the magnitude and persistence of the confounding magnetic field the effect could be a trivial temporary change in swimming direction or a more serious effect on migration.

85. Any effects are likely to be of negligible magnitude as they would be sub-lethal and would affect limited areas of seabed in close proximity to the cables. The mobile organisms such as crabs and shrimps that are most likely to be affected are not abundant on the site and are considered to be of low importance. The sensitivity of receptors is therefore assessed as being low. Overall this effect is assessed as being of negligible significance. This effect is therefore considered to be not significant in terms of the EIA Regulations.

22.5.10 OPERATION PHASE: HEATING EFFECTS OF THE CABLE ON BENTHIC SPECIES AND HABITATS

86. Power cables may induce heating effects which act to warm and dry the surrounding sediments within the immediate vicinity of the cable which may affect the nature of the sediment resulting in possible changes to the infaunal benthic communities. Such effects are considered to be extremely small, and extremely localised, and would be impossible to detect against natural fluctuations in background temperatures.

87. Since the surrounding water column will rapidly dissipate any heat from the cable the only organisms likely to experience heating are those burrowing into surrounding sediments or dwelling in the interstices of rock armouring. The deepest burrowing organisms, such as *Nephrops norvegicus*, likely to be present are expected to burrow to around 0.5 m depth and could come within approximately 0.1 m of the cable if it is buried to 0.6 m (the assumed minimum target depth when buried). There is potential for highly localised effects within tens of centimetres of the cables. The magnitude of this effect is assessed as being negligible.

88. The vast majority of infauna is restricted to the upper sediments less than 20 cm deep and heating effects are not expected to result in temperature increase of sediments in the upper sediment layers. For any species to be affected, in even a small and highly localised way, they would presumably have to be very sensitive to increases in temperature. As the marine species identified from the site-specific survey are recorded throughout the UK and much of European waters, including warmer waters to the south within the Bay of Biscay, and the colder waters associated with more northern regions, they are not considered to be highly sensitive to minor fluctuations in temperature and are considered as having low sensitivity to this effect.

89. The effects to benthic species are therefore assessed as being negligible**.** This effect is therefore considered to be not significant in terms of the EIA Regulations.

22.5.11 DECOMMISSIONING EFFECTS

90. Given the potential variability of the baseline over the operational lifetime of the OfTW, a detailed assessment of decommissioning effects has not been undertaken. However, it is considered likely that effects will be similar in nature, although no greater in magnitude, than those predicted from construction. However, a full assessment of impacts would be undertaken prior to the commencement of the decommissioning works.

22.6 MITIGATION MEASURES AND RESIDUAL EFFECTS

22.6.1 MITIGATION

22.6.1.1 Habitat Disturbance

91. Working areas for the OfTW installation phase must be clearly delineated with vessels operating on DP, where possible, to reduce the area of effect. Where anchors have to be used e.g. for the inshore part of the cable works in water depths <15 m, a Construction Management Plan (CMP) may be used to limit the area of the seabed affected.

22.6.1.2 EMF Mitigation

92. No specific mitigation is proposed in relation to potential EMF effects on benthic fauna.

22.6.1.3 Scour Mitigation

93. The use of scour protection will be considered for areas where significant scour is recorded and this will act to prevent any further erosion from occurring.

22.6.2 RESIDUAL EFFECTS

94. The majority of the mitigation proposed is best practice guidance for the industry. Residual effects for the benthic ecology along the route of the OfTW are considered as remaining as per the assessment.

22.6.3 MONITORING AND ENHANCEMENTS

95. Monitoring of the effects from cable installation will be included as part of the overall benthic monitoring plan. Monitoring methods will be developed in line with statutory guidance and through consultation with the relevant statutory authorities and stakeholders most notably (but not limited to) MS and SNH.

96. Additionally, the proper reporting and control of all wastes and spillages through all phases of the project should be subject to compliance monitoring.

97. As part of the benthic monitoring programme some sampling within the immediate proximity of the cable protection should be undertaken to assess the effects of scour (if any) on the benthic communities. This should be combined with the results from the physical monitoring of the seabed.

22.7 SUMMARY OF EFFECTS

98. A summary of the effects with predicted significance is provided within Table 22.5 below.

Table 22.5 Summary of Effects of OfTW on Benthic Ecology

Effect	Sensitivity of Receptor	Magnitude of Effect	Nature	Assessment of Effect
Construction and Likely Decommissioning Effects				
Disturbance to benthic habitat & species from cable laying process	Medium to Low	Small	Negative	Minor
Risk of introduction of non-native species as a result of cable installation activities	Low	Negligible	Unknown but likely Negative	Negligible
Increased suspended sediments may cause smothering of benthic fauna	Medium to Low	Small	Negative	Minor
Noise generated by cable laying plant and vessels may be adversely affect benthic species	Low	Negligible	Negative	Negligible
Release of seabed contaminants disturbed through the construction process my affect benthic species	Low	Negligible	Negative	Negligible
Direct release of contaminants to the marine environment	Low	Negligible	Negative	Negligible
Loss of habitat through cable protection or use of scour protection	Medium to Low	Negligible	Negative	Negligible
Operational Effects				
Cable protection may cause scour effects there by affecting benthic communities	Low	Negligible	Negative	Negligible
Effects of EMF from the Offshore Transmission Works cable upon benthic receptors	Low	Negligible	Unknown but likely Negative	Negligible
Heating effects from cable may effect upon benthic receptors	Low	Negligible	Unknown but likely Negative	Negligible

22.8 ASSESSMENT OF CUMULATIVE EFFECTS

99. Cumulative, in-combination and inter-relating effects are considered within the main site assessment in Section 10: Wind Farm Benthic Ecology. No further consideration of such effects is given here.

22.9 STATEMENT OF SIGNIFICANCE

100. No significant effects on benthic species and habitats are anticipated as a result of the OfTW. The effect of the OfTW has been assessed as having an overall negligible significance of effect on the receptor benthic habitats and species of the Moray Firth.

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