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Abbreviations and Acronyms

AL	Action Level
CEFAS	Centre for Environment, Fisheries and aquaculture Science
DECC	Department of Energy and Climate Change
GES	Good Environmental Status
LNR	Local Nature Reserve
MarLIN	The Marine Life Information Network
MESH	Mapping European Seabed Habitats
MSFD	Marine Strategy Framework Directive (2008)
MS-LOT	Marine Scotland Licencing Operations Team
MSS	Marine Scotland Science
NIS	Non Indigenous Species
OSPAR	The Convention for the Protection of the marine Environment of the North-East Atlantic (the ‘OSPAR Convention')
PAH	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyl
PMF	Priority Marine Feature
ppm	Parts per Million
PSA	Particle Size Analysis
SNH	Scottish National Heritage
SSC	Suspended Sediment Concentration
TOC	Total Organic Carbon

Glossary

Aerobic	Living or occurring only in the presence of oxygen.
Alien Species	A non-established introduced species, which is incapable of establishing self-sustaining or self-propagating populations in the new area without human interference.
Anaerobic	An environment in which the partial pressure of oxygen is significantly below normal atmospheric levels; deoxygenated.
Anemone	Any of numerous flowerlike marine coelenterates of the class Anthozoa, having a flexible cylindrical body and tentacles surrounding a central mouth.
Anoxic	Describes an environment without oxygen.
Bathyal	Pertaining to the sea floor between 200 m and 4000 m (Lincoln and Boxshall, 1987).
Benthic	Communities of organisms present on the seabed.
Benthos	Those organisms attached to, or living on, in or near, the seabed, including that part which is exposed by tides as the littoral zone.
Bio-accumulate	The ability of organisms to retain and concentrate substances from their environment. The gradual build-up of substances in living tissue; usually used in referring to toxic substances; may result from direct absorption from the environment or through the food-chain.
Bioavailable	Amount of a substance that becomes available (reaches the target organ or systemic circulation) to an organism's body for bioactivity when introduced through ingestion, inhalation, injection, or skin contact.
Biodiversity	The variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.
Biotope	The physical habitat with its biological community; a term which refers to the combination of physical environment (habitat) and its distinctive assemblage of conspicuous species.
Bivalve	Characteristically a shell of two calcareous valves joined by a flexible ligament.
Cefas Action Levels (AL)	Thresholds against which levels of contaminants within sediments can be assessed.
Circalittoral	The subzone of the rocky sublittoral below that dominated by algae (the infralittoral), and dominated by animals.
Colonisation	The process of establishing populations of one or more species in an area or environment where the species involved were not present before.

Desorption	Substance released from or through a surface.
Diversity	The state or quality of being different or varied. In relation to species, the degree to which the total number of individual organisms in a given ecosystem, area, community or trophic level is divided evenly over different species, i.e. measure of heterogeneity. Species diversity can be expressed by diversity indices, most of which take account of both the number of species and number of individuals per species.
Echinoderms	Any of numerous radially symmetrical marine invertebrates of the phylum Echinodermata, which includes the starfishes, sea urchins, and sea cucumbers, having an internal calcareous skeleton and often covered with spines.
Ecosystem	A community of organisms and their physical environment interacting as an ecological unit.
Elasmobranchs	A subclass of fishes, comprising the sharks, the rays, and the Chimæra. The skeleton is mainly cartilaginous.
Epibenthic	Communities of organisms present within the seabed.
Habitat	The place in which a plant or animal lives.
Hydrodynamic	The scientific study of the motion of fluids.
Infralittoral	A subzone of the sublittoral in which upward-facing rocks are dominated by erect algae, typically kelps.
Intertidal	The zone between the highest and lowest tides.
IR.MIR.KR.Ldig.Ldig	Laminaria digitata on moderately exposed sublittoral fringe bedrock.
LR.HLR.MusB.Cht.Cht	Chthamalus spp. on exposed upper eulittoral rock.
LR.LLR.F.FSpi.FS	Fucus spiralis on full salinity sheltered upper eulittoral rock.
LR.MLR.BF.FspiB	Fucus spiralis on exposed to moderately exposed upper eulittoral rock.
LR.MLR.BF.PelB	Pelvetia canaliculata and barnacles on moderately exposed littoral fringe rock.
LS.LSa.FiSa.Po	Polychaetes in littoral fine sand.
LS.LSa.FiSa.Po.Aten	Aten Polychaetes and Angulus tenuis in littoral fine sand.
LS.LSa.MoSa.AmSco.Sco	Scolelepis spp. in littoral mobile sand.
Mollusc	Invertebrates of the phylum Mollusca, typically having a calcareous shell of one, two, or more pieces that wholly or partly enclose the soft, unsegmented body, including the chitons, snails, bivalves, squids, and octopuses.

OSPAR	The Convention for the Protection of the marine Environment of the North-East Atlantic (the 'OSPAR Convention') was open for signature at the Ministerial Meeting of the Oslo and Paris Commissions in Paris on 22 September 1992. It was adopted together with a Final declaration and an Action Plan.
Oxidization	Addition of oxygen to a compound with a loss of electrons.
Priority Marine Feature	Habitats and species which are considered to be marine nature conservation priorities in Scottish waters.
Polychaete	A general term for members of the Class Polychaeta (segmented worms of the Phylum Annelida).
Sessile	Permanently attached to a substratum.
Sorptive	The process in which one substance takes up or holds another; adsorption or absorption.
Sponge	Any of numerous aquatic, chiefly marine invertebrate animals of the phylum Porifera, characteristically having a porous skeleton composed of fibrous material or siliceous or calcareous spicules and often forming irregularly shaped colonies attached to an underwater surface.
SS.SCS.CCS	Circalittoral coarse sediment.
SS.SCS.CCS.MedLumVen	Venerid bivalves in circalittoral coarse sand or gravel.
SS.SCS.OCS	Offshore circalittoral coarse sediment.
SS.SMu.CFiMu.SpnMeg	Seapens and burrowing megafauna in circalittoral fine mud.
SS.SMx.CMx	Circalittoral mixed sediment.
SS.SMx.CMx.FluHyd	Flustra foliacea and Hydrallmania falcata on tide-swept circalittoral mixed sediment.
SS.SMx.CMx.MysThyMx	Mysella bidentata and Thyasira spp. in circalittoral muddy mixed sediment.
SS.SSa.CMuSa	Circalittoral muddy sand.
Sub-tidal	A physical term for the seabed below the mark of Lowest Astronomical Tide.
Trophic	Involving the feeding habits or food relationship of different organisms in a food chain.
Venerid	The common name for members of the Order Veneroida of bivalve molluscs (Class Bivalvia, Phylum Mollusca). They are characterized by a shell composed of two equal sized valves, with umbones forward of the midline (anterior), and a hinge bearing central (cardinal) and lateral teeth.

12 Benthic Ecology

12.1 Introduction

1 This chapter assesses the potential effects of the Inch Cape Offshore Wind Farm and Offshore Transmission Works (OfTW) on benthic ecology. Benthic ecology refers to the communities of organisms living on (epibenthic) or within (benthic) the seabed. These have been characterised within and around the Development Area and Offshore Export Cable Corridor through the evaluation of existing survey data and desk studies, implementation of site specific baseline surveys, and mapping of the identified benthic communities. These communities are categorised into biotopes, areas of common habitat and species, which are defined in the glossary and detailed in *Appendix 12A: Benthic Ecology Baseline Development Area*. Subsequently, this chapter presents an assessment of the potential impacts of the construction, operation and decommissioning phases of the Wind Farm and associated OfTW on benthic ecology. Details of mitigation are also presented.

2 This chapter is supported by the following appendices:

- *Appendix 12A: Benthic Ecology Baseline Development Area*;
- *Appendix 12B: Contaminated Sediment Baseline Development Area*;
- *Appendix 12C: Benthic Ecology Baseline Offshore Export Cable Corridor*; and
- *Appendix 12D: Biotope Mapping*.

3 This chapter also shares direct linkages with the following Environmental Statement (ES) chapters and makes reference to their content where relevant:

- *Chapter 10: Metocean and Coastal Processes*;
- *Chapter 13: Natural Fish and Shellfish*; and
- *Chapter 18: Commercial Fisheries*.

12.2 Consultation

4 Scoping responses as summarised in *Appendix 5A: Summary of Scoping Responses*. Responses received from Scottish Natural Heritage (SNH) and Marine Scotland Science (MSS) which were relevant to the Benthic Ecology Environmental Impact Assessment (EIA) are summarised below in Table 12.1.

Table 12.1: Scoping and Consultation Responses and Actions

Consultee	Scoping Response	Project Response
SNH	The proposed combination of video survey and benthic grabs is essential to adequately determine the dominant habitat types and species present in the Development Area.	Benthic grab and video surveys were carried out in combination and results were collated to allow biotopes to be determined as accurately as possible. Further analysis using geophysical data was carried out to combine the results from the Development Area and Offshore Export Cable Corridor and produce distribution maps of biotopes and habitats. Analysis steps are presented in *Appendix 12D*. The resulting mapping of the dominant habitat types are described within the baseline *Sections 12.5.2* and *12.5.3* and also presented in Figures 12.4, 12.7 and 12.8.
MSS	To check for Biodiversity Action Plan habitats and species, Marine Priority Features and Annex I habitats during survey works.	A seabed video and benthic sampling survey approach was adopted. This allowed habitats and species of conservation importance to be noted in the video survey. Grabs were not carried out in these areas to minimise disturbance to important species and habitats. Following surveys, analysis and mapping of habitats allowed for the habitats and species of conservation importance to be identified and mapped. The resulting mapping of the dominant habitat types are described within the baseline *Sections 12.5.2* and *12.5.3* and also presented in Figures 12.4, 12.7 and 12.8.
	Undertake early analysis of survey data in case this indicates that survey methods need to be revised and/or that further detailed surveys are required.	Analysis of survey results was carried out immediately after surveys were undertaken and laboratory analysis was complete. This early analysis of contaminated sediment data highlighted possible anomalous results; re-analysis of replicate samples was undertaken and presented to Marine Scotland which allowed these results to be confirmed as anomalous (*Appendix 12B*).
	The biotopes/habitat map should be used by the applicant to inform their finalised wind farm layout.	Biotopes across the Project areas have been mapped by combining video, benthic and epibenthic survey results. Results are presented in detail in *Appendix 12D*. The resulting mapping of the dominant habitat types are described within the baseline *Sections 12.5.2* and *12.5.3* and presented in Figures 12.4, 12.7 and 12.8. Assessment of worst case impacts within the Development Area resulting from the Wind Farm and OfTW infrastructure has been carried out as described in *Section 12.4* and detailed in Table 12.2 and 12.3. No significant impacts have been identified on biotopes or habitats and as such no micro-siting of the Wind Farm layout has been deemed necessary.

Consultee	Scoping Response	Project Response
MSS	Scour protection will need to be considered as part of the selection process for WTGs and foundation choice and in respect of potential impacts to benthic ecology.	Necessary scour protection for each potential Wind Turbine Generator (WTG) and foundation type have been considered and incorporated when identifying the worst case option for each impact in regards to the benthic ecology. Jacket foundations with no scour protection have been identified as being the worst case for habitat change as a result of scour and associated sediment transportation. In terms of habitat loss and creation, possible scour protection is considered as a separate installation to foundations. Gravity base substructures (GBS) with scour protection have been identified as the worst case in terms of loss of original habitat. The identification of worst case scenarios can be found in *Section 12.4* and the assessment of these options is detailed in *Sections 12.7* and *12.8*.
	We recommend that the ES presents clear information on and identification of, the main biotopes found on-site.	Biotopes across the Project areas have been classified and mapped by combining video, benthic sample and epibenthic sample survey data with geophysical data. Results are presented in detail in *Appendices 12A, 12C* and *12D*, and summarised in *Section 12.5: Baseline Environment*. The resulting mapping of the dominant habitat types are described within the baseline *Sections 12.5.2* and *12.5.3* and also presented in Figures 12.4, 12.7 and 12.8.

5 In addition to comments received as part of the formal scoping response, consultation was undertaken with MSS via Marine Scotland – Licensing Operations Team (MS–LOT) in regards to the survey methodologies planned for the Development Area baseline surveys. Survey plans were supplied for comment to MSS and SNH (via MS-LOT), with comments incorporated, or discussed, in order that an agreed survey plan was achieved. All surveys were undertaken in line with the agreed methodologies.

6 MSS were further consulted and approved of the survey methods used along the Offshore Export Cable Corridor.

7 The information received through this consultation, along with the formal Scoping Opinion and recognised best practice, has informed the methodology and scope for the assessment of the impacts on benthic ecology presented in this chapter.

8 Consultation with relevant stakeholders (via MS-LOT) was also undertaken in respect of the methodology for the surveys which informed the metocean and coastal processes assessment, outputs from which are used in the assessment of impacts on benthic ecology from increases in suspended sediments and the associated deposition of resuspended sediments. Details of that consultation are provided in *Section 10.1.1* and Table 10.1.

12.3 Policy and Plans

9 Relevant policies and plans are introduced in *Chapter 2: Policy and Legal Background*, the descriptions below provide an overview of how these specifically relate to benthic ecology.

- *UK Marine Policy Statement* (Her Majesty's (HM) Government, 2011). To ensure responsible and sustainable use of the marine environment, developers must ensure that environmental and social impacts of their operations are assessed with this in mind. Under this statement, the United Kingdom (UK) aims to ensure a halting and, if possible, a reversal of biodiversity loss with species and habitats operating as a part of healthy, functioning ecosystems; and the general acceptance of biodiversity's essential role in enhancing the quality of life, with its conservation becoming a natural consideration in all relevant public, private and non-governmental decisions and policies.
- *Scotland's National Marine Plan: Pre-Consultation Draft* (Scottish Government, 2011) The National Marine Plan is a major component of the *Marine (Scotland) Act 2010* and will aim to ensure sustainable economic growth of marine industries, while taking the environment into account. Under this plan developments should aim to avoid harm to marine ecology, biodiversity and geological conservation interests, including through location, mitigation and consideration of reasonable alternatives. Furthermore, proper weighting should be applied to designated sites of conservation importance, species and habitats of importance for the conservation of biodiversity and to species designated to be under statutory protection (e.g. via the European Union (EU) Directive 92/43/EEC (the *Habitats Directive*).

12.4 Design Envelope and Embedded Mitigation

10 The potential development parameters and scenarios are defined as a Design Envelope and presented in *Chapter 7: Description of Development*. The assessment of potential impacts on benthic ecology is based upon the worst case scenario as identified from this Design Envelope, and is specific to the potential impacts assessed in this chapter.

11 Key parameters for the worst case scenario for each potential impact are detailed in Tables 12.2 and 12.3 below. For this assessment these include consideration of the design, construction and operation of: Wind Turbine Generators (WTGs), meteorological masts (met masts), foundations and substructures, Offshore Substation Platforms (OSPs), inter-array cables and Export Cables.

Table 12.2: Worst Case Scenario Definition –Development Area

Potential Impact	Design Envelope Scenario Assessed
Construction (and Decommissioning)	
Direct temporary disturbance of seabed habitats caused by construction based activities	Total seabed area disturbed is 5.54 km^2, equating to 3.69% of the Development Area resulting from: • seabed preparation for 213 WTGs with GBS selected as having the largest disturbance footprint (125 m dredge effected diameter); • seabed preparation for five OSPs with GBS selected as having the largest area disturbance footprint (300 m dredge effected diameter); • seabed preparation for three met masts with GBS selected as having the largest area disturbance footprint (125 m dredge effected diameter); • 353 kilometres (km) Inter-array cable installation with a trench affected width of six metres as the widest possible area of disturbance; • jack up vessel with disturbance footprint per jack up vessel of 600 m2 and three visits per foundation installation/decommissioning required for WTGs, OSPs and met masts; and • vessel anchorage disturbance from 5 m2 anchor footprints deployed at 500 m intervals along the 353 km of inter-array cable.
Indirect impacts of temporary increases in suspended sediment concentrations (SSC) from construction based activities, and associated deposition	Model outputs of anticipated worst case SSC, deposition and sediment transportation from energetic means (cable) and dredging (foundations) are detailed in *Section 10.4*. *Chapter 10* also describes the methodology by which worst case has been identified. Assessment includes: • suspended sediments arising from seabed preparations and installations for 213 WTGs, five OSPs and three met masts with GBS foundation types; and • suspended sediments arising from inter-array cable burial using energetic means (excavated trench 353 km long, one metre wide and two metres depth) as recognised as representing the worst case as described in *Section 10.1.3*.
Release of contaminants bound in sediments	• Sediment release as per 'Indirect impacts of temporary increases in suspended sediment concentrations (SSC) from construction based activities, and associated deposition' impact (above). • Contaminant levels as described in the baseline *Section 12.5*.
Secondary impacts of decreased primary production due to increased SSC within the water column	Sediment release as per 'Indirect impacts of temporary increases in suspended sediment concentrations (SSC) from construction based activities, and associated deposition' impact (above).

Potential Impact	Design Envelope Scenario Assessed
Potential release of pollutants from construction plant	Sources from vessels and plant associated with the construction of WTGs, OSPs, inter-array cables, and associated works.
Introduction of Non Indigenous Species (NIS)	Introduction from vessels and plant associated with the installation of WTGs, OSPs, inter-array cables, and associated works.
Operation	
Loss of original habitat	Total loss of original habitat is 1.87 km^2, equating to 1.25% of the Development Area resulting from: • seabed preparation for 213 WTGs with GBS selected as having the largest footprint (95 m diameter including scour protection); • seabed preparation for five OSPs with GBS selected as having the largest footprint (180 m diameter including scour protection); • seabed preparation for three met masts with GBS selected as having the largest footprint (95 m diameter including scour protection); and • maximum 10% protection on the 353 km inter-array cable installation with protection width of six metres as the widest possible area of disturbance.
Changes in tidal regime and associated sediment transport	Model outputs of predicted changes to hydrodynamics (*Chapter 10*) resulting from WTGs, met masts and OSPs. GBS foundations have been identified as being the worst case for impacts on tidal regime.
Scour and associated sediment transportation leading to changes in habitats	Model outputs of predicted scour effects (*Chapter 10*) resulting from WTGs, met masts and OSPs. Jacket foundations with no scour protection have been identified as being the worst case for impacts on scour and associated sediment transportation.
Colonisation of introduced substrata leading to a change in the benthic ecology and/or biodiversity	Introduction of new substrate available for colonisation from infrastructure as described in 'loss of original habitat' above.
Provision of Introduced Substrata Facilitating Spread of NIS	Introduction of new substrate available for colonisation from infrastructure as described in 'loss of original habitat' above.
Potential release of pollutants from operation plant	Sources from vessels and plant associated with the operation and maintenance of WTGs, OSPs, inter-array cables, and associated works.
Responses to electromagnetic fields and thermal emissions	Total Inter-array cable length of 353 km suitably buried and protected where burial is not feasible. Longest length and shallowest burial, or protection, recognised as the worst case in terms of electromagnetic fields (EMF) exposure.

Potential Impact	Design Envelope Scenario Assessed
Temporary habitat disturbance from operations and maintenance (O&M) activities	Area of seabed disturbed annually is 0.14 km^2, equating to 0.09% of the Development Area resulting from: • jack up vessel with disturbance footprint per vessel of 600 m2 and one visit per foundation (WTGs, OSPs and met masts) every five years; • vessel anchorage disturbance from 5.0 m2 anchor footprints deployed at 500 m intervals along the 353 km of inter-array cable; and • inter-array cable reburial assuming maximum of 10% reburial during operation of the total 353 km with a trench affected area of six metres as the widest possible area of disturbance.

Table 12.3: Worst Case Scenario Definition – Offshore Export Cable Corridor

Potential Impact	Design Envelope Scenario Assessed
Construction (and Decommissioning)	
Direct temporary disturbance of seabed habitats caused by construction based activities	Sub-tidal area of seabed disturbed across export cable corridor is 3.02 km^2 (3.0% of Offshore Export Cable Corridor) resulting from the export cable installation: • AC selected as worst case as it utilises the largest possible number of cables i.e. six DC options utilises less cables than AC; • maximum cable length for each of the six cables is approximately 83 km; and • each of the six cables are installed in a separate trench resulting in six trenches in total. Intertidal area disturbed at the Cockenzie beach landfall option is 2,216 m^2 which equates to 2.0% of total beach area (measured from the Cockenzie Power station to East Cuthill Rocks) resulting from: • the cable corridor width which is disturbed by installation equipment which is six metres for each of the six trenches i.e. 36 m in total. • two jointing pits estimated at 100 m2 each within the intertidal area; and • tidal range at widest point of the beach, and therefore cable length across the intertidal area of 56 m. Intertidal Area disturbed at Seton Sands beach landfall option is 14,636 m^2 which equates to 1.1% of total beach area measure from Wrecked Craigs to Fenny Ness resulting from: • the cable corridor width which is disturbed by installation equipment which is six metres for each of the six trenches; • two jointing pits estimated at 100 m^2 each; and • tidal range at widest point of the beach, and therefore cable length across the intertidal area of 401 m.

Potential Impact	Design Envelope Scenario Assessed
	Mechanical Cutting utilised in any of the intertidal areas where there are rocky habitats.
Indirect impacts of temporary increases in SSC from construction based activities and associated deposition	Model outputs of anticipated SSC, deposition and sediment transportation from installation of the cable by energetic means (*Chapter 10*).
Release of contaminants bound in sediments	• Sediment release as per 'Indirect impacts of temporary increases in SSC from construction based activities and associated deposition' impact (above). • Contaminant levels as per baseline characterisation in *Section 12.5.3*.
Secondary impacts of decreased primary production due to increased SSC within the water column	Sediment release as per 'Indirect impacts of temporary increases in SSC from construction based activities and associated deposition' impact (above).
Potential release of pollutants from construction plant	Sources from vessels and plant associated with the construction of Export Cable and associated works.
Introduction of NIS	Introduction from vessels and plant associated with the construction of Export Cable and associated works.
Operation	
Loss original of habitat	Total area of original habitat loss = 0.6 km^2 resulting from: • Protection of 20% of each of the 83 km long Export Cables. • Protection material 6.0 m wide.
Colonisation of introduced substrata leading to a change in the benthic ecology and/or biodiversity	Introduction of new substrate available for colonisation from Export Cable protection which is predicted to be installed on a maximum of 20% of the total cable length for each cable.
Provision of Introduced Substrata Facilitating Spread of NIS	Introduction of new substrate available for colonisation from Export Cable protection which is predicted to be installed on a maximum of 20% of the total cable length for each Export Cable.
Potential release of pollutants from construction plant e.g. from accidental spillage/leakage or sacrificial anodes	Source from vessels and plant associated with the O&M of Export Cables, and associated works.
Responses to EMF and thermal emissions associated with cabling	Total Export Cable length of approximately 83 km for each six cables, suitably buried to a target depth of 1.0 m and protected where burial is not practicable.

Potential Impact	Design Envelope Scenario Assessed
Temporary habitat disturbance from O&M activities	Annual disturbance from Export Cable reburial is 0.007 km^2 equating to 0.005% of the Export Cable Corridor. This results from a maximum predicted reburial of 10% of the 83 km Export Cable length for each of the six cables during the operational phase.

Embedded Mitigation

12 A range of Embedded Mitigation measures to minimise environmental effects are captured within the Design Envelope (see *Section 4.5.2*). The assessment of effects on benthic ecology has taken account of the following Embedded Mitigation measures:

- Vessels and plant relating to construction, operation and decommissioning activities will follow best practice and guidance for pollution at sea, detailed in the final Environmental Management Plan (EMP) to reduce and coordinate response to pollution events if they were to occur. The final EMP will follow OSPAR, IMO and MARPOL guidelines and industry best practices regarding pollution at sea, this includes provision for storage of pollutants and identifies products suitable for use in the marine environment. The EMP will be finalised prior to construction;
- The risk of invasive species introduction will be managed through prevention methods by following best practice, for example the International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWM), and the Scottish Code of Practice on non-native species. Details will be confirmed in the EMP prior to construction;
- Cables will be suitably buried or will be protected by other means when burial is not practicable which will reduce the impacts of loss of original habitat; and
- For any drilling activities, reversed circulation (air), sea water, water based mud, or synthetic (biodegradable) oil will be used. These compounds have been shown to have reduced environmental impacts over traditional oil based muds. For example, studies at some offshore drilling platforms using water-based drilling mud's have found no adverse effects (Daan and Mulder, 1996).

13 These measures would be delivered as part of the Project (see *Appendix 7A)*.

12.5 Baseline Environment

14 To describe the baseline environment the following activities were undertaken:

- An initial review of existing benthic survey data and desk based studies was carried out.
- Subsequently Project specific surveys, commissioned by Inch Cape Offshore Limited (ICOL), were conducted using marine ecological techniques.
- Baseline data as described in Table 12.4 were then used to characterise and map the marine communities and to identify the location of any sensitive features present (e.g. Annex 1 features of the Habitats regulations, or Priority Marine Features (PMFs)).

15 Key data sources including existing data and those commissioned by the Project are highlighted in Table 12.4, and results are summarised below within the sections for the Development Area (*Section 12.5.2*) and Offshore Export Cable Corridor (*Section 12.5.3*) baselines. Full details are presented in the Baseline Reports *Appendix 12A*, *Appendix 12B*, *Appendix 12C*, and *Appendix 12D*.

Table 12.4: Key Data Sources (full References can be found in the References Section)

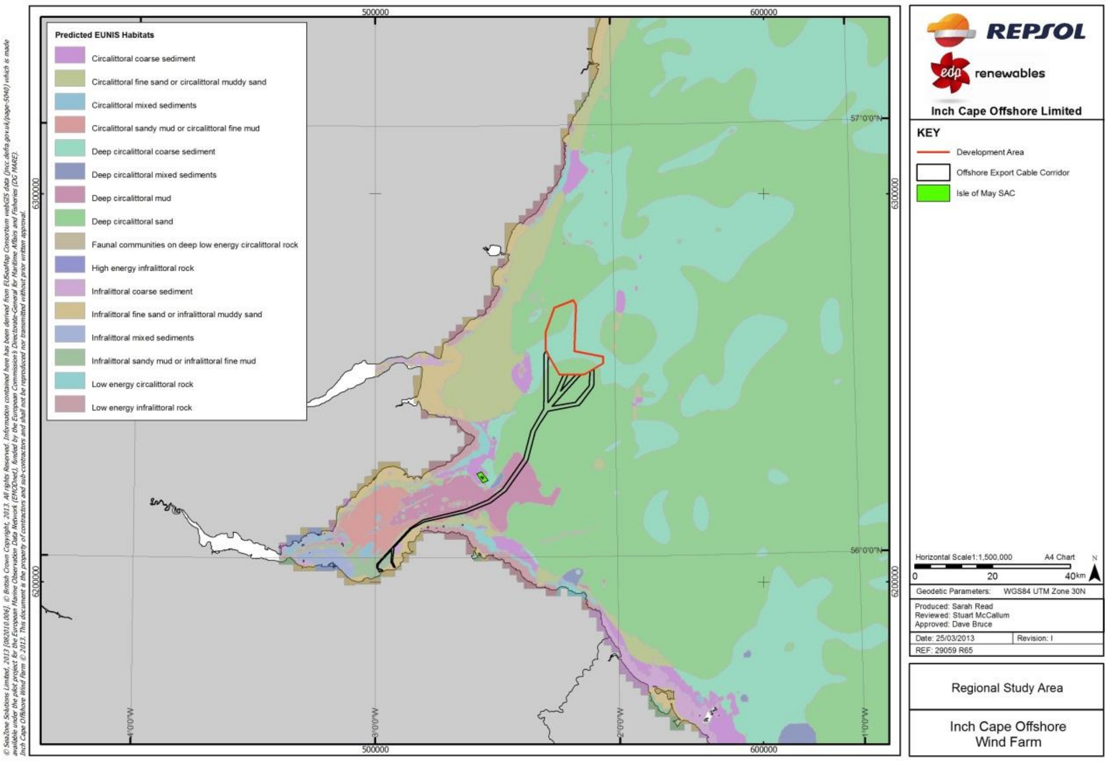
Data Source	Area of Research
Existing Data	
Marine Scotland (pers. comm. 2012)	Contaminant data for Bell Rock disposal ground.
The Marine Nature Conservation Review (MNCR) of East Scotland (Brazier, 1998)	Provides information on the benthic environments in proximity to the Development Area and Offshore Export Cable Corridor.
2004 Strategic Environmental Assessment (SEA) for region 5 (Eleftheriou et al., 2004)	Provides information on the benthic environments in proximity to the Development Area and Offshore Export Cable Corridor.
Clean Seas Environment Monitoring Programme (CSEMP, 2012)	Contaminant data for monitoring station at Montrose Bank and along the east coast of Scotland.
EUSeaMap - Mapping European Seabed Habitats (MESH, 2012)	EU seabed predictive mapping and benthic survey data.
Site Specific Surveys/analysis	
Osiris Hydrographic & Geophysical Projects Limited (Osiris Projects) and iXsurvey Limited	Geophysical survey data of Development Area and Offshore Export Cable Corridor.
AMEC on behalf of ICOL	Benthic and Epibenthic surveys as described in and *12.5.2* and shown in Figures 12.2 and 12.3.
Envision on behalf of ICOL	Geophysical data interpretation and habitat mapping.
EMU on behalf of Neart na Gaoithe offshore wind farm export cable (collected in 2009, reported in 2010)	Intertidal survey at cable landing locations within the Offshore Export Cable Corridor. Benthic survey along within and in the vicinity of the Offshore Export Cable Corridor, survey extent highlighted in Figure 12.6. (Note: these surveys were originally carried out for the Neat na Gaoithe project but overlapped the Offshore Export Cable Corridor and so were used for the ICOL analysis).

Data Source	Area of Research
EMU on behalf of ICOL (2012)	Benthic surveys along Offshore Export Cable Corridor as described in *Section 12.5.3*. Intertidal surveys at cable landing locations within the Offshore Export Cable Corridor as described in *Sections 12.5.3.*
Intertek Metoc on behalf of ICOL	Metocean and coastal process modelling as described in *Chapter 10*.
Envision on behalf of Forth and Tay Offshore Wind Developers Group	Interpretation of benthic and geophysical data for biotope classification and mapping in order that all cumulative Firth of Tay and Forth Developments (Inch Cape, Neart na Gaoithe and Firth of Forth Phase 1 (Alpha and Bravo) have comparable benthic analysis.

12.5.1 Regional Study Area

16 The Regional Study Area used to define the baseline environment, was selected to encompass the Development Area and Offshore Export Cable Corridor, and adjacent seabed areas within a single spring tide excursion of the Development Area and Offshore Export Cable Corridor (see Figure 12.1). Offshore habitats that encompass the cumulative development sites, namely the Firth of Forth and Neart ne Gaoithe offshore developments (Figure 12.1) were also included.

Figure 12.1: Regional Study Area



12.5.2 Development Area

17 A detailed benthic ecology baseline technical report, reviewing existing data and desk studies and reporting site specific surveys, has been produced for the Development Area and is attached as *Appendix 12A*. An overview of this report is presented below. Throughout the document biotopes are referenced using their classification codes and not their full classification titles. This is usual practice as the descriptive nature of full classification titles makes it impractical to replicate them for every reference. Full titles are referenced on first use and can be found in the glossary section.

Existing Data

18 The Marine Nature Conservation Review (MNCR) of East Scotland (Brazier, 1998) provides information on the benthic environments in proximity to the Development Area. In addition, a number of scientific papers which describe the benthic and epibenthic community composition over large areas of the North Sea have been reviewed in the 2004 Strategic Environmental Assessment (SEA) for region 5 (Eleftheriou *et al*., 2004) (which spans the Development Area). Typically, the offshore environment has been studied to a lesser degree than the inshore environment, with the main body of information focused around Bell Rock sewage sludge disposal ground, which is located partially within the Development Area, Figure 12.2. Relevant local information is also available from the long term benthic monitoring records of the Clean Seas Environmental Monitoring Programme (CSEMP, 2012) and the United Kingdom Offshore Operators Association (UKOOA), as well as specific studies for the Mapping European Seabed Habitats (MESH, 2012) project.

19 MESH identifies the Development Area as deep circalittoral sand and coarse sediment, with areas of circalittoral coarse sediment and fine or muddy sand. This predictive information is supported by survey data collected by Envision Mapping in 2003, which identified the biotope Mysella bidentata and Thyasira spp. in circalittoral muddy mixed sediment (SS.SMx.CMx.MysThyMx) at the sampling locations which coincide with the southern end of the Development Area. Monitoring at Bell Rock disposal ground provides long term benthic data within the Development Area, and shows a polychaete and bivalve dominated habitat with occasional opportunistic species present (SEA 5, 2004).

20 Contaminated sediment levels within the Development Area are also available as a result of monitoring at the Bell Rock disposal ground. The most recent data from a survey, undertaken in 2002, shows generally low levels of contaminants, with some elevation of heavy metals but no strong temporal variations of trace metals in surface sediments either during or post disposal operations, which indicates the highly dispersive nature of the area (Hayes *et al*., 2005).

Site Specific Surveys

21 The survey area consisted of the Development Area, an area within a single tidal excursion from the Development Area, and discreet reference stations outside of the tidal excursion. This is in accordance with the Guidelines for the *Conduct of Benthic Studies at Marine Aggregate Extraction Sites* (Ware and Kenny, 2011).

22 In advance of the survey consultation with Marine Scotland was undertaken to develop an agreed survey methodology and programme. Detailed methodologies and full results of the survey are included in *Sections 12A.2* and *12A.3* of *Appendix 12A* and *Sections 12B.2* and *12B.3* of *Appendix 12B* with the survey results summarised below. The benthic survey was undertaken between 19 March 2012 and 25 May 2012. Sampling stations are shown in Figure 12.2 and 12.3, and Table 12.5 below and consisted of the following elements:

- Drop Down Video (DDV) at 124 stations;
- Benthic grabs (including sub-sampling for contaminant analysis, particle size analysis (PSA) and total organic carbon (TOC) analysis) at 87 stations; and
- Epibenthic trawls at 24 stations.

Table 12.5: Summary of Survey Campaign

	Development Area			Tidal Excursion			Control			Total	
	Stations	**Replicates**	**Total Samples**	**Stations**	**Replicates**	**Total Samples**	**Stations**	**Replicates**	**Total Samples**	**Stations**	**Total Samples**
Benthic Grab	74	Single	74	7	Triplicate	21	6	Triplicate	18	87	113
Drop Down Video	108	Single	108	8	Single	8	8	Single	8	124	124
Epibenthic Trawls	20	Double	40	2	Triplicate	6	2	Triplicate	6	24	52

Figure 12.2: Benthic Survey Stations

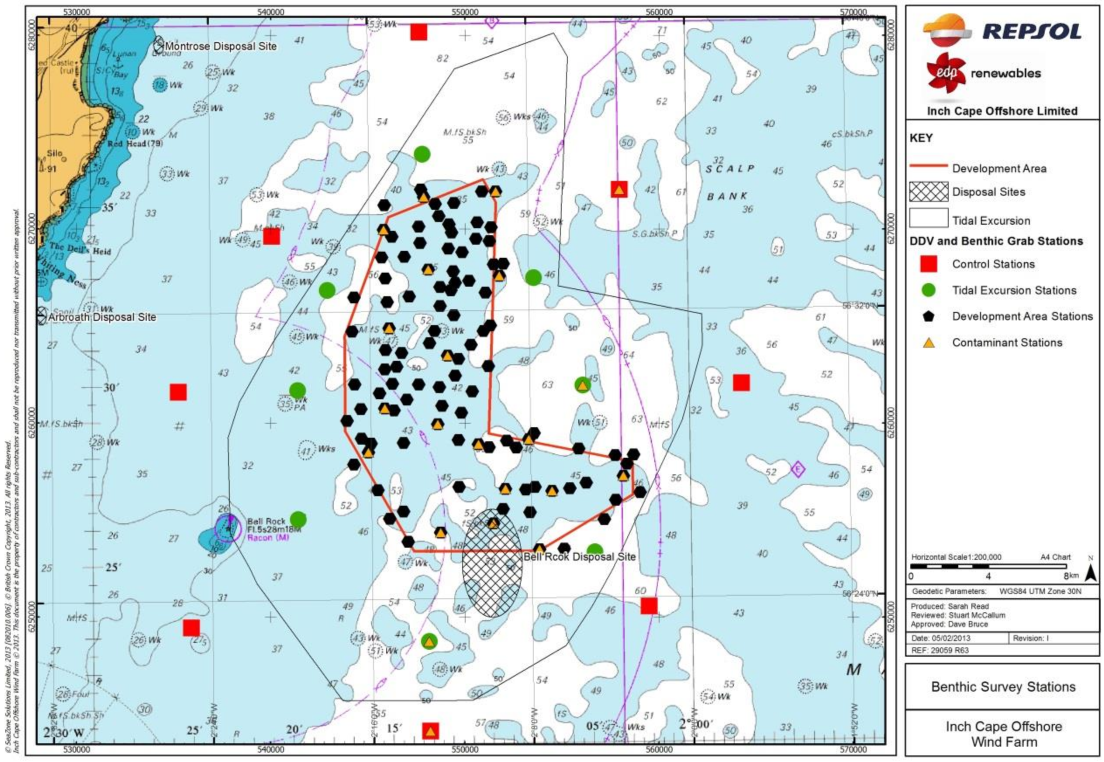
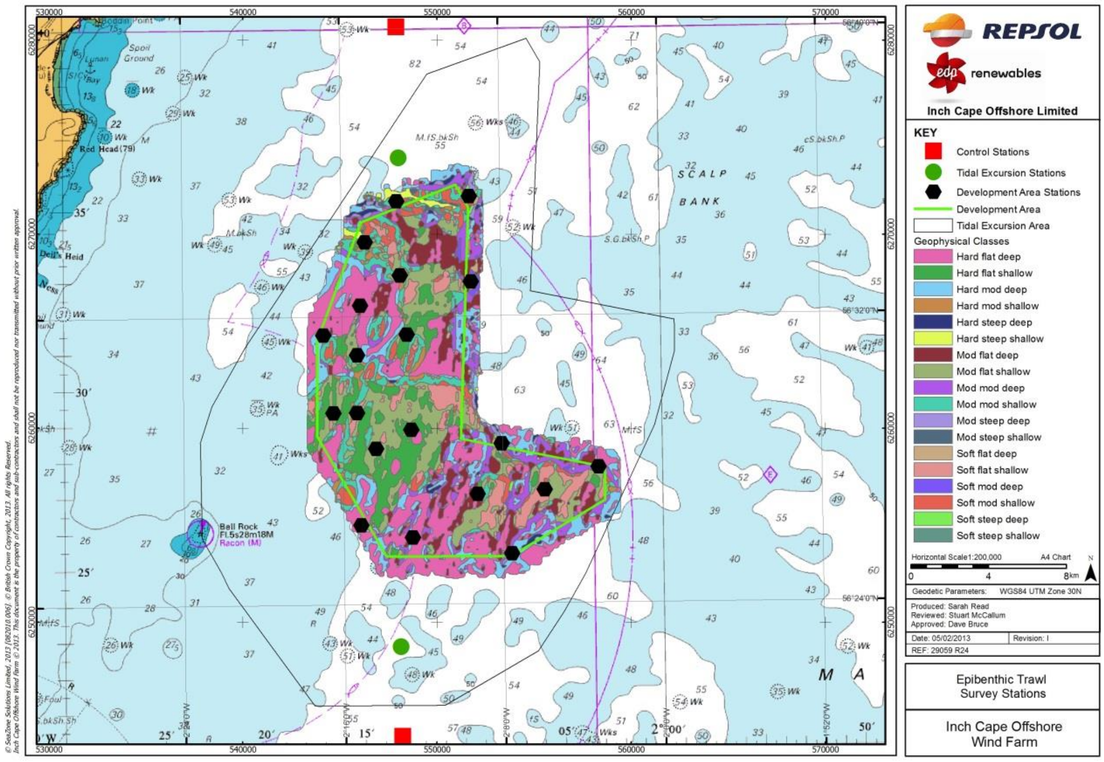


Figure 12.3: Epibenthic Trawl Survey Stations



Results – Physical Environment

23 Data from the geophysical survey, ground-truthed by the PSA data from grab sampling and DDV footage indicated that overall, the Development Area consisted of circalittoral sands and gravelly sands with areas of muddy mixed sediment.

Results – Epibenthic Communities

24 The epibenthic survey data from two metre beam trawls confirmed the assignment of coarse and mixed sediment communities. Catches were dominated by epibenthic species typical of these habitats, i.e. dead man's fingers (*Alcyonium digitatum)*, horned wrack (*Flustra folicacea*), brittlestars (*Ophiothrix fragilis*), hydroids (e.g. *Hydrallmania falcata*) and a number of small fish and mobile benthic invertebrates.

Results – Biotope Classification

25 Through the various benthic survey methods applied across the Development Area, biotopes were identified, with the majority of the sedimentary habitat across the Development Area classified as the circalittoral mixed sediment biotope '*Mysella bidentata* and *Thyasira* spp. in circalittoral muddy mixed sediment (SS.SMx.CMx.MysThyMx)'.

26 The biotopes identified through the supervised classification of geophysical and benthic data as present across the Development Area are detailed in Table 12.6 and Figure 12.4.

Table 12.6: Biotopes Present within the Development Area

Biotope	Area (km^2)	% of Survey Area*	% of Development Area
SS.SCS.CCS.MedLumVen	8	4	4
SS.SCS.OCS	62	31	33
SS.SMx.CMx.MysThyMx	132	65	62

**The geophysical survey area included a buffer around the Development Area and so the Survey Area is slightly larger than the Development Area.*

Results – Habitats and Species of Conservation Importance

27 The following habitats and species of conservation importance have been noted as present within the Development Area:

- (SS.SCS.OCS), is regarded as a conservation priority in the *UK Post-2010 Biodiversity Framework* (JNCC and Defra, 2012);
- Venerid bivalves in circalittoral coarse sand or gravel (SS.SCS.CCS.MedLumVen) is listed under the EC Directive 92/43/EEC (*the habitats directive*) as part of the features: sandbanks which are slightly covered by sea water all the time, large shallow inlets and bays and estuaries; and

- The Icelandic cyprine, *Arctica islandica*, a PMF and listed under OSPAR's list of threatened and/or declining species(OSPAR, 2008b), was recorded at moderate abundances across the Development Area (0-5000 individuals per 100 m^2). All individuals recorded were juveniles, but were greater than one millimetre (mm)in diameter.

28 No evidence of any Annex I biogenic reef features were observed during any of the surveys carried out across the Development Area. A number of reef forming polychaetes were recorded (*Sabellaria spinulosa* and *Serpula vermicularis*), as was a single individual of *Modiolus modiolus*. These species are of high conservation importance when in reef form; no reef features were observed, and therefore they are not considered further in the assessment.

29 The proposed Marine Protection Area (MPA), the Firth of Forth Banks Complex, is an option for the designation for sands and gravels, *Arctica islandica*, and shelf banks and mounds. This proposed MPA sits to the east of the Development Area, approximately one kilometre (km) distant at its nearest point. Where impacts have the potential to affect this proposed MPA they have been identified within this Environmental Impact Assessment.

30 A number of Special Area of Conservation (SAC) including the Isle of May, Firth of Tay and Eden Estuary, Moray Firth and the River Tay, which cite Annex I habitats as their qualifying conservation have been detailed in *Chapter 9*. However, there is no potential connectivity with these SACs and the Development Area relating to Benthic Ecology or Annex I habitat interests due to their remoteness and the limited range of direct or indirect effects. Connectivity with the Offshore Export Cable Corridor is discussed in *Section 12.5.3*.

31 The Aberlady Bay Local Nature Reserve (LNR) includes features of interest relevant to the Benthic Ecology assessment. However as with the SACs there is no potential connectivity with the Development Area due to their remoteness and range of effects.

Results – Contaminated Sediments

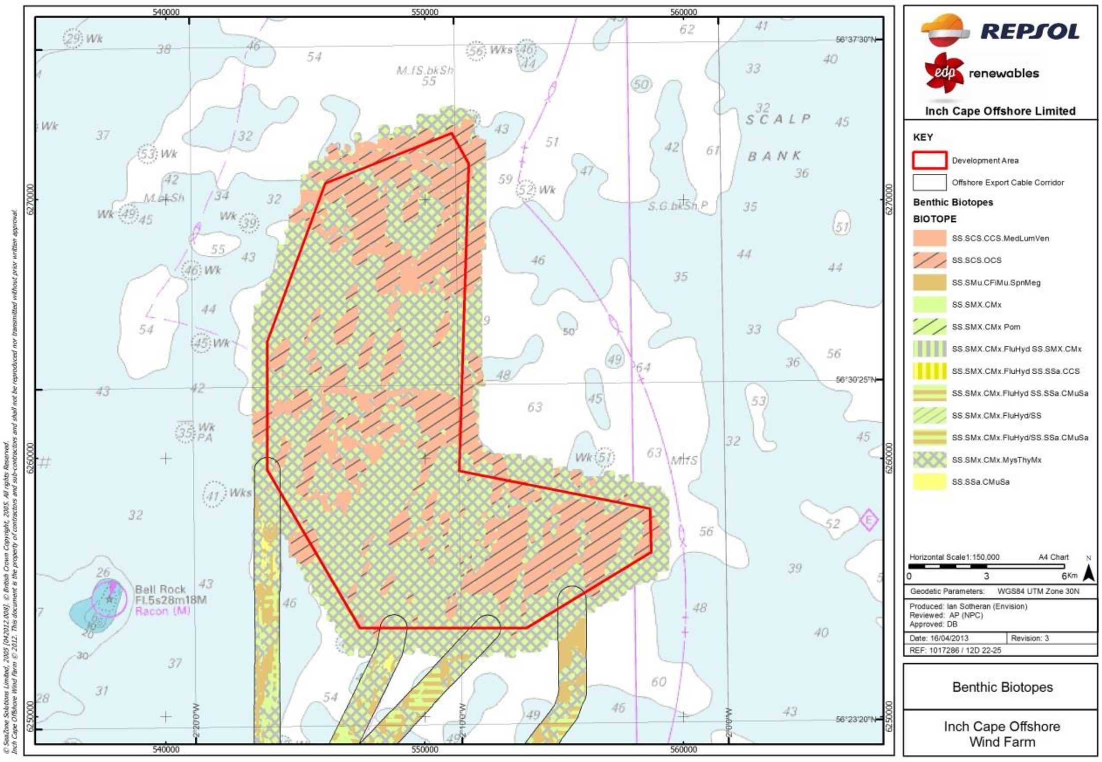
32 Results of the sediment chemistry analyses showed that TOC and sulphide was low at all stations, with TOC below 0.4 per cent and sulphide below 17 $mgkg^{-1}$. Polycyclic Aromatic Hydrocarbons (PAHs), Polychlorinated Biphenyls (PCBs) and organotins were also low across the Development Area, with concentrations below Cefas Action Levels (AL), Canadian Sediment Quality Guidelines and Dutch Standards (defined in *Appendix 12B*). Arsenic, cadmium, chromium, copper, and nickel concentrations exceeded Cefas AL 1.

33 Additionally, nickel and cadmium concentrations exceeded Cefas AL 2 at five locations (Figure 12.2) but on re-analysis of a duplicate sample these values were not reached[1] (Marine Scotland, 2012). As described in *Appendix 12A* levels of all contaminants were spatially variable across the Development Area and there are no identified areas of

[1] Through consultation with MS it was agreed that these levels were anomalous and could therefore be removed from the impact assessments. Email correspondence 5 November 2012.

enhanced contamination, despite the presence of the historical disposal ground at Bell Rock (located partially within the Development Area).

Figure 12.4: The Development Area Biotope Map



12.5.3 Offshore Export Cable Corridor

34 A detailed benthic ecology baseline technical report, reviewing existing data and desk studies, and reporting on site specific surveys, has been produced for the Offshore Export Cable Corridor and is attached as *Appendix 12C*. An overview of this report is presented below.

<u>**Existing Data**</u>

35 The benthic environment along the Offshore Export Cable Corridor is relatively well documented, with a number of studies and surveys having been carried out in the Firth of Forth, including the Clean Seas Environmental Monitoring Programme (CSEMP, 2012)which showed a very impoverished fauna as present within the Firth of Forth (Eleftheriou *et al.*, 2004). Predictive mapping (MESH) highlights the variety of habitats that coincide with the Offshore Export Cable Corridor. Also, recent survey data, from the previous Cockenzie cable option investigated in 2009 for the Neart na Gaoithe offshore wind farm, also exists and has been made available to ICOL.

36 Existing data shows the substrates in the Forth estuary to be mainly sedimentary, with species diversity increasing with increasing salinity and depth offshore. Deep circalittoral sand and mud habitats intersect the Offshore Export Cable Corridor for the majority of its

length, together with circalittoral sandy or fine mud. Infralittoral sandy or fine muds coincide with the Offshore Export Cable Corridor closer inshore, with a number of other broad-scale habitat types also represented, including circalittoral rock, and circalittoral and infralittoral fine muddy sand.

37 A number of sites, designated for nature conservation are intercepted by the Offshore Export Cable Corridor. These sites are detailed in *Chapter 9: Designated Nature Conservation Sites*. The Isle of May Special Area of Conservation (SAC) is designated in relation to sub-tidal benthic features, with rocky reefs surrounding the island. Impacts that have the potential to interact with the characterising features of this SAC are identified within the assessment. A number of other SACs detailed in *Chapter 9* cite Annex I habitats as their qualifying conservation interests, including the Firth of Tay and Eden Estuary , the Moray Firth and the River Tay. There is no potential connectivity with these SACs and the Offshore Export Cable Corridor relating to Benthic Ecology or Annex I habitat interests due to their remoteness and the limited range of direct or indirect effects.

38 The Aberlady Bay LNR includes features of interest relevant to the Benthic Ecology assessment. The distance from Aberlady Bay to the Offshore Export Cable Corridor is approximately 1.5 km at the closest point, and so there will be no direct impacts on the LNR. Indirect impacts that have the potential to interact with the features of interest of this LNR are identified within the assessment.

39 JNCC and SNH have identified one potential nature conservation Marine Protected Area in the vicinity of the Development Area, the Firth of Forth Banks Complex. *Arctica islandica* has been identified as a PMF in this location. Impacts that have the potential to interact with the PMF within this MPA are identified within the assessment. The Firth of Forth Site of Special Scientific Interest covers large areas of the Firth of Forth (including the Offshore Export Cable landfall options, at Cockenzie and Seton Sands) with the marine Notified Natural Features of mudflats and saltmarsh within its boundary. None of these Notified Natural Features are present at the landfall options and as such, no impacts to these features are predicted. Impacts to the habitats present at the landfall points are covered within the Impact Assessment, with baseline conditions discussed below.

40 Where there is potential for indirect impacts on designating features of a European site, other than benthic ecology interests, these are considered in the *Chapter 13*, *Chapter 14: Marine Mammals* and *Chapter 15: Ornithology*.

Site Specific Survey

41 MSS was consulted and agreed with survey methodologies prior to commencement. The survey methods and results are presented in full in *Appendix 12C*, and consisted of:

- Intertidal biotope mapping surveys at the cable landfall options at Cockenzie and Seton Sands (Figure 12.5), and
- Sub-tidal surveys within and in proximity to the Offshore Export Cable Corridor (Figure 12. 6) including;

- DDV at 22 stations;
- DDV transects at 11 rock seabed stations; and
- Benthic grab sampling for PSA and contaminant sampling at 13 Stations.

42 In addition, existing seabed video footage and sediment particle size distribution data from a further 37 stations were used to characterise habitats and associated communities along the sub-tidal Offshore Export Cable Corridor. This data was sourced from the 2009 Neart na Gaoithe survey.

Figure 12.5: Intertidal Survey Area

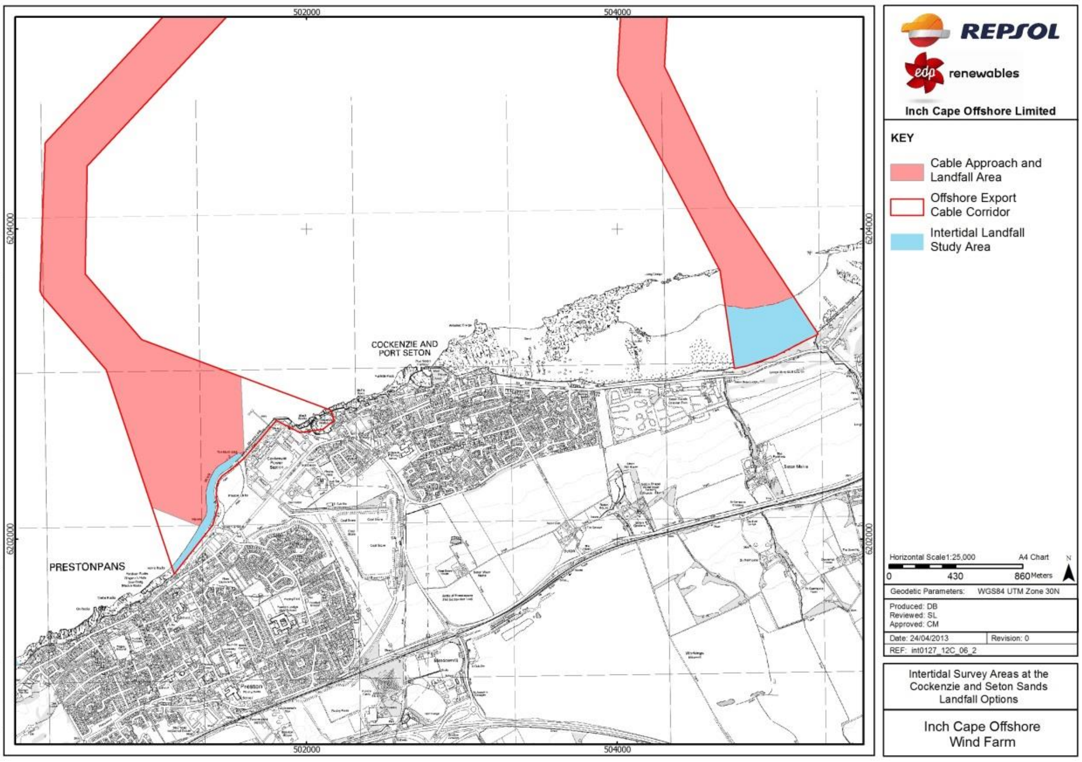


Figure 12.6: Sub-tidal Survey Station Positions

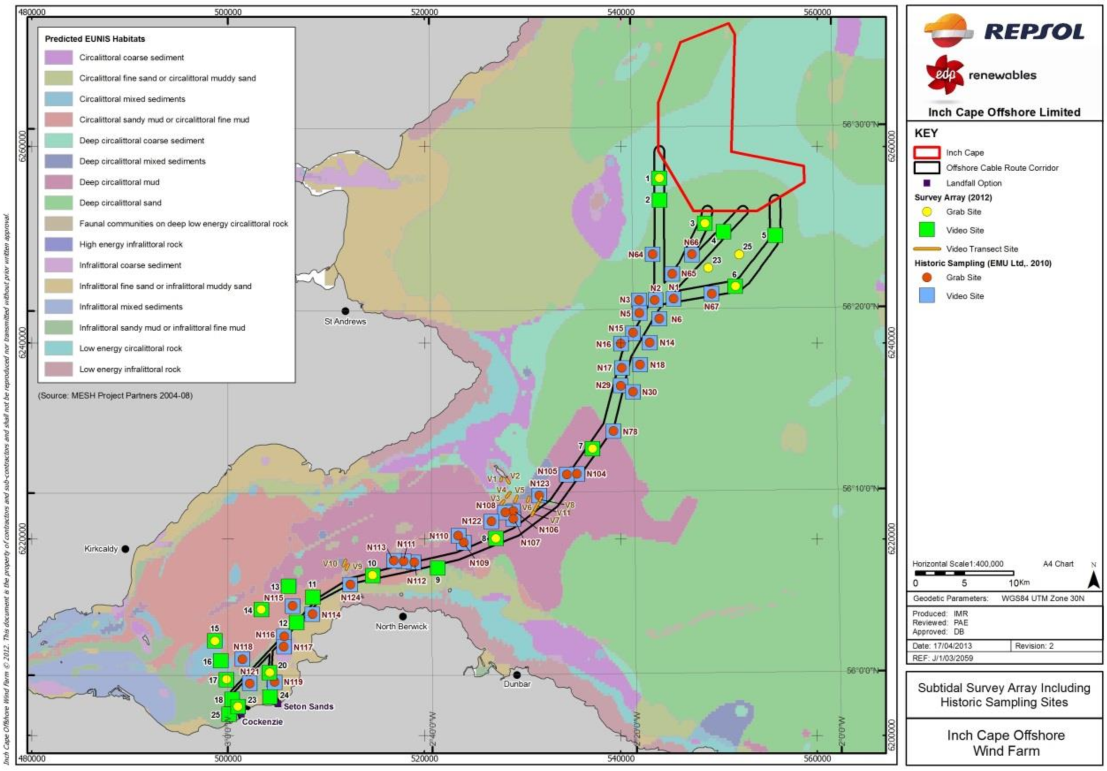


Figure 12.6a: Sub-tidal Survey Station Positions (near Development Area)

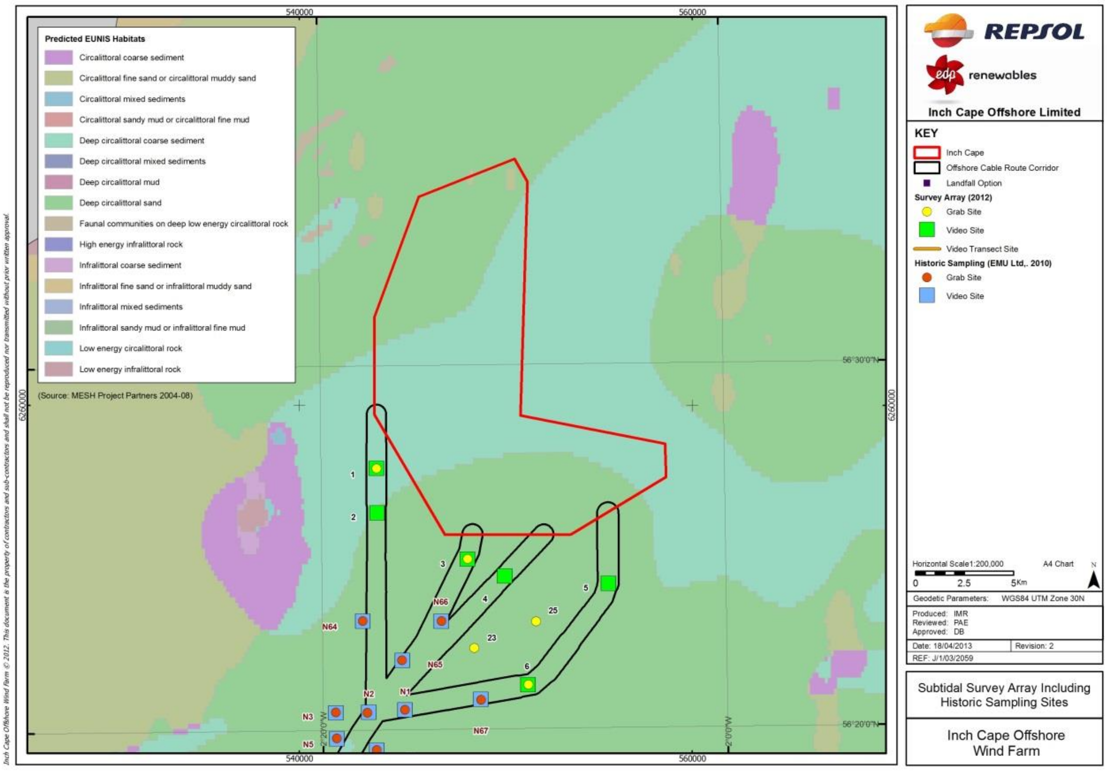


Figure 12.6b: Sub-tidal Survey Station Positions (Mid-section)

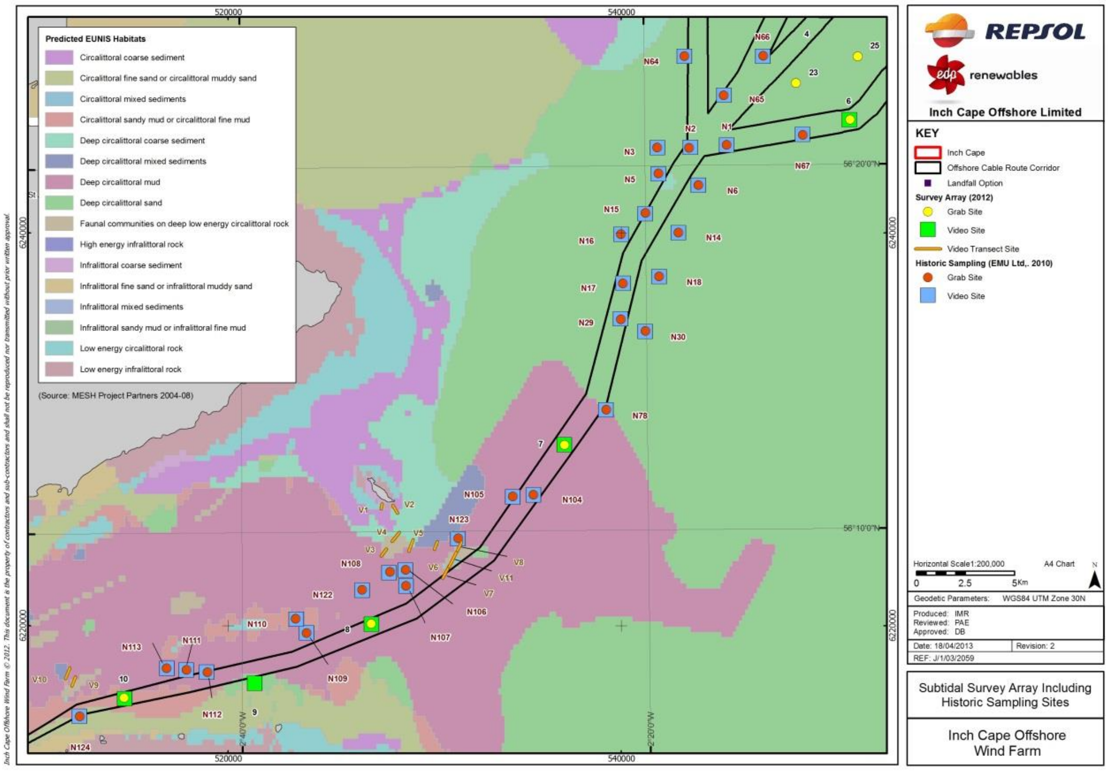
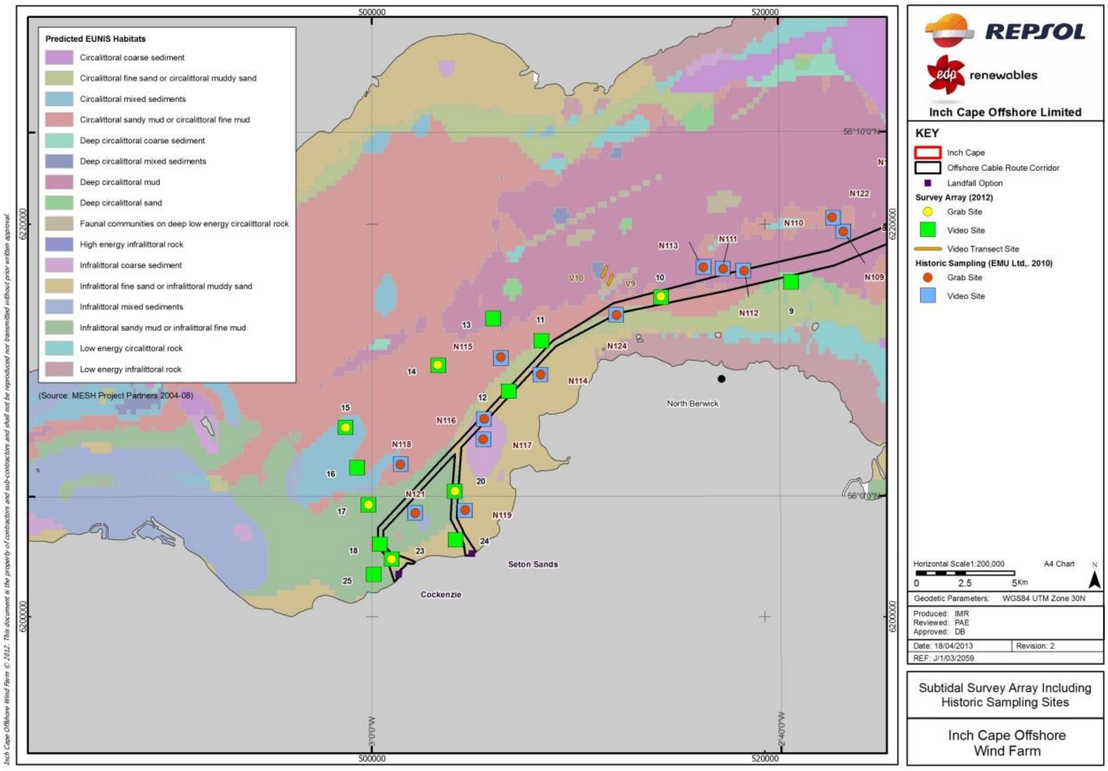


Figure 12.6c: Sub-tidal Survey Station Positions (Near-shore)



Results - Intertidal Surveys

43 Cockenzie was divided into two main areas, one classified as hard substratum and one by mixed substrata. The mixed substrate in the south of the surveyed area ranged from sandy gravel on the upper to mid shore, to sandy gravel and cobbles on the mid to lower shore, with small boulders present on the extreme low shore and sub-tidal area. Algal growth was prevalent on the mid to lower shore with the presence of the biotope LR.FLR.Eph.BLitX, whilst further down the shore LR.LLR.F.Fspi.X became more prevalent. The hard substrata in the northern half of the Cockenzie survey area showed typical zonation for a rocky shore. The biotope LR.MLR.BF.PelB was present on the upper shore, LR.HLR.MusB.Cht.Cht on the mid shore and LR.MLR.BF.FspiB on the mid to lower shore leading to the kelp biotope of IR.MIR.KR.Ldig.Ldig on the extreme low shore in addition to an area of soft sediment classified as LS.LSa.MuSa.Lan.

44 Previous sampling (EMU, 2010), at the northern area of the Cockenzie landfall option, also identified a mussel bed (LS.LBR.LMus.Myt.Mx) represented as a thin band of mussels (a few metres wide) on mid shore mixed cobble and gravel substrates. During the EMU (2012) survey this habitat was not present, suggesting that this is likely to have been a naturally ephemeral feature (*Appendix 12C*).

45 The Seton Sands survey area consisted predominantly of fine sand habitats, though a small area of hard substrata, classified as LR.LLR.F.FSpi.FS, occurred within a fine sand biotope on the upper shore. A series of upper to mid shore mobile sand banks (LS.LSa.MoSa.AmSco.Sco) led to a large mid to low shore polychaete dominated biotope (LS.LSa.FiSa.Po). Polychaete worms were present in large numbers down into the low shore but the bivalve mollusc, *Angulus tenuis*, was present in sufficient numbers on the extreme low shore for the LS.LSa.FiSa.Po biotope to be further classified to LS.LSa.FiSa.Po.Aten.

Results – Sub-tidal Survey

46 Combination of the EMU (2010) and EMU (2012) samples showed that the predominant sediment type present along the Offshore Export Cable Corridor was slightly gravelly muddy sand, with slightly gravelly sand and slightly gravelly sandy mud making up the majority of the remaining sediment classes. Sediments tended to be slightly coarser towards the offshore limit of the Offshore Export Cable Corridor. The dominant mud/sand biotope present along the Offshore Export Cable Corridor was classed as SS.SMu.CFiMu.SpnMeg. Towards the intertidal, sediments became more heterogeneous and were classified as IMx and CMx derived biotopes.

47 Further interpretation of the Offshore Export Cable Corridor survey data was carried out by Envision in order to collate it with the Development Area data, Figures 12.7 and 12.8. This interpretation used the ICOL commissioned geophysical data, alongside the benthic survey data (EMU 2010, 2012).

Results – Contaminated Sediments

48 Contaminant samples (analysis of total PAH, metals and organotin (Tributyltin (TBT)) compounds) were combined with results from 2009. In general, levels of PAHs were below the available Cefas AL for this contaminant. A number of samples collected in the inshore area approaching the Cockenzie landfall and at historic dumping grounds were found to have relatively elevated PAH concentrations. Recent sampling showed metal contaminant concentrations were variable, with Arsenic and Cadmium below Cefas AL1 for all sites, Mercury, Copper, Lead and Zinc all with at least one site above AL1 and Nickel and Chromium showing all sites above AL1. No site exceeded the Cefas AL2 for any metal.

49 In terms of spatial patterns, mercury concentrations were generally low offshore but exhibited a gradient of increasing concentrations closer to the landfall points. Nickel concentrations, however, showed no distributional pattern. The baseline survey showed contamination levels within the Offshore Export Cable Corridor reflect the environmental status of the Firth of Forth. Contaminants were found to be in higher concentrations near shore. This is likely due to anthropogenic activity, for example there is a historic disposal ground, Port Seton, along the Seton Sands inshore corridor and coastal and estuarine waters typically receive contaminants via local anthropogenic activities and riverine inputs.

Results – Habitats and Species of Conservation Importance

50 A number of habitats and species of conservation were identified:

- SS.SCS.CCS - Conservation priority in the *UK Post-2010 Biodiversity Framework* (Joint Nature Conservation Committee (JNCC) and Department for Environment, Food and Rural Affairs (Defra), 2012), identified in 2012, in the offshore environment of the Offshore Export Cable Corridor;
- SS.SMu.CFiMu.SpnMeg - Listed on the Scottish draft list of Priority Marine Features (Howson *et al*., 2012) (*Section 9.3.4*), identified in the offshore environment of the Offshore Export Cable Corridor;
- Stony Reef – potential to be listed under the EC Directive 92/43/EEC (*Habitats Directive*) as part of the feature: Annex I reef. However, examples identified have low resemblance to Annex I reef criteria (Assessment of Reefiness within *Appendix 12C*); and
- The Icelandic cyprine, *Arctica islandica*, is listed on OSPAR's list of threatened and/or declining species (OSPAR,2008b) and is an identified PMF of the potential MPA on the Firth of Forth Banks Complex.

51 Potential Annex 1 rocky reef habitats were also identified during the current video surveys around the Isle of May SAC (Figure 12.1). These habitats were represented by a mosaic of biotopes), reflecting the local heterogeneity, including CR.MCR.EcCr.FaAlCr.Bri, CR.MCR.EcCr.FaAlCr.ADig, CR.MCR.EcCr.FaAlCr.Pom, SS.SMx.CMx.FluHyd, and SS.SMx.CMx.ClloMx.Nem. Although outside of the boundaries of the Offshore Export Cable Corridor, these features may be considered to have particular sensitivity due to their inclusion in, or connection to, designated sites identified in *Chapter 9*.

Figure 12.7: The Offshore Export Cable Corridor Northern Biotope Map

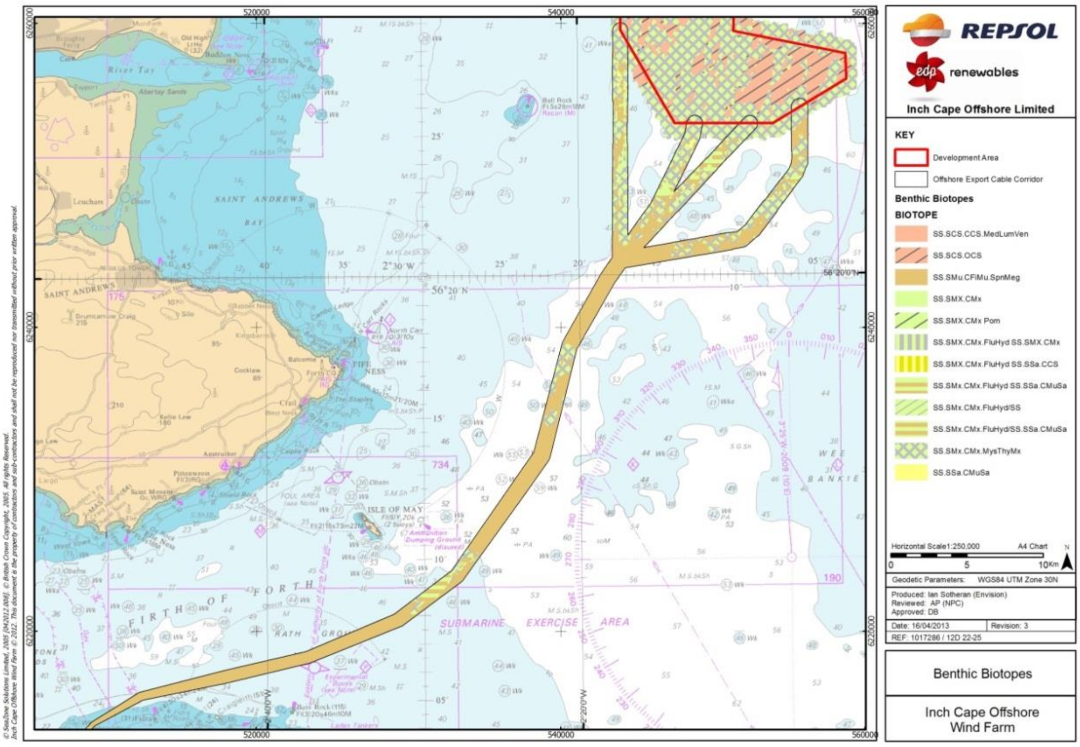
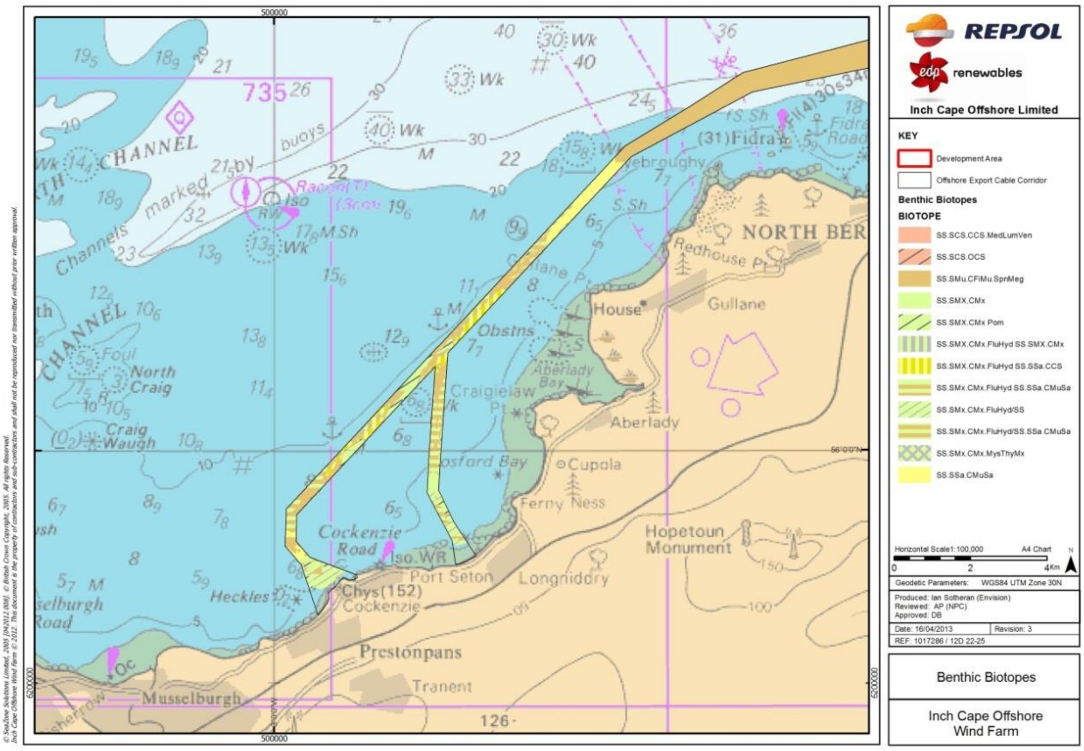


Figure 12.8: The Offshore Export Cable Corridor Southern Biotope Map



12.5.4 Guidance and Methods

52 Relevant information and guidance to the Benthic Chapter Assessments includes:

- Cefas (2004). Offshore Wind Farms: guidance notes for Environmental Impact Assessment in respect of FEPA and CPA requirements. Version 2. www.cefas.co.uk/publications/files/ windfarm-guidance.pdf;
- Defra (2005) Nature conservation guidance on offshore wind farm development. http://www.defra.gov.uk/wildlife-countryside/ewd/windfarms/windfarmguidance.pdf;
- Hendrick et al. (2006). Sabellaria spinulosa reef: a scoring system for evaluating 'reefiness' in the context of the EC Directive 92/43/EEC (*Habitats Directive*). J.Mar.Biol.Ass.UK. 86: 665-677;
- Gubbay (2007). Defining and Managing *Sabellaria spinulosa* Reefs: Report of an Inter-agency Workshop. JNCC report No.405;
- OSPAR (2008a). OSPAR Guidance on Environmental Considerations for Offshore Wind Farm Development. www.ospar.org;
- IEEM (2010). Guidelines for Ecological Impact Assessment in Britain and Ireland - Marine and Coastal Consultation document. www.ieem.net;
- Irving (2009). Identification of the Main Characteristics of Stony Reef Habitats under the EC Directive 92/43/EEC (*Habitats Directive*). Summary of an Inter-agency Workshop 26-27, March 2008. http://www.jncc.gov.uk/page-5023;
- Limpenny *et al.* (2010). Best methods for identifying and evaluating *Sabellaria spinulosa* and cobble reef. Aggregate Levy Sustainability Fund Project MAL0008. Joint Nature Conservation Committee, Peterborough, 134 pp., ISBN - 978 0 907545 33 0;
- Judd, 2012. Guidelines for data acquisition to support marine environmental assessments for offshore renewable energy projects. CEFAS, Report ME5403 – Module 15: May 2012; and
- Ware, S. J. and Kenny, A. J. (2011) Guidelines for the Conduct of Benthic Studies at Marine Aggregate Extraction Sites 2nd Edition, Marine Aggregate Levy Sustainability Fund, 80 pp.

12.5.5 Baseline without the Project

53 A review of previous data sets, mainly composed of those situated within the Bell Rock disposal ground, and surveys as part of the MESH programme (situated within 10 km from the Development Area) highlights that the environment surrounding the Project, has been relatively stable in its sedimentary composition and contamination levels for up to 10 years, with little change observed in the infaunal component for 10-20 years. Notable changes are restricted to a reduction in opportunistic species such as *Capitella* sp. at the Bell Rock disposal ground, indicating a general improvement of conditions at this historic disposal ground. Recent contamination results obtained through the site specific surveys were also

comparable to those recorded in 2002 at the Bell Rock disposal ground which suggests stable levels over the last decade. Such analysis would also suggest that the existing baseline conditions would prevail in the future, should no development occur.

54 Despite the relatively stable conditions highlighted above, the potential for effects as a result of climate change introduces scope for change to baseline conditions (over the Development Area and Offshore Export Cable Corridor).

55 While alterations to the functioning of marine ecosystems associated with climate change across the Development Area and Offshore Export Cable Corridor, in the absence of the Project, are difficult to predict, the response of the near shore environment to sea level rise does allow for a more detailed assessment of potential change to the baseline conditions. This scenario, summarised below, may occur in the absence of the Project as a result of the effects of global climate change. *Chapter 8: Benefits of the Project* explains the positive impacts of the Project on future climate change.

- Sea levels along the coastline of the Forth Estuary predicted to rise by around 0.32 m – 0.58 m over the next 100 years (Firth *et al*., 1997; Forth Estuary Forum, 1999) which suggest that some measurable rise in sea levels at the Offshore Export Cable landfall options will occur in the absence of the Project, subject to the degree of actual warming.
- Coastal "squeeze" may occur resulting in an overall loss in the total area of intertidal habitat at the Cockenzie landfall option due to artificial sea defences. In contrast, the low lying sand dune system backing the shore at Seton Sands is likely to result in little or no reduction in the extent of intertidal habitat as a result of predicted sea level rises during the life of the Project.

12.6 Assessment Methodology

12.6.1 Methodology

56 The impact assessment methods used within this chapter follow the principals and approaches detailed in *Chapter 4: Processes and Methodology*, with further chapter specific assessment parameters detailed below.

Magnitude of Effects

57 Assessment of the magnitude of effects uses a number of criteria, including the absolute scale of the effect (e.g. proportion of habitat lost), its duration, its frequency, the relative scale of the effect alongside documented benchmarks (e.g. those produced by the Marine Life Information Network, MarLIN), the level of tolerance and vulnerability of the receptor to that effect, and the recoverability after cessation of the impacting activity. This is summarised in Table 12.7 below.

Table 12.7: Magnitude of Effect

Category	High Level Environmental Indicator	Corresponding Scale of Effect and Receptor Characteristics	
High	Total loss or major alteration to key elements/features of the baseline conditions	Scale of Effect	>10% of Development Area or Offshore Export Cable Corridor, affected throughout the life of the Project.
		Receptor	Loss of ecosystem function and/or receptor is highly intolerant and will not recover to baseline conditions within the life of the Project.
Moderate	Partial loss or alteration to one or more key elements/features of the baseline conditions	Scale of Effect	5-10% of Development Area or Offshore Export Cable Corridor, affected through operation.
		Receptor	Receptor is intolerant and is lost to impact, however recovery is expected during the life of the Project.
Low	Minor shift away from the baseline conditions	Scale of Effect	1-5% of Development Area or Offshore Export Cable Corridor. Occurs through construction.
		Receptor	Receptor is modified but not lost. Substantial recovery of the receptor expected within five years of cessation of the effect but may take up to 10 years.
Negligible	Very slight change from baseline conditions	Scale of Effect	<1% of Development Area or Offshore Export Cable Corridor. Potential to occur through construction/operational phase.
		Receptor	Community level effects (e.g. diversity, richness) but characteristic and keystone species are expected to remain, recovery is expected to occur quickly and within one or a few years of cessation of the effect.

Sensitivity of Receptor

58 The Sensitivity of receptors has been assessed according to its conservation importance, its relative abundance/spatial extent at geographical scales and its importance to the wider ecological area (Table 12.8). The MarLIN sensitivity criteria are fully included within the

assessment of impact magnitude above, and as such, the following assessment table for receptor sensitivity is more akin to receptor value.

Table 12.8: Sensitivity of Receptor

Receptor Sensitivity	Receptor Characteristics
High	Receptor of high conservation importance (international) that also provides a key ecological function, and is rare in its abundance.
Moderate	Receptors of high conservation importance (International) but with either a low ecological value or high abundances. Or, receptors of low conservation importance, yet with high ecological value or low abundances.
Low	Receptors of medium conservation importance (National), yet with low ecological importance or high abundances. Or, Receptors of low conservation importance, with low ecological importance or high abundances.

Assessment of Impact Significance

59 The assessment of impact significance follows that described in Table 4.6. Impacts described by Moderate/Major or Major are considered to be significant.

Consideration of Receptors

60 Receptors to be considered within the impact assessment were selected based upon analysis of regional and site-specific survey data (see *Section 12.5*), their relative conservation and ecological importance, and if they were highlighted as being of concern during consultation. For this assessment, each biotope, as identified through the detailed habitat mapping (*Appendix 12D*) is assessed, grouped according to their assigned sensitivity in relation to their conservation importance and ecological niche (e.g. sub-tidal infaunal communities, sub-tidal epibenthic communities, intertidal soft sediment communities, intertidal rocky shore communities, intertidal biogenic reefs, etc.) as responses to impacts will be largely consistent within these groups. Due to its internationally important conservation status (JNCC, 2012 and OSPAR, 2008b), the bivalve *Arctica Islandica* is specifically highlighted where impacts are likely on the population of this species. Where impacts on designated sites (including proposed MPAs) are possible, these are identified within the Impact Assessment below.

61 Table 12.9 and Table 12.10 highlight the qualification of the sensitivity assessment of each receptor group for the Development Area and Offshore Export Cable Corridor respectively. In addition, where wider biodiversity impacts are considered, e.g. in the assessment of non indigenous species (NIS) on the wider ecology of the area, these have been assessed against high level receptors accordingly, i.e. the wider benthic ecology of the region.

Table 12.9: Sensitivity of Receptors in the Development Area

Receptor	Grouping	Sensitivity	Qualification
SS.SMx.CMx.MysThyMx	Offshore soft Sediments	Low	Widely distributed habitat (recorded particularly along the east coast of southern Scotland and northern England), not considered of conservation importance or of key ecological importance for species outside this habitat (Rayment, 2008a).
SS.SCS.OCS SS.SCS.CCS.MedLumVen	Offshore soft Sediments	Moderate	Habitats of conservation importance (OCS is regarded as a conservation priority in the UK, whilst MedLumVen is listed under the EC Directive 92/43/EEC (*Habitats Directive*) as part of the features (*Section 9.2*): sandbanks which are slightly covered by sea water all the time, large shallow inlets and bays, and estuaries). These habitats are likely to provide a food source for predatory and opportunistic species, but are widely distributed throughout UK and offshore continental shelf.
A. islandica	Key sensitive species	Moderate	Species of International importance (listed on the threatened and/or declining OPSAR species list, and is a PMF in offshore waters). Provides an important food source, particularly for cod, but is abundant and widely distributed throughout UK coastal and offshore waters.

Table 12.10: Sensitivity of Receptors in the Offshore Export Cable Corridor

Receptor	Grouping	Sensitivity	Qualification
Sub-tidal			
SS.SMu.CFiMu.SpnMeg, SS.SCS.CCS	Sub-tidal soft sediments	Moderate	Habitats of International and National importance but not rare in their abundance. SpnMeg is distributed throughout UK waters and is listed under the EC Directive 92/43/EEC (the *Habitat Directive*), OSPAR convention (1998), *the UK Post-2010 Biodiversity Framework* (JNCC and Defra, 2012), and is a component biotope of the burrowed mud PMF. CCS is regarded as conservation priority in t*he UK Post-2010 Biodiversity Framework*, and is widely distributed around the UK.

Receptor	Grouping	Sensitivity	Qualification
Stony Reef	Key sensitive habitat	Moderate	Stony reef habitats present in the Offshore Export Cable Corridor have at best a low resemblance to Annex I reef criteria only (*Appendix 12C*).
SS.SMx.CMx, SS.SSa.CMuSa, SS.SMx.CMx.MysThyMx SS.SMx.CMx.FluHyd	Sub-tidal soft sediments	Low	Widely distributed habitats throughout the UK and offshore continental shelf, not considered to be of conservational importance. Likely to provide a food resource for predatory and opportunistic species.
Intertidal			
LR.MLR.BF.PelB, LR.HLR.MusB.Cht.Cht, LR.MLR.BF.FspiB, IR.MIR.KR.Ldig.Ldig, LR.LLR.F.FSpi.FS	Intertidal and sublittoral fringe rock	Low	Although of potential to be considered under the Annex I habitat of reef, these habitats were not considered to be of significant conservation value (*Appendix 12C*), and are widely distributed habitats throughout the UK. These habitats are likely to provide a food resource for predatory and opportunistic species.
LS.LSa.MoSa.AmSco.Sco, LS.LSa.FiSa.Po, LS.LSa.FiSa.Po.Aten	Intertidal soft sediments	Low	Although of potential to be considered under the Annex I habitat of mudflats and sandflats not covered by seawater at low tide, these habitats were not considered to be of significant conservation value (*Appendix 12C*), and are widely distributed habitats throughout the UK, Potential to provide a food resource for predatory and opportunistic species.

12.6.2 Uncertainty of Data

62 The uncertainty within the assessment is described as Low, Medium, or High based on data quality, availability of numerical models, presence of relevant case studies, and published studies of effects as follows.

63 Low uncertainty: Receptor responses to specified effect are well studied, and interactions are well understood. Quantitative, project specific data, is available against which to make the assessment, including Project specific modelling studies.

64 Medium uncertainty: Receptor responses to the specified effect are documented, and interactions are understood. Quantitative data or modelling studies are available against which to make the assessment, however these are un-validated or not Project specific.

65 High uncertainty: Receptor responses to specified effect are not well studied, and interactions are poorly understood. Quantitative data is not available against which to make the assessment, which is subsequently undertaken using a qualitative approach.

66 Where uncertainty exists, appropriate conservative assumptions are incorporated into assessment of magnitude. As a consequence, the assigned significance builds uncertainty into the assessment. This provides a high degree of confidence that the assessment conclusions are robust.

67 Key impacts where uncertainty has been incorporated into the assessment of magnitude are the introduction and spread of NIS, and the determination of contaminant bioavailability in disturbed sediments.

68 The introduction and spread of NIS is the area where high uncertainty exists. This uncertainty is present when quantifying the risk of potential colonisation, and in the subsequent prediction of interactions and effects on local fauna. To incorporate this uncertainty, a conservative assessment has been undertaken in relation to the magnitude of effects, in addition to consideration of wider ecological impacts in the assignation of receptors.

69 The assessment of contaminants in sediment and their associated bioavailability after disturbance is considered an area of medium uncertainty. Information on contaminant levels in the Development Area and Offshore Export Cable Corridor sediments have been obtained (*Section 12.5*), and have been used to inform the assessment of magnitude. Use of these levels builds in an appropriate level of conservatism to the assessment.

12.6.3 Identification of Impacts

70 Impacts to benthic ecology were identified at the scoping stage (see *Section 12.2*) and further informed by stakeholder responses within the Scoping Opinion. This consultation ensured that all key aspects, and those of concern to stakeholders, were addressed. Effects are classified as either direct or indirect. Direct effects are those such as loss and disturbance of habitats due to foundation installation, placement of jack up vessels, cable installation, and scour protection. Indirect effects include the redistribution of fine sediments as a result of construction activities, seabed contamination through accidental spillage of pollutants, and effects on seabed characteristics as a result of hydrodynamic changes (e.g. scour).

71 Consideration of Embedded Mitigation is included within Design Envelope and Embedded Mitigation (*Section 12.4*). Additional mitigation is discussed where necessary in *Section 12.11*.

72 Cumulative effects assessments are presented in *Section 12.10*.

12.6.4 Supporting Information for the Assessment

73 The assessments for impacts relating to increases in suspended sediments and the associated deposition of resuspended sediments are based on the outputs from the coastal processes assessment, found in *Chapter 10*.

12.7 Impact Assessment- Development Area

74 Impacts considered within this Development Area assessment are listed below relative to each development phase:

75 Effects of Construction (and Decommissioning):

- Direct temporary disturbance of seabed habitats caused by construction based activities;
- Indirect impacts of temporary increases in suspended sediment concentrations (SSC) from construction based activities and associated deposition;
- Release of contaminants bound in sediments;
- Secondary impacts of decreased primary production due to increased SSC of the water column;
- Potential release of pollutants from construction plant; and
- Introduction of Non Indigenous Species.

76 Effects of Operation

- Loss of original habitat;
- Changes in hydrodynamic regime and associated sediment transport;
- Scour and associated sediment transport leading to changes in seabed habitats;
- Colonisation of introduced substrata leading to a change in the benthic ecology and/or biodiversity;
- Provision of new substrata facilitating spread of NIS;
- Potential release of pollutants from operation plant;
- Responses to electromagnetic fields and thermal emissions; and
- Direct temporary habitat disturbance from operations and maintenance (O&M) activities.

12.7.1 Effects of Construction

<u>Direct Temporary Disturbance to Seabed Habitats Caused by Construction Based Activities</u>

77 Direct temporary disturbance of seabed habitat and associated benthic fauna will occur as a result of seabed preparation for foundation installation, inter-array cable burial, and jacking up activities associated with the installation.

78 As identified in Table 12.2, gravity base foundations (for WTGs, met masts, and OSPs) are the foundation option that present the worst case scenario with respect to temporary habitat disturbance. Temporary disturbance of 3.0 km^2 (2.0 per cent of the Development Area) will result from the dredging operations carried out to prepare the seabed for the gravity base installation. The majority of this area consists of the excavation pits for each foundation, with reduced levels of disturbance predicted outside of the excavation pit, but within the dredge affected area. No impacts of seabed preparation outside of this area are predicted, as studies show that during dredging activities there is little evidence of an impact on community structure outside the immediate boundaries of the intensively dredged site (Newell *et al.,* 2004).

79 Cable installation (ploughing or jetting) is predicted to impact a six metre wide corridor, within which a trench of one metre width will be excavated. The total area of habitat disturbed through cabling for the inter-array cables is 2.1 km^2 (1.4 per cent of the Development Area), though this includes variable levels of effect, from the excavation of sediments within the trench, to compaction related effects under the installation equipment. Additional seabed disturbance from cable installation vessel anchoring will affect a further 0.02 km^2 (0.01 per cent of the Development Area).

80 The number of jack-up vessels required over the construction period has been estimated assuming there is three localised vessel jack up movements at each WTG/platform location. Each jack up is estimated to have 600 m^2 footprint per location. The total area of disturbed habitat due to jack up activity is 0.4 km^2 (0.3 per cent of the Development Area).

81 The total area of habitat disturbance across the Development Area is 5.5 km^2 (3.7 per cent of the Development Area). The areas affected during cable installation and dredging will see variable levels of disturbance, with the greatest effects seen in the immediate vicinity of the trench (one metre width) where 100 per cent mortality can be expected. For the less disruptive activities, such as the contact of inter-array cable laying equipment tracks with the seabed, only the more fragile organisms such as thin shelled bivalves, e.g. *Abra prismatica,* may suffer 100 per cent mortality through compaction. As a result, habitat disturbance can be expected to reduce species richness and diversity across the affected area.

82 The 3.7 per cent of the Development Area disturbed would however not occur simultaneously as the works would be completed in phases, allowing some areas (buried inter-array cable, dredge affected areas, and jack-up vessel contact areas) to begin recovery during the construction phase. For example, the recovery of SS.SMx.CMx.MysThyMx, the most widespread habitat, is likely to begin within the construction period, as with favourable conditions partial recovery should occur within five years, with full recovery likely to take longer (Marshall, 2008).

83 Data from the EIA characterisation surveys show that within and immediately surrounding the Development Area the biotope SS.SMx.CMx.MysThyMx covers an area of 132 km^2. The total identified areas of SS.SCS.OCS and SS.SCS.CCS.MedLumVen are 62 km^2 and 8 km^2 respectively, although interpolation methods have been used for area calculations based on

geophysical and benthic point data (*Appendix 12D*). These habitats can be considered to be intolerant to substratum loss as the associated community is almost entirely infaunal and the removal of the substratum would lead to the loss of the biotope in these areas (Marshall, 2008). However, the biotopes are predicted to be widespread in the wider geographical area.

84 Using the minimum WTG spacing (820 m) the maximum number of WTGs possible within each of the defined habitats areas has been calculated. The maximum possible number of WTGs within each habitat in isolation is:

- 213 for SS.SMx.CMx.MysThyMx;
- 120 for SS.SCS.OCS; and
- 16 for SS.SCS.CCS.MedLumVen.

85 The placement of this many WTGs and associated inter-array cables, OSPs and jack-up placement, causes a disturbance to a percentage of the total habitat, 4.2 per cent, 5.3 per cent and 9.9 per cent of the total habitat area for SS.SMx.CMx.MysThyMx, SS.SCS.OCS, and SS.SCS.CCS.MedLumVen respectively. It is considered that this represents a worst case assessment, and further detail is provided in Table 12.11 where each biotope is assessed individually against the likely maximum potential disturbance. Although realistic, the assessment maintains a degree of conservatism as all OSP's and met masts are considered as present in each habitat type, which although unlikely is considered a possibility at this stage without detailed Wind Farm and OfTW layouts. As such, this approach has been adopted as a conservative assumption.

Table 12.11: Maximum Potential Areas of Direct Temporary Habitat Disturbance for each Biotope

Biotope (Sensitivity)	Activity	Description	Area km^2	% of Biotope
SS.SMx.CMx.MysThyMx (Low)	213 WTG foundations	125 m diameter affected by dredger per WTG.	2.61	1.98
	Three Met masts	125 m diameter affected by dredger.	0.04	0.03
	Five OSPs	300 m diameter affected by dredger per platform.	0.35	0.27
	100% of inter-array cabling disturbance	Trench affected width – six metres.	2.12	1.60

Biotope (Sensitivity)	Activity	Description	Area km^2	% of Biotope
	221 Jack-up	600 m^2 footprint per jack up vessel, one jack up vessel deployed with three movements per WTG, OSP and met mast foundation.	0.40	0.30
	Total		5.52	4.18
SS.SCS.OCS (Moderate)	120 WTG foundations	125 m diameter affected by dredger per WTG.	1.47	2.38
	Three Met masts	125 m diameter affected by dredger.	0.04	0.06
	Five OSPs	300 m diameter affected by dredger per platform.	0.35	0.57
	56% of inter-array cabling disturbance	Trench affected width – six metres.	1.19	1.91
	128 jack-up vessel	600 m^2 footprint per jack up vessel, one jack up deployed with three movements per WTG, OSP and met mast foundation.	0.23	0.37
	Total		3.28	5.29
SS.SCS.CCS.MedLumVen (Moderate)	16 WTG foundations	125 m diameter affected by dredger per WTG.	0.20	2.45
	Three Met masts	125 m diameter affected by dredger.	0.04	0.46
	Five OSPs	300 m diameter affected by dredger per platform.	0.35	4.42
	7.5% of inter-array cabling disturbance	Trench affected width – six metres.	0.16	1.99
	24 jack-up vessels	600 m^2 footprint per jack up vessel, one vessel deployed with three movements per WTG, OSP and met mast foundation.	0.04	0.52
	Total		0.79	9.84

86 *Arctica islandica*, considered to be intolerant to substrate removal (Sabatini *et al.,* 2008), was found at 35 per cent of the benthic grab stations with a maximum count of 5,000 individuals per 100 m^2. *A. islandica* was found in all three of the infaunal communities described through the habitat mapping (*Appendix 12D*). However, it was only in biotopes MysThyMx and MedLumVen that it was recorded as a main contributing species to those communities. Biotope mapping shows that the distribution of *A. islandica* therefore occurs as a contributing species over an area of 140 km^2 of the Development Area (96 per cent). Using the minimum spacing of WTGs, there is the potential to disturb 3.9 per cent of this area through construction related disturbance (potential for 213 WTGs, five OPS, three met masts and 100 per cent inter-array cabling to be located within this area). *A. islandica* is however widely distributed across the wider North Sea, and has been recorded at considerably higher densities than that found at the Development Area (e.g. 28,600 individuals per 100 m^2 in the Fladden Grounds (Witbaard and Bergman, 2003)).

87 Recovery of the species and habitats found across the Development Area will vary depending on the relative life cycles of those affected. For example, populations of *A. islandica* may take more than 10 years to reach maturity, although the high juvenile population recorded at the Development Area indicates a good larval supply to the area, suggesting that recovery to pre-impacted levels (i.e. a return to high juvenile abundance) may occur over a shorter timeframe than this. For most species, full recovery of diversity, abundance and biomass may take two to three years (based on estimates by Newell *et al*. (1998)). Recovery rates may affect the community structure at the Development Area, with a shift to the more generalist species seen, including a proliferation of scavenging species (e.g. starfish) capitalising on any damaged macrofauna (Hiscock *et al*., 2002). Although construction monitoring at offshore wind farm sites is still in its infancy, post construction monitoring at the Round 1 North Hoyle Offshore Wind Farm, which is considerably smaller than the Project, observed some temporal variability in infaunal abundance and species richness, although these variations were thought to be within natural levels of community variability (Cefas, 2009).

88 As described above, a decrease in abundance and richness will likely occur during construction, however according to the biotope mapping of the Development Area (*Appendix D*) no more than 10 per cent of each biotope is likely to be impacted (Table 12.12), including the habitats and species of conservation importance (SS.SCS.OCS and SS.SCS.CCS.MedLumVen and *A. islandica*). Despite the certainty of effects, the relatively small areas likely to be affected, and the likely recovery of the majority of the species within a relatively short time frame, results in the magnitude of effects being classed as low.

89 The low magnitude of effects, and moderate (SS.SCS.OCS, SS.SCS.CCS.MedLumVen, and *A. islandica*) and low (SS.SMx.CMx.MysThyMx) sensitivity results in a minor/moderate and minor impact respectively.

Table 12.12: Impact Summary of Direct Temporary Disturbance to Seabed Habitats Caused by Construction Based Activities

Receptor	Magnitude	Sensitivity	Significance
SS.SMx.CMx.MysThyMx	Low	Low	Minor
SS.SCS.CCS.MedLumVen, SS.SCS.OCS, Arctica islandica	Low	Moderate	Minor/Moderate

Indirect Impacts of Temporary Increases in Suspended Sediment Concentrations (SSC) from Construction Based Activities and Associated Deposition

90 Activities associated with the installation of WTGs, met mast, OSP substructures, and inter-array cables will increase SSCs in the water column through seabed disturbance. Two indirect impacts will result from this activity: increased SSC through the release of sediment into the water column to create sediment plumes; and the subsequent dispersion and deposition of this sediment, leading to potential smothering effects on benthic and epibenthic habitats. The greatest volume of arisings (sediment excavated) and therefore suspended sediment increases, result from the installation of gravity base foundations for WTGs, met masts, and OSPs, and this has therefore been used as the worst case scenario for this assessment.

91 *Chapter 10* assesses and quantifies the SSC during construction of the development, the depth of subsequent sediment deposition and also the distances over which both sediment plumes and deposition are predicted to occur.

Increased SSC

92 During seabed preparation for the installation of gravity based foundations it is predicted that SSCs will reach a maximum of 4000 mgl^{-1} above background levels close to the release location but that within one kilometre, levels will decrease to between 30 mgl^{-1} – 100 mgl^{-1} above background (fair weather baseline SSC is reported to be 15 mgl^{-1}, with winter storm SSC levels estimated to be 81 mgl^{-1} (*Chapter 10*)). These processes therefore exceed the predicted range of natural variability up to one kilometre from the activity. The majority of suspended material is predicted to settle after 10 - 20 minutes and the remainder over one to two hours.

93 Inter-array cable laying techniques are also predicted to cause an increase in the level of suspended sediments, the magnitude of which will primarily depend on the type of sediments present, and the cabling tool used. Detailed modelling of the sediment type present, and assuming a worst case use of energetic means, identified that typical SSCs in the vicinity of the trenching operation would be between 3 mgl^{-1} - 100 mgl^{-1}, with some localised peaks of between 100 mgl^{-1} to over 300 mgl^{-1} (maximum SSC, 322 mgl^{-1}). The bulk of the material (>98 per cent) will settle out within five to ten minutes, and the remaining

fine material will settle out within one hour. This prediction is conservative, estimating that the entire contents of the trench are resuspended by the cabling operation.

94 It is possible that elevated SSC impacts might result from two construction activities combined. This could arise through GBS dredging at the same time as cable burial, or jacket leg scour pit development at the same time as cable burial. As a worst case, the impacts identified above for the individual activities would be additive. For example, GBS dredging (maximum SSC up to 4000 mg/l above background) and cable burial by energetic means (maximum SSC up to 300 mg/l above background) could in theory combine to give a maximum SSC of up to 4300 mg/l above background. However, the potential for combined SSC impacts is unlikely to cause substantially higher impacts than those from the construction activities considered in isolation. First, there is little substantial difference in the predicted SSC since it tends to be the case that one activity or the other will dominate SSC impacts (most notably GBS dredging). Second, the additive impacts would only arise if the activities were being undertaken in close proximity and at a similar time, which is likely to occur infrequently, if at all. For all construction activities, the predicted SSC impacts are localised and transient. As such, the impacts from different construction activities on SSC can effectively be considered as independent.

95 At this level and duration, mortality of the species present is unlikely, but a decrease in growth may be experienced with recoverability predicted to be immediate. The time period for this SSC increase is predicted to be one to two hours at each installation, which is below the MarLIN benchmark of 100 mgl^{-1} for one month. Although dredging activity will be repeated for each installation over the construction period the spacing of WTGs and quick settlement of sediments results in little spatial overlap of increased suspended sediments throughout the construction period. As a result of the short duration of elevated suspended sediments at each foundation installation and the fact that levels quickly reduce with distance from source, benthic flora and fauna will only be subjected to increased SSC for a minimal duration.

96 The biotopes identified within the Development Area (SS.SMx.CMx.MysThyMx, SS.SCS.OCS, & SS.SCS.CCS.MedLumVen) are sedimentary in nature and, therefore, relatively tolerant to increases in SSC due to their predominantly infaunal communities. For example, *A. islandica* is likely to revert to deposit feeding following increases in suspended sediment (Sabatini *et al*., 2008). There are however some filter feeding species present within the main biotopes which are more sensitive to suspended sediment increases. For example, the main biotope, SS.SMx.CMx.MysThyMx, although a sedimentary habitat, does contain suspension feeders which may be adversely affected by an increase in suspended sediment through clogging of their feeding apparatus. Species such as *Amphiura filiformis* can tolerate slight increases in SSC by removing an excess of particles with mucus production, however increased cleaning can lead to an energy burden and reduced ingestion. Only a small area around each dredge location will experience levels of suspended sediment above 100 mg/l, with peak concentrations of 4,000 mg/l. These peak levels will however, be short lived and localised. The magnitude of increased suspended sediment effects is therefore classed as low. The proposed MPA, the Firth of Forth Banks Complex, is greater than one kilometre from the

Development Area, and as SSC levels at this distance are predicted to be within the range of natural variation (*Chapter 10*), no impacts of increased SSC are predicted on this proposed MPA.

97 The low magnitude of effects and moderate (SS.SCS.OCS, SS.SCS.CCS.MedLumVen, and *A. islandica*) and low sensitivity (SS.SMx.CMx.MysThyMx) results in a minor/moderate and minor impact respectively.

Smothering

98 Smothering of benthic fauna is likely to occur as suspended sediments settle out. Settlement is predicted to occur within an elliptical footprint due to the tidal influence, with a maximum thickness of 1.8 m occurring in the immediate vicinity of the release location, and all material settling out within 10 km. The areas of the development area impacted by a range of depositional depths from dredging activities are shown in Table 12.13.

99 Deposition caused by temporary increases in SSC from inter-array cabling activities is also likely to occur within the Development Area. The level of deposition from the inter array cable burial is estimated as a maximum of five millimetres within very close proximity of the cable laying activity, with depositional thicknesses of greater than one millimetre within one kilometre. Outside of this area, any remaining fine material in suspension will remain so indefinitely, or will settle out beyond three kilometres of the cabling location but not at thicknesses great enough to form a noticeable layer.

Table 12.13: Impact Areas for Range of Depositional Thresholds

Threshold	Area Covered due to all foundations (m^2)	% Coverage of Development Area
>3 mm	22,321,930	14.9
>3 cm	11,964,409	8.0
>5 cm	10,091,159	6.7
>30 cm	4,059,200	2.7
>3m	0	-

100 SS.SMx.CMx.MysThyMx, the main biotope across the Development Area, is likely to be tolerant of smothering up to five centimetres (MarLIN benchmark) since the majority of associated fauna are burrowing infauna. For example, the characterising suspension feeders *Mysella bidentata*, *Thyasira spp*., and *Amphiura filiformis*, are all capable of burrowing and are tolerant to a degree of smothering (Marshall, 2008).

101 The tolerance of the circalittoral coarse sediment biotopes (SS.SCS.OCS and SS.SCS.CCS.MedLumVen), to smothering is also considered to be high. This is because

shallow burying siphonate suspension feeders are typically able to escape smothering of 10 cm - 50 cm of their native sediment and relocate to their preferred depth by burrowing (Rayment, 2008a). These characterising species of SS.SCS.CCS.MedLumVen (venerid bivalves), do however require their siphons to be above the sediment surface in order to maintain a feeding and respiration current and so deposition of sediment in the order of 10 cm may reduce feeding and be energetically costly (Rayment, 2008a). Other species within this biotope will be affected to a larger degree, particularly those which cannot burrow through deposited sediment, potentially causing reductions in species richness. For example, sessile epifauna, such as *Hydroides norvegica,* would not be able to relocate following smothering and would not be able to feed or respire (Rayment, 2008a).

102 Sudden smothering of *A. islandica* would halt feeding, however, as a burrower *A. islandica* is able to switch from aerobic to anaerobic respiration and is generally considered to be tolerant of anoxia (Theede *et al*., 1969; Rosenberg and Loo, 1988). Even so, high mortality of a Baltic population was recorded following an anoxic event, thus the intolerance is classed as intermediate by MarLIN (Sabatini *et al.,* 2008). A 50 cm burial event is likely to represent an intolerable level of smothering for A. *islandica*, with very little chance of recovery of individuals. This level of deposition is only likely be found in very close proximity to the release location of the dredged sediment, and as such will represent a small loss (<2.7 per cent of the Development Area according to the modelled parameters) of the area within which *A. islandica* are present. Impacts of smothering on the features within the Firth of Forth Banks Complex proposed MPA (including *A. islandica*) are predicted to be negligible as depositional levels are not predicted to exceed one millimetre beyond one kilometre from the Development Area. Using the model output from the coastal processes assessment and the MarLIN sensitivity benchmark for smothering (five centimetres), the area over which deposition up to five centimetres occurs (i.e. that which will result in mortality of some species) is 9.0 km^2 (6.7 per cent of the Development Area).

103 Large scale mortality, reducing species richness and abundance, is unlikely within the area of deposition due to the tolerance of most species. Areas impacted above the MarLIN bench mark are relatively small, with effects and timescales for recovery not expected to exceed that for physical disturbance during seabed preparation (i.e. 2-3 years). The magnitude of the effect of smothering is therefore classed as moderate.

104 The moderate magnitude of effects, and moderate (SS.SCS.OCS and SS.SCS.CCS.MedLumVen and *Arctica islandica*) and low sensitivity (SS.SMx.CMx.MysThyMx) of receptors results in an impact of moderate and minor/moderate respectively.

Table 12.14: Impact Summary of Temporary Increases in SSC from Construction Based Activities and Associated Deposition

Impact	Receptor	Magnitude	Sensitivity	Significance
Increases in SSC	SS.SMx.CMx.MysThyMx	Low	Low	Minor
	SS.SCS.CCS.MedLumVen, SS.SCS.OCS, *Arctica islandica*	Low	Moderate	Minor/Moderate
Smothering	SS.SMx.CMx.MysThyMx	Moderate	Low	<Minor/Moderate
	SS.SCS.CCS.MedLumVen, SS.SCS.OCS, *Arctica islandica*	Moderate	Moderate	Moderate

Release of Contaminants Bound in Sediments

105 Marine sediments, particularly those comprising fine material, readily accumulate contaminants due to their sorptive nature; this storage reduces the toxicity potential to aquatic organisms (Eggleton and Thomas, 2004). Disturbance to the seabed could lead to the unlocking of contaminants which are then redistributed. Changes in sediment chemistry can also affect desorption into the water column and transformation of contaminants into more bioavailable or toxic chemical forms. Contaminants are known to have detrimental effects on benthic fauna which can then bio-accumulate.

106 As construction activities will re-suspend sediment, there is potential for contaminants to be released and redistributed in a bioavailable form. The magnitude of effects is assessed using contaminant levels recorded within the Development Area during baseline surveys and historical monitoring at Bell Rock disposal ground (detailed in *Appendix 12B*).

107 Despite a relatively large volume of material that could be excavated, the Development Area has a low percentage of fines (<10 per cent), with which contaminants are generally associated. The scale over which the majority of material, and therefore associated contaminants, will be transported during construction is predicted to be up to 10 km from the point of release (*Chapter 10*).

108 The potential for contaminants to remain within the Development Area is partially determined by the sediment type and exposure, with sheltered and moderately exposed areas with low water flow more likely to accumulate contaminants for long periods of time. The baseline survey showed contamination levels outside of the Development Area to be comparable to those within the Development Area. Despite the presence of a historic disposal ground, Bell Rock (situated partially within the Development Area), only low levels of organotins, PAHs and PCBs, were found within the Development Area (below Cefas AL 1, and Dutch and Canadian reference levels). Metal contamination showed higher values, with

Cefas AL 1 being exceeded for arsenic, cadmium, chromium, copper and nickel. Levels were also shown to be stable over the last decade, with comparable values to those recorded by MSS at Bell Rock, highlighting no active sources of contaminants exist in the area and therefore are expected to remain stable in the future.

109 When considering the effects of contamination release, measuring the total concentration does not necessarily accurately represent the bioavailable fraction (Bryan *et al*., 1985). A chemical is said to be bioavailable if it can move through or bind to a permeable surface coating (e.g. skin, gill epithelium, gut lining or cell membrane) of an organism (Newman and Jagoe, 1994). Disturbance activities associated with construction within the Development Area will expose anoxic sediment to an oxic environment and cause changes to the sediment chemistry (Eggleton and Thomas, 2004). This may lead to desorption and the transfer of chemicals to a more bioavailable and toxic form, although accurate measurements of this transformation are difficult to obtain (Eggleton and Thomas, 2004).

110 The sediments within the Development Area were not observed to have an anoxic layer during benthic surveys, although these observations were limited to the depth of the grab penetration. As such, much of the sediment disturbed during construction will not undergo oxidisation, reducing the potential for release of bioavailable contaminants.

111 The known effects of contaminants are limited to a small number of species where experimental and biological effects sampling has been carried out. Some information on the characterising species of the Development Area are reviewed by MarLIN, for example Olsgard (1999) reported that the abundance of *Chaetozone setosa* and *Thyasira sarsi* were only significantly reduced at the highest concentration of copper in the sediment (>2000 ppm). López-Jamar *et al.* (1988) reported that *Thyasira flexuosa* was moderately tolerant of copper in the sediment. The abundance of other species including *Pholoe minuta* had no significant correlation between the sediment content of copper and therefore seem highly tolerant of it (Olsgard, 1999). Bryan (1984) suggests that the larval and embryonic stages of bivalves are particularly intolerant of heavy metal contamination. Echinoderms are also regarded as being intolerant of heavy metals (e.g. Bryan, 1984; Kinne, 1984) while polychaetes are considered tolerant (Rayment, 2008b).

112 Any release of bioavailable contaminants would have a negative effect on the benthic community. However, due to the very low levels of organotins, PAHs, and PCBs recorded within the Development Area, combined with the limited re- distribution potential of any fines (maximum of 10 km from point of release), the magnitude of the re-suspension and deposition of sediments containing these contaminants is judged to be negligible. The sensitivity of the receptors, as described within *Section 12.6.1 Methodology*, are low or moderate, depending on their conservation importance. As such the impacts of PAH, PCB, and organotin release is defined as negligible/minor or minor respectively.

113 Metal concentrations (arsenic, cadmium, chromium, copper and nickel) at the Development Area are elevated above Cefas AL 1, and studies show that metals can reduce the faunal diversity in sedimentary habitats and adversely affect community structure (Hall *et al.*, 1997). Redistribution of metals is likely to have effects if transported to areas with a

comparably low level of contaminants, as species in these areas are not likely to be pre-adapted. However, the mobile nature of the sediments in the area, and the comparable levels of metal contamination across the Development Area, and out to an area beyond one tidal excursion, indicates that the maximum dispersal distance of redistributed sediments from construction activities (10 km) will not exceed areas already influenced by these levels of contamination. Potential areas that may be affected include the Firth of Forth Banks Complex MPA site, however considering the dispersive environment and mobile nature of the sediments present, and the fact that contaminant levels at the Development Area are not recorded as exceeding those in the surrounding area, it is considered that no increases to contaminant levels at the MPA site will result from the construction activity.

114 The presence of the historical disposal ground, Bell Rock, partially within the Development Area and the un-impacted status of benthic communities (Hayes *et al*., 2005) highlights their tolerance to the current levels of contaminants. The comparability of previous studies with the baseline benthic surveys indicates the stable nature of the communities in the area. Whilst abundances of these characterising species fluctuate over time, the communities themselves have shown stability and resilience to influxes of pollution, namely disposal of sewage sludge at the Bell Rock disposal ground.

115 The magnitude of effects of heavy metals is thus classified as low. This reflects the relatively high levels of metal contamination, but takes into account the low silt content of sediments, and the likely restricted area of re-distribution, in addition to the tolerance of benthic communities. The sensitivity of the receptors, as described within *Section 12.6.1 Methodology*, are low or moderate, depending on their conservation importance. As such the impact of metal contaminant release is described as minor or minor/moderate respectively.

Table 12.15: Impact Summary of Release of Contaminants Bound in Sediments

Contaminant	Receptor	Magnitude	Sensitivity	Significance
PAH, PCB and organotins	SS.SMx.CMx.MysThyMx	Negligible	Low	Negligible/Minor
	SS.SCS.CCS.MedLumVen, SS.SCS.OCS	Negligible	Moderate	Minor
Metals	SS.SMx.CMx.MysThyMx	Low	Low	Minor
	SS.SCS.CCS.MedLumVen, SS.SCS.OCS	Low	Moderate	Minor/Moderate

<u>Secondary Impacts of Decreased Primary Production Due to Increased SSC of the Water Column</u>

116 Phytoplankton production can be very low in environments with high turbidity, caused by the attenuation of light in the water column, due to inputs of suspended particulate matter and/or re-suspension of bottom sediments. This can confine photosynthesis to a shallow

photic zone and as a consequence, phytoplankton dynamics are largely controlled by light availability (Cloern, 1999) and nutrient availability.

117 The MarLIN benchmark for increases to turbidity are divided into those that are of short term (one month of high turbidity) and long term (one year at moderate to low turbidity). The construction period, approximately three years, for works within the Development Area therefore falls into the long term category, although turbidity will only increase for short periods within the whole construction phase in transient and localised areas.

118 The majority of primary production occurs in coastal waters and the temporary increase in turbidity due to construction activities is unlikely to have any measurable effect on this large scale process, especially as sediment plumes will be short lived and localised (>98 per cent of increased SSC settled within 10 to 20 minutes, with remainder settling within one to two hours) (see *Chapter 10*). Elevated SSC from construction activities are however predicted to exceed the range of natural variability of 15 mgl^{-1} - 81 mgl^{-1}, with peak levels of up to 4,000 mgl^{-1} above background levels predicted close to the release location and between 30 mgl^{-1} – 100 mgl^{-1} above background within one kilometre of the release point.

119 A decrease in the primary production of phytoplankton may have an effect on food availability, e.g. of deposit feeding species including *A. Islandica*, as reduced phytoplankton based detritus settles out to the seabed. Benthic communities also rely on nutrient input from pelagic and coastal fringe production, however, the nutrient input to such benthic communities originates from a very wide area and the effects on the benthos from changes induced by relatively small scale developments are unlikely to be detectable (Barnes and Hughes, 1992).

120 The magnitude of effects is therefore assessed as negligible as the nutrient input is unlikely to be altered at a detectable level. The sensitivity of the receptors, as described within *Section 12.6.1 Methodology*, are low or moderate, depending on their conservation importance, and as such the impact is negligible/minor and minor respectively.

Table 12.16: Impact Summary of Secondary Impacts of Decreased Primary Production

Receptor	Magnitude	Sensitivity	Significance
SS.SMx.CMx.MysThyMx	Negligible	Low	Negligible/Minor
SS.SCS.CCS.MedLumVen, SS.SCS.OCS, *A. islandica*	Negligible	Moderate	Minor

<u>**Potential Release of Pollutants from Construction Plant**</u>

121 Throughout construction there are sources that have the potential to add to the current levels of contaminants present at the Development Area, e.g. activities associated with WTG, OSP and met mast installations, inter-array cable laying, and associated vessel movements. The risk of accidental release of contaminants includes fuel, lubricating oils,

cleaning fluids, paints, sacrificial anodes, specialised chemicals and litter. Standard controls will be in place, including following best practice and guidelines for the prevention of pollution at sea, including the implementation of an EMP (see *Appendix 7A*), as described in *Section 12.4* that will detail pollution prevention and response procedures. As such it is not predicted that contaminants from construction plant will be introduced into the environment at a high level.

Benthic communities within the Development Area are likely to be pre adapted to current levels of contaminants, due to historical dumping, and likely to recover quickly. The risk of pollutants entering the environment during construction, if best practice as described in *Section 12.4* is followed, is low and as a result the magnitude of effect is low. The sensitivity of the receptors, as described within *Section 12.6.1 Methodology*, are low or moderate, depending on their conservation importance, and as such, this results in minor and minor/moderate impacts respectively.

Table 12.17: Impact Summary of Potential Release of Pollutants from Construction Plant

Receptor	Magnitude	Sensitivity	Significance
SS.SMx.CMx.MysThyMx	Low	Low	Minor
SS.SCS.CCS.MedLumVen, SS.SCS.OCS, *Arctica Islandica*	Low	Moderate	Minor/Moderate

<u>Introduction of Non Indigenous Species</u>

122 The introduction of NIS is possible through a number of pathways, including ships hulls, ballast waters, and the transport of materials to the Development Area. Embedded Mitigation as detailed in *Section 12.4* will reduce the potential for spread of NIS to the Development Area. Furthermore, as NIS is also a descriptor of Good Environmental Status (GES) under the Marine Strategy Framework Directive (MSFD, 2012), the prevention of NIS introduction will be a key component of the draft EMP (*Appendix 7A*).

123 Due to uncertainties within the assessment of NIS introduction at offshore developments, the potential long term effects on the local environment, and the importance in terms of the MSFD, a moderate magnitude of effect is ascribed. The sensitivity of existing benthic communities is considered to be low or moderate depending on their conservation importance, and as such the impact is considered to be minor/moderate and moderate respectively.

Table 12.18: Impact Summary of Introduction and Spread of Non Indigenous Species

Receptor	Magnitude	Sensitivity	Significance
SS.SMx.CMx.MysThyMx	Moderate	Low	Minor/Moderate
SS.SCS.OCS SS.SCS.CCS.MedLumVen *Arctica islandica*	Moderate	Moderate	Moderate

12.7.2 Effects of Operation and Maintenance

Loss of Original Habitat

124 The greatest potential area of habitat loss caused by the placement of WTG, OSP and met mast foundations and inter-array cable protection is 1.9 km^2, representing 1.3 per cent of the Development Area.

125 As with temporary habitat disturbance during the construction phase, a greater percentage of the less abundant habitats within the Development Area have the potential to be impacted by habitat loss. Table 12.19 details out the maximum percentages of original habitat loss that could occur through the minimum spacing of WTGs. This is considered a realistic, yet conservative assessment as all OSP's and met masts are considered as present in each habitat type, which although unlikely, is considered a possibility at this stage without detailed Wind Farm and OfTW layouts.

Table 12.19: Extent of Habitat Loss in Each Biotope

Installation	Parameters	Area Lost (km^2)	% of Habitat
SS.SMx.CMx.MysThyMx - habitat available = 132 km^2			
213 WTGs foundations	95 m diameter of footprint including scour protection	1.51	1.14
Three Met masts	95 m diameter of footprint including scour protection	0.02	0.02
Five OSPs	180 m diameter of footprint including scour protection	0.13	0.10
100% of protected Inter-array Cabling	Max of 10% of cable protected at an affected width – 6 m	0.21	0.16
Total		1.87	1.42
SS.SCS.OCS - habitat available = 62 km^2			
120 WTGs and foundations installation	95 m diameter of footprint including scour protection	0.85	1.37

Installation	Parameters	Area Lost (km^2)	% of Habitat
Three Met masts	95 m diameter of footprint including scour protection	0.02	0.03
Five OSPs installation	180 m diameter of footprint including scour protection	0.13	0.21
56% of protected Inter-array Cabling	Max of 10% of cable protected at an affected width – 6 m	0.12	0.19
Total		1.12	1.80
SS.SCS.CCS.MedLumVen - habitat available = 8 km^2			
16 WTGs and foundations installation	95 m diameter of footprint including scour protection	0.11	1.42
Three Met masts	95 m diameter of footprint including scour protection	0.02	0.27
Five OSPs installation	180 m diameter of footprint including scour protection	0.13	1.59
7.5% of protected Inter-array Cabling	Max of 10 % of cable protected at an affected width – 6 m	0.02	0.20
Total		0.28	3.48

126 As discussed within the construction phase impacts, habitat containing *A. Islandica* as a contributing species covers 140 km^2, and using the minimum WTG spacing, this equates to a possible maximum loss of 1.3 per cent of this habitat.

127 Therefore, 3.5 per cent or less of each habitat type is likely to be affected by permanent habitat loss (Table 12.19). As such, and despite the long term (i.e. present for the operational duration) nature of this effect which precludes recovery from this impact, the magnitude of the loss of original habitat on the benthic ecology at the Development Area is considered to be low according to the definitions described in Table 12.6.

128 The sensitivity of the receptors, as described within *Section 12.6.1 Methodology*, are low or moderate, depending on their conservation importance, and as such this results in minor and minor/moderate impacts respectively.

Table 12.20: Impact Summary of Loss of Original Habitat

Receptor	Magnitude	Sensitivity	Significance
SS.SMx.CMx.MysThyMx	Low	Low	Minor
SS.SCS.CCS.MedLumVen, SS.SCS.OCS, *Arctica islandica*	Low	Moderate	Minor/Moderate

Changes in Hydrodynamic Regime and Associated Sediment Transport

129 Changes to hydrodynamic and sediment transport processes are predicted in *Chapter 10* which in turn have informed this assessment of potential associated effects on the benthic ecology. Results from the predictive modelling indicate a small change to tidal currents, which include increases and decreases in water flow up to 0.04 ms^{-1} (seven per cent change from baseline) in the immediate vicinity of the WTG foundations within the Development Area. These small changes predicted to occur in the hydrodynamic conditions at the Development Area due to the installation of the infrastructure are considered to be well within the range of natural variability with negligible effects to the overall sediment transport predicted (*Chapter 10*).

130 Changes in currents have been predicted to increase on the ebb tide and decrease on the flood tide (*Chapter 10*), and are predicted to slightly and temporarily (over a period of minutes) increase the levels of sediment mobilisation at the Development Area. The main biotopes found across the Development Area are of mixed or coarse sediment and therefore less sensitive to changes in water flow. However, within the main biotope across the Development Area, SS.SMx.CMx.MysThyMx, it is the muddy component of the sediment that supports the various deposit feeders. An increase in currents could lead to a reduction in the finer sediment fraction, as a result of an increase in erosion and winnowing of fine sediments from the seabed, and a decrease in organic matter, reducing the habitats suitability for species such as *Amphiura filiformis*, *Spiophanes bombyx* and *Thyasira flexuosa*. In contrast, a decrease in water flow rate as is predicted on the flood tide may increase the deposition of finer sediments. Although the associated increase in deposition of finer sediment particles may benefit deposit feeders due to increased deposition of organic material, passive suspension feeders may experience a reduction in feeding efficiency due to clogging of feeding apparatus. It is considered that the highly localised and temporary changes in increased sediment mobilisation predicted in the Development Area are unlikely to cause such effects (*Chapter 10*).

131 The highly localised and temporary effects predicted to the hydrodynamics across the Development Area results in a negligible magnitude of effects. The sensitivity of the receptors, as described within *Section 12.6.1 Methodology*, are low or moderate, depending on their conservation importance, and as such this results in a negligible/minor and minor impact respectively.

Table 12.21: Impact Summary of Changes in Hydrodynamic Regime and Sediment Transport

Receptor	Magnitude	Sensitivity	Significance
SS.SMx.CMx.MysThyMx	Negligible	Low	Negligible/Minor
SS.SCS.CCS.MedLumVen, SS.SCS.OCS, *A. islandica*	Negligible	Moderate	Minor

Scour and Associated Sediment Transportation Leading to Changes in Habitats

132 Changes to currents at the scale identified above (*Changes in Hydrodynamic Regime and Associated Sediment Transport*) will however cause localised scour. Scour protection on gravity based foundations would result in no significant increases in suspended sediment or deposition. Therefore, during operation the greatest effect is represented by jacket foundations with no scour protection. As highlighted in *Chapter 10*, without scour protection the lateral extent of the area affected at jacket foundations by scour would be 12 m on a peak spring tide in line with tidal orientation. Total scour footprint per WTG foundation during a spring tide is 2,261 m^2, which results in an area of 0.5 km^2 across the Development Area (0.3 per cent).

133 Peak concentrations of suspended sediment as a result of scour are predicted to be within 30 mgl^{-1} and 100 mgl^{-1} in the immediate vicinity of the foundations (compared to 15 mgl^{-1} background). Levels quickly drop to less than 10 mgl^{-1} above background within 100 m from the foundation and falling to <1 mgl^{-1} above background levels beyond one kilometre from the foundation. This increase in SSC produces a maximum deposition of 1.1 m at the WTG base, and depositions of up to 10 cm within a distance of 150 m from the foundation. Beyond this distance, deposition drops markedly, with depositional depths of <1 mm predicted beyond 200 m from the location of scour.

134 Communities within the direct scour footprint will experience altered conditions during operation but the area of effect is small (0.3 per cent across the Development Area). Within this area benthic communities will experience increased instability, and a loss of finer grained sediments, leading to a reduction in species intolerant to such disturbance over the life of the Wind Farm. The area of scour footprint resulting from the jacket foundations will also be lesser than the area of Loss of Original Habitat identified above for the Gravity base structures (GBS) option and as such will impact on habitats to a lesser extent than the Loss of Original Habitat impact type.

135 Suspended sediment increases due to scour are predicted to be below the MarLIN benchmark of 100 mgl^{-1}. The levels highlighted are however only representative of the peak volumes and are not expected to be constant, rather increased SSC will exist at variable levels depending on the tidal flow rates until scour equilibrium is reached after 12 days. Smothering impacts caused by the deposition of scoured material are also predicted, with levels exceeding the MarLIN benchmark of 5 cm over an area of 4.6 km^2 (3.1 per cent of the

Development Area), with maximum depositional depths of 1.1 m found in the immediate vicinity of the WTG foundations. This may cause unfavourable conditions for intolerant species thereby reducing the species diversity and richness within this area. However, deposition would be gradual over a number of tides, before reaching equilibrium (approximately 12 days for spring tide conditions). The deposition of sediment is also predicted to be temporary, as tidal and wave events will constantly remobilise the fine sediments for further dispersion.

136 The habitats affected by the deposition of scour related sediments are sedimentary in nature and are not sensitive to a temporary increase in deposition rates. As such a temporary reduction in diversity may be experienced, with those species tolerant to deposition and suspended sediment increase favoured in the short term, with full recovery likely once equilibrium has been established, comparable to that described within the construction phase.

137 Smothering of *A. islandica* would halt feeding of this species, however as a burrower *A. islandica* is able to switch from aerobic to anaerobic respiration and is generally considered to be tolerant of anoxia (Theede *et al*., 1969, Rosenberg and Loo, 1988). A 50 cm burial event is likely to represent an intolerable level of smothering for *A. islandica*, with very little chance of recovery of individuals. This level of deposition is only predicted to occur in very close proximity to the WTG foundations, covering 0.4 per cent of the Development Area.

138 Despite the size of the area affected by scour related increased suspended sediments and subsequent smothering, the temporary nature of the impact, gradual deposition of sediments, and tolerance of the receptors, means that the overall magnitude of the effect is considered to be low.

139 The sensitivity of the receptors, as described within *Section 12.6.1 Methodology*, are low or moderate, depending on their conservation importance, and as such this results in a low and low/moderate adverse significance respectively. The impact is therefore not significant.

Table 12.22: Impact Summary of Changes in Hydrodynamic Regime and Sediment Transport

Receptor	Magnitude	Sensitivity	Significance
SS.SMx.CMx.MysThyMx	Low	Low	Low
SS.SCS.CCS.MedLumVen, SS.SCS.OCS, A. islandica	Low	Moderate	Low/Moderate

Colonisation of Introduced Substrata Leading to a Change in the Benthic Ecology and/or Biodiversity

140 Colonisation of scour or inter-array cable protection in addition to foundations themselves is expected within the Development Area. GBS foundations provide the greatest footprint area for colonisation, an area that will be further increased through the use of scour and cable protection to a maximum footprint of 1.87 km^2 (1.3 per cent of the Development Area).

141 This introduction of new substrate will have direct effects on the overall biodiversity of the Development Area, and indirect effects through increased food availability to higher trophic levels (see *Chapter 13*). Furthermore, studies have shown that soft sediment benthic communities in the direct vicinity of the foundations are altered by the introduction of such habitat, with hard substrate species present in the sediments surrounding the foundations (Degraer *et al*., 2011).

142 Community changes will be localised to the new habitat, and to those existing habitats immediately surrounding the new habitat, and due to the necessary separation between WTGs, a significant change to the existing benthic ecology over the entirety of the Development Area is not expected. Changes are likely to be present throughout the operational phase, and effects therefore are predicted to be of negligible magnitude.

143 The sensitivity of existing benthic communities is considered to be low or moderate depending on their conservation importance, and as such the significance of the impact is considered to be negligible/minor and minor respectively.

Table 12.23: Impact Summary of Colonisation of Introduced Substrata

Receptor	Magnitude	Sensitivity	Significance
SS.SMx.CMx.MysThyMx	Negligible	Low	Negligible/Minor
SS.SCS.OCS, SS.SCS.CCS.MedLumVen, *Arctica islandica*	Negligible	Moderate	Minor

Introduced Substrata Facilitating the Spread of NIS

144 Measures to prevent the introduction of NIS will be as described for the construction phase impacts, and will incorporate the Embedded Mitigation identified as described in *Section 12.4*.

145 Negative effects of the introduction of new substrate include the increased risk of spread of NIS through colonisation of the new substrate. For example, splash midge (*Telmatogeton japonicas),* a NIS in Nordic waters, was found on Danish wind farms in the North Sea. However while dense tubes of this species may modify microhabitats, no serious adverse impacts are currently known (Jensen, 2010). Brodin and Andersson (2009) highlighted that the increasing number of offshore wind farms may provide a mechanism by which this

species might expand its geographic range in addition to facilitating the potential for colonisation of invasive species more generally.

146 Effects of NIS are expected to be isolated around foundations and not impact the wider benthic community structure. However, due to the potential for NIS to expand their range, and the use of NIS as a descriptor of GES under the MSFD, the prevention of NIS introduction will be a key component of the EMP (*Appendix 7A*).

147 Despite the limited spatial extent of the effect, and due to uncertainties within the assessment of NIS introduction at offshore developments, the potential long term effects on the local environment, and the importance in terms of the MSFD, a moderate magnitude of effects is ascribed. The existing benthic communities are considered to be of no greater than moderate sensitivity, and as such the impact is considered to be moderate.

Table 12.24: Impact Summary of Introduction and Spread of NIS

Receptor	Magnitude	Sensitivity	Significance
Benthic and epibenthic communities	Moderate	Moderate	Moderate

<u>**Potential Release of Pollutants from Operational Plant**</u>

148 As with the construction phase, a number of possible pollution sources exist during operation. The effects of pollution on the local environment, and the standard controls and implementation of the EMP (*Appendix 7A*) as described in *Section 12.4* and outlined for the construction phase also apply during the operation phase. The impact magnitude is therefore assessed as low.

149 The sensitivity of existing benthic communities in the Development Area is considered to be low or moderate depending on their conservation importance, and as such the impact is considered to be minor and minor/moderate respectively.

Table 12.25: Impact Summary of Potential Release of Pollutants from Operation Plant

Receptor	Magnitude	Sensitivity	Significance
SS.SMx.CMx.MysThyMx	Low	Low	Minor
SS.SCS.OCS SS.SCS.CCS.MedLumVen, Arctica islandica	Low	Moderate	MInor/Moderate

Responses to Electromagnetic Field (EMF) and Thermal Emissions

150 EMF effects are relatively well documented in some fish species such as elasmobranchs, however it is currently poorly understood in invertebrates (*Appendix 13C: Electromagnetic Field Assessment)*. However, decapods (*Crangon crangon*), isopods (*Idotea baltica*) and amphipods (*Talorchestia martensii* and *Talitrus saltator*) have been shown to experience magnetic sensitivity (Gill *et al.,* 2005; Gill *et al*., 2009). However, despite the limited information on EMF effects on benthic organisms, no adverse effects have been observed in the research, with any impacts that may occur expected to be highly localised, and in close vicinity to the cables (Meißner and Sordyl, 2006).

151 Warming of the surrounding area along subsea cables is also possible as electricity is transported along the conductors, and there is evidence that various marine organisms react sensitively to even a minor increase in the ambient temperature (OSPAR, 2009), with some benthic organisms showing intolerance to temperature increases. *A. islandica* is highlighted in the MarLIN sensitivity matrix to be intolerant to temperature increases which could play a part in their distribution in the North Sea (i.e. they are not found south of 53 ° 30 ´ N (Witbaard and Bergman, 2003)). The MarLIN benchmark is defined for both short term changes (5.0 °C for three days) and long term changes (20.0 °C for a year).

152 In general, heat dissipation due to transmission losses can be expected to be more significant for AC cables than for High Voltage DC cables at equal transmission rates, and loss in coarse sediments is expected to be greater than in fine material (OSPAR, 2009). As such *Section 12.4* identifies the AC option as the Design Envelope worst case. Field data for thermal radiation is however limited. The rise in temperature at the Nysted wind farm did not provide conclusive results (Meißner *et al*., 2007), but suggested that the rise in temperature did not exceed 1.4 °C in 20 cm depth above the cable (OSPAR, 2009). In New York, the cross sound cable interconnector project estimated a 0.19 °C rise in temperature at the seabed immediately above the buried cable and an associated increase in seawater temperature of 0.000006°C (The Department for Business, Enterprise and Regulatory Reform (BERR), 2008).

153 The majority of benthic organisms live in the top tens of centimetres, with even deep burrowing bivalves unlikely beyond 0.5 m. The target burial depth of the inter-array cable (one metre), and protection where burial is not feasible, will reduce interaction with benthic species and thus EMF and thermal effects are not predicted beyond a negligible magnitude. The sensitivity of existing benthic communities is considered to be low or moderate depending on their conservation importance, and as such the resulting impact of EMF and heating of the sediments due to electrical transmission is negligible/minor and minor respectively.

Table 12.26: Impact Summary of Electromagnetic Field (EMF) and Thermal Heating Effects

Receptor	Magnitude	Sensitivity	Significance
SS.SMx.CMx.MysThyMx	Negligible	Low	Negligible/Minor
SS.SCS.OCS, SS.SCS.CCS.MedLumVen, *Arctica islandica*	Negligible	Moderate	Minor

<u>Temporary Habitat Disturbance from Operation and Maintenance (O&M) Activities</u>

154 The use of jack-up vessels throughout the operational phase will impact benthic communities through compression of sediments beneath the legs, and subsequent damage to benthic fauna. In addition to the WTG, OSP, and met mast maintenance, inter-array cable maintenance may also be required, with a worst case assumption of up to 10 per cent re-burial of the inter-array cables. The total area of annual disturbance is therefore 0.14 km^2 (0.09 per cent of the Development Area).

155 This area represents a temporary disturbance, with recovery of communities expected in line with that identified for the construction phase impact of temporary habitat disturbance due to foundation installation, i.e. two to three years for the majority of species and habitats. As a result of this, and due to the small area of effect, the magnitude of this impact is considered to be negligible. The sensitivity of existing benthic communities is considered to be low or moderate depending on their conservation importance, and as such the impacts are determined as negligible/minor and minor respectively.

Table 12.27: Impact Summary of Temporary Habitat Disturbance from O&M Activities

Receptor	Magnitude	Sensitivity	Significance
SS.SMx.CMx.MysThyMx	Negligible	Low	Negligible/Minor
SS.SCS.OCS, SS.SCS.CCS.MedLumVen, Arctica islandica	Negligible	Moderate	Minor

12.7.3 Effects of Decommissioning

156 The potential effects of decommissioning are considered to be equivalent to and potentially lower than the worst case effects assessed for the construction phase. The approach to decommissioning is described in *Section 7.12*. A decommissioning plan will be prepared in accordance with the requirements of the *Energy Act 2004* (see *Section 3.2.5*) and will be subject to approval from the Department of Energy and Climate Change (DECC) prior to implementation

157 In particular no seabed preparation through dredging will be required for the decommissioning phase. Removal of the GBS is expected to cause some material to be suspended in the water column. However, the scale of this effect is predicted to be less than the effects of GBS dredging during the construction phase. As such the impacts relating to GBS preparation and SSC would be much lower than those predicted for the construction phase.

12.8 Impact Assessment- Offshore Export Cable Corridor

158 Impacts considered within this Offshore Export Cable Corridor assessment are listed below relative to each development phase:

- Effects of Construction (and Decommissioning):
  - Direct temporary disturbance of seabed habitats caused by construction based activities;
  - Indirect impacts of temporary increases in SSC from construction based activities and associated deposition;
  - Release of contaminants bound in sediments;
  - Secondary impacts of decreased primary production due to increased SSC of the water column;
  - Potential release of pollutants from construction plant; and
  - Introduction of NIS.
- Effects of Operation:
  - Loss of original habitat;
  - Colonisation of introduced substrata leading to a change in the benthic ecology and/or biodiversity;
  - Provision of Introduced Substrata Facilitating spread of NIS;
  - Potential release of pollutants from operation plant;
  - Responses to EMF and thermal emissions; and
  - Direct temporary habitat disturbance from O&M activities.

12.8.1 Effects during Construction

Direct Temporary Disturbance of Seabed Habitats caused by Construction Activities

Sub-tidal Area

159 Disturbance to the seabed, leading to changes in the habitat and species therein will occur during the installation of the Offshore Export Cable. Where cable burial equipment is used, this area of disturbance will be associated with the compression of sediments beneath the plant over the trench affected width of six metres. Within this trench affected area, a trench

of one metre width will be excavated. The activities will be similar to the inter-array cabling, within the Development Area, as described in *Section 12.7.1*.

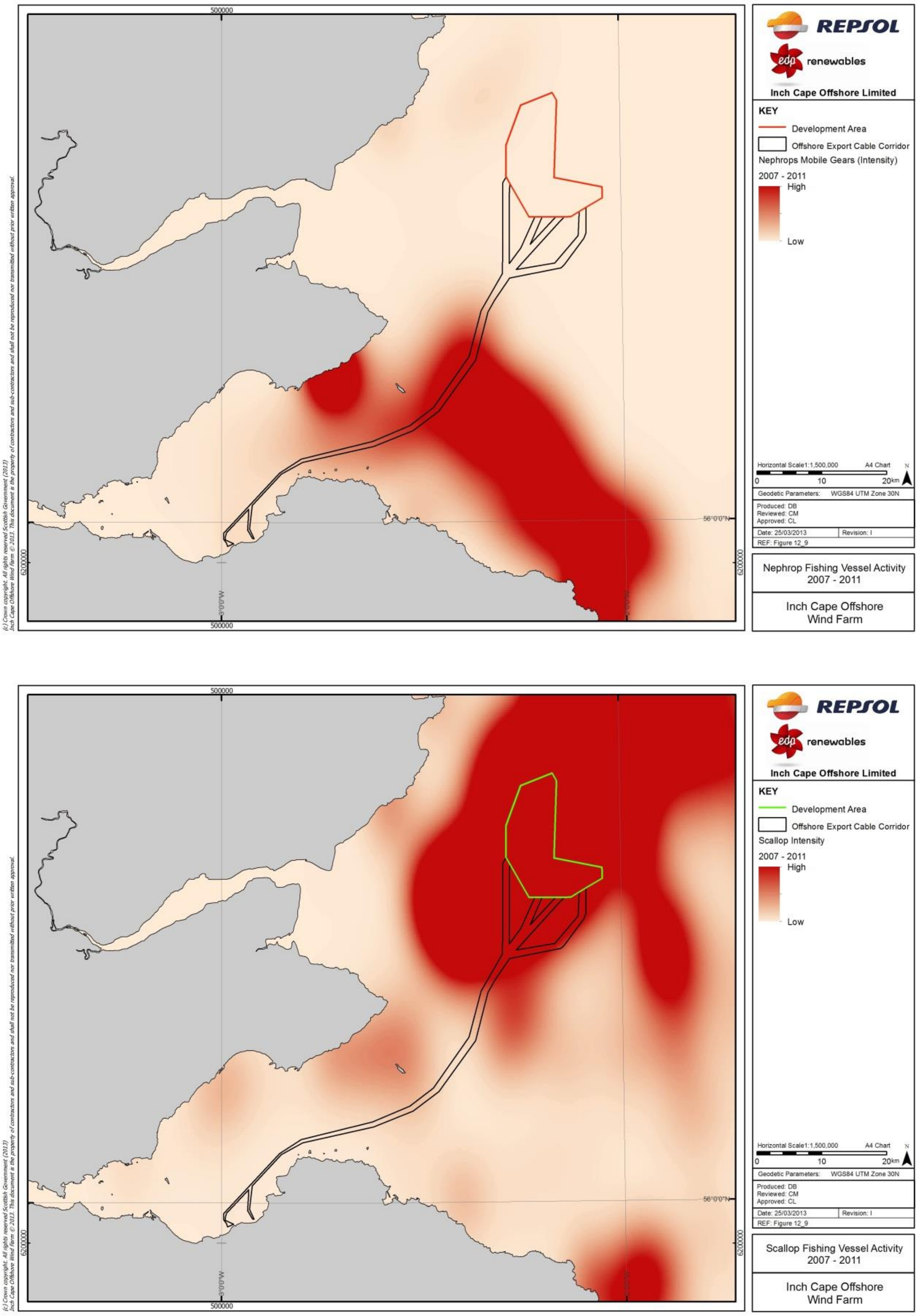
160 The total area of temporary direct disturbance caused by the installation of the Offshore Export Cable is 3.0 km^2, 3.0 per cent of the 100 km^2 Offshore Export Cable Corridor. The majority of the species present will be lost within the immediate vicinity of the one metre trench, however recovery will begin after cable installation so the loss is considered temporary. Effects to the remainder of the six metre trench affected area will be a product of compression and compaction of the sediments beneath the construction plant.

161 A number of habitats of conservation importance were identified during the Offshore Export Cable Corridor baseline surveys namely SS.SMu.CFiMu.SpnMeg, and SS.SCS.CCS. Of these, SS.SMu.CFiMu.SpnMeg is the most dominant in terms of area and is likely to extend away from the Offshore Export Cable Corridor for some distance where hydrographic and sedimentary conditions are favourable.

162 Characterising species of this biotope include the sea pens *Virgularia mirabilis* and *Pennatula phosphorea*. These epifaunal species are likely to be dislodged or damaged by the trenching equipment, however studies of fishing related damage identified that sea pens can re-attach to the sediment if dislodged, and their ability to retract into the sediment may provide some resilience to physical disturbance. The presence of these species in this area of known *Nephrops* trawling indicates that this is the case (Figure 12.9, and *Chapter 18*). Other characterising species that will be affected by the installation of the Offshore Export Cable include the burrowing crustaceans *Nephrops norvegicus*, *Calocaris macandreae,* and *Jaxea nocturna,* and the echiuran worm *Maxmuelleria lankesteri*. Less robust, or shallower burrowing species such as some bivalves and polychaetes are likely to be affected to a greater degree, suffering an initial loss of individuals in this trench affected area, followed by recovery post-cable installation.

163 Recovery of this biotope in areas of total loss is likely to be variable depending on individual species and the level of impact, although complete recovery is likely to require several years (Meißner and Sordyl, 2006). The reproductive biology of the sea pens found in this habitat has not been studied, but work on other species suggest that some may live up to 15 years, and take five or six years to reach sexual maturity (Birkeland, 1974). Larval settlement can be patchy in space and highly episodic in time, with no recruitment taking place in some years (Davis and Van Blaricom, 1978). Recovery of these species is therefore likely to be slow and patchy in its occurrence. Recovery of other species (large burrowing species (e.g. *Nephrops*) and polychaetes and bivalve species) is likely to occur rapidly, with recruitment and adult migration both contributing. It is considered however, that due to the long life histories of a number of key species, the time required for this habitat to reach maturity following loss is approximately five years (Sabatini and Hill, 2008; Budd, 2008b).

Figure 12.9: Fishing Vessel Activity in Relation to the Development Area and Offshore Export Cable Corridor, 2007 – 2011



164 As with SS.SMu.CFiMu.SpnMeg, other infaunal or epifaunal communities present within the trenched area (one metre) can be considered to be temporarily lost during Export Cable installation, with a variety of disturbance related effects experienced within the remainder of the trench affected area. Recovery of infaunal species is likely to be rapid (within one year) due to their relatively high dispersal potential and short life histories (Hill, 2008). Epibenthic species, such as encrusting bryozoans, hydroids, and ascidians are likely to re-establish within two years, with *Flustra foliacea* (a key species of the FluHyd biotope) likely to reach an abundance of occasional (–1.0 – 5.0 per cent cover) within four years and recover to its pre-impacted density within five years (Tyler-Walters and Ballerstedt, 2007).

165 Due to the small areas affected by the cable installation (three per cent of Offshore Export Cable Corridor), and the relatively fast recovery of the majority of species, the magnitude of this impact is considered to be low. Only a very small proportion of the low quality stony reef habitat will be temporarily disturbed, and other examples of this habitat type exist elsewhere outside of the Offshore Export Cable Corridor at the Isle of May SAC, for instance. The wider availability of stony reef habitat will therefore not be affected. The sensitivity of the receptors is considered to be low, or moderate for those habitats of conservation importance, (SS.SMu.CFiMu.SpnMeg, stony reef, and SS.SCS.CCS) and as such the impact of direct temporary habitat disturbance in the offshore environment is considered to be minor or minor/moderate respectively.

Intertidal Area

166 The intertidal areas affected by direct temporary disturbance during construction at Cockenzie and Seton Sands cover 4,320 m^2 and 13,968 m^2 respectively (4.1 and 0.7 per cent of the intertidal area respectively).

Sedimentary Habitats

167 The area affected during Export Cable installation is predicted to be of the same magnitude as for the sub-tidal cable installation described above (six cables each with six metre trench affected areas), with a range of disturbance related impacts in the affected areas, depending on the sensitivity of the organisms to physical abrasion. Recovery of sandy intertidal biotopes characterised by polychaetes is predicted to take between one to two years after installation impacts have ceased (Budd, 2008a), and as such the magnitude of the effect to these features is considered negligible.

168 The sensitivity of the habitats is considered to be low, and as such the impact of habitat loss and disturbance is considered to be negligible/minor.

Rocky Habitats

169 Although it is assumed that from a technical feasibility perspective installation in the intertidal area will avoid areas of hard substrates, impacts to rocky/boulder habitats may occur and will be variable depending on installation methods used (e.g. directional drilling, mechanical cutting, etc.), with mechanical cutting considered the worst case. The removal of rocky habitats will cause a temporary loss of species richness and diversity in these habitats.

Recovery is dependent on the suitability of the replaced substrate and the life cycle of the characterising species, which are typically long for rocky intertidal species (Fucoids four to five years, limpets up to 20 years, but usually < 10 years, and barnacles at least five years but sometimes as long as 20 years (Hill *et al.,* 1998)). As such recovery, assuming a temporary loss of all species, will take at least 10 years, potentially longer to reach full maturity. This process will be helped through adult migration from outside areas, and so the timeframe may be reduced. Due to the potential long timescales required for the recovery of the rocky habitats, despite the small area of effect, a magnitude of low has been predicted.

170 The sensitivity of the habitats is considered to be low, and as such the impact of habitat loss and disturbance is considered to be minor**.**

Table 12.28: Impact Summary of Direct Temporary Disturbance due to Construction Activities

Receptor	Magnitude	Sensitivity	Significance
SS.SMu.CFiMu.SpnMeg, SS.SCS.CCS, Stony Reef	Low	Moderate	Minor/Moderate
SS.SMx.CMx, SS.SSa.CMuSa, SS.SMx.CMx.MysThyMx SS.SMx.CMx.FluHyd	Low	Low	Minor
LR.MLR.BF.PelB, LR.HLR.MusB.Cht.Cht, LR.MLR.BF.FspiB, IR.MIR.KR.Ldig.Ldig, LR.LLR.F.FSpi.FS	Low	Low	Minor
LS.LSa.MoSa.AmSco.Sco, LS.LSa.FiSa.Po, LS.LSa.FiSa.Po.Aten	Negligible	Low	Negligible/Minor

<u>Indirect Impacts of Temporary Increases in Suspended Sediment Concentrations SSC from Construction Based Activities and Associated Deposition</u>

<u>Sub-tidal Area – Increased SSC</u>

171 Cable laying techniques will cause an increase in the level of suspended sediments, the magnitude of which will primarily depend on the type of sediments present, and the cable installation methodology selected. Detailed modelling of the sediment type present (assuming a worst case use of an energetic tool) identified that SSCs in the vicinity of the trenching operation would typically be about 3.0 mgl^{-1} - 10 mgl^{-1} above background (typically between 3.0 mgl^{-1}-100 mgl^{-1}, with some localised peaks of up to 322 mgl^{-1}). Most of the resulting sediment plume will settle out within tens or a few hundred metres of the Export Cable, over a period of seconds or minutes. The finest (mud and silt) sediment fractions will persist for longer in the water column and be carried further, but even these will generally not be advected beyond the near-field vicinity of the Export Cable (less than three kilometers), and will settle out within a few hours of disturbance. This prediction is

conservative, estimating that the entire contents of the trench are resuspended by the cabling operation. Even with this conservative estimate this level is below the MarLIN benchmark of 100 mgl^{-1} for one month.

172 Increased suspended sediments can affect filter feeding mechanisms, clog gills, and affect respiratory processes. The offshore habitats present along the Offshore Export Cable Corridor are predominantly sedimentary in nature, with an infauna that is tolerant of such short term increases in suspended sediment levels. Epifauna such as seapens may suffer some clogging of filter feeding apparatus, especially if subject to high levels. However, these animals are relatively tolerant of increased suspended sediments, and their ability to self-clean their feeding apparatus means that the energetic cost of any clogging is likely to be low (Hill, 2008). Other filter feeding fauna (e.g. bryozoans, soft corals) may suffer some reduction in feeding efficiency, however the epifaunal biotopes typified by these species along the Offshore Export Cable Corridor (e.g. SS.SMx.CMx.FluHyd) are frequently found in high sediment environments and have a high tolerance to this impact (Tyler-walters, 2008b). As a result, the magnitude of effect is considered negligible.

173 The sensitivity of the receptors is considered to be low, or moderate for those habitats of conservation importance, (SS.SMu.CFiMu.SpnMeg, stony reef, and SS.SCS.CCS) , and as such the impact of increased suspended sediments produced via Export Cable installation on the benthic environment is considered negligible/minor and minor respectively**.**

174 The Annex 1 rocky reef habitats identified within the Isle of May SAC (*Chapter 9*) are predicted to be outside of the resulting sediment plume from Export Cable installation activities as they are over four kilometres from the Offshore Export Cable Corridor. As such no impacts are predicted on these qualifying features.

175 At more than 1.5 km for the Offshore Export Cable Corridor the Aberlady Bay LNR is predicted to be outside the areas of highest increased SSC which is within a few hundred metres of the Export Cable. As such no impacts are predicted on these features of interest.

Intertidal Area – Increased SSC

176 In the intertidal environment, construction activities undertaken at high water (i.e. continuation of the sub-tidal ploughing) will have effects (and a subsequent magnitude) analogous to those seen in the sub-tidal area.

177 Other construction activities are predicted to be undertaken at low tide (e.g. directional drilling and open trenching) and as such no significant suspended sediments are predicted during construction by these methods. Immediately after construction however, some localised increases in SSC may be evident as the tide rises. These are likely to be of relatively low magnitude (BERR, 2008) and considering the highly mobile and dynamic nature of the environment, well within the tolerances of the species present (Budd, 2008a; Tyler-Walters, 2008a). As such, no further impacts of increased suspended sediments are predicted in the intertidal area.

178 The sensitivity of receptors is low, and as such the impact of increased suspended sediments produced via Export Cable installation on the benthic environment is considered negligible/minor**.**

Sub-tidal Area – Smothering

179 Smothering, caused by temporary increases in depositional rates due to the increased SSC, is also likely to occur along the Offshore Export Cable Corridor as a result of cabling operations. According to the coastal processes modelling (*Chapter 10*) the proposed cable burial will result in depositional thicknesses of greater than one millimetre within one kilometre of the activity, with peaks of up to five millimetre. Outside of this area, any remaining fine material in suspension will remain so indefinitely, or will settle out beyond three kilometres of the Export Cable location, but not at thicknesses great enough to form a noticeable layer. The MarLIN benchmark for smothering is a depth of five centimetres, which is 10 times the depth of the maximum predicted sediment deposition along the Offshore Export Cable Corridor.

180 The offshore habitats present along the Offshore Export Cable Corridor are predominantly sedimentary in nature, with an infauna that is tolerant of such levels of smothering, able to re-establish burrows or position immediately (within hours) (Hill, 2008, Marshall, 2008). The seapens *V. mirabilis* and *P. phosphorea* are also tolerant of smothering of up to five centimetres sediment, and no impact is predicted on these species (Hill, 2008). Other filter feeding fauna (e.g. bryozoans, soft corals) may suffer some reduction in feeding efficiency, with the more sensitive organisms suffering reduced growth rates, and, in extreme cases, possibly death (Tyler-walters, 2008b). This potential reduction in diversity of the epibenthic species is considered for the MarLIN benchmark of five centimetres, and as such is likely to represent the extremes of reaction along the Offshore Export Cable Corridor. As a result, the magnitude of effects on all receptors is considered negligible. The sensitivity of receptors is low or moderate depending on their conservation status, and as such the impacts of smothering on the benthic environment is considered negligible/minor or minor respectively**.**

181 The Annex 1 rocky reef habitats identified within the Isle of May SAC are predicted to be outside of the depositional footprint from cabling activities as they are over four kilometres from the Offshore Export Cable Corridor. As such no impacts are predicted on these qualifying features.

182 At more than 1.5 km for the Offshore Export Cable Corridor the Aberlady Bay LNR is predicted to be outside the areas of highest deposition which is within a few hundred metres of the Export Cable. As such no impacts are predicted on these features of interest.

Intertidal Area–Smothering

183 In the intertidal environment, construction activities are predicted to be undertaken at low tide and no smothering impacts are predicted during construction. Immediately after construction, some smothering impacts may be evident as the tide rises and SSC is temporarily increased, however these are likely to be of relatively low magnitude, not

exceeding five millimetres in depth. Considering the highly mobile and dynamic nature of the environment, this level is well within the tolerances of the species present, which are tolerant of high scour or mobile sedimentary environments (Budd, 2008a). As the predicted levels of deposition (less than five millimetres) are considerably lower than the MarLIN benchmark (five centimetres) these adverse effects are considered unlikely and a negligible magnitude is predicted.

184 The sensitivity of the habitats is considered to be low as described within the Assessment Methodology *Section 12.6*. As a result, the impact is considered to be negligible/minor**.**

Table 12.29: Impact Summary of Temporary Increases in SSC and Sediment Deposition

Effect	Receptor	Magnitude	Sensitivity	Significance
Increased SSC	SS.SMu.CFiMu.SpnMeg, SS.SCS.CCS,Stony Reef	Negligible	Moderate	Minor
	SS.SMx.CMx, SS.SSa.CMuSa, SS.SMx.CMx.MysThyMx SS.SMx.CMx.FluHyd	Negligible	Low	Negligible/Minor
	LR.MLR.BF.PelB, LR.HLR.MusB.Cht.Cht, LR.MLR.BF.FspiB, IR.MIR.KR.Ldig.Ldig, LR.LLR.F.FSpi.FS	Negligible	Low	Negligible/Minor
	LS.LSa.MoSa.AmSco.Sco, LS.LSa.FiSa.Po, LS.LSa.FiSa.Po.Aten	Negligible	Low	Negligible/Minor
Deposition of resuspended sediments leading to smothering	SS.SMu.CFiMu.SpnMeg, SS.SCS.CCS, Stony Reef	Negligible	Moderate	Minor
	SS.SMx.CMx, SS.SSa.CMuSa, SS.SMx.CMx.MysThyMx SS.SMx.CMx.FluHyd	Negligible	Low	Negligible/Minor
	LR.MLR.BF.PelB, LR.HLR.MusB.Cht.Cht, LR.MLR.BF.FspiB, IR.MIR.KR.Ldig.Ldig, LR.LLR.F.FSpi.FS	Negligible	Low	Negligible/Minor
	LS.LSa.MoSa.AmSco.Sco, LS.LSa.FiSa.Po, LS.LSa.FiSa.Po.Aten	Negligible	Low	Negligible/Minor

Release of Contaminants Bound in Sediments

Sub-tidal Area

185 The sediments found along the Offshore Export Cable Corridor have the potential to accumulate contaminants, the fine fraction, in particularly due to their sorptive nature; this store reduces the toxicity potential to aquatic organisms (Eggleton and Thomas, 2004). Disturbance to the seabed, as would be experienced from the construction of the Export Cable, could lead to the unlocking and re-distribution of contaminants. Contaminants could have detrimental effect on the benthic fauna and potentially bioaccumulate.

186 Organotins were not found to be at levels where effects would be likely on sensitive species such as gastropods, as levels were at the lower end of OSPAR classification (*Appendix 12C Section 12C.7.3*). No recent sampling location recorded metals exceeding Cefas AL2, with present levels comparable to those recorded in the Firth of Forth as part of the CSEMP monitoring.

187 Difficulties in recording contaminant transformations during resuspension events have been highlighted by Vale *et al.* (1998), in which they observed a complex and rapid oxidation of anoxic sediment during laboratory simulations of dredging. Contaminant release has been studied during dredging activities as maintenance dredged sediments are usually anoxic and changes in the physicochemical conditions at the disposal site can result in substantial release of contaminants. However Pieters *et al*. (2002) (cited in Eggleton and Thomas, 2004) observed low contaminant mobilisation during dredging, although metal mobility changed during each dredging technique and was different for every contaminant examined. Van den Berg *et al*. (2001) and De Groote *et al*., (1998) also observed low mobilisation of metal contaminants into the dissolved phase during dredging, which was thought to be due to the rapid scavenging of sulphide liberated metals by newly formed Fe and Mn oxides/hydroxides. This is in agreement with simulated dredging studies, where low or no metal contaminants were released and concentrations returned to background levels within 27 hours (Eggleton and Thomas, 2004).

188 Despite a relatively large total volume of material that will be excavated, this is spread along the entire Offshore Export Cable Corridor. In practice the volume predicted to arise is a conservative estimate as the trench is likely to have sloped sides and therefore only a proportion of this material will be excavated. Fishing, which is similar in its transient nature, causing furrows, although not as deep as during Export Cable burial, has not been considered a major cause of contaminant remobilisation (Eggleton and Thomas, 2004). The relatively fine material associated with the Firth of Forth gives the potential for high suspended sediment levels and strong currents in the area can increase the extent of contamination re-distribution, although concentrations will be lower due to dilution. As described, the maximum distance over which the majority of sediment, and therefore the associated contaminants, will be transported during construction is three kilometres from the release location with most sediment settling within tens or a few hundred meters.

189 Any release of bioavailable contaminants is considered to have a negative effect on the benthic community. Burrowing fauna are typically more difficult to sample, and are for that

reason under-sampled in standard pollution monitoring, and little information was available on the pollution response of characterising species, e.g. sea pens, which will be specific to the individual species and contaminant. Of the species and habitats recorded within the Offshore Export Cable Corridor however, it can be considered that an increase in pollution will lead to a general trend of a reduction in species diversity, with communities becoming dominated by pollution tolerant polychaetes (Hill, 2008).

190 Despite the lack of data regarding the response of benthic organisms to contamination at different levels, and the complexity of predicting the bioavailability following disturbance, due to the comparable contamination levels to records in the Firth of Forth, the restriction of re-distribution to a maximum of three kilometres and the short duration and level of disturbance, the magnitude of effects are considered negligible.

191 The habitats found within the Offshore Export Cable Corridor represent both a low and moderate sensitivity of receptors, according to differing levels of conservation importance, and thus the impact is negligible/minor and minor respectively.

Intertidal Area

192 The effects on the intertidal Offshore Export Cable Corridor area are analogous to those identified above for the sub-tidal area. The habitats in the intertidal zone are of low sensitivity, as described in the Assessment Methodology *Section 12.6*, and as such the impact is assessed as negligible/minor adverse.

Table 12.30: Impact Summary of Release of Contaminants Bound in Sediments

Receptor	Magnitude	Sensitivity	Significance
SS.SMu.CFiMu.SpnMeg, SS.SCS.CCS, Stony Reef	Negligible	Moderate	Minor
SS.SMx.CMx, SS.SSa.CMuSa, SS.SMx.CMx.MysThyMx SS.SMx.CMx.FluHyd	Negligible	Low	Negligible/Minor
LR.MLR.BF.PelB, LR.HLR.MusB.Cht.Cht, LR.MLR.BF.FspiB, IR.MIR.KR.Ldig.Ldig, LR.LLR.F.FSpi.FS	Negligible	Low	Negligible/Minor
LS.LSa.MoSa.AmSco.Sco, LS.LSa.FiSa.Po, LS.LSa.FiSa.Po.Aten	Negligible	Low	Negligible/Minor

Secondary Impacts of Decreased Primary Production due to Increased SSC of the Water Column

193 As with the Development Area, increased SSC from Export Cable laying activities in both the sub-tidal and intertidal areas can lead to a reduction in primary production through a reduction of light penetration. Modelling outputs describing the increase in SSC during the cabling process are described above in the discussion of temporary increases in SSC and sediment deposition. These increases are short lived and transient in nature, and are unlikely to affect the large scale processes which regulate primary production. As such the magnitude of this effect is considered to be negligible.

194 The sensitivity of the receptors, as described within the Assessment Methodology *Section 12.6*, are low or moderate, depending on their conservation importance, and as such the impact is therefore negligible/minor and minor respectively.

Table 12.31: Impact Summary of Secondary Impacts of Decreased Primary Production

Receptor	Magnitude	Sensitivity	Significance
SS.SMu.CFiMu.SpnMeg, SS.SCS.CCS, Stony Reef	Negligible	Moderate	Minor
SS.SMx.CMx, SS.SSa.CMuSa, SS.SMx.CMx.MysThyMx SS.SMx.CMx.FluHyd	Negligible	Low	Negligible/ Minor
LR.MLR.BF.PelB, LR.HLR.MusB.Cht.Cht, LR.MLR.BF.FspiB, IR.MIR.KR.Ldig.Ldig, LR.LLR.F.FSpi.FS	Negligible	Low	Negligible/ Minor
LS.LSa.MoSa.AmSco.Sco, LS.LSa.FiSa.Po, LS.LSa.FiSa.Po.Aten	Negligible	Low	Negligible / Minor

Potential Release of Pollutants from Construction Plant

195 Throughout construction there are sources that could add to the current levels of contaminants during cable laying. There is the risk of accidental release of contaminants such as fuel, lubricating oils, cleaning fluids, paints, sacrificial anodes, specialised chemicals and litter. Standard controls will be in place, including following best practice and guidelines for the prevention of pollution at sea, including the establishment of an EMP (*Appendix 7A*) that will detail pollution prevention and response procedures. As such it is not predicted that contaminants from construction plant will be introduced into the environment at a high level.

196 Due to the Embedded Mitigation the risk of pollutants entering the environment during construction is low and as a result the magnitude of impacts is low. The sensitivity of receptors is low and moderate according to the relative conservation importance of receptors. This results in a minor and minor/moderate impact respectively.

Table 12.32: Impact Summary of Potential Release of Pollutants from Construction Plant

Receptor	Magnitude	Sensitivity	Significance
SS.SMu.CFiMu.SpnMeg, SS.SCS.CCS, Stony Reef	Low	Moderate	Minor/Moderate
SS.SMx.CMx, SS.SSa.CMuSa, SS.SMx.CMx.MysThyMx SS.SMx.CMx.FluHyd	Low	Low	Minor
LR.MLR.BF.PelB, LR.HLR.MusB.Cht.Cht, LR.MLR.BF.FspiB, IR.MIR.KR.Ldig.Ldig, LR.LLR.F.FSpi.FS	Low	Low	Minor
LS.LSa.MoSa.AmSco.Sco, LS.LSa.FiSa.Po, LS.LSa.FiSa.Po.Aten	Low	Low	Minor

Introduction of Non Indigenous Species

197 The introduction of NIS is possible through a number of pathways, including ships hulls, ballast waters, and the transport of materials to the Offshore Export Cable Corridor. Embedded Mitigation will reduce the potential for spread of NIS to the Offshore Export Cable Corridor, and furthermore, as NIS is also a descriptor of GGES under the MSFD, the prevention of NIS introduction will be a key component of the EMP *(Appendix 7A*).

198 Due to uncertainties within the assessment of NIS introduction at offshore developments, the potential long term effects on the local environment, and the importance in terms of the MSFD, a moderate magnitude of effect is ascribed. The existing benthic communities are considered to be of no more than moderate sensitivity, and as such the impact is considered to be moderate.

Table 12.33: Impact Summary of Introduction of Non Indigenous Species

Receptor	Magnitude	Sensitivity	Significance
Benthic and epibenthic communities	Moderate	Moderate	Moderate

12.8.2 Effects of Operation and Maintenance

Loss of Original Habitat

199 The worst case scenario assessed is that up to 20 per cent of the Export Cable would be protected using means other than burial, i.e. rock placement, mattresses etc., covering a maximum area of 0.6 km^2 (0.6 per cent of Offshore Export Cable Corridor). In these areas, the loss of the original habitats and species present can be predicted, with a change to hard substrate.

200 Due to the limited area affected by the Export Cable protection, the magnitude of effects is considered to be negligible. The sensitivity of the receptors is considered to be low or moderate according to their relative conservation importance, and as such the impact is considered to be negligible/minor and minor respectively.

Table 12.34: Impact Summary of Loss of Original Habitat

Receptor	Magnitude	Sensitivity	Significance
SS.SMu.CFiMu.SpnMeg, SS.SCS.CCS, Stony Reef	Negligible	Moderate	Minor
SS.SMx.CMx, SS.SSa.CMuSa, SS.SMx.CMx.MysThyMx SS.SMx.CMx.FluHyd	Negligible	Low	Negligible/Minor
LR.MLR.BF.PelB, LR.HLR.MusB.Cht.Cht, LR.MLR.BF.FspiB, IR.MIR.KR.Ldig.Ldig, LR.LLR.F.FSpi.FS	Negligible	Low	Negligible/Minor
LS.LSa.MoSa.AmSco.Sco, LS.LSa.FiSa.Po, LS.LSa.FiSa.Po.Aten	Negligible	Low	Negligible/Minor

Colonisation of Introduced Substrata Leading to a Change in the Benthic Ecology and/or Biodiversity

201 As within the Development Area assessment, the introduction of new substrate (along the subtidal areas of the Offshore Export Cable Corridor from the export cable protection) will have direct effects on the overall biodiversity of the site, and indirect effects through increased food availability to higher trophic levels (see *Chapter 13*). Furthermore, community changes, through the introduction of hard substrate species, are expected in the sedimentary habitats immediately surrounding the cable protection (Degraer *et al.*, 2011).

202 Changes are likely to be present throughout the operational phase. However, such community changes will be localised to the new habitat (footprint of 0.6 km^2 along the

Offshore Export Cable Corridor), and to those existing habitats immediately surrounding the new habitat. Effects therefore are predicted to be of negligible magnitude.

203 The sensitivity of existing benthic communities is considered to be low or moderate depending on their conservation importance, and as such the significance of the impact is considered to be negligible/minor and minor respectively.

Table 12.35: Impact Summary of Colonisation of Cable Protection Leading to a Change in the Benthic Ecology and/or Increase in Biodiversity

Receptor	Magnitude	Sensitivity	Significance
SS.SMu.CFiMu.SpnMeg, SS.SCS.CCS, Stony Reef	Negligible	Moderate	Minor
SS.SMx.CMx, SS.SSa.CMuSa, SS.SMx.CMx.MysThyMx SS.SMx.CMx.FluHyd	Negligible	Low	Negligible/Minor

Provision of New Substrata Facilitating the Spread of Non Indigenous Species

204 As with the Development Area assessment, the effects of NIS colonisation along the Offshore Export Cable Corridor also need consideration, as the introduction of some hard substrate (up to 20 per cent of the Export Cables length) is a possibility, however only in the sub-tidal region. Effects are expected to be isolated around cable protection and not impact the wider benthic community structure, however due to the potential for NIS expansion, and the use of NIS as a descriptor of GES under the MSFD, the prevention of NIS introduction will be a key component of the EMP (*Appendix 7A*).

205 Due to uncertainties within the assessment of NIS introduction at offshore developments, the potential long term effects on the local environment, and the importance in terms of the MSFD, a moderate magnitude of effects is determined. The existing benthic communities are considered to be of no greater than moderate sensitivity, and as such the impact is considered to be moderate**.**

Table 12.36: Impact Summary of Introduction and Spread of Non Indigenous Species

Receptor	Magnitude	Sensitivity	Significance
Benthic and epibenthic ecology	Moderate	Moderate	Moderate

Responses to EMF and Thermal Emissions

206 As discussed for inter-array cabling within the Development Area (*Section 12.7.2)*, EMF and thermal effects are likely to be restricted to the immediate vicinity of the Export Cable. Reported colonisation on exposed Export Cable (BERR, 2008) by anemones, echinoderms

and sponges also highlights the apparent minimal impact likely on benthic species. The target burial depth of the Export Cable (one metre), and protection where this is not feasible, will reduce interaction with benthic species. Thus effects of EMF and thermal emissions are predicted to be negligible. The sensitivity of receptors is low, and moderate for the habitats and species of conservation importance identified along the Offshore Export Cable Corridor. The resulting impact of EMF and increased temperatures due to electrical transmission is therefore negligible/minor and minor respectively.

Table 12.37: Impact Summary of EMF and Heating Effects

Receptor	Magnitude	Sensitivity	Significance
SS.SMu.CFiMu.SpnMeg, SS.SCS.CCS, Stony Reef	Negligible	Moderate	Minor
SS.SMx.CMx, SS.SSa.CMuSa, SS.SMx.CMx.MysThyMx SS.SMx.CMx.FluHyd	Negligible	Low	Negligible/Minor
LR.MLR.BF.PelB, LR.HLR.MusB.Cht.Cht, LR.MLR.BF.FspiB, IR.MIR.KR.Ldig.Ldig, LR.LLR.F.FSpi.FS	Negligible	Low	Negligible/Minor
LS.LSa.MoSa.AmSco.Sco, LS.LSa.FiSa.Po, LS.LSa.FiSa.Po.Aten	Negligible	Low	Negligible/Minor

Potential Release of Pollutants from Operation Plant

207 As with the construction phase, a number of possible pollution sources exist during operation. The effects of pollution on the local environment, and the standard controls and implementation of the EMP (*Appendix 7A*) outlined for the construction phase, also apply during the operation phase. The impact magnitude is therefore assessed as low.

208 The sensitivity of existing benthic communities is considered to be low or moderate depending on their conservation importance, and as such the impact is considered to be minor and minor/moderate respectively.

Table 12.38: Impact Summary of Potential Release of Pollutants from Operation Plant

Receptor	Magnitude	Sensitivity	Significance
SS.SMu.CFiMu.SpnMeg, SS.SCS.CCS, Stony Reef	Low	Moderate	Minor/Moderate
SS.SMx.CMx, SS.SSa.CMuSa, SS.SMx.CMx.MysThyMx SS.SMx.CMx.FluHyd	Low	Low	Minor

Receptor	Magnitude	Sensitivity	Significance
LR.MLR.BF.PelB, LR.HLR.MusB.Cht.Cht, LR.MLR.BF.FspiB, IR.MIR.KR.Ldig.Ldig, LR.LLR.F.FSpi.FS	Low	Low	Minor
LS.LSa.MoSa.AmSco.Sco, LS.LSa.FiSa.Po, LS.LSa.FiSa.Po.Aten	Low	Low	Minor

<u>**Temporary Habitat Disturbance due to O&M Activities**</u>

209 During operation the worst case scenario that is applied is re-burial or maintenance along a maximum of 10 per cent of the length of the Export Cable (annual area of disturbance is 0.007 km^2), which results in a negligible magnitude for this impact. The sensitivity of the habitats is considered to be low, or moderate for those habitats of conservation importance, and as such the impact is considered to be negligible/minor or minor respectively**.**

Table 12.39: Impact Summary of Temporary Habitat Disturbance due to O&M Activities

Receptor	Magnitude	Sensitivity	Significance
SS.SMu.CFiMu.SpnMeg, SS.SCS.CCS, Stony Reef	Negligible	Moderate	Minor
SS.SMx.CMx, SS.SSa.CMuSa, SS.SMx.CMx.MysThyMx SS.SMx.CMx.FluHyd	Negligible	Low	Negligible/Minor
LR.MLR.BF.PelB, LR.HLR.MusB.Cht.Cht, LR.MLR.BF.FspiB, IR.MIR.KR.Ldig.Ldig, LR.LLR.F.FSpi.FS	Negligible	Low	Negligible/Minor
LS.LSa.MoSa.AmSco.Sco, LS.LSa.FiSa.Po, LS.LSa.FiSa.Po.Aten	Negligible	Low	Negligible/Minor

12.8.3 Effects of Decommissioning

210 The potential effects of decommissioning are considered to be equivalent to and potentially lower than the worst case effects assessed for the construction phase. The approach to decommissioning is described in *Section 7.12*. A decommissioning plan will be prepared in accordance with the requirements of the *Energy Act 2004* (see *Section 3.2.5*) and will be subject to approval from the DECC prior to implementation.

12.9 Impact Interactions

211 The potential for individual impacts identified through the impact assessment to interact and create new, or more significant impacts on benthic ecology has been assessed. Impacts from the effects considered are considered predominantly to be temporally sequential. For example, deposition causing smothering will occur following an increase in suspended sediments but the maximum from each individual effect will not occur simultaneously. Furthermore, assessments are made considering worst case scenarios and peak measurements, and it is unlikely that impacts will interact at these levels.

212 In addition, for a number of effects the worst case scenarios relate to design parameters that will not coexist. For example jacket foundations drive a worst case for scour related impacts, and GBS drive a worst case for habitat loss. There will be no path for additive elements for these effects as the worst cases are independent. As such the effects are not predicted to increase beyond that assigned for each impact in isolation.

213 The potential for impacts from other projects to interact with the impacts identified in the impact assessment and cumulative impact assessment to result in a greater long term effects has been assessed. No such interactions are identified.

12.10 Cumulative Impacts

214 The assessment of cumulative impacts is structured as follows:

- firstly, cumulative impacts of the Wind Farm with the OfTW, i.e. the Project, are assessed (see *Section 12.10.1 to 12.10.3*); and
- secondly, cumulative impacts of the Project with other projects and activities in the area (see *Section 12.10.4* to *12.10.7*).

215 The cumulative assessment takes a precautionary standpoint in that the most sensitive habitats present are taken forward into the assessment of significance. The full list of projects and activities considered as part of the cumulative assessment are found in *Section 4.7*. These fall into the following categories:

- Other offshore wind farms in the Firth of Forth and Tay area; and
- Other projects and activities.

Other Offshore Wind Farms in the Firth of Forth and Tay Area

216 The other offshore wind farms in the Firth of Forth and Tay area include projects developed by Seagreen Wind Energy, and Mainstream Renewable Power, i.e. the Firth of Forth, and Neart ne Gaoithe offshore wind farms. The construction periods for the three projects are:

- Neart ne Gaoithe – Construction to begin in March 2015, ending September 2016;
- Firth of Forth (Alpha, Bravo and Transmission Asset) – Export cable October 2015, ending December 2017, WTGs from July 2016, ending December 2019; and

- Inch Cape Offshore Wind Farm– The construction activities are expected to start in 2016 and work will occur over approximately four years (*see Section 7.10*). The Firth of Forth Offshore Wind Farm phases 2 and 3 also have the potential to interact with the Project and generate cumulative impacts and as such are considered further within this cumulative assessment. However, as stated within the Firth of Forth Phase 1 ES, mitigation for the development would ensure that any sensitive habitats are avoided, and the impacts at phase 2 and 3 are not predicted by Seagreen to be significant. Furthermore, no significant cumulative impacts of the later phases of the development are predicted, and as such these subsequent phases of the Firth of Forth Offshore Wind Farm are not considered further within this cumulative assessment.

Other Projects and Activities

- Other Offshore Wind Farms:
  - European Offshore Wind Development Centre (Aberdeen);
  - Hywind Demonstration Site (near Aberdeen);
  - Methil (Fife Energy Park) Offshore Demonstration Wind Turbine (Methil);
  - Beatrice Offshore Wind Farm (Moray Firth); and
  - Moray Firth Offshore Wind Farm R3 Zone (Moray Firth).

217 These other offshore wind farms are considered to be sufficiently distant to the Project that no cumulative impacts with regard to benthic ecology are predicted.

- Onshore Wind Farms – No cumulative impacts with respect to Benthic Ecology.
- Other Coastal Projects:
  - Forth Replacement Crossing (Firth of Forth);
  - Rosyth Interational Container Terminal Project (Rosyth);
  - Coastal Improvement Works at the Mouth of the Barry Burn (Carnoustie);
  - Edinburgh Harbour Master Plan (Leith);
  - Port of Dundee Expansion; and
  - GlaxoSmithKline Tidal Energy (Montrose).

218 The scale and distance from the Project of these developments means that no interactions or cumulative impacts are predicted on the benthic ecology at a significant level. As such these projects are not considered further within the assessment.

- Other Onshore Projects:
  - Grangemouth Renewable Energy Plant (Grangemouth);
  - Rosyth Renewable Energy Plant (Rosyth);
  - Dundee Renewable Energy Plant (Dundee);
  - Victoria and Albert Museum (Dundee);

- Captain Clean Energy Project Caledonia Clean Energy Project (Grangemouth); and
- Cockenzie Combined Cycle Gas Turbine Power Station (Cockenzie).

219 No cumulative impacts with respect to benthic ecology are predicted, and as such these projects are scoped out of the following assessment.

220 The impacts assessed as having potential cumulative effects over the construction, operation and decommissioning phases are the same as the Development Area and Offshore Export Cable Corridor in isolation, i.e.:

- Effects of Construction (and Decommissioning):
  - Direct temporary disturbance of seabed habitats caused by construction based activities;
  - Indirect impacts of temporary increases in SSC from construction based activities and associated deposition;
  - Release of contaminants bound in sediments;
  - Secondary impacts of decreased primary production due to increased SSC of the water column;
  - Potential release of pollutants from construction plant; and
  - Introduction of NIS.
- Effects of Operation:
  - Loss of original habitat;
  - Changes in hydrodynamic regime and sediment transport leading to changes in seabed habitats (scour);
  - Colonisation of introduced substrata leading to a change in the benthic ecology and/or biodiversity;
  - Provision of Introduced Substrata facilitating spread of NIS;
  - Potential release of pollutants from operation plant;
  - Responses to EMF and thermal emissions; and
  - Temporary habitat disturbance from O&M activities.

221 Table 12.40 summarises the assessment parameters taken from published ES' for the Firth of Forth and Neart ne Gaoithe offshore wind farms during both construction and operation, alongside the project specific design envelopes.

<u>**Impacts Scoped Out**</u>

222 A number of impacts have been scoped out of the following sections as no cumulative effects are predicted. These are summarised below:

- The Project (as defined):

- Changes in hydrodynamic regime and sediment transport leading to changes in seabed habitats (such as scour). No scour or changes to hydrodynamics have been predicted along the Offshore Export Cable Corridor and therefore no cumulative effects arise.

- The Project with other projects:
  - Release of contaminants bound in sediments. Contaminant effects on the benthos was screened out of the Neart na Goaithe assessment due to low levels recorded, and the Firth of Forth assessment assessed the impact of contaminants as negligible with all levels below that which are likely to cause effects. Therefore, no cumulative impact of contaminant release is predicted.

Table 12.40: Cumulative Assessment Parameters

Impact	Neart na Gaoithe	Firth of Forth	Inch Cape
Construction (and Decommissioning)			
Direct temporary disturbance of seabed habitats caused by construction based activities	2.11 km^2 site area disturbed 0.75 km^2 export cable area disturbed Total disturbance – 2.86 km^2	3.75 km^2 disturbed – Alpha 3.75 km^2 disturbed – Bravo 7.96 km^2 Transmission Total disturbance – 15.46 km^2	5.53 km^2 Development Area disturbed 3.02 km^2 Offshore Export Cable Corridor area disturbed Total disturbance – 8.55 km^2
Indirect impacts of temporary increases in suspended sediment concentrations (SSC) from construction based activities and associated deposition	Maximum plume extent = < 5 km	Maximum plume extent – 1 tidal excursion	Maximum plume extent – 10 km (majority of sediment settles within 3.5 km)
Secondary impacts of decreased primary production due to increased SSC of the water column	As Above	As Above	As Above
Release of contaminants bound in sediments	No cumulative impact of contaminant release is predicted		
Potential release of pollutants from construction plant	Increased vessel presence due to construction activities		

Impact	Neart na Gaoithe	Firth of Forth	Inch Cape
Operation			
Loss of Original Habitat	0.31 km^2 site area lost 0.05 km^2 export cable area lost Total loss – 0.36 km^2	Combined loss of 2.18 km^2 across Alpha, Bravo and export cable	1.87 km^2 Development Area lost 0.60 km^2 Offshore Export Cable Corridor lost Total loss – 2.47 km^2
Changes in hydrodynamic regime and sediment transport leading to changes in habitats such as scour	Increase in current speed of 0.02 m/s and decrease by 0.04 m/s Maximum lateral extent of scour = 7.99 m	Negligible magnitude impacts on current speeds Scour Footprint = 0.36 km^2	Increases and decreases in water flow up to 0.04 m/s (7 % change from baseline) Scour Footprint = 0.49 km^2 Lateral extent of footprint on spring tide – 12 m
Colonisation of introduced substrata leading to a change in the benthic ecology and/or a biodiversity	Colonisation of introduced new substrate from foundations, scour protection and cable protection. Footprint of introduced substrata equal to area defined under loss of original habitat		
Introduction and spread of NIS	NIS introduction will be a key component of the EMP (*Appendix 7A*)		
EMF and heating effects	140 km inter-array cable buried to 1 -3 m 2 x 33 km export cable buried to 1-3 m	355 km inter-array cable buried to 0.5 m minimum (for both Alpha and Bravo) 530 km export cable buried to 0.5 m minimum (Transmission)	353 km inter-array cable buried 0 – 3 m (target 1 m) with protection where not buried 6 x 83 km export cable buried 0 – 3 m (target 1 m) with protection where not buried

Impact	Neart na Gaoithe	Firth of Forth	Inch Cape
Temporary habitat disturbance via jacking-up of O&M vessels and cable maintenance	Area disturbed per jack up vessel if 848 m^2, two visits per year of operation gives an annual total 0.1 km^2 Inter-array cable annual maintenance – 0.008 km^2 (assuming total re-burial) Export cable annual maintenance – 0.002 km^2 (assuming 10 % re-burial)	Area disturbed per jack up vessel if 729 m^2, assume one visit per foundation per five years of operation gives an annual total of 0.12 km^2 Inter-array cable annual maintenance – 0.002 km^2 (assuming 10 % re-burial along 355 km cable, width 3 m) Export cable annual maintenance – 0.016 km^2 (assuming 10 % re-burial)	Area disturbed per jack up vessel if 600 m^2, one visit per foundation per five years of operation gives an annual total of 0.13 km^2 Inter-array cable annual maintenance – 0.004 km^2 (assuming 10 % re-burial) Export cable annual maintenance – 0.007 km^2 (assuming 10 % re-burial)

12.10.1 Cumulative Impacts of the Project during Construction

Direct Temporary Seabed Disturbance caused by Construction Based Activities

223 The combination of construction activities in the Development Area and Offshore Export Cable Corridor is predicted to result in a total area of habitat disturbance of 8.6 km^2 based upon the worst case scenario (3.4 per cent of the Development area and Offshore Export Cable Corridor when combined). As described within the individual assessments, the disturbance is considered to be localised and of a small scale in relation to the wider geographical context of available habitats. As a result the magnitude of this effect is considered to be low, with a low to moderate sensitivity ascribed to species and habitats depending on their relative conservation importance. Therefore the impact is considered to be minor/moderate.

Indirect Impacts of Temporary Increases in SSC from Construction Based Activities and Associated Deposition

224 The combination of increased suspended sediment derived from construction activities within the Development Area and the Offshore Export Cable Corridor are not predicted to be carried beyond the near field and as such are unlikely to interact over the majority of the combined areas. Overlap will only occur at a distance of 10 km from the Development Area if cable laying at the northern extent of the Offshore Export Cable Corridor and dredging or cable laying at the southern end of the Development Area occurred at the same time. As such, and due to the small area ultimately affected, no increase in magnitude is predicted beyond the individual impact assessments, with a low magnitude predicted. The habitats likely to be impacted are of low or moderate sensitivity, and as such the overall cumulative impact is minor/moderate.

Release of Contaminants Bound in Sediments

225 The sediments both within the Development Area and along the Offshore Export Cable Corridor have been shown to contain a number of contaminants at varying levels. Although construction activities may lead to the remobilisation of these contaminated sediments, they are not predicted to travel in excess of 10 km from the Development Area, and 3.5 km from the Offshore Export Cable Corridor. The benthic communities in the Development Area and Offshore Export Cable Corridor indicate a certain level of tolerance to the current levels (as indicated by baseline sampling stations), and due to the cumulative levels of sediment resuspension and movement predicted, and as the movement of contaminants into non-contaminated areas is unlikely, the magnitude of effects is predicted to be low, in line with the assessment for the Development Area and Offshore Export Cable Corridor considered separately.

226 The sensitivity of species and habitats varies from low to moderate, and as such the impact is considered to be minor/moderate.

Secondary Impacts of Decreased Primary Production due to Increased SSC of the Water Column

227 Increases in suspended sediment and therefore turbidity will occur at both the Development Area and Offshore Export Cable Corridor during construction phases. The deep benthic communities found at the Development Area could experience a reduction in food availability if an effect on primary production was seen. The effects assessed during the construction phase for the Development Area and Offshore Export Cable Corridor showed small, short lived and localised increases in turbidity that would not affect the large scale processes driving primary production. Cumulatively there would be an increase in turbidity over a wider area, but the low levels predicted mean no increases to effects over those identified in the Development Area and Offshore Export Cable Corridor are expected.

228 These limited effects of construction on primary production results in a negligible magnitude of effects. A low or moderate sensitivity is determined for the species and habitats present, and as such the overall impact is considered to be minor.

Potential Release of Pollutants from Construction Plant

229 The increased need for construction plant over the Project as a whole, when compared to the individual elements, means that the risk of a pollution event occurring increases. However, the potential release of pollutants from construction plant will be managed, and following best practice guidance will reduce the risk of major pollution events.

230 The low risk of pollution events results in a low magnitude of effect, and with a low or moderate sensitivity of species and habitats, the overall impact is considered to be minor/moderate.

Introduction of NIS

231 As with the Development Area and Offshore Export Cable Corridor assessment, the effects of NIS introduction due to vessel and material transport also need consideration.

232 NIS is a descriptor of GES under the MSFD, and as such the prevention of NIS introduction will be a key component of the EMP (*Appendix 7A*). However, due to uncertainties within the assessment of NIS introduction at offshore developments, the potential long term effects on the local environment, and the importance in terms of the MSFD, a moderate magnitude of effects is determined.

233 The sensitivity of existing benthic communities is considered to be low or moderate, and as such the impact is considered to be moderate according to a precautionary standpoint.

12.10.2 Cumulative Impacts of the Project during Operation and Maintenance

Loss of Original Habitat

234 The combination of the installation within the Development Area and Offshore Export Cable Corridor will result in a total area of permanent habitat loss of less than 2.5 km^2 based upon the worst case scenario (equating to <1 per cent of the Development Area and Offshore Export Cable Corridor combined). In relation to the wider geographical context of available habitats this loss is considered to be of negligible magnitude.

235 Habitats and species found within the Project area are considered to be of low or moderate sensitivity, and as such the overall impact is considered to be minor.

Colonisation of Introduced Substrata Leading to a Change in the Benthic Ecology and/or Biodiversity

236 As within the Development Area and Offshore Export Cable Corridor assessments, the introduction of new substrate will have direct effects on the overall biodiversity of the Project areas, and indirect effects through increased food availability to higher trophic levels (see *Chapter 13*). Furthermore, community changes, through the introduction of hard substrate species, are expected in the sedimentary habitats immediately surrounding the cable protection (Degraer *et al*., 2011).

237 Changes are likely to be present throughout the operational phase. However, such community changes will be localised to the new habitat, and to those existing habitats immediately surrounding the new habitat. As such effects are predicted to be of negligible magnitude. The sensitivity of existing benthic communities is considered to be low or moderate, and as such the impact is considered to be minor.

Provision of New Substrata Facilitating the Spread of NIS

238 As with the Development Area and Offshore Export Cable Corridor assessments, the effects of NIS colonisation of any introduced substrata also need consideration. Effects are expected to be isolated around introduced substrate and not impact the wider benthic community

structure, however due to the potential expansion of NIS ranges, and the use of NIS as a descriptor of GES under the MSFD, the prevention of NIS introduction will be a key component of the EMP (*Appendix 7A*).

239 The conclusions of significance for the spread of NIS mirror those for their introduction at the construction phase, and as such this cumulative impact is considered to be moderate.

Potential Release of Pollutants from Operation Plant

240 As with the Development Area and Offshore Export Cable Corridor assessment, a number of possible pollution sources exist during operation. The effects of pollution on the local environment, and the standard controls and EMP (*Appendix 7A*) outlined for the construction phase, also apply during the operation phase. The impact magnitude is therefore assessed as low.

241 The sensitivity of existing benthic communities is considered to be low or moderate, and as such the impact is considered to be minor/moderate.

EMF and Heating Effects

242 Due to the locality of any effects on benthic species as a result of EMF and thermal heating, effects within the Development Area and Offshore Export Cable Corridor do not present cumulative impacts beyond those assessed individually, and are therefore considered to be of negligible magnitude. The sensitivity of existing benthic communities is considered to be low or moderate, and as such the impact is determined as minor.

Temporary Habitat Disturbance of O&M

243 Temporary habitat disturbance of the Offshore Export Cable Corridor and the Development Area resulting from jack-up vessels and cable maintenance, using a 10 per cent re-burial of the Export Cable as the worst case scenario, of 0.13 km^2 per annum.

244 This area represents a temporary disturbance, with recovery of communities expected in line with that identified for the construction phase impact of temporary habitat disturbance, i.e. two to three years for the majority of species and habitats. As a result of this, and due to the small annual area of effect, the magnitude of this impact is considered to be negligible. The sensitivity of existing benthic communities is considered to be low or moderate depending on their conservation importance, and as such the impact is determined as minor.

12.10.3 Cumulative Impacts of the Project during Decommissioning

245 The potential effects of decommissioning are considered to be equivalent to and potentially lower than the worst case effects assessed for the construction phase. The approach to decommissioning is described in *Section 7.12*. A decommissioning plan will be prepared in accordance with the requirements of the *Energy Act 2004* (see *Section 3.2.5*) and will be subject to approval from the DECC prior to implementation

12.10.4 Cumulative Impact of the Project and Other Projects

246 The benthic environments present at the Firth of Forth and Neart na Gaoithe offshore wind farms are summarised below to give some context to the following assessments. The baseline conditions present at the Project are discussed in *Section 12.5*, and in *Appendices 12A, 12B, 12C and 12D*.

247 At a wider level, and described by the EUSeaMap project, the offshore environment across the wider Firth of Forth area is characterised by shelf and bathyal sands, and coarse or mixed sediments, with shallow and shelf muds and sands present within the Firth of Forth. To the south (towards the Northumberland coast) rocky substrate appears more commonly in the offshore environment, but which is restricted elsewhere to a narrow coastal band.

Firth of Forth Offshore Wind Farm

248 Each of the three proposed areas, Alpha, Bravo and the transmission asset (export cable) have been characterised in terms of their benthic ecology as follows:

- Alpha - The western area of the Alpha site is dominated by three communities, namely *Sabellaria* (SBR.PoR.SspiMx), sparse polychaete and bivalves (SCS.ICS.MoeVen), and faunal turf (SMX.CMx.FluHyd) habitats. The central and eastern area consists of sandy muddy mixed sediments dominated by sabellid polychaetes (SS.SMx.OMx).
- Bravo - The Bravo site was comparable, with the western half dominated by rich polychaete (SS.SMx.OMx.PoVen), *Sabellaria* (SBR.PoR.SspiMx), and epifauna/polychaete (SS.SMx.OMx.PoVen) habitats, and the eastern half predominately SS.SMx.OMx.PoVen and SS.SMx.OMx.
- The transmission asset - The transmission asset cable corridor comprises of ophiothrix (SMc.CMx.OphMx) and faunal turf (SMX.CMx.FluHyd) habitat at the area adjoining the Alpha site, then moving into *Sabellaria* (SBR.PoR.SspiMx) and sparse polychaete and bivalve (SCS.ICS.MoeVen) habitats. Moving eastwards is an area dominated by rich polychaete (SS.SMx.OMx.PoVen) and sparse *Amphiura* (SSMx.CMx.MysThyMx) habitats, with outcrops of cobble/faunal turf (SS.SMX.CMx) and epifauna/polychaete (SS.SMx.OMx.PoVen) habitats. Further inshore the area is dominated by a large stretch of *Amphiura/Phoronis* habitat (SS.SMu.CSaMu.AfilMysAint) giving way to cobble/faunal turf (SS.SMX.CMx) at the landfall point. In the intertidal, the exposed sandy beach was devoid of benthic fauna, with the lower eulittoral sediments dominated by polychaetes.

249 Species and habitats of conservation importance were identified, including offshore sub-tidal sands and gravels (PMF), *A. islandica* (JNCC, 2012 and OSPAR, 2008b), shelf banks and mounds (MPA large scale search feature) and sub-tidal rocky reef (Annex 1 reef). *Sabellaria spinulosa* was also identified across the site but not in its reef form. As a result of the species and habitats present, the sensitivity of receptors was classed from very low to moderate.

Neart na Gaoithe Offshore Wind Farm

250 The site and export cable areas have been characterised in terms of their benthic ecology as follows:

- The site is characterised by circalittoral sandy mud (SS.SMu.CSaMu), dominated by *Amphiura filiformis* and *Nuculoma tenuis* (SS.SMu.CSaMu.AfilNten) with circalittoral coarse sediment (SS.SSa.OSa) and offshore circalittoral sand (SS.SCS.CCS) also extensive.
- The export cable is characterised by deep circalittoral mud in the offshore region, dominated by the biotopes SS,SMu.CSaMu.ThyNten, AfilMysAnit and AfilNten, and overlain with SS.SMu.CFiMu.SpnMeg. Further inshore, deep circalittoral coarse sediment and low energy rock habitats prevail, characterised by the biotope SS.SCS.CCS and areas with dense populations of *O. fragilis* (SS.SMx.CMx,OphMx) at the most southerly and northerly boundaries. The intertidal sandy habitats of the two landing points are typical of exposed sites along the east coast of Scotland and devoid of fauna.

251 Habitats of conservation importance were identified, including the littoral biotopes LR.FLR.RkpG, LR.FLR.Eph.EntPor, and LR.MLR.BF.Rho, and the infralittoral IR.MIR.KR.Ldig, which are contained within Annex 1 reef features. Also the littoral rock features (LR.FLR) are UK BAP priority habitats. Offshore, habitats of conservational interest identified consist of small areas of stony reef, however these were not conclusively classified as Annex 1 habitat. Burrowed mud (PMF), circalittoral sands and coarse sediments (BAP priority habitats), and brittlestar beds (SS.SMx.CMx,OphMx) were also identified in the sub-tidal.

252 Species of conservation importance identified were *A. islandica* (OSPAR,2008b; JNCC, 2012), *Echinus esculentus* (IUCN Red List, revised 2012), *Simnia patula* (Scottish Government, last updated 2013) and *Devonia perrieri* (Scottish Government, last updated 2013). As a result of the species and habitats present, the vulnerability of receptors was classed as negligible to low (low to moderate equivalent by the Project classification).

12.10.5 Cumulative Impacts of the Project and Other Projects during Construction

Direct Temporary Disturbance of Seabed Habitats Caused by Construction Activities

253 Total habitat disturbance across all projects (Inch Cape, Firth of Forth and Neart na Gaoithe) assessed (Table 12.40) is 26.9 km^2 based upon all worst case scenarios calculated within each impact assessment. In relation to the wider geographical context of available habitats the disturbance area is considered to be localised (area represents 4.2 per cent of the combined Development Area and Neart na Goaoithe and Firth of Forth sites), and recovery is expected in line with that predicted for the Project (i.e. within two to three years). As such, the cumulative effect magnitude is considered to be low.

254 The sensitivity of benthic communities likely to be affected across the developments is considered to be low or moderate depending on their conservation importance, and as such the impact is determined as minor/moderate.

Indirect Impacts of Temporary Increases in SSC from Construction Based Activities and Associated Deposition

255 Suspended sediment increases for other projects considered in the cumulative assessment area are predicted, with fine particles transported a number of kilometres from source (Table 12.40). However, the spread of sites mean sediment plumes are unlikely to interact at levels beyond background. The locality of some areas of the projects does allow for some overlap if cable burial and dredging occur simultaneously. However the short duration of cable burial would result in effects seen over a number of hours, with most suspended sediment settling within one tidal cycle. The settlement of sediment within these areas therefore could increase beyond predicted levels for each site where overlap occurs. However, the areas likely to be impacted by overlap are small, and as such smothering impact interactions are predicted to be small, especially as low levels of settlement (millimetres) are predicted from cable laying operations.

256 In view of this, the magnitude of impacts is considered to be low and the sensitivity of the species and habitats affected low or moderate, as a number of those of conservation interest reside in areas of overlap. The cumulative impact is therefore predicted to be minor/moderate.

Secondary Impacts of Decreased Primary Production due to Increased SSC of the Water Column

257 Increases in SSC will occur across all the projects during construction phases. The benthic communities present could experience a reduction in food availability if an effect on primary production was seen. However, in relation to the wider environmental drivers of primary production, the increases in SSC are short lived and localised and are not predicted to affect the large scale processes driving primary production.

258 These limited effects of construction on primary production results in a negligible magnitude of effects, and the sensitivity of receptors determined as low or moderate. As such, the overall impact is considered to be minor.

Potential Release of Pollutants from Construction Plant

259 The increased need for construction plant across all projects, means that the risk of a pollution event occurring increases. However, the potential release of pollutants from construction plant will be closely managed, and following best practice guidance will reduce the risk of major pollution events.

260 The low risk of pollution events results in a low magnitude of effect, however with low to moderate sensitivity species and habitats identified, the overall impact is considered to be minor/moderate.

Introduction of NIS

261 Both the Development Area and Offshore Export Cable Corridor assessments highlight the effects of NIS introduction due to vessel and material transport. Embedded Mitigation will reduce the potential for spread of NIS, and the prevention of NIS introduction will be a key component of the EMP (*Appendix 7A*).

262 Due to uncertainties within the assessment of NIS introduction at offshore developments, the potential long term effects on the local environment, and the importance in terms of the MSFD, a moderate magnitude of effects is determined. The sensitivity of existing benthic communities is considered to be low or moderate depending on their conservation importance, and as such the impact is considered to be moderate.

12.10.6 Cumulative Impacts of the Project and Other Projects during O&M

Loss of Original Habitat

263 The total habitat loss of the cumulative development projects, using reported permanent loss areas calculated for each site, is 5.0 km^2, which is equivalent to less than 1.0 per cent of the combined development areas. In relation to the wider geographical context of available habitats this loss is therefore considered to be of negligible magnitude.

264 The sensitivity of benthic communities likely to be affected across the developments is considered to be low or moderate, and as such the impact is determined as minor.

Changes in Hydrodynamic Regime and Associated Sediment Transport

265 Considering all cumulative developments, no interactions are predicted within *Chapter 10*, with any changes in hydrodynamic and sediment transport processes restricted to the near field of each project. In view of this, the magnitude of impacts is considered low, with the sensitivity of receptors ranging from low to moderate. As such the overall cumulative impact is predicted to be minor/moderate.

Scour and Associated Sediment Transportation leading to changes in Seabed Habitats

266 Although no cumulative change in sedimentary conditions are predicted in *Chapter 10*, at each development, potential for scour to occur has been identified in the absence of protection. While the scour footprints for each site are localised to each foundation base, 12 m lateral extent of scour pits are predicted at the Inch Cape Development Area, the associated suspended sediment increases and deposition will occur over a wider area. At the Inch Cape Development Area, increases in SSC are predicted to impact to a distance up to 200 m and at Neart na Gaoithe increased levels are predicted to occur over 250 m. Settlement of this material is also predicted over these areas. Such parameters are not presented for the Firth of Forth, however the total scour pit area is described as 0.7 km^2. Levels of suspended sediment and deposition are not predicted to significantly surpass MarLIN benchmarks in terms of their value (i.e. 100 mgl^{-1} and five centimetres). Smothering impacts caused by the deposition of scoured material may cause unfavourable conditions for

intolerant species, thereby reducing the species diversity and richness within this area. However, deposition would be gradual over a number of days, then reaching equilibrium.

267 No interactions of scoured material are predicted, and as such assessments identified for individual sites are applicable. In addition, impacts are not predicted to be permanent with effects and timescales similar to those predicted for temporary habitat disturbance likely. Community changes and or loss may result within the scour pits, however, this will be localised in the direct vicinity of foundations. The magnitude of this cumulative impact is considered to be low.

268 The sensitivity of receptors present at all sites ranges from low to moderate, according to their relative conservation importance. As such the overall cumulative impact is minor/moderate.

Colonisation of Introduced Substrata Leading to a Change in the Benthic Ecology and/or Biodiversity

269 As with the Project in isolation, the introduction of new substrate will have direct effects on the overall biodiversity of the area, including indirect effects through increased food availability to higher trophic levels (e.g. *Chapter 13*). Furthermore, community changes, through the introduction of hard substrate species, are expected in the sedimentary habitats immediately surrounding the new substrate (Degraer *et al*., 2011).

270 Such community changes will be localised to the new habitat, and to those existing habitats immediately surrounding the new habitat and effects therefore are predicted to be of negligible magnitude. The sensitivity of existing benthic communities is considered to be low or moderate depending on their conservation importance, and as such impact is considered to be minor.

Provision of New Substrata Facilitating the Spread of NIS

271 As with the Project in isolation, the effects of NIS colonisation also need consideration due to the introduction of hard substrate. Although the potential area of substrata available for colonisation is increased over the Project in isolation, the effects are still expected to be isolated around the introduced substrate and not impact the wider benthic community structure. The prevention of NIS introduction will be a key component of implementation of the EMP (*Appendix 7A*).

272 Due to uncertainties within the assessment of NIS introduction at offshore developments, the potential long term effects on the local environment and expansion of NIS, and the importance in terms of the MSFD, a moderate magnitude of effects is determined. The sensitivity of existing benthic communities is considered to be low or moderate depending on their conservation importance, and as such the impact is considered to be moderate.

Potential Release of Pollutants from Operation Plant

273 As with the Project assessment, a number of possible pollution sources exist during operation, and are increased due to the increased vessel use across all developments. The effects of pollution on the local environment, and the standard controls EMP (*Appendix 7A*) outlined for the construction phase, also apply during the operation phase. The impact magnitude is therefore assessed as low.

274 The sensitivity of existing benthic communities is considered to be low or moderate depending on their conservation importance, and as such the impact is considered to be minor/moderate.

Responses to EMF and Thermal Emissions

275 Due to the locality of any effects on benthic species as a result of EMF and thermal heating, cumulative impacts are not presented beyond those assessed individually. Cumulatively with the Inch Cape, Firth of Forth Round 3 – Phase 1 and Neart na Gaoithe sites over 1,500 km of cable will be installed, however, as any effects will be highly localised a negligible magnitude is assigned.

276 As species and habitats of conservation importance are found along the Offshore Export Cable Corridor and found within the equivalent areas of the cumulative projects, a low to moderate sensitivity is applied. As such, the impact is determined as minor adverse.

Temporary Habitat Disturbance from O&M Activities

277 The habitat disturbed from jack-up vessels and other O&M activities e.g. cable re-burial, represents less than one per cent of the combined areas. As such, the cumulative effect magnitude is considered to be negligible.

278 The sensitivity of benthic communities likely to be affected across the developments is considered to be low or moderate, and as such the impact is determined as minor/moderate.

12.10.7 Cumulative Impacts of the Project and Other Projects during Decommissioning

279 General approach to decommissioning is detailed in *Section 7.12* Following the operational phase a decommissioning plan will be prepared as part of the ongoing development work and will be subject to approval from the DECC. It is assumed that the potential impacts during this phase will at worst be as those assessed for the construction phase.

12.11 Mitigation

280 The benthic ecology assessment has assessed worst case scenario impacts of the Project in isolation and cumulatively. This assessment has concluded that changes to the benthic environment within the Regional Study Area from Project related activities will be of no more than a moderate impact to the identified receptors.

281 Based on the outputs from this impact assessment, it has been concluded that the Embedded Mitigation detailed in *Section 12.4* is appropriate to reduce any potential impacts relating directly to benthic ecology to an acceptable level. No Additional Mitigation is proposed for the Project.

12.12 Conclusions and Residual Impacts

12.12.1 The Development Area

282 As all the mitigation considered for the Development Area in this chapter was Embedded Mitigation and therefore included in the assessment conclusions, only residual effects have been presented in this table.

Table 12.41: Summary of Effects and Mitigation - Development Area

Effect	Receptor	Residual Effect
Construction (and Decommissioning)		
Direct temporary disturbance to seabed habitats caused by construction based activities	SS.SMx.CMx.MysThyMx	Minor
	SS.SCS.CCS.MedLumVen, SS.SCS.OCS, *Arctica islandica*	Minor/Moderate
Indirect impacts of temporary increases in SSC from construction based activities	SS.SMx.CMx.MysThyMx	Minor
	SS.SCS.CCS.MedLumVen, SS.SCS.OCS, *Arctica islandica*	Minor/Moderate
Deposition of resuspended sediments leading to smothering	SS.SMx.CMx.MysThyMx,	Minor/Moderate
	SS.SCS.CCS.MedLumVen, SS.SCS.OCS, *Arctica islandica*	Moderate
Release of PAH, PCB, organotins bound in sediments	SS.SMx.CMx.MysThyMx	Negligible/Minor
	SS.SCS.CCS.MedLumVen, SS.SCS.OCS	Minor
Release of metals bound in sediments	SS.SMx.CMx.MysThyMx	Minor
	SS.SCS.CCS.MedLumVen, SS.SCS.OCS	Minor/Moderate
Secondary impacts of decreased primary production due to increased SSC of the water column	SS.SMx.CMx.MysThyMx	Negligible/Minor
	SS.SCS.CCS.MedLumVen, SS.SCS.OCS	Minor

Effect	Receptor	Residual Effect
Potential release of pollutants from construction plant	SS.SMx.CMx.MysThyMx	Minor
	SS.SCS.CCS.MedLumVen, SS.SCS.OCS	Minor/Moderate
Introduction of NIS	SS.SMx.CMx.MysThyMx	Minor/Moderate
	SS.SCS.CCS.MedLumVen, SS.SCS.OCS	Moderate
Operation and Maintenance		
Loss of original habitat	SS.SMx.CMx.MysThyMx	Minor
	SS.SCS.CCS.MedLumVen, SS.SCS.OCS, *Arctica islandica*	Minor/Moderate
Changes in hydrodynamic regime and sediment transport	SS.SMx.CMx.MysThyMx	Negligible/Minor
	SS.SCS.CCS.MedLumVen, SS.SCS.OCS, *Arctica islandica*	Minor
Scour and Associated Sediment Transportation Leading to Changes in Habitats	SS.SMx.CMx.MysThyMx	Minor
	SS.SCS.CCS.MedLumVen, SS.SCS.OCS, *Arctica islandica*	Minor/Moderate
Colonisation of introduced substrata leading to a change in the benthic ecology and/or biodiversity	SS.SMx.CMx.MysThyMx	Negligible/Minor
	SS.SCS.OCS and SS.SCS.CCS.MedLumVen	Minor
Introduced Substrata facilitating the Spread of NIS	SS.SMx.CMx.MysThyMx	Minor/Moderate
	SS.SCS.OCS and SS.SCS.CCS.MedLumVen	Moderate
Potential release of pollutants from operation plant	SS.SMx.CMx.MysThyMx	Minor
	SS.SCS.OCS and SS.SCS.CCS.MedLumVen	Minor/Moderate
Responses to EMF and thermal emissions	SS.SMx.CMx.MysThyMx	Negligible/Minor
	SS.SCS.OCS and SS.SCS.CCS.MedLumVen	Minor
Temporary habitat disturbance from O&M activities	SS.SMx.CMx.MysThyMx	Negligible/Minor
	SS.SCS.OCS and SS.SCS.CCS.MedLumVen	Minor

12.12.2 Offshore Export Cable Corridor

283 As all the mitigation considered for the Offshore Export Cable Corridor in this chapter was Embedded Mitigation and therefore included in the assessment conclusions, only residual effects have been presented in this table.

Table 12.42: Summary of Effects and Mitigation - Offshore Export Cable Corridor

Effect	Receptor	Residual Effect
Construction (and Decommissioning)		
Direct Temporary Disturbance of seabed habitats caused by Construction Activities	SS.SMu.CFiMu.SpnMeg, SS.SCS.CCS, Stony Reef	Minor/Moderate
	SS.SMx.CMx, SS.SSa.CMuSa, SS.SMx.CMx.MysThyMx SS.SMx.CMx.FluHyd	Minor
	LR.MLR.BF.PelB, LR.HLR.MusB.Cht.Cht, LR.MLR.BF.FspiB, IR.MIR.KR.Ldig.Ldig, LR.LLR.F.FSpi.FS	Minor
	LS.LSa.MoSa.AmSco.Sco, LS.LSa.FiSa.Po, LS.LSa.FiSa.Po.Aten	Negligible/ Minor
Indirect impacts of temporary increases in SSC from construction based activities	SS.SMu.CFiMu.SpnMeg, SS.SCS.CCS, Stony Reef	Minor
	SS.SMx.CMx, SS.SSa.CMuSa, SS.SMx.CMx.MysThyMx SS.SMx.CMx.FluHyd	Negligible/Minor
	LR.MLR.BF.PelB, LR.HLR.MusB.Cht.Cht, LR.MLR.BF.FspiB, IR.MIR.KR.Ldig.Ldig, LR.LLR.F.FSpi.FS	Negligible/Minor
	LS.LSa.MoSa.AmSco.Sco, LS.LSa.FiSa.Po, LS.LSa.FiSa.Po.Aten	Negligible/Minor
Deposition of resuspended sediments leading to smothering	SS.SMu.CFiMu.SpnMeg, SS.SCS.CCS, Stony Reef	Minor
	SS.SMx.CMx, SS.SSa.CMuSa, SS.SMx.CMx.MysThyMx SS.SMx.CMx.FluHyd	Negligible/Minor
	LR.MLR.BF.PelB, LR.HLR.MusB.Cht.Cht, LR.MLR.BF.FspiB, IR.MIR.KR.Ldig.Ldig, LR.LLR.F.FSpi.FS	Negligible/Minor
	LS.LSa.MoSa.AmSco.Sco, LS.LSa.FiSa.Po, LS.LSa.FiSa.Po.Aten	Negligible/Minor

Effect	Receptor	Residual Effect
Release of contaminants bound in sediments	SS.SMu.CFiMu.SpnMeg, SS.SCS.CCS, Stony Reef	Minor
	SS.SMx.CMx, SS.SSa.CMuSa, SS.SMx.CMx.MysThyMx SS.SMx.CMx.FluHyd	Negligible/Minor
	LR.MLR.BF.PelB, LR.HLR.MusB.Cht.Cht, LR.MLR.BF.FspiB, IR.MIR.KR.Ldig.Ldig, LR.LLR.F.FSpi.FS	Negligible/Minor
	LS.LSa.MoSa.AmSco.Sco, LS.LSa.FiSa.Po, LS.LSa.FiSa.Po.Aten	Negligible/Minor
Secondary impacts of decreased primary production due to increased SSC of the water column	SS.SMu.CFiMu.SpnMeg, SS.SCS.CCS, Stony Reef	Minor
	SS.SMx.CMx, SS.SSa.CMuSa, SS.SMx.CMx.MysThyMx SS.SMx.CMx.FluHyd	Negligible/Minor
	LR.MLR.BF.PelB, LR.HLR.MusB.Cht.Cht, LR.MLR.BF.FspiB, IR.MIR.KR.Ldig.Ldig, LR.LLR.F.FSpi.FS	Negligible/Minor
	LS.LSa.MoSa.AmSco.Sco, LS.LSa.FiSa.Po, LS.LSa.FiSa.Po.Aten	Negligible/Minor
Potential release of pollutants from construction plant	SS.SMu.CFiMu.SpnMeg, SS.SCS.CCS, Stony Reef	Minor/Moderate
	SS.SMx.CMx, SS.SSa.CMuSa, SS.SMx.CMx.MysThyMx SS.SMx.CMx.FluHyd	Minor
	LR.MLR.BF.PelB, LR.HLR.MusB.Cht.Cht, LR.MLR.BF.FspiB, IR.MIR.KR.Ldig.Ldig, LR.LLR.F.FSpi.FS	Minor
	LS.LSa.MoSa.AmSco.Sco, LS.LSa.FiSa.Po, LS.LSa.FiSa.Po.Aten	Minor
Introduction of NIS	SS.SMu.CFiMu.SpnMeg, SS.SCS.CCS, Stony Reef	Moderate
	SS.SMx.CMx, SS.SSa.CMuSa, SS.SMx.CMx.MysThyMx SS.SMx.CMx.FluHyd	Minor/Moderate
	LR.MLR.BF.PelB, LR.HLR.MusB.Cht.Cht, LR.MLR.BF.FspiB, IR.MIR.KR.Ldig.Ldig, LR.LLR.F.FSpi.FS	Minor/Moderate

Effect	Receptor	Residual Effect
	LS.LSa.MoSa.AmSco.Sco, LS.LSa.FiSa.Po, LS.LSa.FiSa.Po.Aten	Minor/Moderate
Operation and Maintenance		
Loss of original habitat	SS.SMu.CFiMu.SpnMeg, SS.SCS.CCS, Stony Reef	Minor
	SS.SMx.CMx, SS.SSa.CMuSa, SS.SMx.CMx.MysThyMx SS.SMx.CMx.FluHyd	Negligible/Minor
	LR.MLR.BF.PelB, LR.HLR.MusB.Cht.Cht, LR.MLR.BF.FspiB, IR.MIR.KR.Ldig.Ldig, LR.LLR.F.FSpi.FS	Negligible/Minor
	LS.LSa.MoSa.AmSco.Sco, LS.LSa.FiSa.Po, LS.LSa.FiSa.Po.Aten	Negligible/Minor
Colonisation of cable protection leading to a change in benthic ecology and/or biodiversity	SS.SMu.CFiMu.SpnMeg, SS.SCS.CCS, Stony Reef	Minor
	SS.SMx.CMx, SS.SSa.CMuSa, SS.SMx.CMx.MysThyMx SS.SMx.CMx.FluHyd	Negligible/Minor
Provision of New Substrata Facilitating the Spread of NIS	SS.SMu.CFiMu.SpnMeg, SS.SCS.CCS	Moderate
	SS.SMx.CMx, SS.SSa.CMuSa, SS.SMx.CMx.MysThyMx SS.SMx.CMx.FluHyd	Minor/Moderate
Responses to EMF and thermal emissions	SS.SMu.CFiMu.SpnMeg, SS.SCS.CCS, Stony Reef	Minor
	SS.SMx.CMx, SS.SSa.CMuSa, SS.SMx.CMx.MysThyMx SS.SMx.CMx.FluHyd	Negligible/Minor
	LR.MLR.BF.PelB, LR.HLR.MusB.Cht.Cht, LR.MLR.BF.FspiB, IR.MIR.KR.Ldig.Ldig, LR.LLR.F.FSpi.FS	Negligible/Minor
	LS.LSa.MoSa.AmSco.Sco, LS.LSa.FiSa.Po, LS.LSa.FiSa.Po.Aten	Negligible/Minor
Potential release of pollutants from operation plant	SS.SMu.CFiMu.SpnMeg, SS.SCS.CCS, Stony Reef	Minor/Moderate
	SS.SMx.CMx, SS.SSa.CMuSa, SS.SMx.CMx.MysThyMx SS.SMx.CMx.FluHyd	Minor

Effect	Receptor	Residual Effect
	LR.MLR.BF.PelB, LR.HLR.MusB.Cht.Cht, LR.MLR.BF.FspiB, IR.MIR.KR.Ldig.Ldig, LR.LLR.F.FSpi.FS	Minor
	LS.LSa.MoSa.AmSco.Sco, LS.LSa.FiSa.Po, LS.LSa.FiSa.Po.Aten	Minor
Temporary habitat disturbance due to O&M activities	SS.SMu.CFiMu.SpnMeg, SS.SCS.CCS, Stony Reef	Minor
	SS.SMx.CMx, SS.SSa.CMuSa, SS.SMx.CMx.MysThyMx SS.SMx.CMx.FluHyd	Negligible/Minor
	LR.MLR.BF.PelB, LR.HLR.MusB.Cht.Cht, LR.MLR.BF.FspiB, IR.MIR.KR.Ldig.Ldig, LR.LLR.F.FSpi.FS	Negligible/Minor
	LS.LSa.MoSa.AmSco.Sco, LS.LSa.FiSa.Po, LS.LSa.FiSa.Po.Aten	Negligible/Minor

12.12.3 Cumulative Impacts

The Project

284 As all the mitigation considered for the Project in this chapter was Embedded Mitigation and therefore included in the assessment conclusions, only residual effects have been presented in this table.

Table 12.43: Summary of Effects and Mitigation – The Project

Effect	Receptor	Residual Effect
Construction (and Decommissioning)		
Direct temporary disturbance of seabed habitats caused by construction based activities	Benthic and epibenthic populations	Minor/Moderate
Indirect impacts of temporary increases in SSC from construction based activities and associated deposition	Benthic and epibenthic populations	Minor/Moderate
Release of contaminants found in sediments	Benthic and epibenthic populations	Minor/Moderate

Effect	Receptor	Residual Effect
Secondary impacts of decreased primary production due to increased SSC of the water column	Benthic and epibenthic populations	Minor
Potential release of pollutants from construction plant	Benthic and epibenthic populations	Minor Moderate
Introduction of NIS	Benthic and epibenthic populations	Moderate
Operation and Maintenance		
Loss of original habitat	Benthic and epibenthic populations	Minor
Changes in hydrodynamic regime and sediment transport leading to changes in habitats such as scour	Benthic and epibenthic populations	N/A
Colonisation of introduced substrata leading to a change in the benthic ecology and/or a biodiversity	Benthic and epibenthic populations	Minor
Provision of new substrata facilitating the Spread of NIS	Benthic and epibenthic populations	Moderate
Potential release of pollutants from operation plant	Benthic and epibenthic populations	Minor/Moderate
Responses to EMF and thermal emissions	Benthic and epibenthic populations	Minor
Temporary Disturbance from O&M activities	Benthic and epibenthic populations	Minor

The Project with Other Projects

285 As all the mitigation considered for the Project and other projects in this chapter was Embedded Mitigation and therefore included in the assessment conclusions, only residual effects have been presented in this table.

Table 12.44: Summary of Effects and Mitigation - The Project with Other Projects

Effect	Receptor	Residual Effect
Construction (and Operation)		
Direct temporary disturbance of seabed habitats caused by construction based activities	Benthic and epibenthic populations	Minor/Moderate
Indirect impacts of temporary increases in SSC from construction based activities and associated deposition	Benthic and epibenthic populations	Minor/Moderate
Release of contaminants found in sediments	Benthic and epibenthic populations	N/A
Secondary impacts of decreased primary production due to increased SSC of the water column	Benthic and epibenthic populations	Minor
Potential release of pollutants from construction plant	Benthic and epibenthic populations	Minor/Moderate
Introduction of NIS	Benthic and epibenthic populations	Moderate
Operation and Maintenance		
Loss of original habitat	Benthic and epibenthic populations	Minor
Changes in hydrodynamic regime and sediment transport	Benthic and epibenthic populations	Minor/Moderate
Scour and associated sediment transportation leading to changes in seabed habitats	Benthic and epibenthic populations	Minor/Moderate
Colonisation of introduced substrata leading to a change in the benthic ecology and/or a biodiversity	Benthic and Epibenthic populations	Minor
Provision of new substrata facilitating the Spread of NIS	Benthic and epibenthic populations	Moderate

Effect	Receptor	Residual Effect
Potential release of pollutants from operation plant	Benthic and epibenthic populations	Minor/Moderate
Responses to EMF and thermal emissions	Benthic and Epibenthic populations	Minor
Temporary Disturbance from O&M activities	Benthic and epibenthic populations	Minor

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