Offshore EIA Report

Moray Offshore Windfarm (West) Limited

Chapter 1 Introduction

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Acronyms	
Acronym	**Expanded Term**
AD	Air Defence
ATC	Air Traffic Control
CIA	Cumulative Impact Assessment
CIEEM	Chartered Institute of Ecology and Environmental Management
CIfA	Chartered Institute for Archaeologists
ECC	Export Cable Corridor
EDA	Eastern Development Area
EDPR	EDP Renováveis
EDPR UK	EDPR UK Limited
EIA	Environmental Impact Assessment
EPS	European Protected Species
GIS	Geographic Information Systems
GW	Gigawatt
HRA	Habitats Regulations Assessment
IEMA	Institute of Environmental Management and Assessment
MOD	Ministry or Defence
MORL	Moray Offshore Renewables Limited
MW	Megawatt
MWHS	Mean High Water Springs
NETS	National Electricity Transmission System
NRA	Navigational Risk Assessment
OfTI	Offshore Transmission Infrastructure
OFTO	Offshore Transmission Operator
OnTI	Onshore Transmission Infrastructure
OSP	Offshore Substation Platform
PEIR	Preliminary Environmental Information Report
PPP	Planning Permission in Principle
RIAA	Report to Inform Appropriate Assessment
SEA	Strategic Environmental Assessment
TI	Transmission Infrastructure
UK	United Kingdom
WDA	Western Development Area
WTG	Wind Turbine Generator
ZDA	Zone Development Agreement

1 Introduction

1.1 The Development

1.1.1.1 Moray Offshore Windfarm (West) Limited (known as 'Moray West') is promoting the Moray West Offshore Wind Farm. The Moray West Offshore Wind Farm is located in the outer Moray Firth, approximately 22.5 km southeast of the Caithness coastline.

1.2 Purpose of this Offshore Environmental Impact Assessment (EIA) Report

1.2.1.1 This Offshore Environmental Impact Assessment (EIA) Report (Offshore EIA Report) has been prepared on behalf of Moray West in support of the following consent applications to construct and operate the Moray West Offshore Wind Farm and associated Offshore Transmission Infrastructure (OfTI), collectively termed 'the 'Development':

- Section 36 consent under the Electricity Act 1989 as required for generating stations with capacity of > 50 MW; and
- Marine Licences as required under the Marine and Coastal Access Act 2009 and the Marine (Scotland) Act 2010.

1.2.1.2 The purpose of this Offshore EIA Report is to present the necessary information and findings from the environmental impact assessments undertaken as required by the Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017, the Marine Works (Environmental Impact Assessment) (Scotland) Regulations 2017 and the Marine Works (Environmental Impact Assessment) Regulations 2007 (as amended). This Offshore EIA Report considers all activities associated with the Development up to Mean High Water Springs (MHWS).

1.2.1.3 An additional Onshore EIA Report for the Onshore Transmission Infrastructure (OnTI) has also been produced in support of an application for Planning Permission in Principle (PPP) under the Town and Country Planning (Scotland) Act 1997. Collectively the Development and the OnTI form 'the Project'.

1.2.1.4 This Offshore EIA Report has been prepared in line with advice from Scottish Ministers on the scope of the assessment provided in (1) the Scoping Opinion for the Moray West Offshore Wind Farm in August 2016 and (2) the Scoping Opinion for the OfTI in August 2017.

1.2.1.5 This Offshore EIA Report covers the whole of the proposed Moray West Development lifetime (i.e., it considers environmental impacts which may arise from the construction phase; the operational phase (including maintenance activities) and the decommissioning phase).

1.2.2 Development Definitions

1.2.2.1 The following definitions have been used throughout this EIA Report to describe the specific components and areas relating to the Development:

- **Moray Firth Zone** - Zone 1 of the UK offshore wind Round 3 area held under a Zone Development Agreement (ZDA) by Moray Offshore Renewable Power Limited. This comprises the Moray East Site and the Moray West Site.
- **Moray West** - Moray Offshore Windfarm (West) Limited.
- **Moray West Site** - The area of the Moray Firth Zone in which the Moray West Offshore Wind Farm will be located, previously known as the Western Development Area (WDA).
- **Moray West Offshore Wind Farm** - The wind farm to be developed in the Moray West Site.
- **Moray West Offshore Transmission Infrastructure (OfTI)** - The Offshore Transmission Infrastructure associated with the Moray West Offshore Wind Farm.

- **Moray West OfTI Site** - The area within which the OfTI will be located. It includes part of the Moray West Site, within which the Offshore Substation Platform(s) and a portion of the export cables will be located, and the Moray West Offshore Export Cable Corridor within which the remainder of the export cables will be located.
- **Offshore Export Cable Corridor** - Part of the Moray West OfTI Site, within which the majority of the offshore export cable circuits will be located. This corridor is completely outwith the Moray West Site.
- **The Development** - The Moray West Offshore Wind Farm and the associated Moray West OfTI.
- **Landfall Area** – The section of Aberdeenshire Coast located between Findlater Castle and Redhythe Point within which the export cable(s) will be brought ashore and connected to the Moray West Onshore Transmission Infrastructure (OnTI).
- **Moray West Onshore Transmission Infrastructure (OnTI)** - The Onshore Transmission Infrastructure associated with the Moray West Offshore Wind Farm.
- **The Project** - The Development (Moray West Offshore Wind Farm and Moray West OfTI) and the Moray West OnTI.
- **Moray East** - Moray Offshore Windfarm (East) Limited, formerly known as Moray Offshore Renewables Limited (MORL).
- **Moray East Site** - The area of the Moray Firth Zone in which the Moray East Offshore Wind Farm and parts of the Moray East TI will be located, previously known as the Eastern Development Area (EDA).
- **Moray East Offshore Wind Farm** - The wind farm to be developed in the Moray East Site
- **Moray East Transmission Infrastructure (TI)** - Offshore and onshore electricity transmission infrastructure associated with the Moray East Offshore Wind Farm.
- **Telford, Stevenson and MacColl offshore wind farm areas** - The three consented offshore wind farm areas that comprise the Moray East Site.

1.3 The Developer

1.3.1 Moray Offshore Windfarm (West) Limited

1.3.1.1 Moray West is owned 100% by Moray Offshore Renewable Power Limited (referred to as 'Moray Offshore'). Moray Offshore holds the Zone Development Agreement (ZDA) under which it has exclusive rights to investigate and develop offshore wind farms in the Moray Firth Zone EDPR UK Limited (EDPR UK) in turn owns 100% of Moray Offshore and, itself is 100% owned by EDP Renovaveis (EDPR). In March 2017 Moray West signed an Agreement for Lease with The Crown Estate for the Moray West Site.

1.3.1.2 EDPR is a leading global renewable energy company, with headquarters in Madrid, operating in markets around the globe and is continuously expanding its business to new regions making the commitment to lead in each market as well as create value for its stakeholders and shareholders. At the end of Q1 2018 EDPR had 11 gigawatts (GW) of installed capacity. This includes 5.2 GW in Europe, 5.4 GW in US and 331 MW in Brazil.

1.3.2 Moray West Development Strategy

1.3.2.1 Moray West will develop, consent, finance, construct, operate and maintain the Moray West Offshore Wind Farm. Moray West will also develop, consent, finance, and construct the OfTI, however, it will not own, operate or maintain the OfTI in the long term as it is not permissible for a developer to hold both a generation and transmission licence. The consequence of this is that an offshore wind farm owner cannot retain operational control of any transmission infrastructure associated with the wind farm. However, it is permissible for the wind farm owner to construct and install transmission infrastructure assets and transfer these to an Offshore Transmission Owner (OFTO) after commissioning.

1.3.2.2 Moray West has chosen a process known as the OFTO 'generator build' option which involves the wind farm developer also developing and constructing the offshore transmission infrastructure before transferring all relevant agreements, wayleaves and consents to an appointed OFTO. The other option is an 'OFTO–build' strategy where agreements, wayleaves and consents will be transferred to the OFTO prior to construction of the transmission assets.

1.4 Background to Development of the Moray Firth Round 3 Zone

1.4.1.1 The Moray Firth Zone is located on the Smith Bank in the outer Moray Firth and covers approximately 520 km^2 (151 nm^2). An initial appraisal of the Moray Firth Zone found that, at that time, as a result of other human activities, more constraints existed in the west of the Moray Firth Zone than in the east. Such activities were expected to change over time, consequently the decision was taken to divide the Moray Firth Zone into two; an eastern and a western development area, and to develop the eastern area first. These areas are referred to in this Offshore EIA Report as the Moray East Site and Moray West Site respectively.

1.4.1.2 In 2012 an application to the Scottish Ministers was made for consent to construct and operate offshore wind farms in the Moray East Site, which was subdivided into three offshore wind farm projects (Telford, Stevenson and MacColl offshore wind farms). Section 36 Consents for a total capacity of 1,116 MW across the Moray East Site were granted in March 2014 and associated Marine Licences were awarded in September 2014.

1.4.1.3 On 11th September 2017, Moray East was one of three offshore wind farm projects to be allocated a Contract for Difference (CfD). The project will have a maximum capacity of 950MW and will be delivered at a strike price of £57.50/MWh. It is anticipated that Moray East will be built in a single phase with all WTGs to be installed by the end of 2021.

1.4.1.4 Following award of consent for the Telford, Stevenson and MacColl offshore wind farms, EDPR UK initiated further investigation of the Moray West Site for offshore generation, as described in the Moray West Offshore Wind Farm Infrastructure EIA Scoping Report (May 2016) and Moray West OfTI Scoping Report (May 2017).

1.5 Development Overview

1.5.1.1 Chapter 4 of this EIA Report (Volume 2): Description of Development describes the Development in detail including the temporary and permanent works required for the construction, operation and decommissioning of the different components of the Development.

1.5.1.2 The Development location is shown on Figure 1.5.1 (Volume 3a). The Moray West Offshore Wind Farm will comprise up to 85 Wind Turbine Generators (WTGs) Offshore Substation Platforms (OSPs), inter-array cables, OSP interconnector cables and offshore export cables which will come ashore at a point within the Landfall Area. The Mean High Water Spring (MHWS) comprises the landward extent of the Development.

1.5.1.3 From the landfall, electricity will be transported via onshore transmission infrastructure (OnTI) comprising underground cables and a substation, which will be located at Blackhillock in Moray, for connection into the National Electricity Transmission System (NETS). Further information on the OnTI is provided in the OnTI EIA Report. A summary of key potential effects of the OnTI on the environment is also provided in Chapter 18 of this EIA Report.

Amendment to Onshore Planning Application Boundary:

The EIA for the Planning Permission in Principle (PPP) application being submitted for the Onshore Transmission Infrastructure (OnTI) has been undertaken in parallel to the EIA for the Offshore Wind Farm and OfTI. As part of this process, and in response to ongoing consultation with local communities and other key stakeholders, Moray West has made a decision to amend the Onshore Planning Application Boundary (PAB) to exclude Sandend Beach and all potential landfall locations to the west of the beach out towards Findlater Castle (see Image 1.5.1).

Although the Landfall Area presented in this EIA Report and the Marine Licence application for the OfTI has not been amended to reflect the change to the Onshore PAB, Moray West confirms that **Sandend Beach, and potential landfall locations to the west of the beach towards Findlater Castle, will no longer be considered as a potential landfall location**.

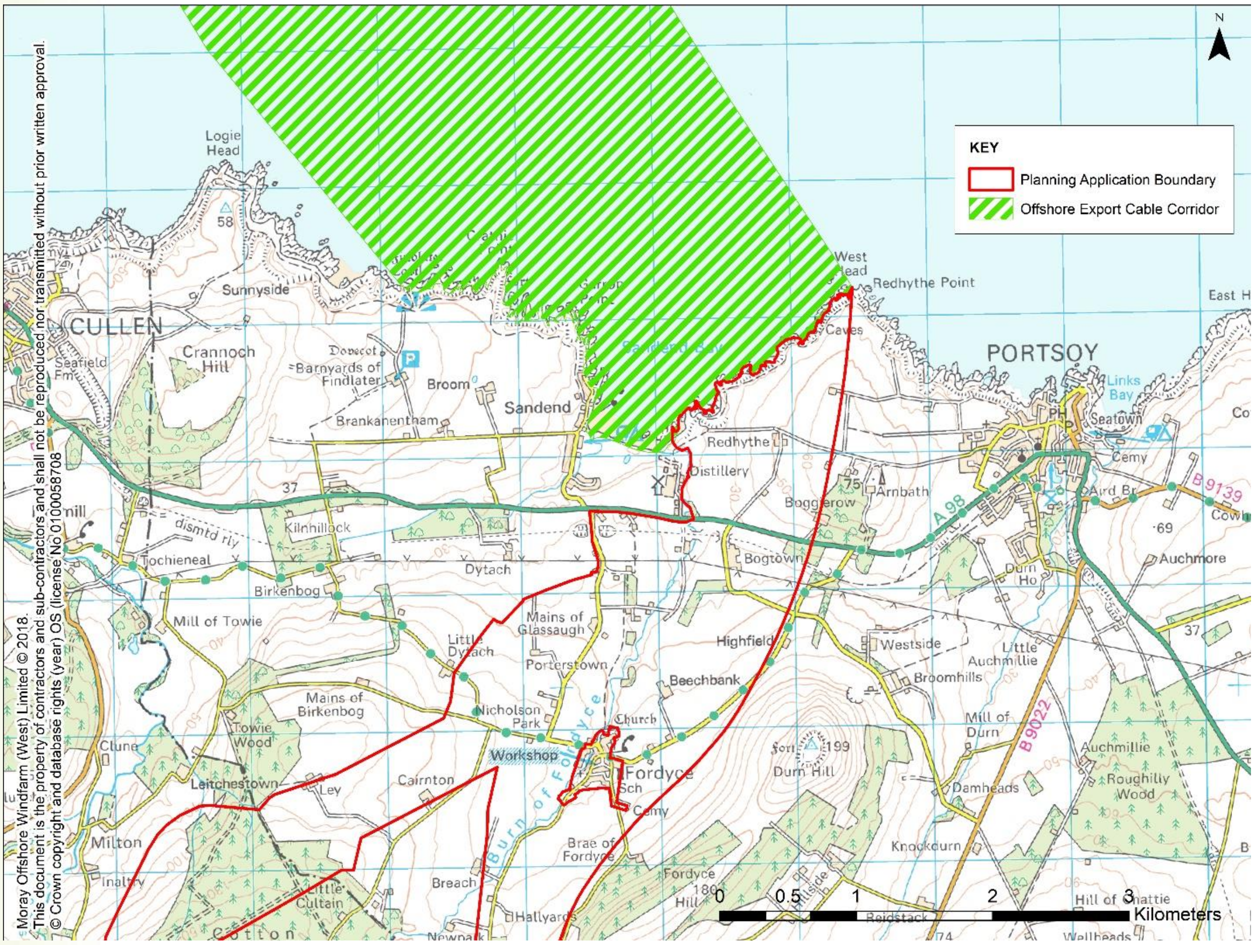

Image 1.5.1: Revised onshore PAB excluding Sandend Beach and areas to the west of Sandend Beach to Findlater Castle

1.6 The EIA Team

1.6.1.1 The team responsible for the production of this Offshore EIA Report has been led by Moray West with the assistance of lead EIA consultants, GoBe Consultants Ltd. The EIA team has been supported during the EIA process by a number of specialist, independent and suitably qualified consultants.

1.6.1.2 GoBe Consultants Ltd. has project managed the production of this EIA Report, assisting Moray West with the compilation of the baseline data, analysis and interpretation, the assessment process including Cumulative Impact Assessment (CIA), consenting, mitigation and monitoring.

1.6.1.3 Specialist consultants, listed in Table 1.6.1 below, have supported the EIA to date, including consultation with relevant stakeholders and preparation of the specialist chapters of the EIA Report. In line with the requirements of the 2017 EIA Regulations, Table 1.6.1 provides a brief summary of the relevant expertise and experience of the technical consultants involved in preparing this EIA Report.

Table 1.6.1: Offshore EIA Report Technical Specialist Consultants

Technical Specialism	Consultant	Relevant Expertise and Experience
EIA Report Introductory Chapters and Summary Chapters, Benthic and Intertidal Ecology, Fish and Shellfish Ecology, Other Human Activities and Report to Inform Appropriate Assessment	GoBe Consultants Ltd	GoBe is an environmental and planning consultancy with a focus on providing EIA, HRA and consenting services to the offshore wind farm industry. With offshore wind involvement since Round 1, GoBe has been involved in the EIA and consenting of approximately 19GW to date. GoBe staff are Institute of Environmental Management and Assessment (IEMA) or Chartered Institute of Ecology and Environmental Management (CIEEM) members (or working towards membership). GoBe is currently seeking IEMA Company membership.
Physical Processes and Water Quality	ABPmer Ltd	ABPmer is a leading UK marine environmental consultancy that is widely recognised for providing technical input to most of the UK's offshore wind, wave and tidal developments. ABPmer has delivered various Physical Processes EIAs including modelling of physical systems, assessments of sediment mobility and coastal processes to a wide range of UK offshore wind developments including the nearby Moray East and Beatrice developments.
Marine Mammal Ecology	Sea Mammal Research Unit Consulting Ltd	SMRU Consulting (SMRUC) is the world's leading marine mammal consultancy with an unrivalled reputation for providing innovative, robust, and environmentally sound solutions for clients active in the marine environment. SMRU Consulting have extensive experience in undertaking offshore wind farm impact assessments for marine mammals.
Ornithology	NIRAS Consulting Ltd	NIRAS Consulting have a long history of providing marine environmental consultancy services to the offshore energy sector (Strategic Environmental Assessment (SEA), EIA, HRA, Environmental Appraisals and Consenting) and are currently involved in over two thirds of the Round 3 offshore wind farm developments in the UK, and have a substantial involvement in the Round 1, 2 and 2.5 offshore wind farms. NIRAS has an experienced and highly skilled technical specialist team with a focus on ornithology and has delivered HRA and EIA support on various wind farm projects across the UK.

Table 1.6.1: Offshore EIA Report Technical Specialist Consultants		
Technical Specialism	**Consultant**	**Relevant Expertise and Experience**
Commercial Fisheries	Brown and May Ltd	Brown & May Marine Limited (BMM) has over 35 years' experience in undertaking a wide range of studies, and surveys in the fields of commercial, fisheries, fish and shellfish ecology. BMM has worked extensively on a wide range of offshore renewables projects providing commercial fisheries EIA Support, stakeholder engagement and post-consent support.
Shipping and Navigation	Anatec Ltd	Anatec has extensive experience of carrying out NRAs for offshore installation projects including offshore renewables, oil and gas installations, ports, marinas, cables, interconnectors and marine aggregate dredging in the UK and worldwide. Our key personnel have been at the forefront of the marine hazard analysis and risk management field for the past 15-25 years. In the past ten years, Anatec have completed Navigation Risk Assessments (NRAs) and supported EIAs for the majority of UK offshore wind farms.
Military and Civil Aviation	Coleman Aviation Ltd	Coleman Aviation Ltd was set up to provide independent consultancy services to the wind farm industry on aviation issues. Wing Commander Mike Coleman has over 27 years' experience working in Air Traffic Control (ATC) and Air Defence (AD) operational teams for the Ministry of Defence (MOD). Over the past five years Coleman Aviation Ltd has provided advice to numerous wind farm developers in resolving wind farm-related aviation issues and EIA Support.
Seascape, Landscape and Visual Assessment (SLVIA)	Optimised Environments Ltd (OPEN)	OPEN have a strong team of landscape architects with over 15 years' experience in undertaking landscape and visual impact assessments. OPEN have provided EIA support on over 50 onshore and offshore wind farm projects including provision of GIS services, visualisations, stakeholder consultations and EIA chapter production.
Socio-economics, Tourism and Recreation	Regeneris Consulting Ltd	Regeneris Consulting is an independent economics consultancy and possesses strong experience in analysing the economic impacts of the UK offshore wind sector. Regeneris has produced ES Chapter Socio-Economic Assessments for eight UK offshore wind farms over the last five years, as well as completing numerous other economic impact reports for offshore wind farms outside of the planning process.
Archaeology and Cultural Heritage	Wessex Archaeology Ltd	Wessex Archaeology is the leading provider of marine archaeological consultancy to the offshore wind industry, working on sites throughout the UK and Europe. Wessex are a Registered Organisation with the Chartered Institute for Archaeologists, and the majority of their staff are also members of CIfA, or other relevant professional body such as Fellows of the Geological Society.

1.7 Structure of the Offshore EIA Report

1.7.1.1 The Offshore EIA Report is divided into four volumes, as shown in Table 1.7.1 below. Table 1.7.1 also identifies the contributing organisations for each chapter.

Table 1.7.1: Structure of the Offshore EIA Report		
Chapter No.	**Chapter Title**	**Consultant / Author**
Volume 1: Non-Technical Summary		
Volume 2: EIA Report		
1	Introduction	GoBe Consultants Ltd
2	Policy and Legislation Context	GoBe Consultants Ltd
3	Site Selection and Alternatives	GoBe Consultants Ltd
4	Description of Development	GoBe Consultants Ltd
5	EIA Methodology	GoBe Consultants Ltd
6	Physical Processes and Water Quality	ABPmer Ltd
7	Benthic and Intertidal Ecology	GoBe Consultants Ltd
8	Fish and Shellfish Ecology	GoBe Consultants Ltd
9	Marine Mammal Ecology	Sea Mammal Research Unit Consulting Ltd
10	Ornithology	NIRAS Consulting Ltd
11	Commercial Fisheries	Brown and May Ltd
12	Shipping and Navigation	Anatec Ltd
13	Military and Civil Aviation	Coleman Associates Ltd
14	Seascape, Landscape and Visual Assessment	OPEN Ltd
15	Socio-economics, Recreation and Tourism	Regeneris Ltd
16	Archaeology and Cultural Heritage	Wessex Archaeology Ltd
17	Other Human Activities	GoBe Consultants Ltd
18	Whole Project Assessment	GoBe Consultants Ltd
19	Summary of EIA	GoBe Consultants Ltd
Volume 3a: Supporting Figures		
Volume 3b: Seascape, Landscape and Visual Assessment Figures and Visualisations		
Volume 4: Supporting Appendices		
Appendix 4.1	Draft Environmental Management Plan	GoBe Consultants Ltd
Appendix 4.2	Draft Decommissioning Plan	GoBe Consultants Ltd
Appendix 5.1	Offshore Wind Farm Scoping Opinion	As issued by MS-LOT
Appendix 5.2	OfTI Scoping Opinion	As issued by MS-LOT
Appendix 5.3	Cumulative Impact Assessment Screening List	GoBe Consultants Ltd
Appendix 6.1	Physical Processes Baseline	ABPmer Ltd
Appendix 6.2	Physical Processes Numerical Modelling	ABPmer Ltd
Appendix 6.3	Physical Processes Impact Assessment	ABPmer Ltd

Table 1.7.1: Structure of the Offshore EIA Report		
Chapter No.	**Chapter Title**	**Consultant / Author**
Appendix 7.1	Benthic Survey Report	Precision Marine Survey Ltd
Appendix 7.2	Intertidal Survey Report	Precision Marine Survey Ltd
Appendix 9.1	Marine Mammal Baseline Characterisation Report	SMRU Consulting Ltd
Appendix 9.2	Underwater Noise Modelling Report	Cefas Noise & Bioacoustics Team
Appendix 9.3	Information to Support Application for a European Protected Species (EPS) Licence	GoBe Consultants Ltd and SMRU Consulting Ltd
Appendix 10.1	Ornithology Technical Report	NIRAS Consulting Ltd
Appendix 10 - Annex 10.1A	Baseline Data Decision Support System (DSS) Report	HiDef Aerial Surveying Ltd
Appendix 10.2	Ornithology Collision Risk Modelling	NIRAS Consulting Ltd
Appendix 10.3	Ornithology Displacement	NIRAS Consulting Ltd
Appendix 11.1	Commercial Fisheries Technical Report	Brown and May Ltd
Appendix 11.2	Draft Commercial Fisheries Mitigation Strategy	Moray West
Appendix 12.1	Navigational Risk Assessment	Anatec Ltd
Appendix 12.2	Consequences Assessment	Anatec Ltd
Appendix 12.3	Hazard Log	Anatec Ltd
Appendix 12.4	MGN 543 Checklist	Anatec Ltd
Appendix 12.5	Regular Operator Letter	Anatec Ltd
Appendix 13.1	Initial Aviation Assessment	Spaven Consulting (previously commissioned by Moray East)
Appendix 13.2	Helicopter Impact Assessment	Spaven Consulting (previously commissioned by Moray East)
Appendix 13.3	Radar Propagation Modelling	Spaven Consulting (previously commissioned by Moray East)
Appendix 14.1	SLVIA Methodology	OPEN Ltd
Appendix 14.2	SLVIA Baseline Landscape Assessment	OPEN Ltd
Appendix 14.3	SLVIA Visibility	OPEN Ltd
Appendix 14.4	SLVIA Cumulative Wirelines Illustrating Moray East Current Base Case Layout	OPEN Ltd
Appendix 15.1	Socio-economics Assessment Methodology	Regeneris Consulting Ltd
Appendix 16.1	Marine Archaeology Baseline	Wessex Archaeology Ltd
Appendix 17.1	Moray Firth High Level Screening Assessment	Pager Power (previously commissioned by Moray East)
Appendix 17.2	Unexploded Ordnance (UXO) Risk Assessment	Alpha Associates (previously commissioned by Moray East)

1.7.1.2 The Offshore EIA Report will be accompanied by a number of additional documents required to support the necessary consent applications. These are detailed in Table 1.7.2.

Table 1.7.2: Consent Application Supporting Documents	
Document	**Author**
Section 36 Consent Application Letter	Moray West
Offshore Wind Farm Marine Licence Application Form	Moray West
OfTI Marine Licence Application Form	Moray West
Gap Analysis	Moray West
Pre-Application Consultation (PAC) Report	Moray West
Report to Inform Appropriate Assessment (RIAA)	GoBe Consultants Ltd
Safety Zone Statement	Anatec Ltd

1.8 Opportunity to Comment

1.8.1.1 Submission of the consent applications will be advertised in accordance with legislative requirements and a period for representations specified. Statutory consultees will also be given an opportunity to make representations on the consents applications.

1.8.1.2 Any formal responses received during the representations period(s) will be considered by Marine Scotland Licensing Operations Team (MS-LOT) in their determination of the consent applications.

1.8.1.3 A copy of the consent applications, with their respective plans showing the areas to which they relate, together with a copy of this Offshore EIA Report, are available for inspection, free of charge, via the Project website (http://www.morayoffshore.com/moray-west/document-library/) and during opening hours at:

- The Highland Council, Planning Office, Glenurquart Road, Inverness, IV3 5NX;
- Caithness Planning Office, Market Square, Wick, KW1 4AB;
- Helmsdale Library and Service Point, Dunrobin Street, Helmsdale, KW8 6JX;
- Buckie Library, Cluny place, Buckie, AB56 1HB;
- Golspie Service Point, Olsen House, Main Street, Golspie, KW10 6RA;
- Brora Library, Gower Street, Brora, Highland, KW9 6PD;
- Moray Council, Planning Office, High Street, Elgin, IV30 1BX; and
- Aberdeenshire Council, Banff Planning Office, Winston House, 39 Castle Street, Banff, AB45 1DQ.

1.8.1.4 Hard copies of the Offshore EIA Report can be purchased from Moray West for a fee of £300. Electronic versions can also be requested.

1.8.1.5 If you wish to comment on this Offshore EIA Report or make representations to MS-LOT, you must do so within the representation period specified in the relevant newspaper advert or consultation letter. Please write to MS-LOT at the following address:

Scottish Government
Marine Laboratory
PO Box 101
375 Victoria Road
Aberdeen
AB11 9DB

1.9 References

Moray West. May 2016. Moray West Offshore Wind Farm Infrastructure Environmental Impact Assessment Scoping Report.

Moray West. May 2017. Moray West Offshore Transmission Infrastructure Scoping Report.

MORAY WEST
OFFSHORE WINDFARM

Offshore EIA Report

Moray Offshore Windfarm (West) Limited

Chapter 2 Policy and Legislative Context

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Acronyms	
Acronym	**Expanded Term**
AC	Alternating Current
ASA	Acoustical Society of America
AST	Atlantic Salmon Trust
BAP	Biodiversity Action Plan
BEIS	Department for Business, Energy & Industrial Strategy
BERR	Department for Business, Enterprise and Regulatory Reform
BOWL	Beatrice Offshore Wind Farm Limited
CBRA	Cable Burial Risk Assessment
CCW	Countryside Council for Wales
Cefas	Centre for Environment, Fisheries and Aquaculture Science
CIEEM	Chartered Institute for Ecology and Environmental Management
CPA	Coast Protection Act
DC	Direct Current
DP	Dynamically Positioned
EcIA	Ecological Impact Assessment
EIA	Environmental Impact Assessment
EMF	Electromagnetic Field
EU	European Union
FEPA	Food and Environment Protection Act
FRS	Fisheries Research Services
GBS	Gravity Base Structures
HRA	Habitats Regulations Appraisal
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
ICES	International Council of the Exploration of the Sea
IEEM	Institute of Ecology and Environmental Management
IHLS	International Herring Larvae Survey
IMARES	Institute for Marine Resources and Ecosystem Studies
IUCN	International Union for Conservation of Nature
JNCC	Joint Nature Conservation Committee
MCZ	Marine Conservation Zone
MHWS	Mean High Water Springs
MINNS	Marine Invasive and Non-Native Species
MMO	Marine Management Organisation
MPA	Marine Protected Area

Acronyms	
Acronym	**Expanded Term**
AA	Appropriate Assessment
BEIS	Business, Energy and Industrial Strategy
CfD	Contracts for Difference
CIA	Cumulative Impact Assessment
DECC	Department for Energy and Climate Change
EC	European Commission
EIA	Environmental Impact Assessment
EMR	Electricity Market Reform
EU	European Union
FID	Final Investment Decision
GHG	Greenhouse Gas
HRA	Habitats Regulations Assessment
LCCC	Low Carbon Contracts Company
LSE	Likely Significant Effect
MS-LOT	Marine Scotland Licensing Operations Team
MW	Megawatts
MWHS	Mean High Water Springs
OSP	Offshore Substation Platform
OfTI	Offshore Transmission Infrastructure
PAC	Pre Application Consultation
RAM	Restricted in the Ability to Manoeuvre
RIAA	Report to Inform Appropriate Assessment
ROC	Renewables Obligation Certificate
SNH	Scottish Natural Heritage
WTG	Wind Turbine Generator

2 Policy and Legislative Context

2.1 Introduction

2.1.1.1 This chapter of the Offshore EIA Report provides a summary of the policy and legislative context for the Moray West Offshore Wind Farm and associated Offshore Transmission Infrastructure (OfTI), 'the Development' and includes:

- A brief overview of international obligations and policy, including European legislation relating to climate change, reducing greenhouse gas emissions and the role of renewable energy;
- UK and Scottish climate change and energy legislation and policy;
- Scottish offshore wind planning and policy;
- The Scottish offshore wind consenting process; and
- Other legislation that may be relevant to the Development.

2.1.1.2 Where policy or legislation exists in respect to specific topics, particularly in terms of the protection or management of those receptors, it is identified in the relevant topic chapters of the EIA Report. Detailed analysis of the applicable policy context for the Development as assessed in the Offshore EIA Report is set out in the Moray West Offshore Planning Statement which accompanies the application for Section 36 Consent and Marine Licences for the Moray West Offshore Wind Farm and associated Offshore Transmission Infrastructure.

2.2 Renewable Energy Policy and the Role of Renewable Sources of Energy

2.2.1.1 Scotland, and the UK as a whole, require new, renewable, sources of energy to combat climate change and ensure that a secure supply of electricity is available to meet increased future demand. The provision of new renewable energy projects will help the government meet legally binding national and international targets on climate change.

2.2.1.2 Offshore wind generation has been identified at European and national level as being capable of providing a significant contribution towards such targets. The UK Round 3 Zone projects, of which Moray West is one, are recognised as being important contributors to Scottish and UK targets for reducing greenhouse gas (GHG) emissions and generating electricity from renewable energy sources by both the Scottish and UK Governments (Scottish Government, 2017; CCC, 2017).

2.2.1.3 This chapter provides the overarching policy context for the Development and the background of the need for the Development at an international and national level.

2.2.2 Climate Change and Renewable Energy Legislation and Policy

<u>International Commitments</u>

2.2.2.1 The Kyoto Protocol is an international agreement, linked to the United Nations Framework Convention on Climate Change, which commits its Parties by setting internationally binding emission reduction targets. The Kyoto Protocol was adopted in Kyoto, Japan, on 11 December 1997 and entered into force on 16 February 2005.

2.2.2.2 At the 2015 United Nations Climate Change Conference, 195 countries adopted the first-ever universal legally binding global climate deal (at the time of writing this had been ratified by 160 parties, including the UK). The agreement (referred to as the Paris Agreement) sets out a global action plan to put the world on track to avoid dangerous climate change by limiting global warming to well below 2°C.

European Legislation and Policy

2.2.2.3 The European Commission (EC) has developed a number of mechanisms to reduce GHG emissions and to focus effort on strengthening and diversifying the generation and supply of energy and in response to the international commitments made at Kyoto and in Paris. The following summarise some of the main targets and legislation relating to climate change and renewable energy:

2020 Targets

2.2.2.4 At a European level, the European Parliament and European Council agreed a climate and energy package known as the 20-20-20 targets in 2008. The targets to be achieved by 2020 include:

- A reduction in European Union (EU) GHG emissions of at least 20% below 1990 levels;
- 20% of EU energy consumption to come from renewable energy sources; and
- 20% reduction in primary energy use compared with projected levels, to be achieved by improvements in energy efficiency.

2.2.2.5 In order to meet these targets, the EC introduced Directive 2009/28/EC on the promotion of the use of energy from renewable sources (the Renewable Energy Directive). Article 3 and Annex I of this Directive set out the mandatory national targets for individual Member States to meet by 2020. As part of this, the UK is subject to a mandatory national target of deriving 15% of gross final energy consumption from renewable sources by 2020 (DECC, 2009).

2030 Targets

2.2.2.6 In October 2014, EU countries agreed on a 2030 framework for climate and energy, which included targets and policy objectives for the period between 2020 and 2030. The targets to be achieved by 2030 include:

- A 40% cut in greenhouse gas emissions compared to 1990 levels;
- At least a 27% share of renewable energy consumption; and
- At least 27% energy savings compared with the business-as-usual scenario.

2.2.2.7 To meet the targets, the EC has proposed:

- A reformed EU emissions trading scheme;
- New indicators for the competitiveness and security of the energy system, such as price differences with major trading partners, diversification of supply, and interconnection capacity between EU countries; and
- First ideas on a new governance system based on national plans for competitive, secure, and sustainable energy. These plans will follow a common EU approach. They will ensure stronger investor capacity, greater transparency, enhanced policy coherence and improved co-ordination across the EU.

2.2.2.8 In order to meet these targets, the EC published a proposal for a revised Renewable Energy Directive on 30th November 2016; the European Parliament voted in favour of the revised Directive in January 2018, which includes a binding target of 27% of all energy consumed coming from renewable energy sources by 2030.

2050 Low Carbon Economy

2.2.2.9 In addition, the EC is looking at cost-efficient ways to make the European economy more climate-friendly and less energy-consuming. Its low-carbon economy roadmap suggests that:

- By 2050, the EU should cut greenhouse gas emissions to 80% below 1990 levels;
- Milestones to achieve this are 40% emissions cuts by 2030 and 60% by 2040;
- All sectors need to contribute; and
- The low-carbon transition is feasible and affordable.

UK Climate Change and Energy Legislation

The Climate Change Act 2008

2.2.2.10 The Climate Change Act 2008 introduced carbon budgets, which put legally binding limits on the amount of greenhouse gases the UK can emit over a five-year period. These carbon budgets are intended to set out a cost-effective path to achieving longer term climate targets. To date, five carbon budgets have been put into law that run up to 2032 as summarised in Table 2.2.1 below.

Table 2.2.1: Summary of the Five Carbon Budgets in UK Law to 2032

Budgetary Period	Years Covered	Carbon Budget ($MtCO_2$)	Average Annual Reduction (cf. 1990)
1	2008-2012	3018	-23%
2	2013-2017	2782	-29%
3	2018-2022	2544	-35%
4	2023-2027	1950	-50%
5	2028-2032	1725	-57%
6	2033-2037	Set by 30/06/21	-
-	-	-	-
-	2050	159	-80%

2.2.2.11 The UK Government subsequently produced Carbon Plans (the first being published in 2009 and the second in 2011) which set out detailed proposals and policies for meeting the carbon budgets across government. The plans deal with matters such as energy efficiency, low carbon transport and industry and electricity generation. In relation to this last point the importance of offshore wind generation is noted in the most recent plan published in 2011.

The Energy Act 2013

2.2.2.12 The 2013 Energy Act contains provisions from the then Department of Energy and Climate Change (DECC) (now the Department for Business, Energy & Industrial Strategy or BEIS) for Electricity Market Reform (EMR)). The EMR sets out the framework for replacing Renewables Obligation Certificates (ROCs) with Contracts for Difference (CfD) to provide stable financial incentives to encourage investment in low carbon electricity generation.

2.2.2.13 CfDs are private contracts between a low carbon electricity generator and the UK Government owned Low Carbon Contracts Company (LCCC). Under a CfD, the electricity generating party is paid the difference between the strike price (the price for electricity reflecting the cost of investment in low carbon technology) and the reference price (a measure of the average market price for electricity in the Great Britain market).

2.2.2.14 The aim of CfDs is to give greater certainty and stability of revenues to electricity generators by reducing exposure to volatile wholesale prices, whilst at the same time protecting the consumer from paying for higher generation support costs when electricity prices are high. It is envisaged that CfDs will help to incentivise renewable energy development in the UK, as reiterated in Amber Rudd's speech on a new direction for energy policy in November 2015.

2.2.2.15 In April 2014, a total of eight projects were awarded CfDs under the 'Final Investment Decision (FID) Enabling for Renewables' process, thereby allocating the first CfDs that were introduced through the EMR programme. Of these eight projects, five were offshore wind farm projects (Beatrice, Burbo Bank Extension, Dudgeon, Hornsea Project One, Walney Extension). In February 2015, a further two offshore wind projects were awarded CfDs in Allocation Round One. In September 2017 Moray East was one of three offshore wind projects to receive a CfD Allocation from Round Two.

Scottish Climate Change Legislation and Policy

The Climate Change (Scotland) Act 2009

2.2.2.16 The UK's target under the Renewable Energy Directive is delivered by individual targets for England, Wales, Scotland and Northern Ireland. The Scottish Government's commitment to tackling climate change is contained in the Climate Change (Scotland) Act 2009, which sets an interim target of a 42% reduction in GHG emissions by 2020, in addition to the target of an 80% reduction by 2050.

Scottish Renewable Energy Policy

2.2.2.17 The Scottish Government has developed a number of strategy and policy positions aimed at tackling climate change and delivering energy security. These broadly sit within and reflect global, EU and UK Government Directives, regulations, plans and policies.

2020 Route Map for Renewable Energy in Scotland

2.2.2.18 At a local level, the 2020 Route Map for Renewable Energy in Scotland (Scottish Government, 2011a) sets out how Scotland will achieve its target to meet an equivalent of 100% demand for electricity from renewable energy by 2020, as well as its target of 11% renewable heat. The 2020 Route Map is an update and extension to the Scottish Renewables Action Plan 2009.

2.2.2.19 Further updates to the Route Map were published in September 2015 (Scottish Government, 2015a). This update reports on progress on development across the renewables sector and towards reaching the 2020 targets, highlighting that provisional figures showed renewable sources generated a record 49.8% of Scotland's gross electricity consumption in 2014. The 2015 update also identifies further collective actions needed to unlock Scotland's full renewable energy potential.

2.2.2.20 The 2020 Routemap for Renewable Energy in Scotland places considerable emphasis on the role of offshore wind in delivering targets and demonstrates the Scottish Government's support for the offshore wind sector, recognising both the potential energy generation and economic development opportunities provided by the deployment of large scale wind turbines.

Scottish Energy Strategy: The Future of Energy in Scotland

2.2.2.21 In December 2017, the Scottish Government published its Energy Strategy. This sets out Scotland's 2050 vision for energy which encompasses the development of a strong low carbon economy, building on the 2020 Route Map, and development of a modern, integrated clean energy system for Scotland. The focus of the strategy is on continued growth of the economy through secure, reliable and affordable energy supplies. The strategy examines Scotland's current energy mix and provides a framework for the future growth of technologies and fuels that will be required to supply Scotland's energy needs over the coming decades (Scottish Government, 2017). With regard to offshore wind the Strategy states that the Scottish Government will:

"open consideration of new opportunities for development in Scottish waters – and renew our support for the development of an innovative and competitive supply chain in Scotland."

The Strategy goes on to further state:

"The competitiveness of Scottish offshore wind has been underlined by Scottish successes (Beatrice, Moray [East] and Neart na Gaoithe) in recent Contract for Difference auctions…

We are determined to continue supporting and growing this sector in Scotland – creating more opportunities for Scottish manufacturers and our supply chain from the developments taking place in our waters and beyond."

2.3 Scottish Waters Offshore Wind Planning Policy

2.3.1 Scotland's National Marine Plan

2.3.1.1 The Scottish Government adopted its National Marine Plan in early 2015 (Scottish Government, 2015b). The purpose of the plan is to provide an overarching framework for marine activity in Scottish waters, in an aim to enable the sustainable development and use of the marine area in a way that protects and enhances the marine environment whilst promoting both existing and emerging industries. This is underpinned by a set of core general policies which apply across all existing and future development and use of the marine environment and sectoral specific policies.

2.3.1.2 With respect to offshore wind, the plan emphasises the growth of the global wind industry and Scotland's contribution to this industry by becoming a key hub for the design, development and deployment of the next generation of offshore wind technologies. The plan emphasises the importance of offshore wind in achieving Scotland's targets for generating the equivalent of 100% of Scotland's own electricity demand from renewable resources by 2020 and to deliver an 80% reduction in GHG emissions by 2050. (Scottish Government, 2015b). The plan also highlights that within the Scottish marine area, there are a number of planned development sites for offshore wind. These include The Crown Estate 'Round 3' offshore wind zones including the Moray Firth Zone (Scottish Government, 2015b).

2.3.1.3 The core objectives and marine planning policies in relation to offshore wind developments seek to:

- Ensure sustainable development of offshore wind in the most suitable locations;
- Maximise economic benefits from offshore wind by securing a competitive local supply chain in Scotland;
- Align marine and terrestrial planning and efficient consenting and licensing processes including, but not limited to, data sharing, engagement and timings, where possible;
- Align marine and terrestrial transmission grid planning and development in Scottish waters;

- Contribute to achieving the renewables target to generate electricity equivalent to 100 % of Scotland's gross annual electricity consumption from renewable sources by 2020;
- Contribute to achieving the decarbonisation target of 50gCO_2/kWh by 2030 (to cut carbon emissions from electricity generation by more than four-fifths);
- Encourage sustainable development and expansion of test and demonstration facilities for offshore wind and marine renewable energy devices; and
- Ensure co-ordinated government and industry-wide monitoring.

2.3.1.4 Where relevant, specific policies are referenced within topic chapters within this EIA Report.

2.3.2 Regional Marine Plans

2.3.2.1 The National Marine Plan, as summarised above, sets the wider context for marine planning within Scottish waters, and including what should be considered when creating local, regional marine plans. Eleven Scottish Marine Regions have been created which cover sea areas extending out to 12nm as defined by the Scottish Marine Regions Order 2015 which came into force on 13th May 2015 and as basis for regional marine planning, to be taken forward by marine planning partnerships.

2.3.2.2 The Moray West OfTI partially lies within the Moray Firth Scottish Marine Region. At the time of writing there is currently no regional marine plan in place for the region.

2.3.3 Sectoral Planning – Offshore Wind

Blue Seas - Green Energy: A Sectoral Marine Plan for Offshore Wind Energy in Scottish Territorial Waters

2.3.3.1 This plan, produced in 2011 sets out proposals for the development of offshore wind in territorial waters (Scottish Government, 2011b). The plan identifies medium term areas of search, one of which was located in the Moray Firth. It was proposed in the plan that the medium term areas of search would be subject to further review as part of the ongoing bi-annual review of the overall plan (Scottish Government, 2011b). The Moray Firth Zone is acknowledged, though not included, in the plan, since it sits outwith territorial waters.

Planning Scotland's Seas: Draft Sectoral Marine Plans for Offshore Renewable Energy in Scottish Waters: Consultation Paper

2.3.3.2 In 2013, the Scottish Government published a consultation paper for the preparation of a draft Sectoral Marine Plan for Offshore Renewable Energy in Scottish Waters. This paper sets out proposals for adopting a marine planning approach to the development of draft Sectoral Marine Plans for Offshore Wind, Wave and Tidal Energy in Scottish Waters (Scottish Government, 2013b). The approach involves giving consideration to resources and key constraints before applying social, economic and environmental assessments to inform the development of options contained within the Draft Sectoral Marine Plans. The Moray Firth Zone is acknowledged in the draft plan.

2.3.3.3 The Draft Plan for Offshore Wind Energy uses the medium term areas of search identified in the Blue Seas – Green Energy plan as the starting point for identifying options for future commercial scale offshore wind development (over 100 MW) in Scottish waters. Following more detailed appraisal and a scoping study, the initial 25 areas of search were reduced to 10. These include an area of search of the north coast of Aberdeenshire (southern Moray Firth) and an area of search of the east coast of Aberdeenshire.

2.3.3.4 Results from consultation on the proposed options presented in this consultation paper were published in a Consultation Analysis Report (Scottish Government, 2014). This report summarises the key responses received from consultation on the proposed options for future commercial scale offshore wind development. The Final Plan for Offshore Wind Energy, taking the responses from consultation into account, is yet to be published.

Scottish Energy Strategy: The Future of Energy in Scotland

2.3.3.5 As described in Section 2.2 of this chapter, in December 2017 the Scottish Government published its Energy Strategy. The strategy examines Scotland's current energy mix and provides a framework for the future growth of technologies and fuels that will be required to supply Scotland's energy needs over the coming decades and confirms continued support for the offshore wind sector in Scotland (Scottish Government, 2017).

Scotland's Offshore Wind Route Map

2.3.3.6 Scotland's Offshore Wind Route Map: Developing Scotland's Offshore Wind Industry to 2020 and Beyond (Scottish Government, 2010 updated 2013a), recognises that, with 25 % of Europe's offshore wind potential, the large scale development of offshore wind represents the biggest opportunity for sustainable economic growth in Scotland.

2.4 Scottish Offshore Wind Consenting Regime and Legislation

2.4.1.1 The following sections describe the policy context and legislative requirements relevant to the consenting and development of all offshore aspects associated with the Development.

2.4.2 Development Consents

2.4.2.1 The Scottish Ministers are the relevant decision-makers in respect of the Section 36 Consent and the Marine Licences. Moray West are applying for a Section 36 Consent and Marine Licence for the Offshore Wind Farm and a Marine Licence for the Offshore Transmission Infrastructure (OfTI). These three licence applications, where are being made simultaneously, are supported by the information presented in this Offshore EIA Report. These consent applications will be processes by Marine Scotland Licensing Operations Team (MS-LOT), on behalf of the Scottish Ministers.

Section 36 Consent

2.4.2.2 Construction and operation of an offshore wind farm of greater than 50 Megawatts (MW) capacity in Scottish Offshore Waters (which covers 12 nm – 200 nm), requires consent under Section 36 of the Electricity Act 1989. A Section 36 Consent is required for all elements of the 'generating station'. For the purpose of this Development this includes the wind turbine generators and inter-array cables elements of the Offshore Wind Farm but does not include the OfTI.

Marine Licences

2.4.2.3 The Marine (Scotland) Act 2010 and the Marine and Coastal Access Act 2009 state that a Marine Licence is required to construct, alter or improve any works or deposit any object in or over the sea, or on or under the seabed. A Marine Licence will therefore be required to construct the Offshore Wind Farm and to construct the OfTI elements of the Development. The Marine Licence requirements under the Marine (Scotland) Act 2010 apply in Scottish Territorial Waters and the Marine Licence requirements under the Marine and Coastal Access Act 2009 apply in Scottish Offshore Waters.

2.4.2.4 In considering a Marine Licence application the Scottish Ministers ensure the proposals are in accordance with the "appropriate marine plans" (as defined in the Marine (Scotland) Act 2010 i.e. any National Marine Plan or relevant Regional Marine Plan in effect) and "appropriate marine policy documents" (as defined in the Marine and Coastal Access Act 2009) i.e. the UK Marine Policy Statement and any relevant Marine Plan in effect), unless relevant considerations indicate otherwise. When making their decision, the Scottish Ministers must also consider:

- The need to protect the environment;
- The need to protect human health;
- The need to prevent interference with legitimate uses of the sea;
- The effects of any use intended to be made of the works in question when constructed;
- Any representations made by anyone with an interest in the outcome of the marine licence applications; and
- Such other matters as the Scottish Ministers consider relevant.

2.4.2.5 A summary of the principal development consents and licences required to develop the Moray West Offshore Wind Farm and OfTI are outlined in Table 2.4.1 below.

<table>
<tr><th colspan="4">Table 2.4.1: Development Consents Required</th></tr>
<tr><th>Development Element</th><th>Development Consent and Licences Required</th><th>Works/Activities</th><th>Decisions Making Body</th></tr>
<tr><td>Moray West Offshore Wind Farm (wind turbines, substructures, foundations and inter-array cables only)</td><td>Section 36 Consent - Electricity Act 1989 (as amended)</td><td>To construct and operate a generating station in excess of 50 MW within the Scottish offshore region.</td><td>Scottish Ministers, acting through MS-LOT.</td></tr>
<tr><td>Moray West Offshore Wind Farm (as above)</td><td>Marine Licence - Marine and Coastal Access Act 2009</td><td rowspan="2">For depositing substances or objects and for the construction, alteration or improvement of any works in or over the sea or on or under the seabed (below Mean High Water Springs (MHWS)) including the temporary placement of construction materials and/or disposal of dredged material etc.</td><td>Scottish Ministers, acting through MS-LOT.</td></tr>
<tr><td>Moray West OfTI (OSPs, OSP interconnector cables, offshore export cables)</td><td>Marine Licence - Marine (Scotland) Act 2010; and Marine and Coastal Access Act 2009</td><td>Scottish Ministers, acting through MS-LOT.</td></tr>
</table>

2.4.3 Consenting Process

2.4.3.1 Where an offshore energy project, such as an offshore wind farm, requires a Section 36 Consent and a Marine Licence, MS-LOT can process both consent applications jointly. The consenting process is summarised below, in line with the relevant guidance document (BSI, 2015).

Pre-Application

2.4.3.2 At the pre-application stage developers are advised to undertake preparatory work and discuss proposals with MS-LOT as early as possible. The first step in the EIA process commences with screening and / or scoping exercises to confirm the requirement for EIA and scope of EIA respectively. It is encouraged that developers consult on the proposal as part of the consenting and EIA process with a variety of statutory consultees and stakeholders. MS-LOT consult with statutory and non-statutory consultees when an EIA screening and scoping opinion is requested by a developers. In the majority of cases MS-LOT liaise directly with consultees but can also direct applicants to specific organisations if appropriate.

2.4.3.3 Moray West elected to undertake an EIA rather than undertaking a screening exercise. Subsequently, as part of a request for a Scoping Opinion, Moray West issued Scoping Reports to MS-LOT in May 2016 for the Moray West Offshore Wind Farm and in May 2017 for the Moray West OfTI. MS-LOT consulted, and sought advice on, the Scoping Reports from a variety of sources within Marine Scotland and from expert external advisors, consultees, stakeholders and other regulators. Based on the advice sought, Scoping Opinions advising of the scope of the EIA for the Wind Farm and OfTI were published in August 2016 and August 2017 respectively.

2.4.3.4 This EIA Report has been prepared based on advice provided in these Scoping Opinions, and the outcomes of additional ongoing consultation with statutory consultees and stakeholders on the Development proposal.

Pre-Application Consultation

2.4.3.5 As part of the application process The Marine (Scotland) Act 2010 sections 22 to 24 set out the requirement for pre-application consultation for developments within Scottish Territorial Waters with the potential for significant impact on the environment and local communities. The process provides opportunities to receive feedback from the public and third sector organisations that can then be addressed in the application and supporting EIA Report. MS-LOT require applicants to have undertaken pre-application consultation with stakeholders, consultees and the public in accordance with the legislative requirements.

2.4.3.6 At the time of EIA Report preparation, pre-application consultation relating to those elements of the Development within 12 nm has been undertaken. The approach to and outcomes of this are presented in a Pre-Application Consultation (PAC) Report, which will accompany the OfTI Marine Licence application.

Application & Determination

2.4.3.7 Moray West has submitted the required consent applications, supported by this Offshore EIA Report, to MS-LOT. Once the application is accepted by MS-LOT, Moray West will circulate application information to consultees identified by MS-LOT, and also place copies of the same information in public viewing places. Moray West will also advertise the applications in national and local press. Publication and consultation on this Offshore EIA Report will be carried out in accordance with the EIA Regulations (as defined below).

2.4.3.8 Consultees then have a fixed period of time in which they may make representations on the consent applications, and these are considered by MS-LOT. Scottish Ministers then proceed to determine the applications and a decision is announced and published.

2.4.3.9 Moray West have entered into a Processing Agreement with MS-LOT, which sets out application and determination timelines.

Post Consent

2.4.3.10 As part of a positive determination, MS-LOT may attach various conditions to the relevant licences and consents and Moray West will have a statutory duty to comply with them.

2.5 The EIA Regulations

2.5.1.1 Certain types of developments are classed as 'EIA Development' under the requirements of the EIA Directive and the domestic regulations implementing it. The purpose of these provisions is to ensure that, in considering whether to grant consents for developments that are likely to have significant environmental effects, the consenting authorities have all the necessary environmental information on which to base their decision. It is considered that due to the nature, scale and size of the Development, there is the potential for significant environmental effects and accordingly an EIA has been carried out.

2.5.1.2 The EIA Directive (Directive 85/337/EEC) and its various amendments were codified by Directive 2011/92/EU. That Directive was also recently amended (Directive 2014/52/EU). The relevant domestic legislation implementing this most recently amended EIA Directive in Scotland and the wider-UK came into force on 16th May 2017, after the Offshore Wind Farm scoping exercise had been carried out and before the equivalent OfTI scoping exercise.

2.5.1.3 This Offshore EIA Report for the Development meets the requirements set out in all applicable legislation; including the Marine Works (Environmental Impact Assessment) (Scotland) Regulations 2017, the Marine Works (Environmental Impact Assessment) (Scotland) Regulations 2007 and the Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017, together referred to as 'the EIA Regulations'.

2.5.1.4 Further detail on the legislative requirements relating to EIA are set out under Chapter 5: EIA Methodology.

2.6 Requirement for Habitats Regulations Assessment

2.6.1.1 Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora, also known as the 'Habitats Directive', provides for the conservation of natural habitats and of wild flora and fauna including in offshore areas. The EC Directive on the conservation of wild birds (Birds Directive) applies to the conservation of all species of naturally occurring wild birds including in offshore areas. In the UK, sites designated as Special Areas of Conservation (SACs) and Special Protection Areas (SPAs) form part of the Natura 2000 network, delivering the requirements of the Directives.

2.6.1.2 Both Directives have been transposed into Scottish Law by The Conservation (Natural Habitats &c.) Regulations 1994 (as amended) (the Habitats Regulations) and in the offshore marine area by the Conservation of Offshore Marine Habitats and Species Regulations 2017 (the Offshore Habitats Regulations). Certain provisions of the Conservation of Habitats and Species Regulations 2017 also apply to section 36 Consent projects within Scotland and its territorial waters however these regulations are not applicable to the Development.

2.6.1.3 The Habitats Regulations and Offshore Habitats Regulations require that wherever a project, that is not directly connected with, or necessary to the management of a Natura 2000 site, and is likely to have a likely significant effect (LSE) on the site (either alone or in-combination with other plans or projects) then an Appropriate Assessment must be undertaken by the Competent Authority to ascertain whether the project would have adverse effects on the integrity of the Natura 2000 Site. The Appropriate Assessment must be carried out before consent or authorisation can be given for the project.

2.6.1.4 Information required to inform an Appropriate Assessment has been gathered and presented in parallel to this Offshore EIA Report. An HRA Screening Report, which identifies those sites and features for which there is a potential LSE has been prepared by Moray West as part of this process. The HRA Screening Report was issued to the competent authority (in this case MS-LOT) and other relevant stakeholders for comment. Subsequently, a Report to Inform Appropriate Assessment (RIAA) has been prepared for submission with the applications. The RIAA considers whether there are any potential for adverse effects on the conservation objectives and integrity of the relevant designated sites and features.

2.6.1.5 Whilst there is likely to be some repetition of information between the Habitats Regulations Assessment (HRA) Screening Report, RIAA and EIA Report, the HRA Screening Report and RIAA do not form part of the EIA process or the EIA Report and are therefore only mentioned to provide context and information.

2.7 Other Consents and Licences

2.7.1 The Energy Act 2004 and the Electricity (Offshore Generating Stations) (Safety Zones) (Application Procedures and Control of Access) Regulations 2007

2.7.1.1 Under Section 95 of the Energy Act 2004 where a renewable energy installation is proposed to be constructed, and the Scottish Ministers consider it appropriate for safety reasons, designated areas may be declared as safety zones.

2.7.1.2 Safety zones are intended to ensure the safety of the renewable energy installation or other installations in the vicinity during construction, operation, extension or decommissioning. Safety zones may exclude non-wind farm vessels from navigating through a designated area for a designated period.

2.7.1.3 This Offshore EIA Report confirms the intended application of safety zones by Moray West (see Chapter 12: Shipping and Navigation). It is currently assumed that during construction of the Development, 500 m safety zones will be applied around any structure where construction work is underway, as indicated by the presence of a large construction vessel(s). It is intended that 50 m safety zones are applied around any partially completed structure where work is not underway and around completed structures prior to their commissioning. During the operational phase of the Development, 500 m safety zones will be applied around any structure undergoing major maintenance, defined as work requiring a large or Restricted in the Ability to Manoeuvre (RAM) vessel.

2.7.2 Energy Act (2004) (Decommissioning)

2.7.2.1 Sections 105 to 114 of the Energy Act 2004 require a decommissioning scheme for an offshore renewable energy installation to be approved by the Scottish Ministers. The potential effects of the decommissioning of the Development will be assessed within the EIA, and a draft Decommissioning Plan has been prepared to accompany the Offshore EIA Report.

2.7.3 The Crown Estate Act 1961 (Seabed Lease)

2.7.3.1 The Crown Estate Commissioners are the owners of much of the foreshore and the seabed below the territorial seas of the UK under the provisions of the Crown Estate Act 1961 and are the party entitled to exercise the right to exploit areas for the production of energy from water or winds within designated areas. The Commissioners require a lease of the seabed and foreshore (where applicable) to be entered into for developments on the marine estate, including cable laying and construction of offshore structures.

2.7.3.2 In March 2017 Moray West signed an Agreement for Lease (AfL) with The Crown Estate Commissioners in respect of the Moray West Site. Under the provisions of the Scotland Act 2016, The Crown Estate’s management functions in Scotland have been transferred to the Crown Estate Scotland since April 2017.

2.7.4 The Conservation (Natural Habitats, &c.) Regulations 1994 and the Conservation of Offshore Marine Habitats and Species Regulations 2017 (European Protected Species Licensing)

2.7.4.1 Under the Habitats Regulations and the Offshore Habitats Regulations certain activities which would normally constitute an offence against European Protected Species (EPS), which are species requiring strict protection, can be carried out legally under a licence. An example of such an activity is the piling of OSP and WTG foundations, which may generate underwater noise at levels that could disturb cetaceans, which are EPS. The licences are granted by Scottish National Heritage (SNH) or the Scottish Ministers depending on the reason for the licence application. Moray West will apply for licences as appropriate and prior to the start of construction, and have provided a Report to Inform a European Protected Species (EPS) Licence Application as part of this application (see Appendix 9.3).

2.7.5 Town and Country Planning (Scotland) Act 1997

2.7.5.1 Planning permission will be separately sought by Moray West for the OnTI under the Town and Country Planning (Scotland) Act 1997. The Town and Country Planning (Environmental Impact Assessment) (Scotland) Regulations 2017 will apply to that application. As such a separate scoping exercise has been undertaken for the OnTI and a separate Onshore EIA Report will be prepared for submission with the application for planning permission. The Offshore EIA Report will consider the OnTI where relevant and to the extent that the details of the OnTI are known, to ensure that the effects of the Project as a whole are considered.

2.8 References

BSI (2015) Environmental impact assessment for offshore renewable energy projects – Guide. Report Number PD 6900:2015

CCC (Committee on Climate Change), 2017. Meeting Carbon Budgets: Closing the policy Gap. 2017 Report to Parliament. Available from: https://www.theccc.org.uk/wp-content/uploads/2017/06/2017-Report-to-Parliament-Meeting-Carbon-Budgets-Closing-the-policy-gap.pdf [Accessed on 23 March 2018]

DECC (Department of Energy and Climate Change), 2009. Renewable Energy Strategy.

Scottish Government, 2017. Scottish Energy Strategy: The Future of Energy in Scotland. Available from: http://www.gov.scot/Publications/2017/12/5661 [Accessed 24 January 2018].

Scottish Government, 2015a. 2020 Routemap for Renewable Energy in Scotland. Available online from: http://www.gov.scot/Resource/0048/00485407.pdf [Accessed 28 August 2017].

Scottish Government, 2015b. Scotland's National Marine Plan. Available from: http://www.gov.scot/Resource/0047/00475466.pdf. [Accessed on 28th August 2017].

Scottish Government, 2014. Planning Scotland's Seas: Consultation Analysis Overview Report. Available from: http://www.gov.scot/Publications/2014/04/3277 [Accessed on 28th August 2017].

Scottish Government, 2013a. Scotland's Offshore Wind Route Map: Developing Scotland's Offshore Wind Industry to 2020. Available online from: http://www.gov.scot/Publications/2013/01/5856/downloads [accessed 28th August 2017].

Scottish Government, 2013b. Planning Scotland's Seas: draft Sectoral Marine Plans for Offshore Renewable Energy in Scottish Waters: Consultation Paper. Available from: http://www.gov.scot/Publications/2013/07/8702 [Accessed on 28th August 2017].

Scottish Government, 2012a. Offshore Wind Energy in Scottish Waters - Draft Initial Plan Framework. Available from: http://www.gov.scot/Resource/0039/00398537.pdf [accessed on 6th September 2017].

Scottish Government, 2012b. Draft Regional Locational Guidance – Offshore Wind in Scottish Waters. Available from: http://www.gov.scot/Topics/marine/marineenergy/Planning/windrlg [accessed on 6th September 2017].

Scottish Government, 2011a. 2020 Routemap for Renewable Energy in Scotland. Available online from: http://www.scotland.gov.uk/Publications/2011/08/04110353/0 [accessed 1 Sep 2011].

Scottish Government, 2011b. Blue seas – Green Energy: A sectoral Marine Plan for Offshore Wind Energy in Scottish Territorial Waters. Available from: http://www.gov.scot/Resource/Doc/346375/0115264.pdf [accessed on 28th August 2017].

Scottish Government, 2011c. Scoping Study for Offshore Wind Farm Development in Scottish Waters Scottish Marine And Freshwater Science Volume 2 Number 13. Available from: http://www.gov.scot/Resource/Doc/363758/0123511.pdf [accessed on 6th September 2017].

Scottish Government, 2010. Scotland's Offshore Wind Route Map: Developing Scotland's Offshore Wind Industry to 2020. Available online from: http://www.gov.scot/Publications/2010/09/28115850/0 [accessed 11 Oct 2011].

MORAY WEST
OFFSHORE WINDFARM

Offshore EIA Report

Moray Offshore Windfarm (West) Limited

Chapter 3 Site Selection and Alternatives

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Liability

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Acronyms	
Acronym	**Expanded Term**
AA	Appropriate Assessment
BOWL	Beatrice Offshore Windfarm Limited
CION	Connections and Infrastructure Options Note
DECC	Department of Energy and Climate Change
ECC	Export Cable Corridor
EIA	Environmental Impact Assessment
HDD	Horizontal Directional Drilling
HRA	Habitats Regulations Assessment
MaRS	Marine Resource System
MoD	Ministry of Defence
NGET	National Grid Electricity Transmission Limited
nm	Nautical Mile
OCT	Open Cut Trench
OESEA	Offshore Energy Strategic Environmental Assessment
OfTI	Offshore Transmission Infrastructure
OSP	Offshore Substation Platform
REZ	Renewable Energy Zone
SAC	Special Area of Conservation
SHE-T	Scottish Hydro Electric Transmission
WTG	Wind Turbine Generator
ZAP	Zone Appraisal and Planning
ZDA	Zone Development Agreement

3 Site Selection and Alternatives

3.1 Introduction

3.1.1.1 This chapter presents the main stages in the site selection process for the proposed Development, and the alternatives considered by Moray West.

3.1.1.2 The EIA Regulations (Chapter 2: Policy and Legislation) requires that the EIA Report include information on the alternatives to the relevant project studied by the developer. In Schedule 4 of the Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017 the requirement is:

"a description of the reasonable alternatives (for example in terms of project design, technology, location, size and scale) studied by the developer, which are relevant to the proposed project and its specific characteristics, and an indication of the main reasons for selecting the chosen option, including a comparison of the environmental effects".

3.1.1.3 Similar provisions appear in the other EIA Regulations.

3.2 Site Selection Process

3.2.1.1 Site selection for the Development has been guided by four key factors:

- The selection and subsequent award of the Moray Firth Zone;
- The Zone Appraisal and Planning (ZAP) process which identified areas for the development of wind farms within the zone;
- The grid connection agreement between Moray West, National Grid and SHE-Transmission (SHE-T), which confirmed Blackhillock, Moray, as the grid interface point for the Development, and which enabled the identification of offshore and onshore export cable route corridors and the onshore substation; and
- Consultation and technical investigations which have enabled refinements to be made in the location and design of the Development.

3.3 Identification of Round 3 Offshore Wind Zones within UK Waters (12 nm to 200 nm)

3.3.1.1 The Moray Firth Zone was identified as a suitable area offering 'potential for offshore wind' by The Crown Estate as part of the Round 3 Offshore Wind Zone tendering process in 2008. In their briefing note titled 'Round 3 Offshore Wind Site Selection at National and Project Levels' (The Crown Estate, 2008), The Crown Estate explain the zone selection process which is summarised below.

3.3.1.2 The Crown Estate Round 3 Offshore Wind Zones were the subject of the Offshore Energy Strategic Environmental Assessment (OESEA) undertaken in 2008 and 2009 (The Department of Energy and Climate Change (DECC) 2009). The OESEA was prepared to assess the implications of further rounds of offshore wind farm leasing in the UK Renewable Energy Zone (12 nm to 200 nm) as well as the implications of other industry activities. The results of this strategic level analysis showed that the zones represent suitable 'areas of opportunity' for offshore wind farm projects, and have the ability to deliver the required capacity of energy from offshore wind within acceptable environmental limits. However, it was recognised that there may be many local or regional constraints to the development of offshore wind farm projects within the zone boundaries.

3.3.1.3 The Crown Estate used their Marine Resource System (MaRS) Geographic Information System (GIS) tool to identify suitable areas for offshore wind farm development. The Round 3 Zones were identified in an iterative process that took account of a number of constraints imposed by existing or future use of the sea (The Crown Estate, 2012).

3.3.1.4 The finalised Round 3 Zones were selected following the completion of a three stage iterative process involving consultation with a range of stakeholders.

3.3.1.5 As the Competent Authority, The Crown Estate was responsible for carrying out a full Habitats Regulations Assessment (HRA) of the Round 3 Offshore Wind Plan. This included an Appropriate Assessment (AA) for those sites where likely significant effects (LSE) could not be excluded at that screening stage. Where appropriate, the outcomes from this HRA have been taken into consideration by the various Round 3 developers as part of the process of zone and project development.

3.3.1.6 In bidding for the Moray Firth Zone as part of the Round 3 tender process as it was considered that, on balance, although there were environmental and technical constraints present in the zone, there remained good opportunities for development. In 2010, an exclusivity agreement for the Moray Firth Zone (a Zone Development Agreement (ZDA)) was awarded by The Crown Estate and which is now held by Moray Offshore Renewable Power Limited.

3.4 Zone Appraisal and Planning (ZAP)

3.4.1.1 The identification of individual projects within the Moray Firth Zone was undertaken by the process of Zone Appraisal and Planning (ZAP) which is a non-statutory strategic planning process recommended by The Crown Estate specifically for Round 3.

3.4.1.2 The aim of ZAP was to:

- Optimise the development opportunity within the Moray Firth Zone ('the Zone') through the identification of the most technical and environmentally suitable development sites;
- Encourage wide stakeholder engagement at a strategic level to help inform the longer-term development strategy; and
- Consider potential cumulative impacts across the Zone, and in relation to other nearby offshore wind farm developments and marine activities.

3.4.1.3 An appraisal of potential constraints / key considerations was undertaken in 2010 in order to identify suitable areas for development within the Zone (BMT Cordah & RPS, 2009; Moray East, 2010b). It considered a range of engineering, environmental and economic factors. Available bathymetric and seabed geology data was analysed, 'hard constraints' (e.g. oil and gas wells, surface structures with helipads, pipelines and cables, wrecks) present within the Zone were mapped, and other environmental features were considered.

3.4.1.4 The appraisal resulted in the division of the Zone into eastern and western areas (now referred to as the Moray East and Moray West Sites), which were each subject to a distinct set of engineering constraints and environmental considerations. The arc-shaped boundary between the Moray East and Moray West Sites (Figure 3.4.1 – Volume 3a) reflects a buffer previously applied to oil platforms in the Beatrice oil field to allow for helicopter access.

3.4.1.5 From an environmental perspective, key receptors identified as requiring consideration across the Zone include marine mammals, seabirds, potential interference to military and civil aviation radar and use of the Zone by commercial fisheries. Potential effects on shipping and navigation were also identified as requiring consideration, although levels of maritime traffic throughout the Zone are generally low.

3.4.1.6 The main potential constraints / areas for consideration identified within the Moray West Site were as follows:

- Presence of existing oil platforms and other subsea infrastructure (i.e. wells and pipelines) associated with the Beatrice oil field along the north west boundary of the Moray West Site and associated potential interference with helicopter and navigation access routes to these platforms (the Beatrice oil field is due to be decommissioned between 2024 and 2027);
- Presence of the Beatrice Demonstrator Turbines within the Moray West Site (these are also to be removed as part of the decommissioning of the Beatrice oil field);
- Presence of a large section of the Ministry of Defence (MoD) Practice Area D807. This has since been removed;
- Allowance for a buffer zone between wind turbine development in the Zone and the adjacent Beatrice Offshore Windfarm Limited (BOWL) offshore wind farm which is currently under construction; and
- Proximity to the Moray Firth and Dornoch Firth & Morrich More Special Area of Conservation (SAC) and sensitive marine mammal features.

3.5 Moray West Offshore Wind Farm Site

3.5.1.1 From the ZAP process, Moray Offshore identified two main areas for development within the Zone; the Moray East Site and the Moray West Site (Figure 3.4.1 – Volume 3a). The decision was taken to develop the Moray East Site first, primarily due to the presence of a greater number of constraints in the Moray West Site associated with the Beatrice oil field and associated infrastructure. The first offshore wind farm projects to be proposed within the Moray East Site were the now consented Telford, Stevenson and MacColl Offshore Wind Farms, with a total generating capacity of 1,116 MW.

3.5.1.2 Following award of consents to the Moray East developments, EDPR UK initiated further investigation of the suitability of the Moray West Site for offshore generation. It became clear that the constraints that were initially present within the Moray West Site had diminished over time. The MoD Practice Area had been removed and the oil platforms adjacent to the Zone were subject to decommissioning proposals. It was noted that an additional hard constraint was now present within the Zone in the form of the planned Beatrice Offshore Wind Farm export cables, but that these could be managed.

3.5.1.3 The Moray West Offshore Wind Farm was taken forward to EIA Scoping in May 2016, based on the boundaries shown in Chapter 1: Introduction - Figure 1.5.1 (Volume 3a). Information presented in the Scoping Report, and subsequently presented in this EIA Report, was informed by findings from various studies and surveys that had been undertaken as part of the previous Telford, Stevenson and MacColl Offshore Wind Farm applications where these had overlapped with or were directly applicable to the Moray West Site. The Offshore Substation Platforms (OSPs) and a portion of the export cable circuits will also be located within these boundaries.

3.6 Development Options

3.6.1.1 With regard to defining the final Development in terms of turbine sizes, numbers, layouts, construction methods etc., it has been necessary, and will continue to remain necessary, to consider a range of possible development options based on different design parameters. This is referred to as the ‘Design Envelope’ approach to consenting, and is recognised as standard practice across the offshore wind industry. This approach has been developed specifically to give Developers flexibility within their consents to accommodate any future improvements in technology or construction methods in their final Development design.

3.6.1.2 With respect to this Development, the components requiring greatest flexibility in terms of specific design parameters include the Wind Turbine Generators (WTGs) (i.e. numbers, rotor diameter, maximum blade tip heights etc.) and substructures types e.g. monopiles, pin-pile jackets, suction caissons or gravity base structures. These components will then also influence other components of the Development such as layouts and spacing between individual WTGs, number and positioning of Offshore Substation Platforms (OSPs) and cables (inter-array, OSP interconnector and export).

3.6.1.3 Although the 'Design Envelope' has been developed specifically to take into account future developments in technologies and construction methods, the final extent of that Design Envelope (e.g. maximum design parameters) is influenced by environmental and physical (i.e. seabed characteristics, water depth etc.) factors. These factors include specific design measures and limits that have already been put in place, or have been developed during the EIA process, to prevent or minimise the potential for any potential adverse effects on the environment (referred to as embedded measures or any changes introduced / limits applied to the Design Envelope based on specific outcomes from this EIA Report e.g. where potentially significant effects have been identified.

3.6.1.4 The Design Envelope for this Development is described in detail in Chapter 4: Description of the Development. Further detail on applying the Design Envelope approach to the assessment of impacts is provided in Chapter 5: EIA Methodology.

3.7 Identification of Grid Interface Point and Landfall Appraisal

3.7.1 Initial Grid Connection Options

3.7.1.1 Moray West began discussions with National Grid Electricity Transmission Limited (NGET) and Scottish Hydro Electric Transmission (SHE-T) (the grid licence holder in Scotland) in 2016, with the objective of identifying potential onshore grid interface points with sufficient capacity for the Development. At this point, NGET commenced the Connections and Infrastructure Options Note (CION) process.

3.7.1.2 A number of potentially suitable grid interface points (Figure 3.6.1 – Volume 3a) were considered through this process based on an understanding of the grid infrastructure capacity in relation to the location of Development, the potential capacity of Development and its target connection timescale. The connection locations identified comprised:

- Blackhillock;
- Brora / Dunbeath;
- Cullen / Portgordon;
- New Deer; and
- Spittal.

3.7.2 National Grid Connection Offer

3.7.2.1 The aim of the CION is to provide an assessment of the options to connect a development to the National Electricity Transmission System (NETS). The process facilitates an appraisal of a variety of options and identifies the preferred onshore connection points and offshore transmission network configuration for the development. The CION is developed to initially make a representative Connection Offer to an applicant and subsequently develop the most economic and efficient design option for the connection of a project. This involves assessment by NGET, SHE-T and the developer from an economic and strategic perspective, in terms of the additional costs and investments required for the connection, based on the capacity requested and the timing of when the developer predicts that the connection will be required. An important element of this assessment is the cost that will be passed on to the consumer (the public and businesses) as a result of the works which will be required to ensure the network can accommodate the development.

3.7.2.2 As part of the economic assessment, the CION considers the total life cost of the connection – assessing both the capital and projected operational costs to the onshore network (over a development's lifetime) to determine the most economic and efficient design option. Whilst a developer inputs into this process in terms of the comparative costs for different options which National Grid may consider, the eventual offer is determined by National Grid. In addition to economic assessment, the CION process also requires consideration of environmental and consenting risks associated with each of the potential connection options.

3.7.2.3 Based primarily on likely costs and timing of grid infrastructure upgrades three potential locations were initially discounted, leaving Blackhillock and New Deer as the focus of the further appraisal process.

3.7.2.4 In April 2017, Moray West was formally offered by National Grid a grid interface point at Blackhillock as a result of this process, allowing landfall optioneering to commence.

3.7.3 Landfall Appraisal

3.7.3.1 On receipt of the grid connection offer, an initial desk-based assessment of potential landfall options along the Moray / Aberdeenshire coast was undertaken. The basis for the desk-based assessment was to identify potential landfall locations that would facilitate potential options for an export cable corridor route from the Moray West Site. This involved consideration of the following environmental and technical constraints:

- Presence of existing infrastructure (both onshore and offshore);
- Coastal landform and topography e.g. presence of high cliffs;
- Presence of land designated for nature conservation / other features of importance;
- Proximity to residential properties;
- Other land uses e.g. business, recreational, agriculture;
- Proximity to water courses;
- Potential for interactions with water supplies;
- Suitability of access for equipment / plant required to bring cables ashore (e.g. Horizontal Directional Drilling (HDD) rig or trenching tools);
- Presence of Common Good Land; and
- Minimisation of third party interactions.

3.7.3.2 On this basis, a number of potential landfall options were identified along a stretch of coastline running from Portknockie to Portsoy in Moray / Aberdeenshire (see Figure 3.6.2 – Volume 3a). Potential options for bringing the cables ashore at Portgordon (west of Portknockie) were also examined. However, Portgordon is already being used as the landfall for both the Caithness to Moray HVDC Interconnector Project and the offshore export cables for the Beatrice Offshore Wind Farm. Consequently, remaining available space at this landfall (both onshore and on the offshore approach) is fairly constrained. It was therefore concluded that, due to the limited space combined with an increased risk of third party interactions and potential environmental effects (on the basis the most suitable environmental and technical routes have already been occupied), Portgordon was discounted as a potential landfall location.

3.7.3.3 Potential landfall locations between Portgordon and Portknockie are also limited due to the presence of built development associated with Buckie, Portessie and Findochty, presence of the A942 Great Eastern Road which runs along this section of coastline, areas of environmental and archaeological sensitivity, and the presence of steep cliffs along sections of the coast between Portessie and Portknockie. Work to refine the landfall area of search therefore focused on potential landfall location along the stretch of coast to the east of Portnockie, between Cullen Bay and Portsoy.

3.7.3.4 These potential landfall locations were visited by a multi-disciplinary team of environmental and consenting specialists, and cable construction and installation engineers, to identify a preferred Landfall Area.

3.7.3.5 The following points were noted for the visited locations:

- Cullen Bay – it was considered that cable installation in this location would be technically challenging due to the presence of a steep embankment and viaduct immediately inshore of the beach. There would also be potential constraints associated with routing through either the golf course or a designed landscape garden. Access to the site for construction would be challenging, with potential requirements for occasional temporary closures of the main road in and out of Cullen village;
- Beach area to north of Cullen – potential technical challenges identified in this location due to the presence of steep slopes adjacent to the shore;
- Coastline between Cullen and Findlater Castle – majority of this section of coast is dominated by steep cliffs of between 20 and 30 m in height (up to 50 m in certain locations). The exception is Sunnyside Beach - a small beach located at a mid-point along the stretch of coastline between Cullen and Findlater Castle. The beach area offers a potential location as a landfall for the cables. However, the beach is backed by steep cliffs (approximately 30 m height). Due to the height of the cliffs at the back of the beach, and along this entire section of the coast, cable installation is not considered to be a technically feasible option in this location;
- Coast between Findlater Castle and Sandend Bay – much of this stretch of the coast is also dominated by high steep cliffs that are not technically feasible for cable installation. The exception is Garron Point located at the western end of Sandend Bay where, although still a rocky section of the coastline, the gradient of the cliffs has started to reduce significantly on the approach to the main part of the bay;
- Sandend Beach – the main beach located within Sandend Bay, offers a potential suitable location for bringing the cables ashore using either open cut trench (OCT) or HDD techniques. It is acknowledged as a popular surfing beach due to long fetch. The beach is also in close proximity to residential properties located around the small harbour at the west end of the bay and properties which extend south along the western side of the beach. Potential challenges were noted with routing the cable through an area of dunes located at the back of the beach and constraints with surrounding local land uses including local caravan park (also located at the back of the beach) and distillery located at the eastern end of the bay;
- Redhaven Beach – located at the eastern end of Sandend Bay, east of the distillery. This smaller beach also offers potential suitable locations for bringing the cables ashore using either open cut trench (OCT) or HDD techniques. There is also an existing access track that could potentially provide access directly onto the beach. A potential challenge was noted with the size of the beach and ability to maintain sufficient separation distances between the offshore cable circuits on the approach to the landfall; and

- Stretch of coast between Redhaven Beach and Redhythe Point. This section of the coastline comprises a mixture of small bays (immediately to the east of Sandend beach) and rocky cliffs. The cliffs increase in both gradient and height towards Redhythe point, reaching heights of up to approximately 30 m. Cliffs along the section of coastline immediately to the east of Redhaven Beach are more gently sloping and lower in height (approximately 10 m). This section of the coast also offers potential as a suitable landfall, with technical challenges.

3.7.3.6 It should be noted that the entire section of coast between Cullen and Redhythe Point (Portsoy), except Sandend Beach, is located within the Cullen to Stake Ness Coast Site of Special Scientific Interest (SSSI) which is designated for the geological and biological features of the cliffs along this section of the coast.

3.7.3.7 Following the site visits and further desk-based analysis of potential constraints, a Landfall Area on the Aberdeenshire coastline was selected that runs from Findlater Castle in the west to Redhythe Point in the west. The final landfall location, to be determined post-consent and following further constraints analysis and site investigation, will sit within this Landfall Area.

Amendment to Onshore Planning Application Boundary:

The EIA for the Planning Permission in Principle (PPP) application being submitted for the Onshore Transmission Infrastructure (OnTI) has been undertaken in parallel to the EIA for the Offshore Wind Farm and OfTI. As part of this process, and in response to ongoing consultation with local communities and other key stakeholders, Moray West has made a decision to amend the Onshore Planning Application Boundary (PAB) to exclude Sandend Beach and all potential landfall locations to the west of the beach out towards Findlater Castle (see Image 1.5.1 in Volume 2 - Chapter 1: Introduction).

Although the Landfall Area presented in this EIA Report and the Marine Licence application for the OfTI has not been amended to reflect the change to the Onshore PAB, Moray West confirms that **Sandend Beach, and potential landfall locations to the west of the beach towards Findlater Castle, will no longer be considered as a potential landfall location**.

3.7.4 Export Cable Corridor

3.7.4.1 Having identified a stretch of coastline within which the landfall would be located, a desk-based assessment was undertaken to identify the Offshore Export Cable Corridor. An initial appraisal of physical and environmental constraints between the Moray West Site and the Landfall Area was undertaken. Table 3.7.1 below lists the constraints that were considered.

Table 3.7.1: Offshore Constraints

Constraint	Preference
Ground conditions (exposed bedrock)	Avoid
Military practice and exercise areas	Avoid
Wrecks	Avoid
Navigation aids	Avoid
Boulders	Avoid if possible

Table 3.7.1: Offshore Constraints	
Constraint	**Preference**
Cables (crossing)	Avoid if possible and where not possible, minimise number
Cables (proximity)	Avoid if possible
Pipelines (crossing)	Avoid if possible and where not possible, minimise number
Pipelines (proximity)	Avoid if possible
Offshore infrastructure (offshore wind farms, platforms)	Avoid / maintain separation distance
Depressions	Avoid if possible
Seabed mobility	Avoid if possible
Sandwaves, megaripples etc.	Avoid if possible
Excessive slopes	Avoid if possible
Dumping grounds	Avoid if possible
Foul ground	Avoid if possible
Anchorages	Avoid if possible
Designated sites of nature conservation interest	Avoid if possible
Potential Annex I habitat	Avoid if possible
Sensitive fish species spawning grounds	Avoid if possible
Areas of commercial fishery importance	Avoid if possible
Planned developments (cables, pipelines)	Manageable
Shipping routes	Manageable
Fishing grounds	Manageable

3.7.4.2 The following criteria, defined by the Moray West engineering team, were also applied in identifying the Moray West Offshore Export Cable Corridor:

- Point of exit from the Moray West Site – given that the location of the OSP(s) within the Moray West Site are still to be determined, the precise exit points for the export cable circuits is also unknown. Therefore, in order to retain flexibility for positioning the OSPs, the potential exit area for the offshore export cable circuits extends along the entire southernmost boundary of the Moray West Site.
- Moray West Offshore Export Cable Corridor – the following criteria were agreed:
  - The corridor should be 3 km wide, to allow for detailed routing and micro-siting of the cable circuits;
  - The cable route should be as direct as possible whilst avoiding known constraints; and
  - Cable crossings should be minimised, if they are required then the route should be altered where possible to ensure that the cables can cross at 90 degrees.

3.7.4.3 The Moray West Offshore Export Cable Corridor is shown in Figure 1.5.1 (Chapter 1 Figures – Volume 3a). The criteria listed above were adhered to in defining the corridor, with the following exceptions:

- A small number of wrecks are present within the corridor, but the width of the corridor allows for routing around these features; and
- Cable crossings cannot be avoided, but the width of the corridor will allow for adequate crossings to be achieved.

3.8 Appraisal of Onshore Export Cable Corridor Options

3.8.1.1 Alongside the appraisal of potential offshore corridors linked to the landfall stretch of coast, a similar exercise was undertaken to define an Onshore Export Cable Corridor and associated infrastructure (substation). This process is described in the Moray West Onshore EIA Report which focuses on assessing potential impact of the onshore transmission infrastructure (OnTI) from the landfall to the substation at Blackhillock. A summary of the key findings from the OnTI EIA and discussion of any potential impacts in relation to this Development is provided in Chapter 18 of this EIA Report: Whole Project Assessment.

3.9 Identification of the Development for Scoping and Environmental Impact Assessment (EIA)

3.9.1.1 Following the identification of the Landfall Area of search and Moray West Offshore Export Cable Corridor, as depicted in Figure 1.5.1 (Chapter 1 Figures – Volume 3a), EIA Scoping of the OfTI was progressed in May 2017.

3.9.1.2 Further site selection work has been undertaken following OfTI Scoping. This has included an additional engineering-led landfall site visit, benthic and intertidal surveys of the Moray West Site and Moray West Offshore Export Cable Corridor, and landowner and stakeholder engagement. This work has enabled the refinement of the Development to the point of public engagement and consent application accordingly:

- Confirmed Moray West Offshore Wind Farm boundaries and indicative WTG and OSP layouts;
- Identified a preferred Moray West Offshore Export Cable Corridor of up to 3 km width; and
- Identified a Landfall Area of search, within which a final landfall location will be identified following more detailed environmental and engineering investigations.

3.10 References

Department of Energy and Climate Change (DECC) (2009) Offshore Energy Strategic Environmental Assessment Post Public Consultation Report June 2009.

National Grid (2015) The Connection and Infrastructure Options Note (CION) Process, Guidance Note V02 March 2015.

The Crown Estate (2008) Briefing note - Supporting information relating to the announcement of Round 3.

The Crown Estate (2010) Round 3 zone appraisal and planning - A strategic approach to zone design, project identification and consent. Prepared by Emu Ltd.

The Crown Estate (2012) Round 3 Offshore Wind Site Selection at National and Project Levels.

MORAY WEST
OFFSHORE WINDFARM

Offshore EIA Report

Moray Offshore Windfarm (West) Limited

Chapter 4 Description of Development

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Acronyms	
Acronym	**Expanded Term**
CAA	Civil Aviation Authority
CPS	Cable Protection System
DP	Dynamically Positioned
EIA	Environmental Impact Assessment
HAT	Highest Astronomical Tide
HDD	Horizontal Directional Drilling
HLV	Heavy Lift Vessels
HVAC	High Voltage Alternating Current
IALA	International Association of Marine Aids to Navigation and Lighthouse Authorities
ICCP	Impressed Current Cathodic Protection
JUV	Jack Up Vessel
MCA	Maritime and Coastguard Agency
MHWS	Mean High Water Springs
MLWS	Mean Low Water Springs
MS-LOT	Marine Scotland Licensing and Operations Team
NLB	Northern Lighthouse Board
NOREL	Nautical and Offshore Renewables Energy Liaison
OSP	Offshore Substation Platform
PLGR	Pre-Lay Grapnel Run
RAL	RAL is a colour matching system used in Europe
RAM	Restricted in the Ability to Manoeuvre
ROV	Remotely Operated Vehicle
SAR	Search and Rescue
SCADA	Supervisory Control And Data Acquisition
SOV	Service Operations Vessel
TJB	Transition Joint Bay
TP	Transition Piece
UK	United Kingdom

Acronyms	
Acronym	**Expanded Term**
UPS	Uninterruptible Power Supplies
UXO	Unexploded Ordnance
WTG	Wind Turbine Generator

4 Description of Development

4.1 Introduction

4.1.1 Purpose of this Chapter

4.1.1.1 This chapter of the Offshore EIA Report describes the Development, comprising the Moray West Offshore Wind Farm and associated Offshore Transmission Infrastructure (OfTI). It describes the design of the Development as currently understood and the proposed methods and timing of the construction, operation and maintenance (O&M) and decommissioning of the various Development components.

4.1.1.2 The information provided in this chapter underpins the EIA by providing the primary design parameters that form the basis of the offshore consent applications. This chapter does not, however, present detail on additional derived design parameters such as maximum footprint (m^2 or km^2) of different substructures on the seabed, maximum area of seabed disturbance during cable installation, rotor blade rotational speeds or hammer energies required to install monopile or pin-pile foundations that require consideration as part of the assessment of impacts on specific topics and receptors.

4.1.1.3 These derived design parameters are defined as part of the realistic worst case Design Envelope presented in each of the topic chapters (Chapters 6 to 17). Within each chapter, tables have been prepared which identify specific derived parameters for each impact identified as requiring assessment for that topic. This approach ensures that each impact is assessed against the worst case design parameters that are of direct relevance to that specific topic / receptor.

4.1.1.4 Further information on the approach to the Design Envelope is provided below.

4.2 Design Envelope Approach

4.2.1.1 Throughout this chapter the Design Envelope (otherwise known as the ‘Rochdale Envelope’) approach has been taken where primary design parameters are not known. It is not possible to provide precise final details of the Development, or the way in which it will be built, a number of years ahead of the time it will be constructed. In the offshore wind sector, improvements in technology and construction methodologies occur frequently and unless an envelope approach is taken information provided as part of the consent application could become rapidly outdated, resulting in an uneconomical and potentially unbuildable project.

4.2.1.2 The Design Envelope therefore sets out a series of design options for the Development and it contains a reasoned minimum and maximum extent for a number of key design parameters. The final, detailed design, will lie within the minimum and maximum extent of the consents sought. The detailed design of the Development can therefore vary within this ‘envelope’ without rendering the EIA inadequate.

4.2.1.3 For each of the topic chapters within the Offshore EIA Report, and for each of the impacts assessed therein, the Design Envelope considered will be the scenario which would give rise to the greatest potential effect. For example, if several WTG models are within the Design Envelope, then the assessment will be based on the WTG model understood to have the greatest impact magnitude. This may be the WTG model with the greatest tip height or the largest area of seabed required during construction, depending upon the topic under consideration. Any Development design parameters equal to, or less than, those assessed in this Design Envelope will have environmental effects of the same level or less.

4.3 Development Overview

4.3.1 Development Boundary

4.3.1.1 The Development boundary is shown in Figure 4.3.1. The boundary encompasses:

- The Moray West Site. This is where the offshore wind farm will be located, which will include the Wind Turbine Generators (WTGs), WTG foundations and substructures, inter-array cables, up to two Offshore Substation Platform(s) (OSP(s)), OSP interconnector cables and, to the extent located within the Moray West Offshore Wind Farm Site, the offshore export cables.
- The Moray West Offshore Export Cable Corridor. This is where the offshore export cables will be located.

4.3.1.2 The Moray West Site is located on the Smith Bank in the Outer Moray Firth, approximately 22.5 km from the Caithness coastline. The Moray West Site covers an area of approximately 225 km^2 and the Offshore Export Cable Corridor covers an area of approximately 185 km^2.

4.3.2 Outline Description

4.3.2.1 The Development will comprise of WTGs and all infrastructure required to transmit the power generated by the WTGs to shore.

4.3.2.2 The key components of the Development will be as follows:

- Up to 85 offshore WTGs;
- Up to two OSPs;
- Substructures and associated seabed foundations (for WTGs and OSPs);
- Subsea inter-array cables linking individual WTGs with each other and linking strings of WTGs with the OSPs;
- Subsea interconnector cables linking OSPs (if two OSPs are installed);
- Subsea export cables running from the OSPs to shoreline landfall;
- Scour protection around substructures and cable protection (if required); and
- Monitoring equipment, such as metocean buoys (if required).

4.3.2.3 Once onshore, electricity generated by the Development will be transmitted via underground cables to a substation at Blackhillock in Moray where the electricity will then be connected into the National Electricity Transmission System (NETS). The landfall, onshore underground cables and substation comprise the Moray West Onshore Transmission Infrastructure (OnTI). The OnTI, together with the Development (Moray West Offshore Wind Farm and OfTI) comprise the Project.

4.3.2.4 It is currently planned that construction of the Development would commence in 2022 and end in 2024, spanning 36 months. Site investigation required to establish seabed conditions and any seabed preparation works would take place prior to 2022. Timescales are subject to Moray West securing a route to market through the Contract for Difference (CfD) process.

4.3.2.5 It is likely that the components for the Development will be fabricated at a number of manufacturing sites within the United Kingdom and further afield. A local construction base (or 'intermediate delivery port' facility) may be used to stockpile components, such as WTG towers, nacelles and blades, before delivery to site for installation. Alternatively, components may be delivered directly to site for installation.

Amendment to Onshore Planning Application Boundary:

The EIA for the Planning Permission in Principle (PPP) application being submitted for the Onshore Transmission Infrastructure (OnTI) has been undertaken in parallel to the EIA for the Offshore Wind Farm and OfTI. As part of this process, and in response to ongoing consultation with local communities and other key stakeholders, Moray West has made a decision to amend the Onshore Planning Application Boundary (PAB) to exclude Sandend Beach and all potential landfall locations to the west of the beach out towards Findlater Castle (see Image 4.3.1 below).

Although the Landfall Area presented in this EIA Report and the Marine Licence application for the OfTI has not been amended to reflect the change to the Onshore PAB, Moray West confirms that **Sandend Beach, and potential landfall locations to the west of the beach towards Findlater Castle, will no longer be considered as a potential landfall location**.

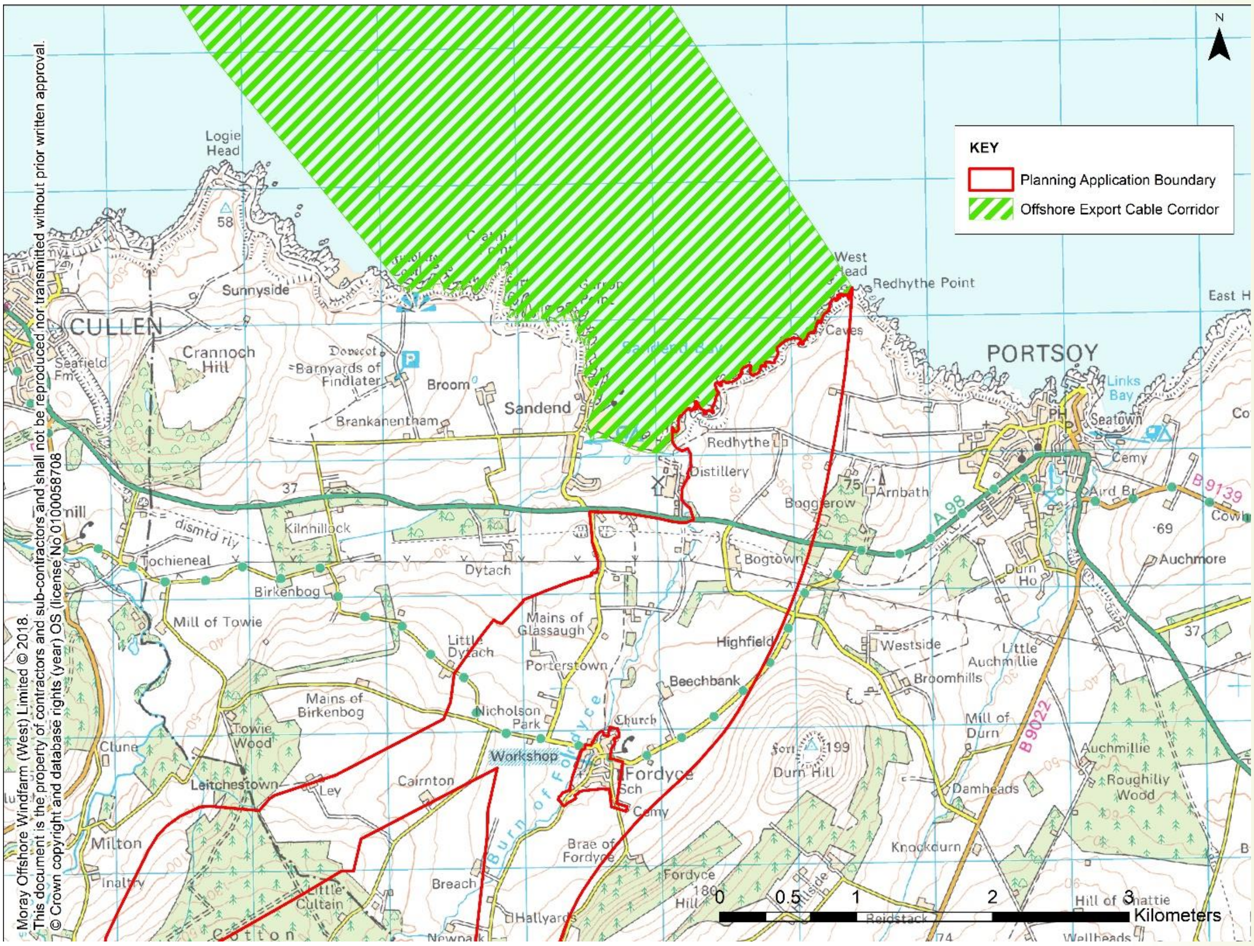


Image 4.3.1: Revised onshore PAB excluding Sandend Beach and areas to the west of Sandend Beach to Findlater Castle

4.4 Offshore Wind Farm Infrastructure

4.4.1 Offshore Wind Turbine Generators (WTGs)

Design

4.4.1.1 Moray West requires flexibility in WTG choice to ensure that anticipated changes in available technology and project economics can be accommodated within the Development design. The Design Envelope therefore sets maximum and, where relevant, minimum realistic worst-case scenario parameters against which potential environmental effects can be assessed. For the purposes of this assessment, four WTG model types are currently under consideration. These are referred to throughout the Offshore EIA Report as Model 1, Model 2, Model 3 and Model 4. Subject to final design it is possible that alternative WTG model types may be selected. However, the physical parameters of the WTGs, such as maximum blade tip height, rotor diameter, and height of nacelle will remain within the maximum envelope described in this chapter and subsequent topic assessment chapters.

4.4.1.2 This Development description does not refer directly to the capacity of individual WTGs, but rather their number and physical dimensions. In recent years, the capacity of the current generation of WTGs has become more flexible and may be different depending on the environmental conditions at a particular site; therefore, it is not considered appropriate to constrain the Design Envelope based on WTG capacity. It should be noted that the EIA assessments presented in subsequent chapters are not linked to or affected by WTG capacity.

4.4.1.3 The Development will comprise up to 85 WTGs. Although a range of WTG models will be considered, these will follow the conventional offshore WTG design architecture with three blades and a horizontal rotor axis.

4.4.1.4 The blades are connected to a central rotor hub, which turns a shaft connected to a generator or gearbox (if required). The generator and gearbox are located within a containing structure known as a nacelle situated adjacent to the rotor hub. The nacelle is supported by a tubular tower structure, which is affixed to a supporting substructure at an elevation above sea level. The nacelle is able to rotate or 'yaw' on the vertical axis in order to face the oncoming wind direction.

4.4.1.5 WTGs operate within a set wind speed range. At approximately 3 ms^{-1} (metres per second) the WTG will start to generate electricity and at around 15 ms^{-1} they will reach maximum output. At around 25 ms^{-1} the WTG output starts to reduce towards zero. This enables the WTG to shut down gradually in high wind speeds to protect the WTG and foundation.

4.4.1.6 Based on findings from the ornithological assessment (Volume 2 – Chapter 10), the minimum clearance between the Highest Astronomical Tide (HAT) sea level and the lowest point of the blade for each WTG has been increased from 22 m to 35 m in order to mitigate potential adverse effects on seabirds. However, the rotor diameter and therefore maximum blade tip height will be dependent on the chosen WTG design. The worst-case scenario Design Envelope in terms of maximum rotor diameter and maximum blade tip height will be dependent on the selected model of WTG as presented in Table 4.4.1 below.

Table 4.4.1: WTG Parameters

Parameter	Maximum Design Envelope			
	Model 1 WTGs	Model 2 WTGs	Model 3 WTGs	Model 4 WTGs
Maximum number of WTGs	85	85	72	62

Table 4.4.1: WTG Parameters				
Parameter	Maximum Design Envelope			
	Model 1 WTGs	Model 2 WTGs	Model 3 WTGs	Model 4 WTGs
Minimum height of lowest blade tip above HAT (m)	35	35	35	35
Maximum blade tip height above HAT (m)	199	230	265	285
Maximum rotor blade diameter (m)	164	195	230	250

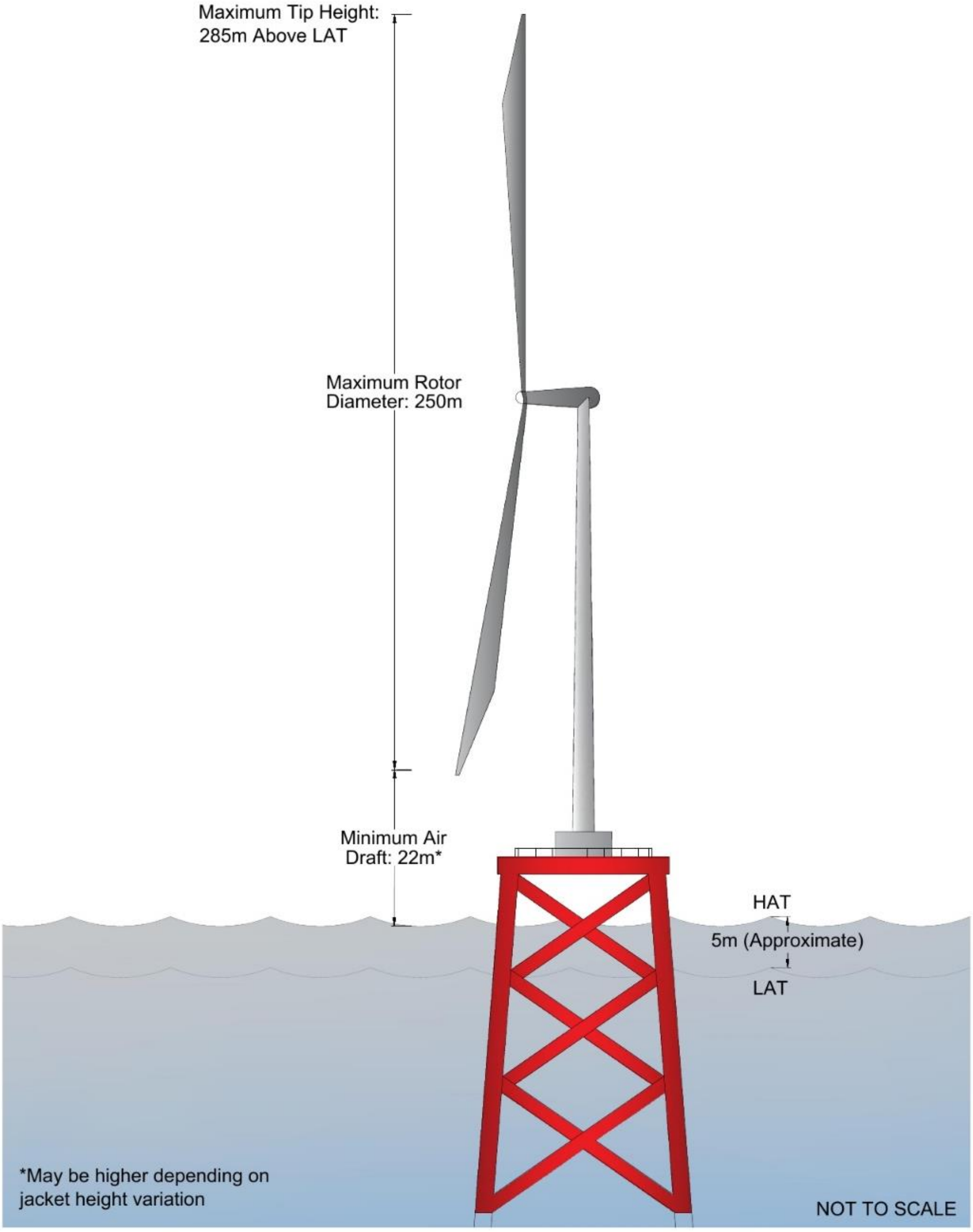


Image 4.4.1: Illustration of WTG based on Model 4 WTG parameters

Layout

4.4.1.7 Designing and optimising the layout of the WTGs and other offshore surface infrastructure is a complex, iterative process taking into account a large number of inputs and constraints including, but not limited to:

- Site conditions:
  - Wind speed and direction;
  - Water depth;
  - Sea current, tidal and wave conditions;
  - Ground conditions;
  - Environmental constraints (anthropogenic and natural); and
  - Seabed obstructions (wrecks, unexploded ordnance (UXO), oil wells, existing cables).
- Design considerations:
  - WTG type;
  - Installation set-up;
  - Foundation design;
  - Electrical design; and
  - O&M requirements.

4.4.1.8 The Moray West Offshore Wind Farm layout will have spacing between neighbouring WTGs of no less than 1,200 m downwind and 1,050 m crosswind. The layout will have some form of regularity in plan (i.e. grid or diamond pattern) and will allow for a single line of orientation, subject to micro-siting.

4.4.1.9 In order to inform the EIA process, Moray West has prepared indicative layouts associated with each of the four WTG model options. These layouts also display indicative OSP locations. It is important to note that these layouts are indicative and may not reflect the final layout, which will be determined following further site investigation post-consent and informed by any design principles agreed through the ongoing EIA process.

4.4.1.10 Figure 4.4.1 (Volume 3a) presents an indicative layout based on the maximum number of structures (85 WTGs and 2 OSPs).

Oils and Fluids

4.4.1.11 Each WTG will contain components that require lubricating oils, hydraulic oils and coolants for operation. Examples of substances contained in the WTG include:

- Grease;
- Synthetic oil/ hydraulic oil;
- Nitrogen;
- Transformer silicon/ oil;
- Sulphur hexafluoride (SF_6); and
- Water/ glycerol.

4.4.1.12 The volume of oil and fluids would vary depending on wind turbine design, i.e. whether conventional design or gearless or whether one or two rotor bearings are used in the design. It may also depend on the amount of redundancy designed into the system.

4.4.1.13 WTGs contain sensors that enable early detection of loss of fluids and leaks. In the unlikely event of a leak within the nacelle, bunding is typically present to contain any fluids.

Control Systems

4.4.1.14 Each WTG will have its own control system to carry out functions like yaw control and ramp down in high wind speeds. All the WTGs will also be connected to a central Supervisory Control and Data Acquisition (SCADA) system for the monitoring and control of the wind farm remotely. This allows functions such as remote WTG shutdown if faults occur. The SCADA system will communicate with the wind farm via fibre optic cables, microwave, or satellite links. Individual WTGs can also be controlled manually from within the WTG nacelle or tower base in order to control the WTG for commissioning or maintenance.

Access

4.4.1.15 The WTGs may be accessed either from a vessel via a boat landing(s) or stabilised gangway via the substructure, or by hoisting from a helicopter to a heli-hoist platform on the nacelle. Any helicopter access would be designed and operated in accordance with relevant Civil Aviation Authority (CAA) guidance and standards.

Aids to Navigation, Colour, Marking and Lighting

4.4.1.16 The wind farm will be designed and constructed to satisfy the requirements of the CAA, Maritime and Coastguard Agency (MCA), and the Northern Lighthouse Board (NLB) in respect of marking, lighting and fog-horn specifications.

4.4.1.17 The legal requirement for offshore WTG aviation lighting is stipulated in Article 223 of the Air Navigation Order 2016 (reproduced in CAP393 Air Navigation: The Order and the Regulations), with other documents providing further policy information and guidance. It is noted that the Air Navigation Order only requires medium intensity red lighting to be fitted to turbines on the periphery of a group of turbines subject to approval by the Civil Aviation Authority (CAA). Additional requirements relate to the requirement for lighting and marking relating to the use of helicopter landing facilities on turbines and also for the purposes of assisting Search and Rescue (SAR) operations. Aviation lighting for the final layout design will be agreed post-consent with the CAA (and in relation to SAR operations with the MCA).

4.4.1.18 Maritime navigational marking and lighting for the final layout design will be agreed post-consent with the NLB. The colour scheme for nacelles, blades and towers is generally RAL 7035 (light grey). Foundation steelwork is generally in RAL 1023 (traffic light yellow) up to HAT +15m or to Aids to Navigations, whichever is higher.

4.4.1.19 During operations, lighting will be as per the above guidance and take into account any new guidance from the current lighting trials being undertaken by the Navigation and Offshore Renewable Energy Liaison (NOREL) group. As a minimum all WTGs and the Wind Farm will comply with the requirements of IALA Recommendation O-117.

4.4.1.20 The positions of all structures will be conveyed to the UK Hydrographic Office so that they can be incorporated into Admiralty Charts and the Notice to Mariners procedures.

Installation

4.4.1.21 Generally, WTGs are installed using the following process:

- WTG components are picked up from a port in the UK or further afield either by an installation vessel or transport barge. To date, installation vessels have typically been jack-up vessels (JUVs) to provide a stable platform on site from which installation of the WTGs can be carried out. Dynamically positioned (DP) floating heavy lift vessels (HLVs) may also be employed. Generally, blades, nacelles and towers for a number of WTGs are loaded separately onto the vessel.
- Typically, some pre-assembly operations are carried out ahead of transit to site to ease the offshore installation process. The components will then transit to the Moray West Site and will be lifted onto the existing foundation or transition piece using a crane that will be attached to the installation vessel. The exact methodology for assembly is dependent on WTG type and installation contractor and will be defined in the pre-construction phase post-consent. It is also possible to transport pre-assembled WTGs to site for installation.

4.4.1.22 For the EIA process, conservative assumptions are made on the type and maximum number of vessels involved in installation, and the number of return trips to the Moray West Site from port that are required throughout the WTG installation campaign. Vessel requirements are discussed in more detail in Section 4.8.2: Construction Vessels and Helicopters.

4.4.2 Substructures for WTGs

4.4.2.1 There are a number of substructure types that are being considered for the Moray West Offshore Wind Farm. As with the WTGs, Moray West will require flexibility in substructure choice to ensure that anticipated changes in available technology and project economics can be accommodated within the Development design. The final selection will depend on a range of factors including selected WTG model, physical and environmental constraints, project economics and procurement approach.

4.4.2.2 The WTG substructures provide the seabed foundation and supporting structure to an elevation above water level for the WTGs. There are a number of foundation and substructure types that can be used and the types will not be confirmed until the final design of the wind farm post-consent. Consequently, the EIA will consider a range of types, including:

- Piled monopile substructures (‘monopiles’);
- Pin-piled jacket substructures;
- Suction caisson foundation (for jacket or monopile substructures); and
- Gravity base structure foundations.

4.4.2.3 If available to the market at the time of construction, hybrid substructure types may also be used, for example whereby monopile and gravity base structures may be used in combination. The design parameters of such substructures will not exceed those defined for the substructure types listed above.

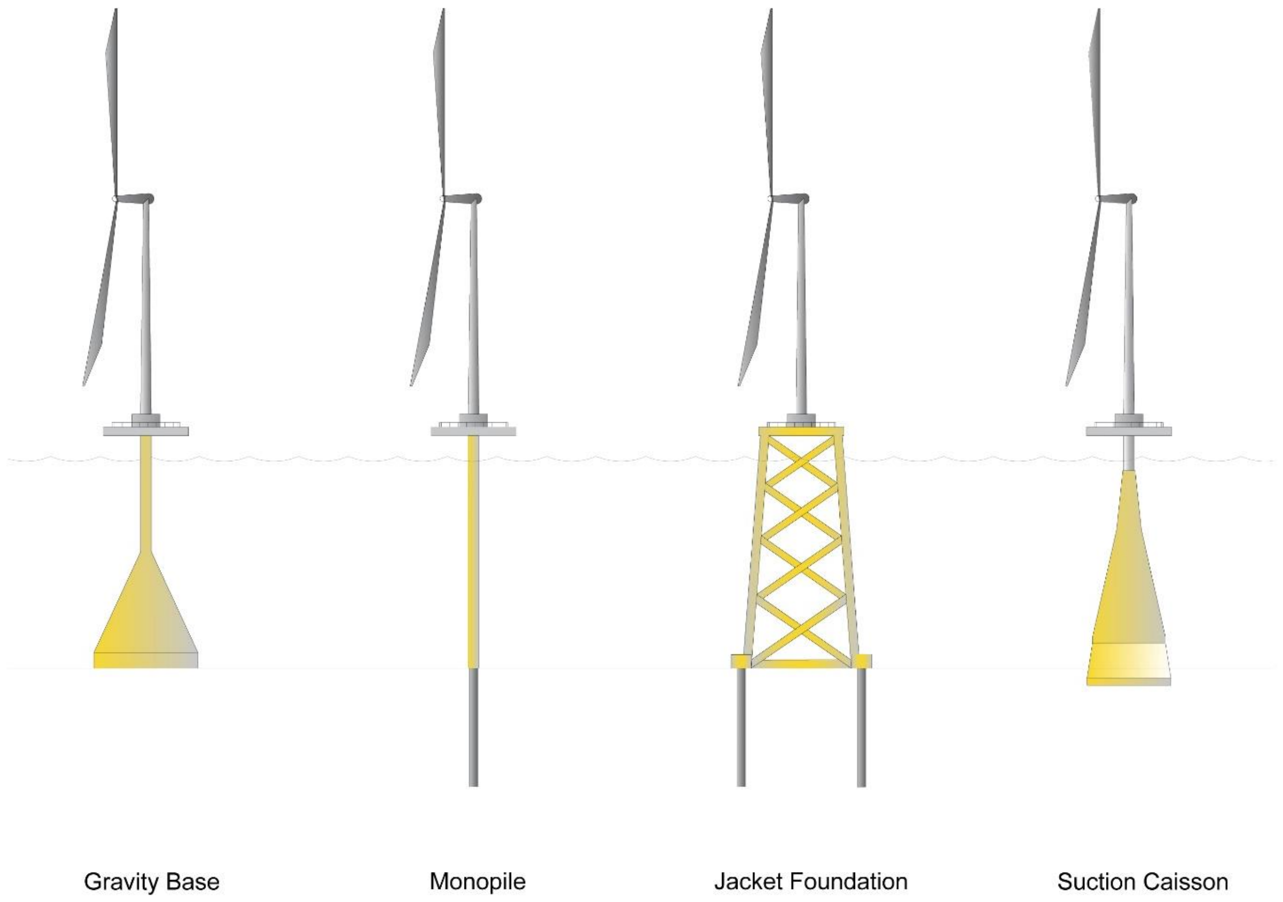


Image 4.4.2: Schematic of WTG substructure types

Monopile Substructures

Design

4.4.2.4 A monopile typically consists of a single tubular steel column (pile) embedded into the seabed and extending to approximately water surface level. A tubular steel transition piece (TP) of similar diameter is fitted on to the pile and secured mechanically (e.g. bolts) or by a grouted interface. The TP may include integrated ancillary components, such as boat landing, working platform, sacrificial anodes etc., as well as providing the connection to the wind turbine tower. The TP is usually painted yellow and marked according to relevant regulatory guidance and may be installed separately following the monopile installation. A fully integrated pile and TP structure may also be considered. The maximum dimensions of the monopile substructures can be seen in Table 4.4.2 below.

Table 4.4.2: Monopile Parameters		
Parameter	**Maximum Design Envelope**	
	Model 1 WTGs	**Model 4 WTGs**
Number of monopiles	85	62
Diameter of monopile (m)	12	15
Embedment depth (below seabed)	50	50

Installation

4.4.2.5 In the case of all substructure types, the substructures will be fabricated offsite, stored at a suitable port facility and transported to site as needed. Long term Metalization and Impressed Current Cathodic Protection (ICCP) Systems may be installed either during manufacture or after the installation of the substructure

4.4.2.6 Again, in the case of all substructure types, prior to installation, pre-construction preparatory works may be required, such as seabed levelling, sand wave clearance or boulder clearance. If debris is present below the seabed surface, then excavation may be required for access and removal. Any unexploded ordnance (UXO) found may be removed and/or detonated on site. The requirement for any preparatory works would be informed by choice of substructure type and by site-specific geophysical and geotechnical surveys, likely to be completed post-consent.

4.4.2.7 Seabed preparations for monopile installation are usually minimal. If preconstruction surveys show the presence of boulders or other seabed obstructions at foundation locations, these may be removed if the foundation cannot be re-sited to avoid the obstruction.

4.4.2.8 Monopiles and TP will be transported to site either on the installation vessel (either JUV or HLV) or on transport barges. Alternatively, monopiles can be sealed and floated horizontally so that they can be towed to site using tugs. Once on site, the monopiles will be installed using the following process:

- Upend and lower pile to seabed using vessel gripper system to maintain verticality;
- Drive pile through seabed to the required embedment depth using either vibro hammer, impact hammer or a combination of techniques;
- Lift transition piece onto monopile (note this may be undertaken at a later date from pile installation); and
- Secure transition piece onto monopile either with grout, bolts or other connection mechanism.

4.4.2.9 If percussive piling installation is not possible due to the presence of rock or hard soils, the material inside the monopile may be drilled out before the monopile is driven to the required depth. This can be done in advance of the driving or if the pilling rate slows significantly during piling, known as refusal. If drilling is required, spoil arising from the drilling will be disposed of adjacent to the foundation location.

4.4.2.10 The piling would include a 20 minute ‘soft start’ where the hammer energy will be kept at a minimum of approximately 10% maximum energy before being gradually increased in order to maintain a steady embedment rate. Depending on the soil condition encountered, maximum hammer energy will only be required at the later stages of the piling operation.

4.4.2.11 Where grout is used to attach the TP to monopile, this will comprise an inert cement mix that is pumped into the anulus between the TP and the monopile. The grout will be pumped either from the installation vessel or a support vessel. The process will be carefully controlled and monitored to ensure minimal grout is lost to the surrounding environment. The bolted solution will use bolts to connect the TP to the monopile in a similar manner to that used to connect the turbine and the TP.

4.4.2.12 Monopile installation may take up to nine months in total. Up to two installation vessels may be used, with up to two piling simultaneously

Pin-piled Jacket Substructures

Design

4.4.2.13 Piled jacket substructures are formed of a steel lattice construction (comprising tubular steel members and welded joints) secured to the seabed by hollow steel pin-piles connected to the jacket feet. The piles rely on frictional and end bearing properties of the seabed for support. Unlike monopiles, there is no separate TP; the TP and ancillary structure is fabricated as an integral part of the jacket. Pin-piles will typically be of a smaller diameter than monopiles.

4.4.2.14 Jacket substructures would be three- or four-legged (Image 4.4.3 below). The design envelope for jacket substructures with pin-piles is shown in Table 4.4.3 below.

Table 4.4.3: Pin-pile Jacket Parameters

Parameter	Maximum Design Envelope	
	Model 1 WTGs	Model 4 WTGs
Number of jackets	85	62
Number of legs per jacket	3 or 4	3 or4
Separation of adjacent legs at seabed level (m)	35	40
Leg diameter (m)	3	3.5
Piles per foundation	4	4
Pin-pile diameter (m)	3.5	4
Embedment depth (below seabed)	60	60

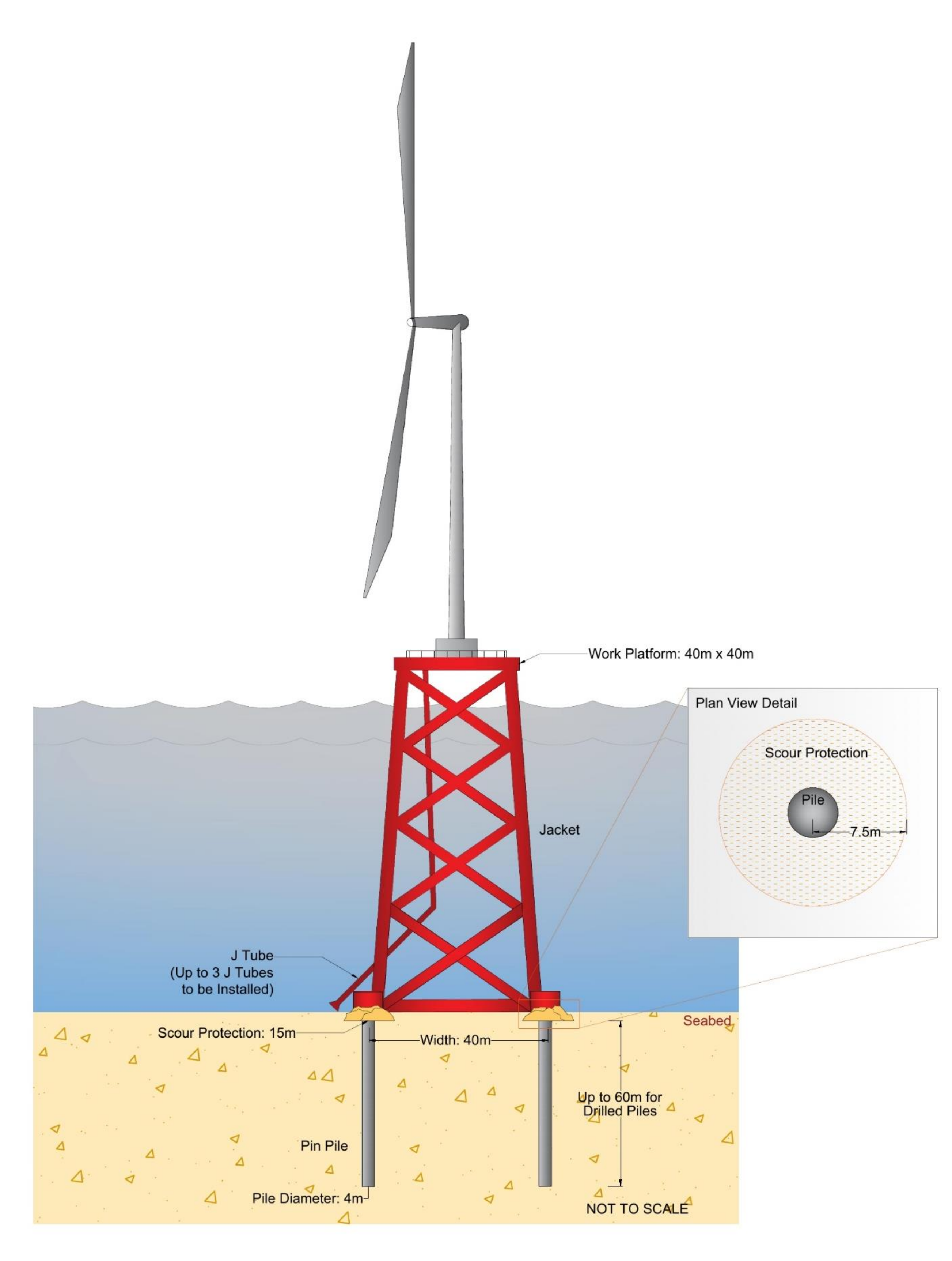


Image 4.4.3: Illustration of a four legged jacket substructure

Installation

4.4.2.15 As with the installation of the monopiles, piled jacket structures will be transported to site by installation vessels or barges and lowered onto the seabed by the installation vessel.

4.4.2.16 The pin-piles can be installed either before or after the jacket is lowered to the seabed. If before; a piling template will be placed on the seabed to guide the pile locations. This is usually a welded steel structure. The piles will then be installed through the template, and the jacket affixed to the piles after it has been lowered into position, either mechanically (swage / gripper) or by grouted connection. If after; the piles will be installed through the jacket feet at the seabed, or through the legs of the jacket from the top of the structure.

4.4.2.17 As with monopiles, pile driving would include a 'soft start' procedure for approximately 20 minutes before hammer energies are increased gradually during the piling operation to maintain a sufficient rate of penetration. Depending on the soil condition encountered, maximum hammer energy will only be required at the later stages of the piling operation.

4.4.2.18 The pin-piles can be impact driven, drilled or vibrated into the seabed, in a similar way to monopiles. However, as pin-piles are smaller, the maximum hammer energy (for impact driving) to be used would be lower. The seabed preparation would be as for the monopile substructures. Pin-pile installation may take up to nine months in total. Up to two installation vessels may be used, with up to two piling simultaneously.

Suction Caisson Foundations (for both Jacket or Monopile Substructures)

Design

4.4.2.19 Suction caissons are a foundation concept that has been used extensively for the support of structures in the oil and gas sector and are being increasingly employed for offshore wind supporting structures. The concept consists of a steel cylindrical skirt or skirts (the bucket) sealed at the top, which penetrate into the seabed under the weight of the jacket and hydrostatic forces created as a result of hydraulically excavating the internal cavity of the bucket. Once sealed into position these hydrostatic forces provide the structure with sufficient connection with the seabed for the environmental (wind, wave and tide) and turbine loads.

4.4.2.20 Suction caissons can be used with either jacket or monopile substructures. For both the jacket and monopile substructures the TP and ancillary structures may be fabricated as an integrated part of the substructure.

4.4.2.21 Suction caisson jacket substructures will be three or four-legged, whereas monopile caissons will comprise larger, singular structures. Consequently, the dimensions of the suction caissons required for jacket substructures compared to monopile substructures will be different. The design envelopes for suction caisson jacket substructures and suction caisson monopile substructures are presented in Tables 4.4.4 and 4.4.5 respectively.

Table 4.4.4: Suction Caisson Jacket Parameters

Parameter	Maximum Design Envelope	
	Model 1 WTGs	Model 4 WTGs
Number of jackets	85	62
Number of legs per jacket	3 or 4	3 or4
Separation of adjacent legs at seabed level (m)	35	40
Leg diameter (m)	3	3.5
Suction caissons per foundation	4	4

Table 4.4.4: Suction Caisson Jacket Parameters		
Parameter	Maximum Design Envelope	
	Model 1 WTGs	Model 4 WTGs
Suction caisson diameter (m)	20	25
Caisson penetration depth (below seabed) (m)	15	20
Height of caisson remaining above seabed once installed (m)	10	10

Table 4.4.5: Monopile Suction Caisson Parameters		
Parameter	Maximum Design Envelope	
	Model 1 WTGs	Model 4 WTGs
Number of suction caissons	85	62
Suction caissons per foundation	1	1
Suction caisson diameter (m)	45	55
Caisson penetration depth (below seabed) (m)	30	35
Height of caisson remaining above seabed once installed (m)	10	10

Installation of Suction Caisson Foundations (for Both Jacket and Monopile Substructures)

4.4.2.22 The suction caissons (already attached to jacket or monopile substructures) will be transported to site on a jack-up barge or suitable heavy lift vessel. The suction caisson structures (jacket or monopile) will be lowered to the seabed using a crane. The suction caisson will then either be pushed into the seabed or a negative pressure will be created within the skirt by a pipe that is used to "suck the water out" of the caisson. This will secure the suction caisson and associated substructure to the seabed. Concrete or an appropriate filler may then be injected into the caisson between the seabed and the caisson lid

4.4.2.23 As well as the boulder and obstruction removal that is described in the monopiles section above, some seabed levelling may be required before the suction caissons are installed.

4.4.2.24 Where required, grout will be used to provide a strong connection between the suction caisson and the jacket / monopile. This will be installed using a Remote Operated Vehicle (ROV). After grouting, scour protection may also need to be installed around each suction caisson depending on local conditions.

4.4.2.25 Should the TP not form part of an integrated structure, it will be lifted into position and secured onto the monopile or jacket substructure either with grout, bolts or another connection mechanism.

<u>Gravity Base Substructures</u>

Design

4.4.2.26 Gravity base substructures are concrete or concrete-steel hybrid structures, sometimes including additional ballast (typically sand, gravel, rock or dredged material) that sit on the seabed to support the turbine tower. Gravity bases vary in shape but are significantly wider at the base (at seabed level) to provide support and stability to the structure. Conical or upside down T-shaped bases are being considered for the Development (Image 4.4.4).

4.4.2.27 The Design Envelope for gravity base substructures is shown in Table 4.4.6.

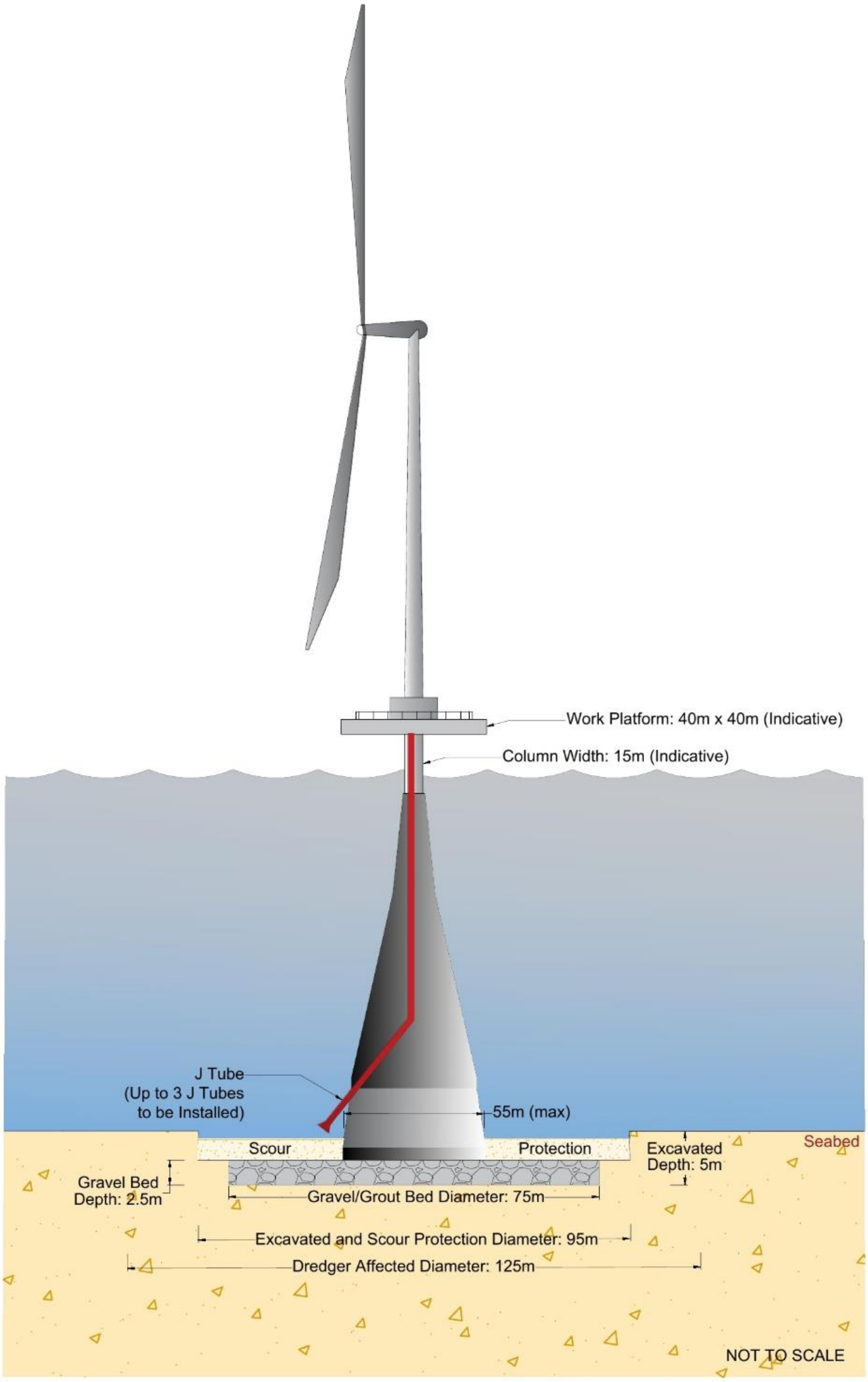


Image 4.4.4: Illustration of a gravity base substructure

Table 4.4.6: Gravity Base Foundation Parameters		
Parameter	**Maximum Design Envelope**	
	Model 1 WTGs	**Model 4 WTGs**
Number of gravity base substructures	85	62
External diameter at sea surface (m)	12	15
External diameter at seabed (m)	45	55
Height of installed base above seabed (m)	20	30

Installation

4.4.2.28 A gravity base does not require piling or drilling to remain in place. They can either be brought to site on barges or installation vessels as for the other foundation types, or alternatively they can be floated to site. This would be done by designing the structures to be buoyant and towing them to site using tugs and support vessels. The foundations would then be lowered to the seabed in a controlled manner either by pumping in water, or installation of ballast (or both).

4.4.2.29 Gravity base substructures need to be placed in pre-prepared areas of seabed. Seabed preparation would involve levelling and dredging of the soft mobile sediments as required, as well as any boulder and obstruction removal, and the installation of a gravel bedding and levelling layer. Dredging would be carried out by dredging vessels using suction hoppers or similar, and the spoil would either be deposited on site or at a licensed marine disposal site. It is possible that a portion of it could be used as under-base infill and ballast. The bedding and levelling layer installation would be undertaken by a rock installation vessel such as a 'fall pipe' type vessel.

4.4.2.30 Some gravity base structure solutions may require the injection of a cement grout mix under the foundation to strengthen the sea bed and / or fill voids to ensure structural integrity.

4.4.3 Scour Protection for Substructures

4.4.3.1 Scour protection is designed to prevent substructures for WTGs, OSPs and other offshore infrastructure, being undermined by hydrodynamic and sedimentary processes, resulting in seabed erosion and subsequent scour hole formation. The shape of the substructure is an important parameter influencing the potential depth of scour hole formation. Scour around substructures is typically mitigated by the use of scour protection measures. Several types of scour protection exist, and the Development is considering use of the following:

- Graded rock placement – layers of graded stones placed around / on structures to inhibit erosion;
- Rock bags – rock-filled fibre mesh bags, which adopt the shape of the seabed/structure as they are lowered onto it;
- Concrete mattresses - typically several metres wide and long, of cast articulated concrete blocks which are linked by a polypropylene rope lattice, which are placed on / around structures to stabilise the seabed and inhibit erosion; and
- Frond mats – mats typically several metres wide and long, comprised of continuous lines of overlapping buoyant polypropylene fronds that create a drag barrier which prevents the sediment in their vicinity from being transported away. The frond lines are secured to a polyester webbing mesh base that is itself secured to the seabed by a weighted perimeter or anchors pre-attached to the mesh base by polyester webbing lines.

4.4.3.2 The amount and type of scour protection required will vary for the different substructure types being considered and the final design of the substructures, which will in turn be influenced by the results of pre-construction seabed investigation. As with the WTG types and substructures, flexibility in scour protection choice is required to ensure that anticipated changes in available technology can be accommodated within the final Development design.

4.4.3.3 The final choice and detailed design of a scour protection solution for the Moray West Offshore Wind Farm will be made after detailed design of the foundation structure, taking into account a range of aspects including geotechnical data, meteorological and oceanographic data, water depth, maintenance strategy and cost.

4.4.3.4 Scour protection options for WTG substructures and area of scour protection (m^2) are shown in Table 4.4.7 below.

Table 4.4.7: Scour Protection Parameters

Parameter	Maximum Design Envelope				
	Monopile	Pin-Pile Jacket (per pin-pile)	Suction Caisson Jacket (per caisson)	Mono Suction Caisson	Gravity Base
Scour protection options	Rock placement; rock bags; concrete mattressing; frond mats				
Area of scour protection (including foundation) per foundation (m^2)	1,080	167	1,100	4,712	4,712

4.4.4 Inter-array Cables

4.4.4.1 Inter-array cable circuits carry the electrical current produced by the WTGs. They link the WTGs to one another and the WTGs to the OSP(s), from where the electricity generated can be transformed in voltage and transferred to shore. A small number of WTGs will typically be grouped together on the same cable ‘circuit’ or ‘string’, with multiple ‘circuits/strings’ connecting back to the OSP(s).

<u>Design</u>

4.4.4.2 The inter-array cable circuits will consist of a number of power conductor cores, usually made from copper or aluminium, and fibre optic communication cables surrounded by layers of insulating material as well as material to armour the cable for protection from external damage and material to keep the cable watertight.

4.4.4.3 The Design Envelope for inter-array cables is shown in Table 4.4.8 below.

Table 4.4.8: Inter-array Cable Circuit Parameters

Parameter	Maximum Design Envelope
Cable specification	3-core cable, most likely with integrated fibre optics
Length of cable (km)	275
Voltage range (kV)	33 - 72.5

Installation

4.4.4.4 Seabed obstructions, including UXO where relevant, will be removed where necessary prior to cable installation. Pre-lay grapnel runs (PLGR) will be conducted to remove linear seabed surface debris along cable routes; debris will be brought ashore for recycling or disposal. Where boulders are present they may need to be removed by grab or plough methods, and they will be moved onto seabed adjacent to the cable route.

4.4.4.5 The cables will be buried below the seabed wherever possible, to a minimum depth of 1 m, noting that trench depths may vary across the site down to 3 m depending on seabed conditions.

4.4.4.6 Possible installation methods include jetting, cutting and ploughing whereby the seabed is opened and the cable laid within the trench simultaneously using a tool towed behind the installation vessel. Alternatively, it may also be necessary to install the cable by pre-trenching whereby a trench is opened in one operation and then the cable laid subsequently from another vessel. These operations may occur post-cable lay whereby the cable is surface laid onto the seabed, a trench is opened up, and the cable is then laid into the trench.

Ploughing

4.4.4.7 A forward blade cuts through the sea bed to create a trench (laying the cable behind where trenching and laying are undertaken simultaneously). Ploughing tools can either be pulled directly by a surface vessel or mounted onto self-propelled caterpillar tracked vehicles which run along the sea bed taking power from a surface vessel.

4.4.4.8 Ploughing is suited to a wide variety of seabed types. However, even if ploughing is the primary method adopted for laying the inter-array cables, it may still be necessary to adopt alternative installation methods i.e. jetting or cutting in certain locations such as areas where seabed obstacles are present, or in areas of harder seabed, or where there are cable crossings or jointing loops etc.

Jetting

4.4.4.9 Jetting tools may be mounted on towed sleds or on tracked cable burial vehicles operated and controlled from a host vessel via an umbilical cable or as a ROV. A jetting system works by fluidising the seabed using water jets to create a trench.

Cutting

4.4.4.10 Cutting tools may be mounted on towed sleds or on tracked cable burial vehicles operated and controlled from a host vessel via an umbilical cable or as a ROV. Mechanical cutting methods may be used in areas of harder seabed. They typically deploy chain, wheel or scoop type slot cutters to mechanically remove spoil and create a trench.

4.4.4.11 Where cable burial is not suitable, or where the minimum burial depth cannot be achieved, cable protection may be required (see Section 4.4.5 below).

4.4.4.12 The Design Envelope for inter-array cable installation is shown in Table 4.4.9 below.

Table 4.4.9: Inter-array Cable Installation Parameters

Parameter	Maximum Design Envelope
Burial technique	Ploughing Jetting Cutting
Typical trench depth (m)	1

Table 4.4.9: Inter-array Cable Installation Parameters	
Parameter	**Maximum Design Envelope**
Maximum trench depth (m)	3
Number of cable circuits per trench	1 (2 if fibre optic cables are installed separate from the power cable)
Maximum trench width (m)	3
Maximum trench affected width (m)	15 (where seabed boulder clearance by plough is required)

Crossings

4.4.4.13 If the inter-array cables must cross infrastructure such as existing cables, both the third-party asset and the installed cable must be protected. This protection would usually consist of rock placement or concrete mattressing. The detailed design of the crossing would be developed by both parties and Moray West would seek to enter into a crossing agreement with the third-party to reflect this. The Design Envelope for the cable crossing protection is shown in Table 4.4.10 below.

Table 4.4.10: Inter-array Cable Crossing Protection Parameters	
Parameter	**Maximum Design Envelope (all subject to Crossing Agreements)**
Crossing technique	Rock placement Concrete mattressing Grout bags
Number of cable crossings	15
Length of crossings (m)	200
Width of crossings (m)	<6

4.4.5 Cable Protection

4.4.5.1 There may be a requirement for cable protection around the inter-array cables as they transition from the seabed to enter the WTGs via J-tubes or I-tubes (hollow tubes that hang from the substructure that are in the shape of an "I" or "J"). The exact amount of cable protection required at each cable end will depend on the burial depths achieved by the inter-array cable installation.

4.4.5.2 In some cases, it may be necessary to use alternative methods (other than burial) to provide an adequate degree of protection for the cables. The method of cable protection may include rock placement or use of concrete mattresses or grout bags and/or installation of a cable protection system (CPS) around the cable.

4.4.5.3 If rock placement, mattressing or grout bags are used to protect cables, they are typically used to construct a berm on the seabed on top of the cable. Such berms would be 1.5 m in width and up to 1 m in height and would have a sloped profile above seabed level.

4.4.5.4 Cable protection systems (CPS), which may be used alone or in combination with other protection methods, are effectively protective polymer or steel sleeves which are fixed installed around the cable to provide mechanical protection. These may be utilised at cable crossing points and near offshore structures.

4.5 Offshore Transmission Infrastructure

4.5.1 Offshore Substation Platforms (OSPs)

Design

4.5.1.1 Up to two offshore substation platforms (OSPs) will be located within the Moray West Site (see Figure 4.4.1, Volume 3a). OSPs provide a centralised connection point for the inter-array cable circuits and contain the primary electrical equipment and ancillary components that are required to transform the voltage of the electricity generated at the WTGs to a higher voltage that is suitable for transporting power to the onshore electricity transmission network.

4.5.1.2 In terms of appearance, the most common designs use a platform consisting of a single or multi-level 'topside' within or upon which sits the primary electrical equipment and ancillary components. The topside is supported above sea level on a foundation structure (Image 4.5.1). The primary electrical equipment on the topside typically includes step-up transformers and switchgear. The ancillary components typically include communication and control equipment as well as emergency refuge facilities. The OSP(s) will be high voltage alternating current (HVAC).

4.5.1.3 Table 4.5.1 presents the Design Envelope parameters for the OSPs.

Table 4.5.1: OSP Parameters

Parameter	Maximum Design Envelope	
	1 OSP	2 OSPs
Topside length (m)	100	75
Topside width (m)	100	75
Topside height above HAT (m)	70	60

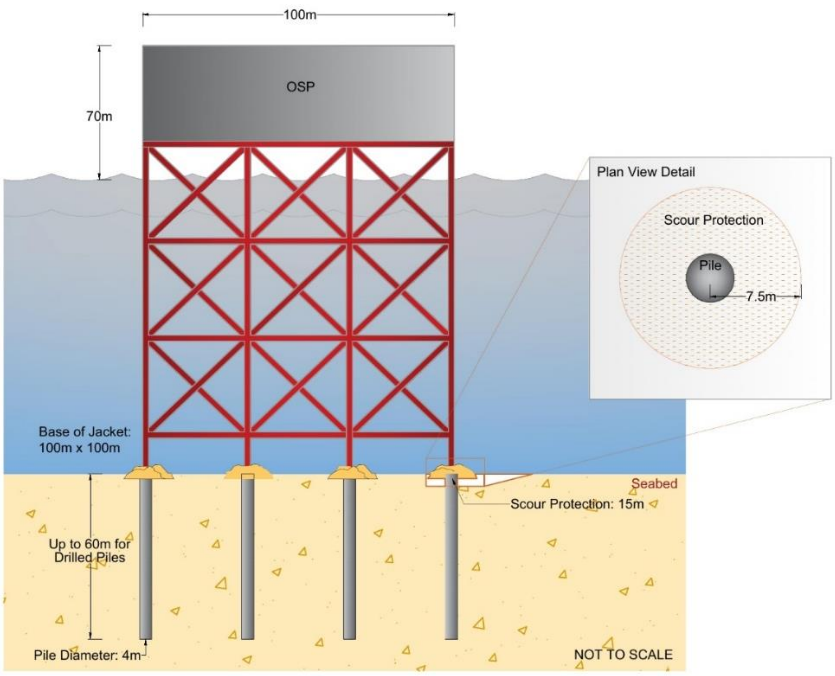


Image 4.5.1: Illustration of an OSP

Substructures

4.5.1.4 The OSPs will be supported by pin-pile or suction caisson jackets, jack-up, monopile, mono suction caisson or gravity base substructures. The characteristics of the substructures will be similar to those already described under those appropriate headings above (see Section 4.4.2 above). The jack-up concept, which is not considered for WTGs, is described below.

Jack-Up Design

4.5.1.5 The fabricated jack-up (with or without the WTG pre-installed) consists of a self-elevating platform with a buoyant hull and movable legs, made of tubular steel sections, capable of raising its hull over the surface of the sea. The buoyant hull enables transportation of the unit and all attached machinery (substation) to site. Once on location, the legs of the jack-up will be lower onto the seabed enabling the hull to then be raised to the required elevation above the sea surface. Once installed, the jack-up supporting the OSP(s) will remain fixed at the site for the duration of the operation of the offshore wind farm.

Jack-Up Installation

4.5.1.6 The jack-up is towed to site, unless self-propelled, and then has its legs lowered to the seabed and pre-loaded (ballast water is added to the legs) before being jacked-up to appropriate clearance above the sea surface before being fixed in situ, most likely using pin-piles as for the jacket substructure.

4.5.1.7 Table 4.5.2 below presents the Design Envelope parameters for the OSP substructure options.

Table 4.5.2: OSP Substructure Parameters

Element	2 OSPs	1 OSP
Monopiles		
Number of monopiles	2	1
Diameter of monopile (m)	15	15
Embedment depth (below seabed)	50	50
Jack-Ups		
Number of jack ups	2	1
Number of legs per jack up	4	4
Separation of adjacent legs at seabed level (m)	50	100
Leg diameter (m)	3.5	3.5
Pin-pile Jackets		
Number of jackets	2	1
Number of legs per jacket	4	8
Separation of adjacent legs at seabed level (m)	50	100
Leg diameter (m)	3.5	3.5
Piles per jacket	4	8
Pin-pile diameter (m)	3.5	4

Table 4.5.2: OSP Substructure Parameters		
Element	**2 OSPs**	**1 OSP**
Embedment depth (below seabed)	60	60
Suction Caisson Jackets		
Number of jackets	2	1
Number of legs per jacket	4	4
Separation of adjacent legs at seabed level (m)	35	40
Leg diameter (m)	3.5	3.5
Suction caissons per foundation	4	4
Suction caisson diameter (m)	20	30
Caisson penetration depth (below seabed) (m)	15	25
Height of caisson remaining above seabed once installed (m)	10	10
Suction Caisson Monopiles		
Number of suction caissons	2	1
Suction caissons per substructure	1	1
Suction caisson diameter (m)	45	55
Caisson penetration depth (below seabed) (m)	30	35
Height of caisson remaining above seabed once installed (m)	10	10
Gravity Base Structures		
Number of gravity base substructures	2	1
External diameter at sea surface (m)	15	15
External diameter at seabed (m)	55	80
Seabed preparation diameter (m)	95	120
Seabed excavated depth (m)	5	8
Height of installed base above seabed (m)	20	30

Oils, Fluids and Effluents

4.5.1.8 Examples of substances contained in OSPs are as follows:

- Diesel for the emergency diesel generators (in diesel storage tanks);
- Oil for the transformers;
- Deionised water for cooling systems;
- Glycol;
- Sewage and grey water;

- Lead acid for UPS and batteries;
- Engine oil; and
- SF6 (insulating gas for preventing electrical discharge).

4.5.1.9 To avoid discharge of oils to the environment the OSPs would be subject to best-practice design, for example, with a self-contained bund to collect any possible oil spill. To avoid discharge or spillage of oils it is anticipated that the transformers would be filled for their life and would not need interim oil changes.

4.5.1.10 Any oil spillage from the diesel tank or from the transformer would be collected in a separate oil waste tank. Both oil waste and other wastes (waste water etc.) would be brought to shore in a secure container and disposed according to industry best practice procedures.

Lighting Requirements and Colour Scheme

4.5.1.11 As with the WTGs, the OSPs will be marked in accordance with the requirements of the NLB, MCA and CAA.

Installation

4.5.1.12 The OSPs will be pre-fabricated onshore. Installation of the substructures and application of scour protection (where required) will occur using the methods described in Section 4.4.3 above in relation to WTG substructures.

4.5.1.13 The installation of the OSP topsides will be carried out by a HLV.

4.5.2 OSP Interconnector Cables

Design

4.5.2.1 If two OSPs are installed, an interconnector cable circuit may be used to link the two OSPs. The extent of the possible cabling between OSP(s) will depend upon the distance between OSP(s), which will be located within the Moray West Site. The voltage for the OSP interconnector cables will be between 33 and 400 kV as presented in the Design Envelope table (Table 4.5.3) below.

Table 4.5.3: OSP Interconnector Cable Parameters

Parameter	Maximum Design Envelope
Cable specification	3-core cable with integrated fibre optics
Cable diameter (mm)	200 (subject to crossing agreement)
Total length of cable circuit (km)	15
Voltage range (kV)	33 - 400

Installation

4.5.2.2 The OSP Interconnector cables will be installed using the methods described above for the inter-array cabling (Section 4.4.4). Cables will be buried and / or protected as described in Section 4.4.5 above.

4.5.3 Offshore Export Cables

Design

4.5.3.1 Offshore export cable circuits will transfer power from the OSPs to the landfall location in the Landfall Area. Two export cable circuits will be installed in total, and they will be located within the Offshore Export Cable Corridor shown in Figure 4.3.1 (see Volume 3a).

4.5.3.2 Like the inter-array cables, the offshore export cables will consist of a number of conductor cores, usually made from copper or aluminium. These will be surrounded by layers of insulating material as well as material to armour the cable for protection from external damage, and material to keep the cable watertight. Export cables however, are typically larger in diameter than inter-array cables, due to the larger conductor cores required to transport greater volumes of power. Fibre optic cabling, which allows for communication with the Development, is typically wrapped around the export cables, though may be installed separately.

4.5.3.3 The Design Envelope for export cables is shown in Table 4.5.4 below.

Table 4.5.4: Export Cable Parameters

Parameter	Maximum Design Envelope
Number of export cable circuits	Up to 2
Cable circuit specification	3-core cable, most likely with integrated fibre optics
Total length of cable (km)	65 per circuit
Voltage range (kV)	132 - 400

Installation

4.5.3.4 The installation method for the export cable circuits will be as described for inter-array cables (see Section 4.4.4).

Crossings

4.5.3.5 Management of cable crossings will be as described for inter-array cables (see Section 4.4.4 above). A maximum of six cable crossings will be required.

4.5.4 Cable Protection

4.5.4.1 Export cable protection measures will be as described for inter-array cables (see Section 4.4.5 above).

4.5.5 Landfall

4.5.5.1 The offshore export cable 'landfall' is the location where the offshore export cable circuits are brought ashore and connected to the onshore export cable circuits within transition joint bays (TJBs). The TJBs comprise buried underground chambers that are installed at a location above Mean High Water Springs (MHWS) (to minimise the potential for seawater to enter the TJB). The landfall and TJBs are discussed further in Chapter 18 and described in full in the Moray West Onshore EIA Report.

4.5.5.2 At the landfall, the offshore export cable circuits will be installed using one, or a combination of, the following:

- Jetting / open-cut trenching – This involves excavating a trench from a point below MLWS to the TJBs using one of the methods described in Section 4.4.4 above. From the cable laying vessel, the offshore export cable circuits are brought to the landfall by a combination of floating and pulling ashore. Once in position the cables are sunk to the seabed and then laid in the trench before the trench is backfilled.

- Horizontal directional drilling (HDD) – HDD involves drilling holes from the landward side of the landfall to a point where marine installation equipment can operate. Ducts or pipes are installed in the drilled holes and the cables are then pulled into the ducts.

4.6 Other Offshore Infrastructure

4.6.1.1 It is anticipated that up to five buoys would be required across the Moray West site, these would be LiDAR, wave and/or guard buoys.

4.6.1.2 These devices would be attached to the sea bed using mooring devices such as common sinkers (small block of heavy material such as concrete, steel, etc.) or anchored by means of regular anchors. They could have one single mooring point or several points (usually up to three).

4.7 Safety Zones

4.7.1.1 Moray West will apply to MS-LOT for a notice declaring safety zones around construction activities and in the vicinity of offshore structures thereafter under specific development scenarios. The safety zone notice will be applied for under Section 95 of the Energy Act 2004 in accordance with Schedule 16 of the Energy Act 2004 and the Electricity (Offshore Generating Stations) (Safety Zones) (Application Procedures and Control of Access) Regulations 2007.

4.7.1.2 During the construction phase, Moray West will apply for 500 m safety zones around any WTG or OSP where construction work is underway, as denoted by the presence of a large RAM construction vessel. Smaller 50 m safety zones will also be applied for around any partially completed WTG or OSP when work is not underway, or around any completed structure prior to commissioning. These safety zones are considered necessary to protect technicians, crew and vessels on-site during construction, in addition to the structures themselves.

4.7.1.3 During the operational phase, Moray West will apply for 500 m safety zones around any WTG or OSP where major maintenance (defined as any work requiring a large RAM vessel) is underway. As with the construction phase safety zones, these are considered necessary to protect the technicians, crew and vessels on-site during the maintenance work. Safety zones are not considered necessary during normal operations given mitigation measures in place however if a need was identified a case could later be made in line with the regulations.

4.7.1.4 Safety zones are also likely to be necessary during the decommissioning phase, however this will be determined at an appropriate stage when decommissioning plans are known via risk assessment. As such, the decommissioning phase will not be covered by the initial safety zone application, with a separate application submitted separately if such safety zones were deemed necessary.

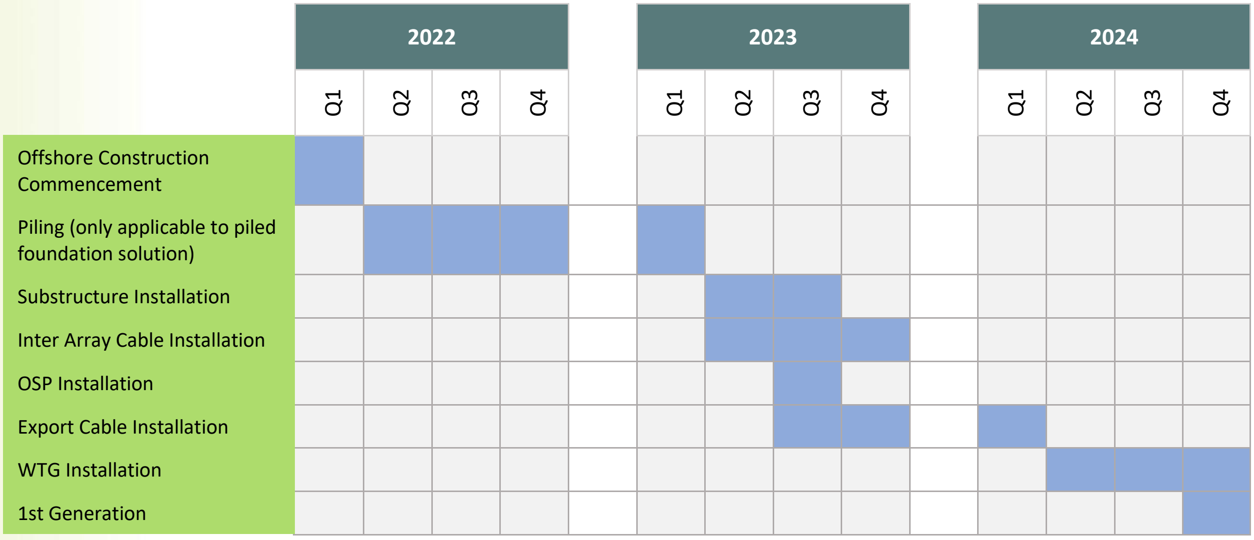
4.7.1.5 A separate Safety Zone Statement is provided in support of the Moray West consent applications (Moray West Offshore Wind Farm Safety Zone Statement, Anatec, 2018).

4.8 Construction Programme and Sequencing

4.8.1 Indicative Programme

4.8.1.1 A high-level indicative construction programme is presented in Graph 4.8.1 below. The programme illustrates the likely duration of the major installation elements, and how they may relate to one another if built out in a single construction campaign. It covers installation of the major components and does not include elements such as preliminary site preparation and commissioning of the wind farm post-construction. Offshore construction is currently planned to commence in 2022 and complete in 2024. First generation is currently predicted to occur in 2024 and the Wind Farm is currently predicted to be fully commissioned in 2025.

4.8.1.2 Timing of construction works will be subject to CfD and actual works durations will be dependent on a number of factors including, component and vessel availability, weather and final construction strategy. Construction is intended to take place 24 hours per day, 365 days per year, subject to weather conditions, until construction is complete.



Graph 4.8.1: Offshore Construction Programme

4.8.1.3 The sequence of activities associated with the installation of the Development are likely to be as follows, with various activities set out below being undertaken concurrently:

- Detailed pre-construction site investigations – some of these may be subject to separate licence applications;
- Onshore manufacture of components;
- Seabed preparation works;
- Transport to site and installation of foundations (monopiles, pin-piles, suction caissons and GBSs);
- Transport to site and installation of substructures (TPs and jacket structures) on pre-installed foundation structures;
- Transport to site and installation of inter-array cables;
- Transport to site and installation of OSPs;
- Transport to site and installation of export cables;
- Transport to site and installation of wind turbine generators; and
- System testing and commissioning.

4.8.2 Construction Vessels and Helicopters

4.8.2.1 Construction will require a variety of different vessel and helicopter options dependent on the final WTG, foundation, construction port, and construction strategy taken.

4.8.2.2 It is expected that up to two installation vessels (JUVs or HLVs) would be involved in foundation and WTG installation at any one time. Each of these vessels may be accompanied by several other support vessels, tugs, and / or transport barges.

4.8.2.3 To install the inter-array cables and offshore export cables, cable lay vessels or barges will be used. These will either be positioned using Dynamic Positioning (DP) systems or using anchors. If they use anchors, they will be accompanied by anchor handling vessels.

4.8.2.4 To install the OSP(s), a heavy lift vessel will be required which has a crane capable of lifting the OSP foundation(s) and topside(s). This will either be positioned using DP systems or using anchors. Where vessels require anchoring, they will be accompanied by anchor handling vessels.

4.8.2.5 Construction operations may be supported by a Service Operation Vessel (SOV), which can accommodate construction personnel and house workshops, spare parts storage and office space, as well as provide a platform from which personnel can directly access WTGs and OSPs via a gangway.

4.8.2.6 All of the vessels described above could be working in the Moray West Site and along the Offshore Export Cable Corridor simultaneously.

4.9 Operations and Maintenance

4.9.1 Operations and Maintenance Strategy

4.9.1.1 Once commissioned, the Wind Farm would operate for the licensed period and / or the duration of the seabed lease held by Moray West. All offshore infrastructure including wind turbines, substructures, cables and offshore substations would be monitored and maintained during this period in order to maximise operational efficiency and safety for other sea users.

4.9.1.2 The operation and control of the Wind Farm would be managed by a Supervisory Control and Data Acquisition (SCADA) system, connecting each turbine to the onshore control room. The SCADA system would enable the remote control of individual turbines, the Wind Farm in general, as well as remote interrogation, information transfer, storage and the shutdown or restart of any wind turbine if required.

4.9.1.3 The indicative programme (see Section 4.8) suggests that Operation and Maintenance (O&M) activity will commence in 2024 based on a construction start date of 2022.

4.9.1.4 The overall O&M strategy will be finalised once the technical specification of the Development is known, including WTG type and final Development layout. O&M activities will most likely be coordinated from an onshore O&M harbour base located in close proximity to the Development.

4.9.1.5 The O&M strategy for the Development will allow for the use of either a Special Operations Vessel (SOV) that will accommodate O&M personnel offshore, or a combination of Crew Transfer Vessels (CTVs), supply vessels, and helicopters. Larger heavy lift vessels or jack up barges may be used for occasional major maintenance works.

4.9.1.6 Maintenance activities can be categorised into two levels: preventative and corrective maintenance. Preventative maintenance is according to scheduled services whereas corrective maintenance covers unexpected repairs, component replacements, retrofit campaigns and breakdowns.

4.9.1.7 Typical maintenance activities would include: general wind turbine service; oil sampling / change; UPS (uninterruptible power supply)-battery change; service and inspections of wind turbine safety equipment, nacelle crane, service lift, high voltage (HV) system and blades; major overhauls (typically every few years); wind turbine repairs and restarts.

4.9.1.8 During the life of the Development, there should be no need for scheduled repair or replacement of the sub-sea cables, however, reactive repairs may be required and periodic inspection may be required. Periodic surveys would also be required to ensure the cables remain buried and if they do become exposed, re-burial works would be undertaken.

4.9.2 O&M Vessels

4.9.2.1 A number of vessel visits to each turbine and OSP would be required each year to allow for scheduled and unscheduled maintenance.

4.9.2.2 If O&M activity is coordinated entirely from an onshore base, this would mean small crew vessels sailing to and from the Moray West Site on a daily basis from shore. If the SOV option is preferred, the majority of small crew vessels would be operated on a daily basis from a single SOV, although further support vessels are also still likely to transit to and from shore each day and helicopter operations may still be utilised. OSPs would require one visit a week maximum.

4.9.2.3 Although it is not anticipated that large components (e.g. wind turbine blades or substation transformers) would frequently require replacement during the operational phase, the failure of one of these components is possible. Should this be required, large jack-up or heavy lift vessels may need to operate continuously for significant periods to carry out these major maintenance activities.

4.9.3 Safety Zones

4.9.3.1 During O&M activities Moray West would seek to agree appropriate safety zones around major maintenance works (see Section 4.7 above for further detail on Safety Zones).

4.10 Decommissioning

4.10.1.1 At the end of the operational lifetime of the offshore wind farm, it is anticipated that all structures above the seabed level will be completely removed. The decommissioning sequence will generally be the reverse of the construction sequence (reverse lay) and involve similar types and numbers of vessels and equipment. Closer to the time of decommissioning, it may be decided that removal would lead to greater environmental impacts than leaving components in-situ, in which case certain components may be cut at or below the seabed (e.g. piles) or left buried (e.g. cables).

4.10.1.2 A decommissioning plan and programme would be required to be submitted prior to the construction of the Development. The decommissioning plan and programme would be updated during the lifespan of the wind farm to take account of changing best practice and new technology. Indicative decommissioning plans are described below.

4.10.2 WTGs

4.10.2.1 WTGs will be removed by reversing the methods used to install them.

4.10.3 Substructures

4.10.3.1 Pile foundations would likely be cut approximately 2m below the seabed, with due consideration made of likely changes in seabed level, and removed. This could be achieved by inserting pile cutting devices. Once the piles are cut, the substructures could be lifted and removed from the site. At this time, it is not thought to be reasonably practicable to remove entire piles from the seabed, but endeavours will be made to ensure that the sections of pile that remain in the seabed are fully buried.

4.10.3.2 Gravity base substructures could be removed by removing their ballast and either floating them (for self-floating designs) or lifting them off the seabed. Suction caissons can be removed using approximately the reverse of the process required to install them, using a pump system to apply pressure inside the caissons, allowing them to be released and extracted from the seabed. Jack-up foundations would be removed by release of footings from the seabed and re-floated, with their legs jacked up.

4.10.3.3 In order to preserve the marine habitat that has become established over the life of the Development, it may be preferable to leave any scour protection around substructures or covering cables in-situ. However, if it is considered preferable to remove the scour protection this could be achieved using the following techniques:

- Dredging of the scour protection with subsequent transportation to an approved site for appropriate disposal or re-use;
- For rock placement, the individual boulders may be recovered using a grab vessel, deposited in a hopper barge, and transported to an approved site for appropriate disposal or re-use; or,
- For other systems such as mattresses or CPS, the components could be recovered onto a crane vessel for appropriate recycling or disposal.

4.10.4 Cables

4.10.4.1 Currently there is no statutory requirement for removal of decommissioned cables and removing buried cables is difficult.

4.10.4.2 Exposed cables are more likely to be removed to ensure they don't become hazards to other users of the seabed. Although it is expected that most inter-array and export cables will be left in situ, for the purposes of the EIA it has been assumed that all cables will be removed during decommissioning. It is expected that cable protection installed will be left in situ for the same reasons as described in paragraph 4.10.3.3 above.

4.10.4.3 The removal of buried cables is not an operation for which there is much precedent, though the following indicative steps are likely to apply:

- Identify the location where cable removal is required – this may require deployment of ROVs;
- Removal of seabed material or cable protection measure where necessary to allow access to the cable;
- Mobilise suitable vessels for cable removal;
- Raise cables from seabed using a grapnel; then,
- The required sections of cables will be cut and the remaining ends weighted and returned to the seabed; and then,
- Transport cable to onshore facility for processing and reuse, recycling and/or disposal.

4.10.4.4 To minimise the environmental disturbance during wind farm decommissioning the preferred option is to leave cables buried in place in the ground at landfall with the cable ends cut, sealed and securely buried as a precautionary measure.

Offshore EIA Report

Moray Offshore Windfarm (West) Limited

Chapter 5 EIA Methodology

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Acronyms	
Acronym	**Expanded Term**
AC	Alternating Current
AfL	Areas for Lease
ASA	Acoustical Society of America
AST	Atlantic Salmon Trust
BAP	Biodiversity Action Plan
BERR	Department for Business, Enterprise and Regulatory Reform
BOWL	Beatrice Offshore Wind Farm Limited
CBRA	Cable Burial Risk Assessment
CCW	Countryside Council for Wales
Cefas	Centre for Environment, Fisheries and Aquaculture Science
CfD	Contract for difference
CIA	Cumulative Impact Assessment
CIEEM	Chartered Institute for Ecology and Environmental Management
CPA	Coast Protection Act
DC	Direct Current
DP	Dynamically Positioned
EC	European Commission
EcIA	Ecological Impact Assessment
EIA	Environmental Impact Assessment
EMF	Electromagnetic Field
EU	European Union
FEPA	Food and Environment Protection Act
FRS	Fisheries Research Services
GBS	Gravity Base Structures
HRA	Habitats Regulations Appraisal
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
ICES	International Council of the Exploration of the Sea
IEEM	Institute of Ecology and Environmental Management
IEMA	Institute of Environmental Management and Assessment
IHLS	International Herring Larvae Survey
IMARES	Institute for Marine Resources and Ecosystem Studies
IUCN	International Union for Conservation of Nature
JNCC	Joint Nature Conservation Committee

Acronyms	
Acronym	**Expanded Term**
MCZ	Marine Conservation Zone
MHWS	Mean High Water Springs
MINNS	Marine Invasive and Non-Native Species
MMO	Marine Management Organisation
MORL	Moray Offshore Renewables Limited
MPA	Marine Protected Area
MS-LOT	Marine Scotland- Licensing Operations Team
OfTI	Offshore Transmission Infrastructure
OnTI	Onshore Transmission Infrastructure
OSPAR	Oslo/Paris convention (for the Protection of the Marine Environment of the North-East Atlantic)
PAC	Pre-Application Consultation
SNH	Scottish Natural Heritage
UK	United Kingdom
WTG	Wind Turbine Generator

5 Environmental Impact Assessment (EIA) Methodology

5.1 Introduction

5.1.1.1 This chapter describes the approach and method used throughout the EIA for the Development to identify and evaluate the likely impacts and subsequent effects (including cumulative and inter-related) of the Development upon physical, biological and human receptors. Information on topic specific methodologies is presented within the topic chapters of this EIA Report – Volume 2 (Chapters 6 to 17) and supporting Technical Appendices (Volume 4).

5.1.1.2 This document has been prepared in accordance with the 'the EIA Regulations' as defined in Chapter 2: Policy and Legislative Context. The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017 require that (regulation 4):

(2) The environmental impact assessment must identify, describe and assess in an appropriate manner, in light of the circumstances relating to the proposed development, the direct and indirect significant effects of the proposed development (including, where the proposed development will have operational effects, such operational effects) on the factors specified in paragraph (3) and the interaction between those factors.

(3) The factors are—

(a) population and human health;

(b) biodiversity, and in particular species and habitats protected under Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (1) and Directive 2009/147/EC of the European Parliament and of the Council on the conservation of wild birds (2);

(c) land, soil, water, air and climate; and

(d) material assets, cultural heritage and the landscape.

5.2 Environmental Impact Assessment Legislation and Guidance

5.2.1.1 The impact assessment methodology employed in this EIA Report draws upon the following legislation and guidance:

- The EIA Regulations (Chapter 2: Policy and Legislative Context);
- Assessment of the environmental impact of offshore wind farms (OSPAR Commission, 2008);
- Relevant guidance issued by other government and non-governmental organisations (e.g. licensing and EIA guidance published by MS-LOT and SNH); and
- Receptor specific guidance documents (e.g. Ecological Impact Assessment [EcIA] guidance, Marine and Coastal, issued by the Chartered Institute of Ecology and Environmental Management [CIEEM] (CIEEM, 2016)).

5.3 Environmental Impact Assessment Methodology

5.3.1.1 The assessment of impacts on each 'topic' (e.g. benthic and intertidal ecology, ornithology, shipping and navigation, etc.) forms a separate chapter within this Offshore EIA Report. Each topic chapter includes the following information:

- Identification of the study area for the topic specific assessment;
- A description of the legislation, policy and guidance relevant to the topic assessment;

- Summary of consultation activity, including comments received in the Scoping Opinions, and how the outcomes of consultation have been considered in EIA;
- Description of the environmental baseline conditions; and
- Presentation of impact assessment, which includes:
  - Identification of the worst case design scenario for each impact assessment;
  - A description of the measures adopted as part of the Development, including mitigation and measures that form part of the Development's design;
  - Identification of likely impacts and assessment of the significance of identified effects, taking into account any measures adopted as part of the Development, which are designed to prevent, reduce or offset environmental impacts;
  - Identification of any further mitigation measures in respect of the assessment of likely significant effects. These will be included in the reporting of any residual effects and will be secured through specific design changes or conditions attached to the relevant consents. These conditions will be agreed during the determination period;
  - Identification of any future monitoring required;
  - Assessment of any cumulative effects; and
  - Assessment of any inter-related effects.

5.3.2 Scoping and Consultation

5.3.2.1 The EIA for the Development has been informed by the outcomes of formal scoping exercises, ongoing consultation with statutory bodies and other stakeholders and consultation with local communities. A list of all statutory and non-statutory stakeholders consulted during scoping and preparation of the EIA Report is provided in Table 5.3.1 below.

Table 5.3.1: List of Consultees

Organisation	Scoping Report*	Meetings	Other**
Scottish Natural Heritage (SNH)	✓	✓	✓
Joint Nature Conservation Committee (JNCC)	✓		
Scottish Environmental Protection Agency (SEPA)	✓		
Marine Scotland Licencing Operations Team (MSLOT)	✓	✓	✓
Marine Scotland Science (MSS)	✓	✓	✓
Aberdeenshire Council	✓	✓	✓
Moray Council	✓	✓	✓
The Highland Council	✓	✓	✓
British Telecom (Radio Network Protection Team)	✓		✓
Civil Aviation Authority (CAA)	✓	✓	
Chamber of Shipping	✓	✓	
Crown Estate Scotland	✓	✓	
Defence Infrastructure Organisation	✓	✓	✓
Fisheries Management Scotland	✓	✓	

Table 5.3.1: List of Consultees			
Organisation	**Scoping Report***	**Meetings**	**Other****
Joint Radio Company	✓		✓
Maritime and Coastguard Agency (MCA)	✓	✓	
Marine Safety Forum	✓		✓
Marine Scotland Compliance, Buckie Fisheries Office	✓		
Marine Scotland Compliance, Fraserburgh Fisheries Office	✓		
Marine Scotland Compliance, Scrabster Fisheries Office	✓		
Marine Scotland Compliance, Ullapool Fisheries Office	✓		
Moray Firth Partnership	✓		
NATS Safeguarding	✓	✓	
Northern Lighthouse Board (NLB)	✓	✓	
Royal Yachting Association (RYA) Scotland	✓	✓	
RSPB	✓	✓	
Scottish Canoe Association	✓		
Scottish Fisherman's Federation	✓	✓	
Scottish Fisherman's Organisation	✓		
North & East Coast Inshore Fisheries Groups	✓		
Scottish Wildlife Trust	✓		✓
Surfers Against Sewage	✓		
Whale & Dolphin Conservation	✓		
Historic Environment Scotland	✓		✓
Transport Scotland	✓		
Cromarty Firth Port Authority	✓		
Scottish Surfing Federation	✓		
Sport Scotland	✓		
Visit Scotland	✓		
Scottish Government Planning	✓		
Aberdeenshire Council - Banff, Buchan and Gariloch Planning Team	✓		
Aberdeenshire Council - Buchan and Formantine Planning Team	✓		
Beatrice Offshore Renewables Ltd.	✓		
Suncor Energy	✓		
Cruising Association	✓		
Faroese Telecom	✓		

Table 5.3.1: List of Consultees			
Organisation	**Scoping Report***	**Meetings**	**Other****
Highlands and Islands Airports Limited	✓		
Scottish Pelagic Fishermen's Association	✓		
Scallop Association	✓	✓	✓
SHE - Transmission	✓		
Ithaca Energy	✓		
Babcock Offshore Helicopters	✓		
CHC Helicopters	✓		
Bristows Helicopters	✓		
University of Aberdeen	✓		
PA Resources AB (publ)	✓		
Moray Firth Sea Trout Project	✓		
Scottish Enterprise	✓		
Highlands and Islands Enterprise	✓		
Moray Canoe and Kayak School	✓		✓
Deveron Paddlers	✓		✓
Suds Surf School	✓		✓
New Wave Surf School	✓		✓

* Hard copy or email link to electronic copy of the Moray West Offshore Wind Farm Scoping Report 2016 and / or Moray West Offshore Transmission Infrastructure (OfTI) Scoping Report 2017
** Email / telephone correspondence or consultation through attendance at public events.

5.3.2.2 The two Scoping Opinions issued by MS-LOT in relation to the Moray West Offshore Wind Farm and the OfTI are provided in full in Volume 4, Appendices 5.1 and 5.2 respectively. A summary of key issues raised during consultation (both as part of the Scoping Opinion and in response to additional pre-application consultation) and Moray West's response to those issues, has also been included in each technical chapter of the EIA Report (Chapters 6 to 17).

5.3.2.3 Moray West has also submitted (electronic copy only) a completed Gap Analysis spreadsheet. The Gap Analysis is a tool used by MSLOT to track all consultation activities, issued raised during these activities and actions/steps taken to close out issue. The Gap Analysis (which has been submitted electronically as an additional supporting document) will remain live for the duration of the determination period in order to track how all comments received on the application have also been addressed and closed out.

5.3.2.4 In accordance with the Marine Licensing (Pre-application Consultation) (Scotland) Regulations 2013, Pre-Application Consultation (PAC) was undertaken with local communities and other interested members of the public in January 2018 in Portsoy, on components of the OfTI located within Scottish Territorial Waters (12 nm) e.g. the majority of the export cable circuits and the landfall. Further PAC events on the landfall and onshore transmission infrastructure (OnTI) where held during March and April 2018 at locations in both Sandend and Portsoy. These public exhibitions were accompanied by appropriate advertisement through the local media to seek opinion and feedback. A record of this consultation is provided in the accompanying Offshore Pre-Application Consultation Report (Moray West, 2018).

5.3.2.5 Following submission of the Marine Licence and Section 36 Consent applications and this Offshore EIA Report there will be a period of formal consultation where the public and statutory consultees will be given the opportunity to comment on the Development. Moray West will continue its consultation, including with local communities, during this period to keep them informed on progress of the Development.

5.3.3 Application of the Design Envelope

5.3.3.1 The Offshore EIA Report utilises the Design Envelope approach, previously referred to as the 'Rochdale Envelope' approach. This approach reflects the evolving nature of the offshore wind industry in terms improvements in technology and construction methods by allowing the impact assessment to assess potential effects associated with a range of realistic current, and potential future design parameters e.g. rotor diameters for WTGs.

5.3.3.2 The basis to this approach, by retaining maximum flexibility in the design parameters considered in the application, is to ensure that the final development design can be accommodated within the existing consents, reducing the need for any potential future variations to those consents.

5.3.3.3 Under the Design Envelope approach, for each impact assessment the realistic 'worst case' scenario from within the range of potential options for each development parameter will be identified, and the assessment will be undertaken on this basis.

5.3.3.4 Volume 2, Chapter 4 (Description of the Development) sets out the Development design parameters and identifies the range of potential design values for all relevant components of both the Moray West Offshore Wind Farm and the OfTI. Each of the impacts arising from the Development will be assessed against the Design Envelope scenario which would give rise to the greatest potential effect.

5.3.3.5 As the impact assessment is undertaken using the realistic 'worst case' scenario identified in the Design Envelope, it can be considered that for any assessment using different design parameters that are equal to, or captured within (e.g. less than), those assessed in the Design Envelope, the potential environmental effects will be either the same, or less, for the receptors under consideration.

5.3.4 Characterisation of the Existing Environment

5.3.4.1 Characterisation of the existing environment has been undertaken to determine the baseline conditions. This involved the following steps:

- Identification of the study area for each receptor based on the relevant characteristics of the receptor (e.g. mobility/range);
- Review of available, existing baseline data sources;
- Review of potential impacts that might be expected to arise from the Development;
- Determination of whether there was sufficient baseline data to make the EIA judgements with sufficient confidence;
- Collation of further data where required. This targeted specific receptors and was directed at answering key questions and filling key data gaps; and
- Review of additional baseline information to inform further characterisation of the existing environment.

5.3.4.2 In preparing this Offshore EIA Report a significant amount of existing data from a number of sources including desk-based research and existing survey data (including site-specific surveys and studies) has been collated.

5.3.4.3 The specific approach to establishing a robust baseline (upon which impacts can be assessed) is set out in detail within each topic chapter.

5.3.5 Identification of Impacts and Assessment of Significance of Effects

5.3.5.1 The Development has the potential to create a range of 'impacts' and 'effects' with regard to the physical, biological and human environment. The Institute of Environmental Management and Assessment (IEMA) (2012) sets out that:

In undertaking EIA, it is commonplace for practitioners to correlate the sensitivity of the receiving environmental resource, or receptor, with the potential impact, to identify the environmental effect. The significance of an effect is then frequently determined by way of professional judgement and/or the use of matrices.

Characteristics of potential impacts are set out within the EIA Regulations in the context of screening (which was not undertaken for the Development). The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017 describes them (paragraph 3 of Schedule 1 to the Regulations "characteristics of the potential impact") as follows:

The likely significant effects of the development on the environment must be considered in relation to criteria set out in paragraphs 1 and 2 above, with regard to the impact of the development on the factors specified in regulation 4(3), taking into account -

(a) the magnitude and spatial extent of the impact (for example geographical area and size of the population likely to be affected);

(b) the nature of the impact;

(c) the transboundary nature of the impact;

(d) the intensity and complexity of the impact;

(e) the probability of the impact;

(f) the expected onset, duration, frequency and reversibility of the impact;

(g) the cumulation of the impact with the impact of other existing and/or approved development;

(h) the possibility of effectively reducing the impact.

5.3.5.2 Similar provisions appear in the other EIA Regulations.

5.3.5.3 Throughout this Offshore EIA Report, the term 'impact' is used to define a change that is caused by an action. For example, pile driving of foundations during construction (the action) results in increased levels of subsea noise (the impact). The term 'effect' is used throughout this assessment to express the outcome of an impact (i.e. the increased levels of noise (impact) from the piling of foundations (action) has the potential to disturb marine mammals or fish (the effect)) when reporting on its level of significance. Effects can be direct, indirect, secondary, cumulative, inter-related or transboundary. They can also be beneficial, adverse or negligible.

<u>Defining Magnitude and Sensitivity</u>

5.3.5.4 The EIA for those potential effects scoped in will describe the level of significance of the adverse and positive effects arising from the Development using a standard EIA methodology. The assessment process will consider the potential magnitude of the impact to the baseline conditions arising from the Development and the sensitivity of the particular EIA topic under consideration.

Magnitude

5.3.5.5 The magnitude of the impact depends on a range of factors, all of which feed into the magnitude assigned to each impact. These factors are:

- Size and scale of impact – spatial extent e.g. geographical area over which the impact occurs and / or increase in amounts / volumes or quantities;
- Duration – the time over which the impact occurs (this may be expressed as short, medium or long-term, and temporary or permanent);
- Seasonality of impact - e.g. is the impact expected to occur all year or during specific times of the year e.g. summer;
- Frequency – how often the impact occurs over the lifetime of the development; and
- Reversibility – the ability for the receiving environment / exposed receptor to return to baseline conditions.

5.3.5.6 Categorisation of magnitude of impact will vary for specific topics but will broadly follow the principles set out in Table 5.3.2 below in so far as it is relevant.

Table 5.3.2: Definition of Impact Magnitude

Magnitude of Impact	Description
High	Total loss or major alteration to key elements/features of the baseline conditions Impact occurs over a large scale or spatial extent (defined individually for each technical area) resulting in widespread, long term or permanent changes in site characteristics or affecting a large proportion of receptor population. Impact will occur repeatedly or continuously over a long period of time.
Moderate	Partial loss or alteration to one or more key elements/features of the baseline conditions. Impact occurs over a medium scale or spatial extent (defined individually for each technical area) with short to medium term change to site characteristics or affecting a moderate proportion of the receptor population. Impact will occur repeatedly or continuously over a moderate period of time or at moderate intensity for short periods of time.
Low	Minor shift away from the baseline conditions. Impact is localised and temporary or short term (defined individually for each technical area) with detectable change to site characteristics or noticeable change to small proportion of the receptor population. Low frequency impact occurring occasionally or intermittently and at low intensity
Negligible	Very slight change from baseline conditions. Impact is highly localised and short term resulting in very slight / imperceptible changes to site characteristics / receptors population. Full rapid recovery is expected.
No change	No change from baseline conditions.

Sensitivity

5.3.5.7 The sensitivity of a receptor is a function of the its capacity to accommodate change and reflects its ability to recover if it is impacted. The sensitivity of a receptor is based on the following factors:

- Capacity / tolerance: ability of the receptor to accommodate an impact and recover from, or adapt to the impact;

- Vulnerability: based on current status or condition of the receptor population and its ability to accommodate additional external pressure; and
- Value: based on conservation status of the receptor (e.g. International, European, National).

5.3.5.8 The scale of sensitivity will be classed as 'Negligible', 'Low', 'Moderate', 'High' or 'Very High'. In carrying out individual assessments, a more specific scale of increasing sensitivity will be defined where this is appropriate. Guidance will also be taken from the value attributed to elements through designation or protection under law.

5.3.5.9 Criteria on receptor sensitivity, specific to the receptors being assessed, are provided in each of the topic chapters of this Offshore EIA report.

Evaluation of Significance of Effect

5.3.5.10 Overall significance of an effect is determined by correlating the magnitude of the impact and the sensitivity of receptor. In order to ensure a transparent and consistent approach throughout the EIA Report, a matrix approach has been adopted as a guide (see Table 5.3.3 below). There is however latitude for professional assessment where deemed appropriate in the application of the matrix.

Table 5.3.3: Significance of Effect

Sensitivity of Receptor	**Magnitude of Impact**				
	No change	**Negligible**	**Low**	**Moderate**	**High**
Negligible	Negligible	Negligible	Negligible or Minor	Negligible or Minor	Minor
Low	Negligible	Negligible or Minor	Negligible or Minor	Minor	Minor or Moderate
Moderate	Negligible	Negligible or Minor	Minor	Moderate	Moderate or Major
High	Negligible	Minor	Minor or Moderate	Moderate or Major	Major
Very High	Negligible	Minor	Moderate or Major	Major	Major

5.3.5.11 The terms assigned to categorise effect significance can be described as follows:

- Negligible: where the Development would cause no discernible improvement in or deterioration of the existing environment;
- Minor: beneficial or adverse – where the Development would cause a small but perceptible improvement in or deterioration of the existing environment;
- Moderate: beneficial or adverse – where the Development would cause a noticeable improvement or deterioration of the existing environment; and
- Major: beneficial or adverse – where the Development would cause a considerable improvement or deterioration of the existing environment.

5.3.5.12 By cross-referring the expected magnitude of impact, with the sensitivity of receptor an evaluation of effect significance can be assigned for all impacts. Effect significance may be one, or a range of, negligible, minor, moderate, or major. In general, any effect with a significance of moderate or greater is considered 'significant' in EIA terms. For each topic specific chapter, what is considered 'significant' will be clearly defined. Where further mitigation is not possible a residual significant effect may remain.

Acknowledging Levels of Certainty

5.3.5.13 The determination of the significance of effect incorporates and describes any uncertainty inherent within the assessment. This may arise from the data used within the assessment, the identification of activities and impacts, the confidence in determining impact magnitude and receptor sensitivity and ultimately in assigning significance levels of predicted resulting effects.

5.3.6 Embedded Mitigation

5.3.6.1 Schedule 4 of the EIA Regulations requires that:

'A description of the measures envisaged to avoid, prevent, reduce or, if possible, offset any identified significant adverse effects on the environment and, where appropriate, of any proposed monitoring arrangements (for example the preparation of a post-project analysis). That description should explain the extent to which significant adverse effects on the environment are avoided, prevented, reduced or offset, and should cover both the construction and operational phases' is to be included within the EIA Report.

5.3.6.2 EIA is an iterative process involving a feedback loop during the impact assessment process. Where an effect is initially assessed as significant in EIA terms, changes are made (where practicable) to relevant project parameters in order to reduce or offset the significance of that impact. The assessment is then repeated and the process continues until the EIA practitioner is satisfied that:

- The effect has been reduced to a level that is not significant in EIA terms; or
- No further changes may be made to Development design parameters in order to reduce the magnitude of impact (and resulting effect significance). In such cases an overall effect that is still significant in EIA terms may be presented.

5.3.6.3 The iterative approach to the Moray West EIA, as described above, has been used as a means of informing the Development design. This approach has been employed in order to demonstrate commitment to measures by adopting them as part of the Development. These measures have been referred to throughout the Offshore EIA Report as 'embedded mitigation'. These measures will ultimately form part of the requirements included in the consent or the conditions within the Marine Licences.

5.3.6.4 By employing this method, the significance of each identified effect may be presumed to be representative of the maximum residual effect that the development will have, should it be approved and constructed.

5.3.7 Additional Mitigation Measures

5.3.7.1 In select cases, additional mitigation measures have been outlined within the topic chapters. This includes mitigation measures where:

- The threshold of significance of effect has been reached (i.e. where an issue is significant in EIA terms) when including design mitigation measures (embedded mitigation), but there are additional mitigation measures available to reduce the level of effect; or
- Mitigation has been proposed but has not yet been confirmed (i.e. awaiting sign-off from regulators, stakeholders etc.) as agreed mitigation or is unproven (i.e. the mitigation is not proven to be effective at reducing the residual significance of effect).

5.3.8 Assessing Residual Effects

5.3.8.1 Following the identification of any necessary additional mitigation measures, impacts will be re-assessed and all residual significance will be described. Where any significant effects remain, a discussion will explain why the significance cannot be reduced.

5.4 Inter-related Effects

5.4.1.1 The EIA Regulations require consideration of the inter-relationships between topics that may lead to environmental effects. For example, impacts of habitat loss / disturbance on fish and shellfish species may also effect birds and marine mammals as a result of an impact on prey species. Potential inter-related effects are identified and assessed in relevant topic chapters within this EIA Report.

5.4.1.2 It is important to note that the inter-relationships assessment considers only effects produced by the Development and not those from other projects (which are considered within the CIA; see Section 5.5 below).

5.5 Cumulative Impact Assessment

Overview

5.5.1.1 The EIA Regulations require that a description of the likely significant effects of a project should be provided for cumulative effects. This section sets out the approach that has been adopted for the Cumulative Impact Assessment (CIA) requirement of the EIA process that is applicable to the Development.

5.5.1.2 European Commission (EC) Guidelines for the Assessment of Indirect and Cumulative Impacts as well as Impact Interactions (EC, 1999) provide the following definition of cumulative and in combination effects, which have been applied in this Offshore EIA Report:

"*Cumulative impacts: impacts that result from incremental changes caused by other past, present or reasonably foreseeable actions together with the project*".

5.5.1.3 The key issues in considering a CIA relate to defining appropriate boundaries in time and space, identifying and predicting future resource use and impacts, and evaluating the significance of cumulative effects that are predicted to take place. The CIA process therefore comprises three stages:

- **Screening Exercise** - creation of an initial list of plans, projects and activities based on defined range criteria for key receptors;
- **Stakeholder Consultation** - refinement of the outcomes from the Screening Exercise in order to agree key receptors, range criteria and produce final list of plans, projects and activities to be included in the CIA; and
- **Assessment of Potential Cumulative Effects** - Once the list of relevant plan, projects and activities has been agreed with the consenting authorities, a CIA will be completed for each environmental technical area and receptor.

Screening Exercise

5.5.1.4 A desk-based screening exercise was undertaken. The screening exercise identified a list of projects (and plans and activities where relevant) for consideration in CIA.

5.5.1.5 The list took account of the following:

- Projects that are not currently in the planning system but are likely to enter the planning system in the near future (e.g. areas for lease (AfL) or projects at feasibility / early design stages);

- Projects currently within the marine planning system at scoping stage or for which an application has been submitted but which are not yet consented;
- Projects that are consented and are yet to be constructed or are under construction; and
- Projects that are currently operational but that were not operational when baseline data was collected, or operational projects that have an ongoing impact.

5.5.1.6 The list identified those plans, projects and activities where there exist pathways for overlap with the Development; these potential pathways are summarised in Table 5.5.1 below.

Table 5.5.1: Cumulative Impact Pathways

Nature of Overlap	Definition
Conceptual overlap	For a cumulative effect to occur it must be established that a cumulative impact has the potential to directly or indirectly affect the receptor(s) in question. In EIA terms this is described as an impact-receptor-pathway, and is hereafter referred to as a conceptual overlap. An example of a conceptual overlap can be seen where increased suspended sediment concentrations from a nearby project (impact) affect fish and shellfish (receptor) that are also potentially affected by the Development. Conversely, a conceptual overlap cannot be demonstrated between activities such as the operation of a subsea cable and aircraft navigation. It is in cases such as this second example where projects, plans and activities have been screened out.
Physical overlap	The impacts on one receptor from Moray West and one or more other plans, projects or activities overlap i.e. sediment plumes interact, or noise contours from piling, while not overlapping directly, impact on the general range of a mobile species such as harbour porpoise.
Temporal or sequential overlap	The specific impacts on a receptor have to interact temporally, or sequentially, for there to be a cumulative effect. For those impacts only active during construction, e.g. piling noise, it is necessary to determine the potential overlap of construction, or sequential construction periods, with other plans, projects and activities in order to assess the likelihood of any overlap.

5.5.1.7 A long list of plans, projects and activities was produced as part of the screening exercise. This was subsequently refined as a result of consultation.

Assessment of Potential Cumulative Effects

5.5.1.8 The plans, projects and activities considered within CIA are listed in Volume 4, Appendix 5.3 (CIA Screening List).

5.5.1.9 To inform the assessment of potential cumulative effects within each topic chapter, for each plan, project and activity identified, all publicly available data and / or information has been gathered and reviewed in order to identify the proposed construction methods, construction programme and other timescales of interest and obtain an understanding of the elements of the project that may lead to cumulative impacts with the Development.

5.5.1.10 This has included reviewing the assessment of significant effects presented within supporting EIA Reports (previously, Environmental Statements (ESs)) / Scoping Reports and other post-application survey validation / assessment reports. For each key receptor, an overall quantitative assessment of the Development combined with each individual project is presented and potential significance of effects identified as far as possible.

5.5.1.11 Where sufficient information is not present publicly e.g. for projects at Scoping or earlier stages in their planning / EIA process, a qualitative assessment has been undertaken based on the level of information available at the time.

Consideration of Other Offshore Wind Farm Projects

5.5.1.12 For the Firths of Forth and Tay offshore wind farms (Inch Cape, Neart na Gaoithe, Seagreen) that are already consented but not currently under construction and are making new applications for revised design envelopes, the cumulative assessment for each topic is based on the worst case scenario from either the previously consented parameters or the Scoping Report / EIA Report (if submitted) (whichever is worst case). The exception to this is the marine mammal ecology assessment (Chapter 9) which presents parameters for both the consented projects and the revised applications.

5.5.1.13 Information on construction timescales for Neart na Gaoithe has been taken from the submitted EIA Report, whereas similar information for Inch Cape and Seagreen has been taken from their 2017 Scoping Reports. The Inch Cape 2017 Scoping Report indicates construction commencing between 2020 and 2021 and occurring over approximately two years. The Seagreen 2017 Scoping Report indicates construction commencing in 2022 and lasting approximately 36 months.

5.5.1.14 For the Moray East Offshore Wind Farm, the cumulative assessment for all topics except marine mammals, ornithology and seascape, landscape and visual assessment (SLVIA) is based on the consented design parameters for the Telford, Stevenson and MacColl wind farms.

5.5.1.15 With respect to the cumulative assessment for SLVIA, this is based on the consented worst case scenarios (for the Telford, Stevenson and MacColl wind farms). However, the assessment also includes information on the Moray East most likely scenario which comprises a revised Design Envelope of 100 WTGs. This additional information is presented in Volume 4 of the EIA Report – Technical Appendix 14.4.

5.5.1.16 The Moray East most likely scenario reflects the current status of the Moray East offshore wind farm, which having been awarded a CfD in September 2017 for 950 MW, is progressing towards completion of their Design Specification and Layout Plan (DSLP). The DSLP, which is based on 100 WTGs is due to be submitted in Q2 2018.

5.5.1.17 In terms of marine mammals, the cumulative assessment has considered the Moray East consented design parameters (with respect to the number of animals predicted to be disturbed during each piling event) with the most likely design scenario (100 WTGs) with respect to the total number of piling events modelled to inform the cumulative impact assessment.

5.5.1.18 For ornithology, the cumulative assessment is based on the Moray East project as consented, with consideration given to the Moray East most likely turbine scenario (100 WTGs) also presented qualitatively. An appraisal of the differences between assessed, consented and as-built turbine scenarios has also been conducted with this exercise identifying the large degree of precaution inherent in the cumulative assessments presented. Where possible the findings from the MacArthur Green headroom study (MacArthur Green, 2017), which considers the likely headroom that exists in current cumulative collision risk estimates due to the assessed turbine scenarios representing a higher collision risk to birds than the as built or planned turbine scenarios, have been used to quantify the potential reductions that may occur as a result of such changes.

5.5.1.19 As noted above, for the Beatrice Offshore Wind Farm and the European Offshore Wind Deployment Centre ('Aberdeen Offshore Wind Farm') the cumulative assessment is based on the 'as built' design parameters (presented in the approved DSLPs) for both of these projects.

5.5.1.20 For quantitative assessment of projects, the assessment criteria used to determine the magnitude of impact, sensitivity of receptor, and overall significance of effect will follow the same methodology as that presented above. A combination of matrix and professional judgement will be applied to the evaluation of significance. Significance will either be adverse or beneficial and negligible, minor, moderate or major in nature. For qualitative assessment, a more high-level significance will be concluded using professional judgement.

5.5.1.21 Finally, for any cumulative effects that are identified to be significant adverse, further assessment will be completed and mitigation and other measures developed in order to minimise / reduce cumulative effects to an acceptable level of significance where possible.

5.6 Whole Project Assessment

5.6.1.1 The Development, comprising the Moray West Offshore Wind Farm and associated OfTI, is one element of the 'whole Project', which comprises the Development and the associated OnTI. In the absence of the OnTI, there would be no means by which the electricity generated by the wind farm could be transferred to the National Grid Network, and in the absence of the Development, there would be no requirement for the OnTI.

5.6.1.2 The Development and the OnTI are seeking consent/permission under different planning regimes and thus separate applications will be made, supported by separate EIA Reports.

5.6.1.3 A 'whole project assessment' is presented in Chapter 18 of this EIA Report. The chapter provides a succinct description of the OnTI and summarises, as far as is already known, the potential environmental effects arising from the OnTI. These potential effects are then considered together, as far as possible, with the potential environmental effects arising from the Moray West Offshore Wind Farm and the OfTI. It is intended that this chapter allows the reader of the EIA Report to understand the scope and potential effects of the Project as a whole, and not only the Development in isolation.

5.7 References

BSI (2015). PD 6900:2015. Environmental impact assessment for offshore renewable energy projects – Guide.

CIEEM (2016). Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater and Coastal, 2nd edition. Chartered Institute of Ecology and Environmental Management, Winchester

IEMA (2012). Impacts and effects: Do we really understand the difference? [Internet, available: https://transform.iema.net/article/impacts-and-effects-do-we-really-understand-difference accessed 07/02/18].

MacArthur Green Ltd. (2017). *Estimates of Ornithological Headroom in Offshore Wind Farm Collision Mortality*. Report to the Crown Estate.

Marine Scotland (2017). Moray Offshore Renewables Limited Western Development Area – Scoping Opinion for the proposed Section 36 Consent and associated Marine Licence(s) application for Moray Offshore Renewables Ltd. – Western Development Area, Outer Moray Firth.

Moray East (2012). Moray East Offshore Wind Farm Environmental Statement.

Moray East (2012). Moray Firth Offshore Wind Developers Group (MFOWDG) Cumulative Impact Assessment Discussion Document.

Moray Offshore Windfarm (West) Limited (2017a). Moray West Offshore Transmission Infrastructure Scoping Report.

Moray Offshore Windfarm (West) Limited (2017b). Moray West Onshore Transmission Infrastructure Scoping Report.

OSPAR, 2008. OSPAR Guidance on Environmental Considerations for Offshore Wind-Farm Development. Reference Number 2008-3.

Planning Inspectorate (PINS) (2015a). Advice Note Twelve: Transboundary Impacts. [Internet, available: https://infrastructure.planninginspectorate.gov.uk/wp-content/uploads/2013/04/Advice-note-12v2.pdf, accessed 05/04/17].

Planning Inspectorate (PINS) (2015b). Advice Note Seventeen: Cumulative Effects Assessment. [Internet, available: https://infrastructure.planninginspectorate.gov.uk/wp-content/uploads/2015/12/Advice-note-17V4.pdf, accessed 05/04/17].

Planning Inspectorate (PINS) (2017a). Secretary of States Scoping Opinion – Thanet Extension. Planning Inspectorate Reference: EN010084

RenewableUK, (2013). Cumulative Impact Assessment Guidelines Guiding Principles For Cumulative Impacts Assessment In Offshore Wind Farms

Scottish Natural Heritage (SNH) (2005). Cumulative Effects of Wind Farms. Version 2 Revised 13.04.05

SNH (2012). Assessing the Cumulative Impact of Onshore Wind Energy Developments.

MORAY WEST
OFFSHORE WINDFARM

Offshore EIA Report

Moray Offshore Windfarm (West) Limited

Chapter 6 Physical Processes and Water Quality

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Acronyms	
Acronyms	**Expanded Term**
ABPmer	ABP Marine Environmental Research
BERR	Department for Business, Enterprise and Regulatory Reform
BOWL	Beatrice Offshore Windfarm Limited
BSI	British Standards Institution
Cefas	Centre for Environment, Fisheries and Aquaculture Science
COWRIE	Collaborative Offshore Wind Research into the Environment
CPA	Coast Protection Act
Defra	Department for Environment, Food and Rural Affairs
EDA	Eastern Development Area
EIA	Environmental Impact Assessment
ES	Environmental Statement
FEED	Front End Engineering Design
FEPA	Food and Environmental Protection Act
GBS	Gravity base structure
HAT	Highest Astronomical Tide
HDD	Horizontal Directional Drilling
JNCC	Joint Nature Conservation Committee
LAT	Lowest Astronomical Tide
MCA	Maritime and Coastguard Agency
MHWS	Mean High water of Spring Tides
MMO	Marine Management Organisation
MORL	Moray Offshore Renewables Limited
NCCA	National Coastal Change Assessment
O&M	Operation and Maintenance
OfTI	Offshore Transmission Infrastructure
OnTI	Onshore Transmission Infrastructure
OSP	Offshore Substation Platform
OWF	Offshore Wind Farm
pMPA	proposed Marine Protected Area
SAC	Special Areas of Conservation
SAS	Surfers Against Sewage
SEPA	Scottish Environmental Protection Agency
SNH	Scottish Natural Heritage
SPA	Special Protection Area

Acronyms	
Acronyms	**Expanded Term**
SSC	Suspended Sediment Concentration
SSSI	Sites of Special Scientific Interest
UKCP09	United Kingdom Climate Projections
WDA	Western Development Area
WTG	Wind Turbine Generator

Glossary of Terms	
Term	**Definition**
Advection	The transfer of a substance (in water or air) via bulk motion.
AL	Action level
Astronomical tide	The tide levels and character which would result from the gravitational effects of the earth sun and moon without any atmospheric influences.
Bathymetry	Topography of sea/estuary seabed measured from a fixed vertical datum.
Beach	A deposit of non-cohesive material (e.g. sand, gravel) situated on the interface between dry land and the sea (or other large expanse of water) and actively "worked" by present-day hydrodynamic processes (ie waves, tides and currents) and sometimes by winds.
Bedforms	Features on the seabed (e.g. sand waves, ripples) resulting from the movement of sediment over it.
Bedload	Sediment particles that travel near or on the seabed.
Benthic habitats	Marine habitats on the seabed.
Breaking	Reduction in wave energy and height in the surf zone due to limited water depth.
Clay	A fine grained sediment with a typical grain size of less than 0.004 mm. Possesses electromagnetic properties which bind the grains together to give a bulk strength or cohesion.
Climate change	A long term trend in the variation of the climate resulting from changes in the global atmospheric and ocean temperatures and affecting mean sea level, wave height, period and direction, wind speed and storm occurrence.
Coast	A strip of land of indefinite length and width that extends from the seashore inland to the first major change in terrain features.
Coastal defences, coastal works	Collective terms covering protection provided to the coastline. These include coast protection and sea defences.
Coastal processes	Collective term covering the action of natural forces on the coastline and adjoining seabed.

Glossary of Terms	
Term	**Definition**
Cumulative effects	The combined effect of more than one development on the environment.
Current	Flow of water generated by a variety of forcing mechanisms (e.g. waves, tides, wind etc).
Dalradian (geology)	The Dalradian Series is a sequence of highly folded and metamorphosed sedimentary and volcanic rocks of late Precambrian to Early Cambrian age, about 540 million years old, which occurs in the southeastern portions of the Scottish Highlands of Great Britain.
Dispersion	The separation of waves by virtue of their differing rates of movement.
Downdrift	The direction of predominant movement of littoral drift along the shore.
Dredging overspill	The overflow of sediment laden fluid from a dredging vessel.
Dunes	Accumulations of windblown sand on the backshore, usually in the form of small hills or ridges, stabilised by vegetation or control structures. A type of bed form indicating significant sediment transport over a sandy seabed.
Ebb	Period when tide level is falling; often taken to mean the ebb current which occurs during this period.
Erosion	Movement of material by such agents as running water, waves, wind, moving ice and gravitational creep.
Estuary	Semi-enclosed coastal body of water which has a free connection with the open sea and where fresh water, derived from land drainage, is mixed with sea water.
Extreme	The value expected to be exceeded in a given (long) period of time.
Flood tide	The period of time when tidal water levels are rising.
Fines	Relatively fine sediments less than 0.062 mm diameter (i.e. silts, muds and clays).
Geomorphology	The physical shape and characteristics of the seabed or coastline and the processes that shape it.
Geophysical survey	Activities to obtain data on the distribution and nature of geophysical properties of the seabed (e.g. bathymetry, surficial sediment type and bedforms, sub-surface geology). Geophysical survey outputs typically include multibeam bathymetry, side-scan sonar and sub-bottom profiler data.
Habitat	The natural home of an animal or plant.
Indirect effect	Impacts on the environment, which are not a direct result of the development but are often produced away from it or as a result of a complex pathway. Sometimes referred to as secondary impacts.
Intertidal	The zone between the highest and lowest astronomical tide water marks.
LOD	Level of detection

Glossary of Terms	
Term	**Definition**
Longshore	Along the shore.
Longshore drift	Or alongshore or littoral drift. Movement of sand and shingle along the shore. It takes place in two zones, at the upper limit of wave activity and in the breaker zone. Movement of beach (sediments) approximately parallel to the coastline.
Proposed Marine Protected Area	A marine area proposed for protective designation.
Quaternary (geology)	Geological developments over the last 2.6 million years.
Mean sea level	The average level of the sea over a period of approximately 18.6 years, taking account of all tidal effects but excluding surge events.
Mitigation	Measures, including any process, activity or design to avoid, reduce, remedy or compensate for adverse effects.
Numerical modelling	Refers to analysis of coastal processes using computational models.
Onshore	A direction landward from the sea.
PAH	Polyaromatic Hydrocarbons
Salinity	Measure of the concentration of dissolved salts in water. Typically measured in unit of PSU (Practical Salinity Unit), equivalent to parts per thousand.
Saltation	A term used to describe the movement of a particle being transported that is too heavy to remain in suspension. The particle is rolled forward by the current, generates lift and rises, loses the forward momentum and settles to the seabed. The process is then repeated.
Sand	Sediment particles, mainly of quartz, with a diameter of between 0.062 mm and 2 mm, generally classified as fine, medium, coarse or very coarse.
Scour	Local erosion of sediments caused by local flow acceleration around an obstacle and associated turbulence enhancement.
Sediment transport	The movement of a mass of sedimentary material by the forces of currents and waves. The sediment in motion can comprise fine material (silts and muds), sands and gravels. Potential sediment transport is the full amount of sediment that could be expected to move under a given combination of waves and currents, i.e. not supply limited.
Shingle	A loose term for the coarsest beach material, a mixture of gravel, pebbles and larger material. Often well rounded and of hard rock such as chert or flint.
Site of Special Scientific Interest (SSSI)	SSSIs are a representative sample of British habitats, with each site seen as an integral part of a national series, established with the aim of maintaining the present diversity of wild animals and plants in Great Britain. It should be noted that selection is on scientific grounds rather than to enhance amenity or provide recreation.
Special Area of Conservation (SAC)	Land protected under Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora.

Glossary of Terms	
Term	**Definition**
Special Protection Area (SPA)	Land classified under Directive 79/409 on the Conservation of Wild Birds.
Surge	Change in water level as a result of meteorological forcing (wind, high or low barometric pressure) causing a difference between the recorded water level and that predicted using harmonic analysis. May be positive or negative.
Suspended sediment concentration	Mass of sediment in suspension per unit volume of water.
Tidal excursion ellipse	The path followed by a water particle in one complete tidal cycle (i.e. flood – ebb).
Till	Collective term for the group of sediments laid down by the direct action of glacial ice.
TEL	Total Exceedance Level
Wake	Disturbance in the flow field behind an obstruction.
Diffraction	Process by which energy is transmitted laterally along a wave crest. Propagation of waves into the sheltered region behind a barrier such as a breakwater.
Wavelength	Straightline distance between two successive wave crests.
Wave period	The time taken for two successive wave crests to pass the same point.

6 Physical Processes and Water Quality

6.1 Introduction

6.1.1.1 This chapter considers the likely significant effects on physical processes and water quality associated with the construction, operation and maintenance and decommissioning of the Moray West Windfarm and associated Offshore Transmission Infrastructure (OfTI) ("the Development"). The specific objectives of the chapter are to:

- Identify the relevant planning legislation, guidance and policy relevant to physical processes and water quality;
- Detail the consultation activities and responses relevant to and which have informed the physical processes and water quality assessment;
- Describe the physical processes and water quality baseline;
- Describe the assessment methodology and significance criteria used in completing the impact assessment;
- Describe the potential effects, including direct, indirect and cumulative effects;
- Describe the mitigation measures proposed to address likely significant effects; and
- Assess the residual effects remaining following the implementation of mitigation.

6.1.1.2 The assessment has been carried out by ABPmer and follows available industry guidance and best practice. ABPmer is a leading UK marine environmental consultancy that has provided the physical processes EIA for the majority of UK offshore wind farms, including the nearby Moray East and Beatrice developments.

6.1.1.3 This chapter is supported by:

- EIA Report Volume 4 - Technical Appendix 6.1: Physical Processes Baseline;
- EIA Report Volume 4 - Technical Appendix 6.2: Physical Processes Numerical Modelling; and
- EIA Report Volume 4 - Technical Appendix 6.3: Physical Processes Impact Assessment.

6.2 Legislation, Policy and Guidance Framework

6.2.1 Legislation

6.2.1.1 The following legislation is relevant in terms of water quality:

- European Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy – commonly referred to as the Water Framework Directive (European Commission, 2000);
- European Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive) European Commission, 2008);
- Water Environment and Water Services (Scotland) Act 2003 (HMSO, 2003); and
- The Water Environment (Controlled Activities) (Scotland) Regulations 2011. Scottish Statutory Instrument 2011 No. 209 (HMSO, 2009), as amended.

6.2.2 Relevant Policy

6.2.2.1 The National Marine Plan (Scottish Government, 2015) emphasises that development proposals should not have unacceptable adverse impacts on coastal processes (Planning Policy Principle GEN 8). It states that changes to coastal processes, including changes in sediment movement and wave patterns, resulting from development, should be minimised and mitigated.

6.2.2.2 General Policy GEN 12 covers water quality and resource which states that developments and activities should not result in a deterioration of the quality of waters to which the Water Framework Directive (WFD), Marine Strategy Framework Directive (MSFD) or other related Directives apply.

6.2.3 Relevant Guidance

6.2.3.1 In undertaking the assessment, the following guidance has been considered:

- 'Environmental impact assessment for offshore renewable energy projects.' (BSI, 2015);
- 'Review of environmental data associated with post-consent monitoring of licence conditions of offshore wind farms.' MMO Project No: 1031. (Fugro-EMU, 2014);
- A handbook on environmental impact assessment Guidance for Competent Authorities, Consultees and others involved in the Environmental Impact Assessment Process in Scotland (Scottish Natural Heritage (SNH), 2013);
- 'Offshore wind farms: guidance note for Environmental Impact Assessment in respect of Food and Environmental Protection Act (FEPA) and Coast Protection Act (CPA) requirements: Version 2' (Department for Environment, Food and Rural Affairs (Defra), Centre for Environment, Fisheries and Aquaculture Science (Cefas) and Department for Transport (DfT), 2004);
- 'Guidelines for data acquisition to support marine environmental assessments of offshore renewable energy projects' (Cefas, 2011);
- 'Guidance on Environmental Impact Assessment in Relation to Dredging Applications' (Office of the Deputy Prime Minister, 2001);
- 'Nature Conservation Guidance on Offshore Wind Farm Development' (Defra, 2005);
- 'Marine Renewable Energy and the Natural Heritage: An Overview and Policy Statement' (SNH, 2003);
- 'Coastal Process Modelling for Offshore Wind Farm Environmental Impact Assessment' (COWRIE, 2009); and
- 'Marine Scotland Licensing and Consents Manual covering marine renewables and offshore wind energy development. Report commissioned for Marine Scotland (ABPmer, 2012).

6.2.3.2 It is noted that Marine Scotland commissioned a set of guidance documents to be produced for the marine renewable industry, specifically wave and tidal devices, which included reference to Environmental Impact Assessment (EIA) requirements (ABPmer, 2012). It is considered that some elements of the advice offered can be transferred across to the Scottish offshore wind industry, and as such is referenced within this study. Moray West is currently unaware of any similar guidance from Scottish Environmental Protection Agency (SEPA) and as such, the Marine Scotland guidance is considered to be the most relevant / appropriate.

6.3 Consultation

6.3.1.1 Moray West has framed its assessment of potential effects on physical processes / water quality pathways and receptors through consultation with key stakeholders.

6.3.1.2 Table 6.3.1 details the key issues raised in relation to physical processes in the Moray West Offshore Wind Farm Scoping Opinion (August 2016) and the OfTI Scoping Opinion (August 2017). It also summarises other issues / concerns that have been raised during additional consultation activities undertaken as part of the EIA process and how these have been addressed in the preparation of this EIA Report.

Table 6.3.1: Consultation Responses		
Date and Consultee	**Issue Raised**	**Moray West Approach**
JNCC and SNH Offshore Wind Farm Scoping Opinion (August 2016)	Confirmation is required that sufficient bathymetry data are available to characterise bedforms in the Moray West Site.	The bathymetric survey data coverage is shown in Figure 2.1 of Technical Appendix 6.2 (Volume 4): Physical Processes Numerical Modelling. It is considered that the width of the data available in each line, and the relatively narrow spacing between the lines is sufficient (in conjunction with the other bathymetry data sources) to adequately describe both bathymetry and seabed type over the area of the Moray West Site for the purposes of the EIA. This is because the geological and oceanographic setting of the Moray West Site and Smith Bank is such, that it is unlikely for there to be meaningful variation in bathymetry or seabed type over distances less than the gaps between the survey lines. Continuous swath bathymetry data coverage is provided within the Moray West Site area by an earlier Maritime and Coastguard Agency (MCA) survey undertaken in 2006. A summary of the baseline sedimentary environment is provided in Section 6.4.2, whilst a full baseline description is provided in Technical Appendix 6.1 (Volume 4): Physical Processes Baseline.
JNCC and SNH Offshore Wind Farm Scoping Opinion (August 2016)	A discussion and explanation of the similarities or differences between the WDA and EDA is required. A synthesis of the available information on bathymetry, geology and sedimentary environment is required.	A summary of the regional environmental baseline is provided in Section 6.4.2, whilst a full baseline description is provided in Technical Appendix 6.1 (Volume 4): Physical Processes Baseline.
JNCC and SNH Offshore Wind Farm Scoping Opinion (August 2016)	Potential effects on water quality scoped out in the scoping report should be reconsidered.	The full list of issues assessed in this chapter is provided in Table 6.5.1.
	Requirements for new numerical modelling should be reviewed as part of the study.	The proposed assessment approach was set out in the Moray West physical processes method statement position paper (ABPmer, 2017). New tidal and wave modelling was proposed and this approach was broadly supported by JNCC and SNH. Details of the modelling approach, model calibration and validation is provided in Technical Appendix

Table 6.3.1: Consultation Responses		
Date and Consultee	**Issue Raised**	**Moray West Approach**
		6.2 (Volume 4): Physical Processes Numerical Modelling.
	The marine and coastal habitats of the Moray Firth, the Dornoch Firth and Culbin Bar Special Areas of Conservation should be considered as potential receptors.	Physical process receptors (e.g. sensitive coastlines or sedimentary features) have been separately identified in this assessment in Table 6.4.1. These receptors include the marine and coastal habitats of the Moray Firth, the Dornoch Firth and Culbin Bar Special Areas of Conservation (SAC).
Marine Scotland and SNH OfTI Scoping Opinion (August 2017)	Confirmation is required that sufficient bathymetry data are available to characterise the Moray West Site.	The bathymetric survey data coverage is shown in Figure 2.1 of Technical Appendix 6.2 (Volume 4): Physical Processes Numerical Modelling, including continuous swath bathymetry data coverage within the Moray West Site area by an earlier Maritime and Coastguard Agency (MCA) survey undertaken in 2006.
	The hard-rock interest of the Cullen to Stake Ness Coast SSSI should be should be considered as potential receptors.	A full assessment of potential impacts within the Landfall Area (including to the hard-rock interest of the Cullen to Stake Ness Coast SSSI) is presented in Section 6.8.2 (for the construction phase), Section 6.8.3 (for the operation phase) and Section 6.8.4 (for the decommissioning phase).
	The applicability of the modelling undertaken for Moray East and BOWL to Moray West OfTI in respect to hydrodynamics and sediment transport should be reviewed prior to further use. The need for new local sediment transport modelling should be considered.	An assessment of potential changes to hydrodynamics during the operational phase of the Moray West Offshore Wind Farm and OfTI is provided in Section 6.7.3. Considerations of related cumulative effects are discussed in Section 6.9.4. Hydrodynamic assessments are based on new modelling that takes account of the present realistic worst case design envelopes of these Developments, which has changed since the earlier assessments for the Moray East and Beatrice Developments. An assessment of potential changes due to sediment disturbance during the construction phase of the Moray West Offshore Wind Farm and OfTI is provided in Section 6.7.2 and in Technical Appendix 6.3 (Volume 4): Physical Processes Impact Assessment. This includes use of previously undertaken modelling. A comparison of the design basis for the two situations is provided to demonstrate the suitability of the analogue.
SNH OfTI Scoping Opinion (August 2017)	Consideration should be given to outputs from the National Coastal Change Assessment (NCCA)	Outputs from the NCCA have been used to develop baseline understanding. A summary of the baseline is provided in Section 6.4.2, whilst a full baseline description is provided in

Table 6.3.1: Consultation Responses		
Date and Consultee	**Issue Raised**	**Moray West Approach**
		Technical Appendix 6.1 (Volume 4): Physical Processes Baseline.
Marine Scotland OfTI Scoping Opinion (August 2017)	Changes to water quality from sediment disturbance should be scoped into the assessment if the cable makes landfall at Cullen Bay.	The cable will make landfall at a location between Findlater Castle and Redhythe Point. As such, this issue is now scoped out as there will be no landfall at Cullen Bay.
	Changes to water quality from chemical release and changes to water quality from contaminated sediment should be scoped in at this stage of the assessment cycle. Mitigation measures will need to be secured in relation to these effects through the EIA process.	A full assessment of these potential effects is provided in Section 6.8.2, 6.8.3 and Section 6.8.4.
SNH Offshore Wind Farm Scoping Opinion (August 2016)	The proposed modelling should be informed by site-specific characteristics of the Moray West site.	All of the Moray West assessments (including those involving numerical modelling) have been informed by a detailed appraisal of baseline conditions within the array. These baseline conditions are described in Technical Appendix 6.1 (Volume 4): Physical Processes Baseline.
	The environmental setting of Moray West should be compared with Moray East and Beatrice. This needs to be carried out to ascertain the suitability of the existing modelling results as an analogue for the present study.	A full baseline description is provided in Technical Appendix 6.1 (Volume 4): Physical Processes Baseline. This describes physical process characteristics at both a site-specific and regional scale and demonstrates the broad similarities between the three wind farm array areas. The use and suitability of previous modelling results (mainly in relation to sediment disturbance during the construction phase) is described on a case-by-case basis in Technical Appendix 6.3 (Volume 4): Physical Processes Impact Assessment.
SEPA OfTI Scoping Opinion (August 2017)	The 'Scottish Environment' Water Body data should be collated in support of the Water Framework Directive as referenced in the Scoping report.	Noted. This information has been included within the water quality baseline characterisation section (Section 6.4.2).
	One key interest is pollution prevention measures during the periods of construction, operation, maintenance, demolition and restoration. The applicant should systematically identify all aspects of site work that might impact upon the environment, potential pollution risks associated with the proposals and identify the principles of preventative measures and mitigation. A draft	Noted. This information has been included within our water quality impact assessment and embedded / additional mitigation sections (Sections 6.8.2, 6.8.3 and 6.8.4)

Table 6.3.1: Consultation Responses		
Date and Consultee	**Issue Raised**	**Moray West Approach**
	Schedule of Mitigation should be produced as part of this process.	
	The principles of the Environmental Management Plan should be set out in the ES outlining how the draft Schedule of Mitigation will be implemented. This document should form the basis of the more detailed site specific Environmental Management Plan which, along with detailed method statements, may be required by condition.	Noted. This information has been included within our water quality impact assessment and embedded / additional mitigation sections (Sections 6.8.2, 6.8.3 and 6.8.4)

6.4 Baseline Conditions

6.4.1 Baseline Characterisation Approach

Study Area

6.4.1.1 The marine processes and water quality study area within which baseline conditions and potential changes have been considered is shown in Volume 3a - Figure 6.4.1 and is defined as:

- The Moray West Site;
- The Offshore Export Cable Corridor; and
- The seabed and water column that may be influenced by changes to marine processes due to the Development (separated into a near-field and a far-field extent).

6.4.1.2 With respect to marine processes and water quality, the far field spatial extent of the study area has primarily been determined using expert judgment, drawing upon knowledge developed from other Round 3 projects and in particular modelling results showing the anticipated extent of change from the Moray East and Beatrice Offshore Wind Farms.

6.4.1.3 The near-field study area includes the Moray West Site and Offshore Export Cable Corridor, and up to one spring tidal excursion distance outside these areas. The spring tidal excursion distance (which is calculated using outputs from ABPmer *et al*., 2008) is spatially variable, but is typically in the range 2 to 6 km.

6.4.1.4 Direct changes to the seabed are expected to be confined to the near-field study area while indirect changes (e.g. due to disruption of waves, tides or sediment pathways) could also be experienced in the far-field study area. The magnitude of indirect impacts is expected to diminish with distance from the Moray West Site and Offshore Export Cable Corridor.

Desk Study / Field Survey

6.4.1.5 The baseline characterisation has primarily been achieved on the basis of data collected during targeted metocean and geophysical survey campaigns, data created using numerical models (described in Technical Appendix 6.2 (Volume 4): Physical Processes Numerical Modelling), and data and information from previously published studies (identified via literature review).

6.4.1.6 An extensive number of data sources have been used to characterise the baseline. A full list of these data sources is provided in Technical Appendix 6.1 (Volume 4): Physical Processes Baseline. The locations of key survey datasets are shown in Volume 3a - Figure 6.4.2.

6.4.1.7 A desk study and literature search on water quality within the Moray Firth has drawn upon the following sources of information:

- Moray Firth Partnership (2007). Mary Firth Learning Zone website http://www.morayfirth-partnership.org/waterquality.html [accessed March 2018];
- Scottish Environment Protection Agency (SEPA) Water Framework Directive (WFD) classification data https://www.sepa.org.uk/data-visualisation/water-classification-hub/ [accessed March 2018];
- Scotland's Environment interactive online mapping facility https://map.environment.gov.scot/sewebmap/ [accessed March 2018]; and
- Marine Scotland interactive mapping facility http://marine.gov.scot/themes/clean-and-safe [accessed March 2018].

6.4.2 Present Day Baseline

6.4.2.1 This section provides a summary of the key baseline characteristics of physical processes and water quality in the Moray West Site and surrounding area. This includes physical characteristics of the study area and features (receptors) that could potentially be affected by a change in physical processes. This includes information on the following:

- Physical characteristics of the study area:
  - Water levels;
  - Currents;
  - Waves;
  - Sediments;
  - Morphology; and
  - Water quality.
- Important features (potential receptors) within the study area:
  - Smith Bank;
  - Designated coastal habitats/ features;
  - Stratification fronts; and
  - Recreational surfing venues.

6.4.2.2 A detailed description of these key baseline characteristics is provided in Technical Appendix 6.1 (Volume 4): Physical Processes Baseline.

Physical Characteristics of the Study Area

Water Levels

6.4.2.3 The Moray West Site is situated within a meso-tidal setting (typical tidal ranges in water level between 2 to 4 metres) and is characterised by a mean spring tidal range of 3.1 m and a maximum astronomic range (HAT to LAT) of approximately 4.4 m.

6.4.2.4 There is some variation in tidal range along the Offshore Export Cable Corridor, with the highest water levels experienced at the landward end. At Buckie, (near the Landfall Area), the mean spring range is 3.4 m.

6.4.2.5 Storm surges may cause short term modification to predicted water levels and under an extreme (1 in 50-year return period) storm surge, water levels may be up to 1.25 m above predicted levels.

6.4.2.6 It is probable that relative sea levels will rise in this region during the course of the 21st Century and by 2050 is likely to be approximately 0.22 to 0.35 m higher across the Moray West Site.

6.4.2.7 Climate change may be expected to slightly increase the mean water level over the lifetime of the proposed development; however, the tidal range about the new mean level will likely remain not measurably affected.

Currents

6.4.2.8 Information available on the strength of tidal currents in the region of the Moray West Site shows that recorded (depth-averaged) peak spring current speeds are around 0.25-0.3 m/s, with the fastest speeds recorded in the north of the Moray West Site.

6.4.2.9 Peak spring current speeds increase to the north of the Moray West Site towards the Pentland Firth. Peak spring current speeds are similarly low (0.3 m/s or less) elsewhere in the Moray Firth.

6.4.2.10 Along most of the Offshore Export Cable Corridor, peak spring current speeds are typically less than 0.3 m/s.

6.4.2.11 Both storm waves and storm surges may cause short term modification of astronomically-driven tidal currents. During a 1:1 year storm event, orbital currents are likely to approach 1 m/s in the north of the Moray West Site, in the relatively shallow water over the crest of Smith Bank. Currents of this magnitude are considerably greater than that observed during peak spring tidal flows. Similarly, under an extreme (1 in 50-year return period) storm surge, current speeds may be more than twice that encountered under normal peak spring tide conditions.

6.4.2.12 Residual tidal currents (over a period of days to weeks) are directed generally into the Moray Firth.Climate change is not expected to have any effect on the local tidal current regime (currents are largely controlled by the corresponding tidal range) over the lifetime of the proposed development.

Waves

6.4.2.13 The wave regime in the Outer Moray Firth includes both swell waves generated elsewhere in the North Sea and locally generated wind waves. The wave regime in the Outer Moray Firth is typically characterised by wind waves, although longer period swell waves can be identified within the observational wave records collected from within and nearby to the Moray West Site.

6.4.2.14 The Offshore Export Cable Corridor is likely to be exposed to waves of equal or possibly larger size than the Moray West Site from exposed offshore sectors; the size of waves from other fetch limited sectors will vary along the cable corridor route depending upon the wind direction and corresponding fetch. The variable and on average greater water depths along the Offshore Export Cable Corridor mean that the ability of a given wave condition to penetrate to the seabed may also be variable.

6.4.2.15 Even though water depths within the Moray West Site are no less than 35 m, storm waves sufficiently large to cause water motion at the seabed are not uncommon.

6.4.2.16 Along the coastlines of the mid and Inner Moray Firth, waves have a critical role to play in driving sediment transport through the process of longshore drift.

6.4.2.17 Climate change is predicted to cause variability in the inter-annual wave climate over the lifetime of the proposed Development; however, historical trends have shown that this variability may include both increases and decreases in mean storminess on decadal timescales.

Stratification and Fronts

6.4.2.18 The Outer Moray Firth may experience some seasonal thermal stratification.

6.4.2.19 Applying general oceanographic theory, it is likely that the strength and natural position of seasonal stratification fronts is governed by the magnitude of tidal current flows in the adjacent inshore areas and of seasonal stratification in adjacent offshore areas.

6.4.2.20 Climate change is not expected to have any effect on the range of natural variability in the location or strength of stratification and fronts over the lifetime of the proposed development.

Sediments

6.4.2.21 Seabed sediments across the Moray West Site generally consist of Holocene gravelly sand and sand with a minor proportion of fines (<5 to 10% silt and clay sized). A modal peak grain size between 150 to 215 µm (fine sand) was found in the majority of the grab samples collected from the Moray West Site (See Volume 3a - Figure 6.4.3). Other modal peak grain sizes were also variably observed, ranging from 24,000 µm (pebble gravel) to 350 µm (medium sand). The proportion of shell in sediment samples from and nearby to the Moray West Site are frequently in excess of 50% (Partrac, 2010; British Geological Survey (BGS), 1987).

6.4.2.22 Seabed sampling was successfully undertaken at 12 locations within the Offshore Export Cable Corridor (for further detail on sampling, see Volume 4, Technical Appendix 7.1: Benthic Survey Report). Near to the Moray West Site, in intermediate water depths, the Offshore Export Cable Corridor transits areas of mixed sands and gravels, with a small proportion of fines (<5 to 10%) present. Seabed sediments become progressively finer in deeper water along the route, becoming relatively muddy (30 to 65% fines) in the deepest parts. The sediment character and distribution in these offshore sections is the result of the relatively benign tidal regime and the spatially variable effect of wave action at the seabed, depending upon the local water depth.

6.4.2.23 Across much of the Moray West Site, surficial marine sediments are generally thick (~5 to 15 m in the west of the Moray West Site, up to 30 m in the east) In some locations, the underlying glacial till is very close to the surface (<2 m thickness).

6.4.2.24 An extensive blanket of Quaternary deposits is present across almost the entire Moray Firth with sediment thicknesses in excess of 100 m commonly observed. Within the Moray West Site the Quaternary units are of variable thickness, ranging from <10 m to c. 150 m. These sediments are underlain by a thick unit of firm to very hard Lower Cretaceous clay.

6.4.2.25 The available evidence suggests that (bedload) material is travelling into the Firth from the north, passing along the Caithness coast and towards the Inner Moray Firth. Tidal currents are largely incapable of mobilising anything larger than fine sand-sized material within the Moray West Site and as a result, there is only limited net bedload transport of sediment due to tidal currents alone.

6.4.2.26 However, the combination of tidal and non-tidal currents and wave induced currents during storms results in considerably higher current speeds at the seabed. As a result, it is likely that the commonly present fine sand is regularly mobilised within the Moray West Site during storms. Owing to the combination of slightly higher tidal current speeds and smaller water depths, it is likely that the northern areas of the Moray West Site are most active in this way.

6.4.2.27 Within the Moray West Site, suspended sediment concentrations (SSCs) is typically very low (approximately < 5 mg/l). However, during storm events, near seabed SSC can be significantly increased in the short-term due to the influence of waves stirring the seabed. Coarser sediments may be transported a short distance in the direction of ambient flow or down-slope under gravity before being redeposited. Finer material that persists in suspension will eventually be transported in the direction of net tidal residual flow, i.e. to the south-west, into the Firth.

6.4.2.28 Climate change is not expected to have any effect on the type or distribution of sediments within the extent of and over the lifetime of the proposed Development.

Morphology

6.4.2.29 The Moray West Site spans the crest and western flank of Smith Bank and is characterised by water depths in the range 35 to 54 m below LAT. The shallowest depths are found in the north of the Moray West Site and the greatest depths are found in the south.

6.4.2.30 Bedforms identified within the Moray West Site have been considered alongside the findings from the sediment mobility analysis as well as published literature from this region, to develop a conceptual understanding of the morphological regime. Particular attention has been focused on ascertaining those mapped bedforms which are likely to be active and those that are relict.

6.4.2.31 Active seabed bedforms are controlled by the combination tidal flows and wave-induced orbital currents. Low sediment waves orientated transverse to the main axis of tidal flow are suggested to be present in the north of the Moray West Site whilst sharp-edged sand patches are suggested to be present across much of the Moray West Site.

6.4.2.32 Relict seabed bedforms exist as a result of past processes (mainly glacial) and therefore are not maintained by contemporary physical processes. Of particular note are a series of tunnel valleys cut by pressurised flow beneath the former British Ice Sheet, along with glacial moraine ridges deposited between approximately 15,000 to 20,000 years ago.

6.4.2.33 The coastal characteristics of the Moray Firth coastline are highly variable, ranging from the predominantly hard rock Caithness and Buchan coastline, to the soft coastlines of the Inner Firth.

6.4.2.34 Climate change is not expected to have any effect on the form or function of Smith Bank over the lifetime of the proposed development.

Water Quality

6.4.2.35 Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for the Community action in the field of water policy (Water Framework Directive (WFD)) is transposed into Scottish legislation by the Water Environment and Water Services (Scotland) Act 2003, as amended (WEWSSA). The purpose of this Act is to protect the water environment by preventing deterioration; protecting and enhancing aquatic ecosystems; promoting sustainable water use; reducing pollution and mitigating against floods and droughts. The main regulatory bodies are the Scottish Ministers and SEPA.

6.4.2.36 A programme of monitoring and water classification is undertaken by SEPA (SEPA, 2018) as part of the WFD and WEWSSA requirements. The most recent coastal water classification data available from SEPA for 2016 (https://www.sepa.org.uk/data-visualisation/water-classification-hub/) shows that all of the coastal waters within the Moray Firth (out to 3 nm) fall into the 'Good' water body status. For the Inner Moray Firth, the status of 'Good' has been in place since 2013, but prior to this the status was recorded as 'High' (since 2007). The section of coastal water between Findochty and Knock Head, where the Landfall Area for the Offshore Export Cable Corridor will be, previously met the 'High' category in 2014, but is now placed within the 'Good' water body category. One other water body that previously met the 'Moderate' category (Rosehearty to Cairnbulg Point) has improved to the 'Good' category. The Scotland's Environment website (http://www.environment.gov.scotland/) suggests that the future objective for the Findochty to Knock Head section is to obtain 'High' classification by 2027 and longer term.

6.4.2.37 There are no 'Bathing Waters' within the study area, with Cullen Bay being the closest designated 'Bathing Water' (approximately 4 km in distance from Findlater Castle) which is categorised of 'Sufficient' status under the Bathing Waters (Scotland) Regulations 2008 implementing Directive 2006/7/EC (Bathing Water Directive (BWD)). Similarly, there are no 'Shellfish Waters' within the Offshore Export Cable Corridor or study area.

6.4.2.38 The main pressures on water quality within the Moray Firth are associated with human activities that take place within the riverine, tidal and coastal waters as opposed to offshore waters (Moray Firth Partnership, 2007). Sources of potential impacts relate to sewage, industrial discharges and diffuse discharges.

6.4.2.39 Little data is available for the offshore area (over 3 nm) as no specific marine water quality monitoring has been undertaken.

Key Features (Receptors) within the Study Area

Smith Bank

6.4.2.40 The Moray West Site is situated on Smith Bank. Overall, Smith Bank is approximately 35 km long from south-west to north-east, around 20 km wide, rising from a base level of between 50 and 60 m below sea level to less than 35 m at the crest. The position, elevation and orientation of the bank is closely associated with the underlying Smith Bank Fault block and the geophysical survey undertaken by Osiris (2011) reveals that Cretaceous sediments are relatively close (<10 m) to the seabed across much of the crest of the bank. The main body of Smith Bank is underpinned by solid bedrock, with variable thickness layers of stable overlying sedimentary deposits and a more mobile sediment veneer. The position and form of Smith Bank is therefore controlled by the underlying geology and so is not sensitive as a whole to minor changes in sediment transport onto, over or off the Bank.

6.4.2.41 The distribution of seabed sediment types and thicknesses, patterns of waves, currents and water levels, and typical levels of SSC, on Smith Bank are described in relation to the Moray West Site in the previous section. Further information may also be found in Technical Appendix 6.1 (Volume 4): Physical Processes Baseline.

6.4.2.42 Smith Bank is not designated for protection but is the main bathymetric feature and area of seabed that could potentially be affected by the Moray West Offshore Wind Farm.

Designated Coastal Habitats / Features

6.4.2.43 The Moray Firth and Caithness areas are noted for the richness of their natural heritage and much of the Caithness coastline is protected under international or national nature conservation legislation. The distribution of receptors and designated areas of seabed are shown in Volume 3a - Figure 6.4.4

6.4.2.44 The only designated areas to be directly affected by the Development footprint are the Moray Firth pSPA and the Southern Trench pMPA (proposed Marine Protected Area). The Moray Firth pSPA (proposed Special Protection Area) is proposed for designation with respect to shallow sandy substrates, coastal rocky outcrops and deep muddy channels in coastal and more nearshore areas that provide habitats for a variety of bird species. The Southern Trench pMPA is proposed for designation with respect to a variety of geological features (the Southern Trench itself is an example of an enclosed glacial seabed basin), ecological habitats (burrowed muds in deeper parts of the trench) and other oceanographic features (seasonal stratification and fronts off Fraserburgh).

6.4.2.45 As shown in Volume 3a - Figure 6.4.4, the route of the Offshore Export Cable Corridor will not transect the deeper parts of the Southern Trench (and so will avoid the more muddy seabed habitat areas in the Moray Firth pSPA and Southern Trench pMPA), and will be relatively distant (more than 6 spring tidal excursion lengths) from the stratification features off Fraserburgh.

6.4.2.46 Most of the designated sites are protected on the basis of the habitats they contain; however, several designated areas have been assigned conservation status because of the geological and geomorphological features present, which are maintained by present-day physical processes.

Examples include the Dalradian[1] and Quaternary[2] geology within the Cullen to Stake Ness SSSI, the actively prograding spit at Whiteness Head and the active gravel beach complex at the mouth of the River Spey which are both afforded SSSI (Site of Special Scientific Interest) status.

6.4.2.47 A list of all protected sites identified within the study area that could potentially be affected by changes in physical processes is provided in Table 6.4.1 below.

Table 6.4.1: Designated Coastal Habitats and Features Identified within the Study Area

Receptor	Designation	Description
Smith Bank	(None)	A submerged bathymetric high in the Outer Moray Firth, covered by a veneer of sands and gravels of variable thickness and proportion
Southern Trench	pMPA	An enclosed (glacial) seabed basin with associated benthic habitat types. Notable stratification and frontal systems off Fraserburgh supporting local primary production and feeding habitats
Moray Firth	pSPA	Shallow sandy substrates, coastal rocky outcrops and deep muddy channels
Loch of Strathbeg	SPA and Ramsar	Marshes, reedbeds, grassland and dunes
Troup, Pennan and Lion's Heads	SPA	Sea-cliffs, occasionally punctuated small sand or shingle beaches
The Moray and Nairn Coast	SPA and Ramsar	Intertidal flats, saltmarsh and sand dunes
The Inner Moray Firth	SPA and Ramsar	Extensive intertidal flats and smaller areas of saltmarsh
Cromarty Firth	SPA and Ramsar	Extensive intertidal flats and salt marsh
The Dornoch Firth	SPA and Ramsar	Large estuary containing extensive sand-flats and mud-flats, backed by saltmarsh and sand dunes
The East Caithness Cliffs	SPA	Old Red Sandstone cliffs, generally between 30 to 60 m high, rising to 150 m at Berriedale
The Moray Firth	SAC	Sand banks
Dornoch Firth	SAC	Extensive areas of mudflats and sandflats. Sub-tidally, the Firth supports rich biogenic reefs
Berriedale and Langwell, Oykel, Morriston and Spey	SACs	Riverine systems emptying into the Moray Firth
Culbin Bar	SAC	Extensive dunes, vegetated shingle and salt meadows
Cullen to Stake Ness Coast SSSI (Landfall Area)	SSSI	Dalradian geological exposures
Culbin Sands, Culbin Forest and Findhorn Bay SSSI	SSSI	Extensive dunes, vegetated shingle and salt meadows (Culbin Bar). Intertidal flats, saltmarsh and sand dunes (Findhorn Bay)

[1] The Dalradian Series is a sequence of highly folded and metamorphosed sedimentary and volcanic rocks of late Precambrian to Early Cambrian age, about 540 million years old, which occurs in the southeastern portions of the Scottish Highlands of Great Britain.
[2] Geological developments over the last 2.6 million years.

Table 6.4.1: Designated Coastal Habitats and Features Identified within the Study Area		
Receptor	**Designation**	**Description**
Morrich More SSSI	SSSI	Large coastal emerged strand plain, attached sandy barriers and spits, stabilized dunes, saltmarshes and sandflats
Whiteness Head SSSI	SSSI	Shingle spit complex with examples of curved shingle bars, ancient bars and shortened bars

Surfing Beaches

6.4.2.48 There is potential that changes to baseline wave characteristics could potentially be detrimental to the quality or frequency of certain surfing wave conditions. Surf beaches within the Moray Firth region have previously been identified in a report by Surfers Against Sewage (SAS) (SAS, 2009). These are also listed in Table 6.4.2 below.

Table 6.4.2: Surf Beaches within the Study Area		
Receptor	**Designation**	**Description**
Skirza	(Surf beach)	Sand beach (with particular wave climate)
Freswick Bay	(Surf beach)	Sand beach (with particular wave climate)
Keiss	(Surf beach)	Sand/ shingle beach (with particular wave climate)
Sinclair’s Bay	(Surf beach)	Sand/ shingle beach (with particular wave climate)
Ackergill	(Surf beach)	Sand/ shingle beach (with particular wave climate)
Lossiemouth	(Surf beach)	Sand beach (with particular wave climate)
Spey Bay	(Surf beach)	Sand/ shingle beach (with particular wave climate)
Cullen	(Surf beach)	Sand/ shingle beach (with particular wave climate)
Sunnyside Bay	(Surf beach)	Rocky beach (with particular wave climate)
Sandend Bay	(Surf beach)	Sand beach (with particular wave climate)
Boyndie Bay	(Surf beach)	Sand/ Shingle beach (with particular wave climate)
Banff Beach	(Surf beach)	Sand beach (with particular wave climate)
Pennan	(Surf beach)	Rocky beach (with particular wave climate)
Widemans	(Surf beach)	Sand/ shingle beach (with particular wave climate)
Phingask	(Surf beach)	Sand/ shingle beach (with particular wave climate)
West Point	(Surf beach)	Sand/ shingle beach (with particular wave climate)
Fraserburgh	(Surf beach)	Sand beach (with particular wave climate)
St Combs to Inverallochy	(Surf beach)	Sand beach (with particular wave climate)

6.4.3 Future Baseline

6.4.3.1 The baseline environment is not static and will exhibit some degree of natural change over time, with or without the Development in place, due to naturally occurring cycles and processes. Therefore, when undertaking impact assessments it is necessary to place any potential impacts in the context of the envelope of change that might occur naturally over the timescale of the Development.

6.4.3.2 Further to potential change associated with existing cycles and processes, it is necessary to take account of potential effects of climate change on the marine environment. Mean sea level is likely to rise during the 21st Century as a consequence of either vertical land (isostatic) movements or changes in eustatic sea level. It is predicted in UKCP09 that by 2050, relative sea level will have risen by approximately 0.22 to 0.35 m above 1990 levels (medium emissions scenario) in the Landfall Area with rates of change increasing over time (Lowe *et al*., 2009). A rise in sea level may allow larger waves, and therefore more wave energy, to reach the coast in certain conditions and consequently result in an increase in local rates or patterns of erosion and the equilibrium position of coastal features.

6.4.3.3 Climate change may cause variability in the inter-annual wave climate over the lifetime of the proposed development; however, historical trends have shown that this variability may include both increases and decreases in mean storminess on decadal timescales. There is no clear consensus on the future storm and wave climate, with this future uncertainty stemming from diverse projections of future storm track behaviour (Woolf and Wolf, 2013).

6.4.3.4 Climate change is not expected to have any effect on the range of natural variability in the location or strength of stratification and fronts over the lifetime of the proposed development, nor any measurable influence on the distribution of seabed sediments.

6.4.3.5 In terms of water quality, it is unlikely that within the Moray Firth this will change significantly. Sections of coastline water quality categories may fluctuate from ‘Good’ to ‘Moderate’ or ‘High, but as the majority of the coastline has been categorised as ‘Good’ over the previous five year period (2013 – 2018), it is considered that this will remain the future baseline.

6.5 Assessment Methodology

6.5.1 Assessment Approach

6.5.1.1 The potential impacts to be assessed in relation to physical processes and water quality for the Development are specified in the respective wind farm and OfTI Scoping Reports (Moray West, 2016; Moray West, 2017a), and are summarised in Table 6.5.1. The technical studies underpinning the assessments presented in this chapter are set out within Technical Appendix 6.3 (Volume 4): Physical Processes Impact Assessment.

6.5.1.2 The nature of the impacts scoped in for assessment is similar to that previously considered for the (now consented) Moray East Offshore Wind Farm and OfTI, and the (now consented and being built) Beatrice Offshore Wind Farm (BOWL) and OfTI (BOWL, 2012). Consideration of offshore water quality has not previously been included within the scoping reports or EIA for the Telford, Stevenson and MacColl offshore wind farms or for Beatrice Offshore Wind Farm, but has been included within this EIA Report as a result of the Scottish Ministers Scoping Opinion (Marine Scotland, 2017).

6.5.1.3 For the most part physical processes are not in themselves receptors but are instead 'pathways'. However, changes to physical processes have the potential to indirectly impact other environmental receptors (COWRIE, 2009). For example, the creation of sediment plumes (which is considered in the physical processes assessment) may lead to settling of material onto benthic habitats. The potential significance of this particular change is assessed in Chapter 7 (Volume 2): Benthic and Intertidal Ecology. Other environmental receptors that have to the potential to be indirectly affected by changes in physical processes are identified in Table 6.5.1.

6.5.1.4 There are however, a small number of features that are considered to be potentially sensitive physical processes receptors. These include:

- Smith Bank;
- Designated coastal habitats/ features;
- Stratification fronts; and
- Recreational surfing venues.

6.5.2 Impacts Identified as Requiring Assessment

6.5.2.1 Based on the above discussion, as part of this assessment it has been necessary to distinguish between potential changes to 'pathways' and potential 'impacts' on receptors (physical processes receptors and other environmental receptors), the latter requiring an assessment of 'effect significance' to be undertaken.

6.5.2.2 Potential 'changes' to pathways and impacts on receptors identified as requiring consideration in the physical processes assessment are listed in Table 6.5.1 below. This table also identifies other environmental receptors (covered in other EIA topics) that could be affected by certain pathway changes.

6.5.2.3 The list of pathway changes and impacts on receptors is based on expert judgement, reflects responses provided by statutory consultees and other stakeholders in the wind farm and OfTI Scoping Opinions and takes into account further comments received as part of ongoing community consultation activities.

<table>
<tr><th colspan="3">Table 6.5.1: Summary of Pathway Changes / Impacts Considered in the Physical Processes Assessment</th></tr>
<tr><th>Potential Change / Impact</th><th>Pathway / Receptor</th><th>Assessment of Effects on Other Topic Receptors</th></tr>
<tr><td colspan="3">Construction</td></tr>
<tr><td>Increases in SSC and deposition of disturbed sediments to the seabed due to dredging for seabed preparation prior to foundation installation</td><td>Pathway</td><td rowspan="4">Chapter 7: Benthic and Intertidal Ecology (Section 7.7.2)
Chapter 8: Fish and Shellfish Ecology (Section 8.7.1)</td></tr>
<tr><td>Increases in SSC and deposition of disturbed sediments to the seabed due to the release of drill arisings during foundation installation</td><td>Pathway</td></tr>
<tr><td>Increases in SSC and deposition of disturbed sediment to the seabed due to cable installation within the Moray West Site and Offshore Export Cable Corridor</td><td>Pathway</td></tr>
<tr><td>Indentations left on the seabed by jack-up vessels and large anchors</td><td>Pathway</td></tr>
<tr><td>Impacts to designated marine and coastal geomorphological features (due to construction activities)</td><td>Receptor</td><td rowspan="3">Assessed in this chapter Section 6.8</td></tr>
<tr><td>Impacts to recreational surfing venues</td><td>Receptor</td></tr>
<tr><td>Impacts to Smith Bank (due to construction activities)</td><td>Receptor</td></tr>
<tr><td>Changes to water quality from chemical release</td><td>Receptor</td><td rowspan="2">Chapter 7: Benthic and Intertidal Ecology (Sections 7.4.2 & 7.7.2)
Chapter 8: Fish and Shellfish Ecology (Section 8.7.1)</td></tr>
<tr><td>Changes to water quality from contaminated sediments</td><td>Receptor</td></tr>
</table>

Table 6.5.1: Summary of Pathway Changes / Impacts Considered in the Physical Processes Assessment		
Potential Change / Impact	**Pathway / Receptor**	**Assessment of Effects on Other Topic Receptors**
Operation and Maintenance		
Changes to the tidal regime	Pathway	Chapter 7: Benthic and Intertidal Ecology (Section 7.7.3) Chapter 8: Fish and Shellfish Ecology (Section 8.7.2)
Changes to the wave regime	Pathway	
Changes to sediment transport and sediment transport pathways	Pathway	
Scour of seabed sediments	Pathway	Chapter 7: Benthic and Intertidal Ecology (Section 7.7.3) Chapter 8: Fish and Shellfish Ecology (Section 8.7.2)
Impacts to designated marine and coastal geomorphological features (due to operation)	Receptor	Assessed in this chapter Section 6.8
Impacts to recreational surfing venues (due to operation)	Receptor	
Impacts to stratification fronts (due to operation)	Receptor	
Impacts to Smith Bank (due to operation)	Receptor	
Changes to water quality from chemical release	Receptor	Chapter 7: Benthic and Intertidal Ecology (Sections 7.4.2 & 7.7.2) Chapter 8: Fish and Shellfish Ecology (Sections 8.7.2)
Changes to water quality from contaminated sediments	Receptor	
Decommissioning		
Increases in SSC and deposition of disturbed sediment to the seabed within the Moray West Site and Offshore Export Cable Corridor	Pathway	Chapter 7: Benthic and Intertidal Ecology (Section 7.7.3) Chapter 8: Fish and Shellfish Ecology (Section 8.7.3)
Impacts to designated marine and coastal geomorphological features (due to decommissioning activities)	Receptor	Assessed in this chapter Section 6.8
Impacts to Smith Bank (due to decommissioning activities)	Receptor	
Changes to water quality from chemical release	Receptor	Chapter 7: Benthic and Intertidal Ecology (Sections 7.4.2 & 7.7.3) Chapter 8: Fish and Shellfish Ecology (Section 8.7.3)
Changes to water quality from contaminated sediments	Receptor	

6.5.3 Scoped Out Impacts

6.5.3.1 In accordance with the scoping reports produced in 2016 and 2017 (Moray West, 2016 & Moray West, 2017a) and in line with the scoping opinions received from MS-LOT in August 2016 and August 2017, no potential impacts upon physical processes have been scoped out of the assessment.

6.5.3.2 Potential changes to water quality from sediment disturbance has been scoped out in accordance with the Scoping Opinion. Scottish Ministers only required this potential impact to be scoped in if it was proposed that the Offshore Export Cable Corridor would make landfall at Cullen Bay. As the proposed Landfall Area is between Findlater Castle and Redhythe Point, this potential impact is scoped out.

6.5.4 Assessment Approach and Criteria

6.5.4.1 In order to determine the potential change to the marine physical environment relative to the existing (baseline) coastal environment, and the nature and duration of that change a combination of analytical methods has been used. These include:

- The 'evidence base' containing monitoring data collected during the construction and O&M of other offshore wind farm developments. This evidence base also includes numerical modelling and desk based analyses previously undertaken to support other sufficiently analogous offshore wind farm EIAs;
- New numerical modelling of potential changes to waves and tides (see Technical Appendix 6.2 (Volume 4): Physical Processes Numerical Modelling and Technical Appendix 6.3 (Volume 4): Physical Processes Impact Assessment for further details);
- Analytical assessments of project-specific data; and
- Standard empirical equations describing the relationship between (for example) hydrodynamic forcing and sediment transport or settling and mobilisation characteristics of sediment particles released during construction activities (e.g. Soulsby, 1997).

6.5.4.2 The assessment has been undertaken in accordance with industry best practice and guidance, the full list of which is provided in Section 6.2.3. Full details of the methodological approach to the assessment are provided in Technical Appendix 6.3 (Volume 4): Physical Processes Impact Assessment.

6.5.4.3 The assessment also considers likely naturally occurring variability in, or long-term changes to, physical processes within the Development lifetime due to natural cycles and / or climate change (e.g. sea level rise). This is important as it enables a reference baseline level to be established against which the potentially modified physical processes can be compared, throughout the Development lifecycle. Baseline conditions for physical processes are described in detail within the Technical Appendix 6.1 (Volume 4): Physical Processes Impact Baseline, and include for the potential effects of climate change. The assessment of effects upon physical processes and water quality receptors is a systematic process that is determined by taking into account the 'Sensitivity of the receptor' and the 'Magnitude of the impact' to determine the 'Significance of the Effect.' These assessment criteria are described in more detail below. Published thresholds for the significance of effects to physical process or water quality receptors are not available and as such, professional judgement has been used.

6.5.4.4 Results from the assessment of potential effects are presented in Section 6.8. It is noted here that the criteria used for assessing potential cumulative effects are the same as for the Development alone assessment.

Sensitivity Criteria

6.5.4.5 The sensitivity of each receptor has been assessed using professional judgement and described with a standard semantic scale. Definitions for each term are provided in Table 6.5.2. These expert judgements regarding receptor sensitivity / importance are closely guided by the conceptual understanding of regional-scale physical processes, developed during the baseline characterisation process (Technical Appendix 6.1 (Volume 4): Physical Processes Baseline).

Table 6.5.2: Receptor Sensitivity Criteria	
Receptor Sensitivity	**Description / Reason**
High	No or very low capacity to accommodate the proposed form of change; and / or receptor designated and /or of international or national level importance. Likely to be rare with minimal potential for substitution. May also be of high socioeconomic importance.
Moderate	Moderate to low capacity to accommodate the proposed form of change; and / or receptor designated and / or of national or regional level importance. Likely to be relatively rare. May also be of moderate socioeconomic importance.
Low	Moderate to high capacity to accommodate the proposed form of change; and / or receptor not designated but of district level importance.
Negligible	High capacity to accommodate the proposed form of change; and / or receptor not designated and only of local level importance.

Magnitude of Impact

6.5.4.6 The magnitude of impact describes the extent or degree of change that is predicted to occur to a receptor. It has been assessed using expert judgement and described qualitatively with a standard semantic scale. Definitions for each term are provided in Table 6.5.3. These expert judgements regarding the magnitude of effect relative to baseline conditions have been made by experienced marine physical process and water quality specialists and formed following consideration of a range of information sources including:

- Available survey data and supporting reports / publications described in the summary of available baseline data;
- The existing evidence base from other offshore wind farms and similar projects; and
- Standard empirical equations e.g. for the assessment of scour, sediment transport and settling.

Table 6.5.3: Magnitude of Impact Criteria	
Magnitude	**Description / Reason**
High	Permanent changes, over large parts of the near- and far-field, to key characteristics or features of the particular environmental aspect's character or distinctiveness.
Moderate	Noticeable, temporary (for part of the project duration) change, or barely discernible change for any length of time, encountered within the near-field and parts of the far-field, to key characteristics or features of the particular environmental aspect's character or distinctiveness.
Low	Noticeable, temporary (for part of the project duration) change, or barely discernible change for any length of time, restricted to the near-field and immediately adjacent far-field areas, to key characteristics or features of the particular environmental aspect's character or distinctiveness.
Negligible	Changes which are not discernible from background conditions.
No change	No measurable change.

Significance Criteria

6.5.4.7 The significance of potential effects has been determined by taking into account the sensitivity and importance of the receptor and the magnitude of the impact and applying to construction, operation and maintenance and decommissioning stages of the Development (Table 6.5.4). 'Major' and 'Moderate' effects are considered 'significant' in EIA terms.

Table 6.5.4: Significance of Potential Effects

		Magnitude				
		High	**Moderate**	**Low**	**Negligible**	**No Change**
Sensitivity	**High**	Major	Moderate	Moderate	Minor	Negligible
	Moderate	Moderate	Moderate	Minor	Negligible	Negligible
	Low	Moderate	Minor	Negligible	Negligible	Negligible
	Negligible	Minor	Negligible	Negligible	Negligible	Negligible

6.5.4.8 It is noted here that a distinction is made throughout the assessment between the magnitude, extent and duration of 'impacts' and the resulting significance of the 'effects' upon physical processes receptors. Various actions may result in impacts: for instance, the installation of the export cable in the Landfall Area, causing a localised and short term change to intertidal morphology (which is defined as a physical processes receptor). The significance of effect associated with the impact will be dependent upon the sensitivity / importance of the receptor, with particular consideration given to the receptor's ability to tolerate and recover from the impact, as well as status.

6.5.5 Data Limitations

6.5.5.1 A large body of project and non-project specific data is available to characterise the environmental setting of the Moray West Site and Offshore Export Cable Corridor. A full list of data sources used to inform the physical processes baseline is provided in Technical Appendix 6.1 (Volume 4): Physical Processes Baseline, the locations of key datasets are shown in Volume 3a - Figure 6.4.2.

6.5.5.2 Collectively, the combined datasets provide sufficient detail to enable robust characterisation of the Moray West Site and Offshore Export Cable Corridor in terms of the metocean, seabed and sub-seabed setting. Although high resolution survey data is not available for the Offshore Export Cable Corridor, the availability of existing information has enabled a robust assessment to be undertaken.

6.6 Design Envelope Parameters

6.6.1 Realistic Worst Case Design Scenario

6.6.1.1 As identified in Volume 2 - Chapter 4: Development Description, Moray West is considering a range of potential construction methods and design options for the Development. The Design Envelope presented in Volume 2 - Chapter 4 represents the maximum design parameters for each of the options under consideration e.g. substructure type or turbine model.

6.6.1.2 In order to determine potential impacts of the various options it is necessary to define the 'realistic worst case scenario'. The realistic worst case scenario represents, for any given receptor and potential impact on that receptor, various options in the Design Envelope that would result in the greatest potential for change to the receptor in question.

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

6.6.1.4 Table 6.6.1 presents the realistic worst case scenario for changes to physical processes pathways and potential impacts to physical processes receptors and water quality during construction, operational and maintenance and decommissioning phases of the Development and provides justification as to why the options and design parameters identified are considered to be the realistic worst case scenario.

Table 6.6.1: Design Envelope Parameters Relevant to the Physical Processes and Water Quality Impact Assessment		
Potential Pathway Change / Impact	**Realistic Worst Case Scenario**	**Justification**
Construction		
Increases in SSC and deposition of disturbed sediments to the seabed due to dredging for seabed preparation prior to foundation installation (applicable only to gravity base foundations)	Greatest volume of sediment disturbed and released at a single WTG foundation location • Largest gravity base WTG foundation (Model 4), associated base diameter of 55 m; • Dredged diameter up to 95 m, maximum dredged depth of 5 m; and • Spoil volume per WTG location 35,441 m^3. Greatest volume of sediment disturbed and released at a single OSP foundation location • Largest gravity base OSP foundation, associated base diameter of 80 m, • Dredged diameter up to 120 m, maximum dredged depth of 8 m; and • Total spoil volume per foundation 90,478 m^3. Greatest volume of sediment disturbed and released within the Moray West Site • 85 x smaller gravity base WTG foundations (Model 1), associated base diameter of 45 m. Dredged diameter up to 85 m, maximum dredged depth of 5 m, total spoil volume for all WTG foundations 2,411,663 m^3; • 1x gravity base OSP foundation, associated base diameter 80 m, dredged diameter up to 120 m, maximum dredged depth of 8 m, total spoil volume for all OSP foundations 90,478 m^3 (total excavated area for two small OSPs based on 95 m diameter and 5 m depth is 70,880 m^3). • Total spoil volume for all WTG and OSP foundations 2,502,141 m^3; For all dredging scenarios • Dredging carried out using a representative trailer suction hopper dredger (5,000 m^3 hopper capacity, filled in 3 to 4 hours, 30 kg/s overspill rate when working, with split bottom for spoil disposal). • Multiple dredgers may be working simultaneously; • Disposal of material onto the seabed 'close' (within a few 100 m) to the installation works within the Moray West Site; and	Seabed preparation could be required prior to installation of gravity base and suction caisson foundations. Three realistic worst scenarios are identified, corresponding to the greatest volume of sediment disturbance locally (from individual WTG and OSP foundations) and across the entire array (total from all foundations). The greatest volume of dredging related sediment disturbance for a single WTG foundation is associated with the largest diameter gravity base (Model 4), whereas, for all WTGs it is associated with a larger number of smaller diameter gravity base foundations (Model 1). Suction caisson foundations have the same associated seabed diameter as the gravity base option. It is assumed a similar or smaller area and volume of seabed preparation will be required for suction caisson foundations.

Table 6.6.1: Design Envelope Parameters Relevant to the Physical Processes and Water Quality Impact Assessment		
Potential Pathway Change / Impact	**Realistic Worst Case Scenario**	**Justification**
	• Foundation installation phase lasting up to 9 months within the 36 month construction phase.	
Increases in SSC and deposition of disturbed sediments to the seabed due to the release of drill arisings during foundation installation (applicable only to piled foundations)	<u>Greatest volume of sediment disturbed and released at a single WTG or OSP foundation location</u> • Largest monopile WTG (Model 4), and OSP foundations, associated drill diameter 15 m, drilling to 50 m penetration depth, spoil volume per foundation 8,836 m^3; <u>Greatest volume of sediment disturbed and released within the Moray West Site and Moray West OfTI Site</u> • 62 x larger monopile WTG foundations (Model 4), associated drill diameter 15 m, drilling to 50 m penetration depth, total spoil volume for all WTG foundations 547,815 m^3; • 2 x OSP monopile foundations, associated drill diameter 15 m, drilling to 50 m penetration depth, total spoil volume for all OSP foundations 17,671 m^3; • Total spoil volume for all WTG and OSP foundations 565,486 m^3; <u>For all drilling scenarios</u> Note: drilling is an alternative to pile driving therefore the parameters for drilling in terms of durations of pile installation etc. are different to the parameters relating to pile driving. • Drilling rate of up to 2 m/hour (minimum drilling duration of 25 hours for each foundation and <48 hours per pile); • Up to 2 simultaneous drilling operations; • Assumes 100% release of material from each foundation; • Disposal of drill arisings at or above the water surface 'close' to the installation works within the Moray West Site; and • Foundation installation phase lasting up to 9 months in the 36 month construction period.	Although the volumes of material released via drilling (for monopiles, or for pin-piles for jacket foundations) are less than for seabed preparation via dredging, drilling has the potential to release larger volumes of relatively finer sediment. Two realistic worst scenarios are identified, corresponding to the greatest volume of sediment disturbance locally (from individual WTG or OSP foundations) and across the entire array (total from all foundations). The greatest potential volume of drill arisings from both individual and all WTG and OSP foundations is associated with the largest diameter monopile foundation. Drilling pin-piles for jacket foundations results in a much smaller volume of drill arisings.
Increases in SSC and deposition of disturbed sediment to the seabed due to cable installation within the	<u>Inter-array cables</u> • Installation method: Ploughing, jetting, trenching, rock cutting;	Cable installation may utilise a range of standard techniques, including jetting, ploughing, trenching and/or cutting. Of these,

Table 6.6.1: Design Envelope Parameters Relevant to the Physical Processes and Water Quality Impact Assessment		
Potential Pathway Change / Impact	**Realistic Worst Case Scenario**	**Justification**
Moray West Site and Offshore Export Cable Corridor	• Multiple inter array cable trenches, up to 275 km total length within the Moray West Site; • V-shape trench; width = 3 m; depth = 3 m; total volume of disturbance = (275 km x 3 m x 3 m x 0.5) = 1,237,500 m^3; • Maximum cable laying rate of 1,000 m/hr; • Cable installation lasting up to 6 months; and • Up to 4 simultaneous operations. <u>OSP interconnector cable</u> • Only required in conjunction with two OSPs; • Installation method: Ploughing, jetting, trenching, rock cutting; • One interconnector cable trench, up to 15 km in length between two OSPs within the Moray West Site; • V-shape trench; width = 3 m; depth = 3 m; total volume of disturbance= (15 km x 3 m x 3 m x 0.5) = 67,500 m^3; • Maximum cable laying rate of 1,000 m/hr; and • Cable installation lasting up to ~3 months; and • Up to 4 simultaneous operations. <u>OfTI export cables</u> • Installation method: jetting; • Up to two export cable trenches, each up to 65 km in length from the Moray West Site boundary to the Landfall Area (130 km in total); • V-shape trench; width = 3 m; depth = 3 m; total volume of disturbance= (130 km x 3 m x 3 m x 0.5) = 585,000 m^3; • Maximum cable laying rate of 1,000 m/hr; • Cable installation lasting up to 6 months; and • Up to 4 simultaneous operations.	jetting type techniques will most energetically disturb the greatest volume of sediment in the trench profile and as such is considered to be the maximum adverse scenario for sediment dispersion. Certain ploughing tools may affect a greater seabed width (up to 15 m), however, the maximum depth of disturbance is only achieved in a limited width (order of a few metres) in the center of the tool and the sediment volume affected to the sides is less likely to be fully disturbed (resuspended) in this way. Any prior seabed preparation (e.g. localised boulder clearance or levelling) has a smaller potential to cause sediment disturbance than the realistic worst case cable burial activity being assessed.

Table 6.6.1: Design Envelope Parameters Relevant to the Physical Processes and Water Quality Impact Assessment		
Potential Pathway Change / Impact	**Realistic Worst Case Scenario**	**Justification**
Indentations left on the seabed by jack-up vessels and large anchors	• Jack-up barge with up to 6 legs in total, area of up to 275 m^2 per spudcan; • Maximum area of seabed disturbance for the jack-up vessel of 1,650 m^2, with a penetration depth of approximately 0.5 m to 11 m for each spudcan; • The maximum vessel anchor size is assumed to be 3 m.	Representative estimates. Based on typical but conservative values for presently available vessels being used for offshore wind farm construction.
Impacts to designated marine and coastal geomorphological features (due to construction activities)	<u>Landfall Area</u> • Between Findlater Castle to Redhythe Point. <u>Open cut trenching in the Landfall Area</u> • Up to two cable trenches through mobile sediments in intertidal areas; • Burial depth up to 3 m below seabed or beach (to be confirmed by cable burial risk assessment); • Trench width up to 3 m wide; and • Trenches to be open for a period of days to a few weeks. <u>Horizontal Directional Drilling (HDD) in the Landfall Area</u> • Underground routing of the cable requiring no surficial sediment disturbance; • May be used as an alternative to open cut trenching in the Landfall Area (between the onshore side and extending typically no further than 2 km offshore). • Cable transition and HDD exit pits will be located onshore (above MHWS) and sufficiently set back to avoid any interaction with the beach during construction and during the operational lifetime of the Development. • The cable will enter the marine environment (HDD punch out) in the subtidal area.	The methods that may be used to install cables across the inter-tidal area include HDD and open-cut (trenching). There are two primary means by which the morphology of the Landfall Area could potentially be impacted during the construction phase: • Disturbance of sediments during (open cut) cable trenching across the beach, resulting in associated changes to seabed levels; and • Changes to the nearshore wave regime/longshore sediment transport due to the presence of (open) HDD exit pits and temporary installation structures (e.g. cofferdams).
Impacts to Smith Bank (due to construction activities)	<u>WTG and OSP Foundations</u> • Greatest seabed area impacted (496,509 m^2, associated with installation of 85 smaller WTG gravity base foundations (Model 1) with scour protection diameter 85 m, and two OSP gravity base foundations with scour protection diameter 95 m); <u>Inter-array and interconnector cables</u>	Defined as the greatest total area of direct seabed change or disturbance (irrespective of associated depth and volume). Includes the area of activities that are part of construction but that are not active during operation. The impact of cable or scour protection (that would be installed during

Table 6.6.1: Design Envelope Parameters Relevant to the Physical Processes and Water Quality Impact Assessment		
Potential Pathway Change / Impact	**Realistic Worst Case Scenario**	**Justification**
	• Greatest seabed area impacted (4,350,000 m^2, associated with installation of 275 km of inter-array cables and 15 km of interconnector cable, 15 m width of trenching related seabed disturbance. Jack-up barge spudcan imprints • Greatest area impacted (143,550 m^2, associated with jack-up barge spudcan imprints of 1,650 m^2 (6 legs, area up to 275 m^3 per spudcan) for each jack-up barge, 85 WTG and 2 OSP foundations in total) All direct changes • Greatest total seabed area impacted 4,990,059 m^2.	construction) is separately assessed in relation to the operation phase.
Changes to water quality from chemical release	Synthetic compound, heavy metal and hydrocarbon contamination may be released accidentally as a result of offshore infrastructure installation and the presence of various construction vessels during the construction period (up to 25 at any one time and will comprise of installation, support, transport and cable lay vessels, tugs, cranes and barges). Water-based drilling muds associated with drilling to install foundations may also be required. There may also be potential contamination of intertidal habitats resulting from machinery use and vehicle movement.	These parameters are considered to represent the maximum adverse scenario with regards to vessel movement during construction.
Changes to water quality from contaminated sediments	The maximum area of seabed preparation and disturbance across the Moray West Site has been quantified based on the following: • Area of seabed preparation (125 m diameter dredge-affected area) required for installation of gravity base structure foundations (based on 55 m diameter gravity base) (see Chapter 4 Description of Development Table 4.4.6). The resulting area of disturbance per foundation is 12,272 m^2. Therefore, for 62 foundations the maximum area of disturbance would be 1,043,120 m^2 (1.043 km^2); • Seabed disturbance within the area of seabed preparation (125m diameter dredge-affected area) required for two small offshore substation platforms (OSPs) using gravity base foundation (55 m diameter). Total area of seabed disturbance amounts to 24,544 m^2; • Jack up barge seabed footprint for 85 foundations, based on a max jack up barge	Based on maximum potential for exposure of contaminated sediments during seabed preparation works for foundation installation and for cable laying. This is associated with the largest spatial footprint and area of seabed disturbance, which is associated with the Model 4 (62 WTG) scenario and installation of two small OSPs, resulting in the installation of up to 63 substructures and associated inter-array, interconnector and export cable circuits.

Table 6.6.1: Design Envelope Parameters Relevant to the Physical Processes and Water Quality Impact Assessment		
Potential Pathway Change / Impact	**Realistic Worst Case Scenario**	**Justification**
	footprint of 1,650 m^2 (275 m^2 per spud can and max 6 legs per jack-up), the maximum disturbance would be 143,550 m^2; • Installation of up to 275 km inter-array cables (with worst case trench affected width of 15 m) of 4,125,000 m^2 (4.125 km^2); and • Installation of up to 15,000 m of inter OSP cabling (with worst case trench affected width of 15 m) of 225,000 m^2 (0.225 km^2). The total maximum area of seabed disturbance during construction within the Moray West Site would be 5,538,397 m^2 (5.538 km^2) and would occur over a 36 month period. The maximum area of temporary habitat loss and disturbance across the Offshore Export Cable Corridor has been quantified based on the following: • Installation of export cable circuits within up to two trenches, each 65 km in length and 15 m width. Which would result in a maximum disturbed area of 1,950,000 m^2 (1.95 km^2) and would occur over a six month period (within the overall 36 month construction period). The overall total footprint of disturbance of the Moray West Site and Offshore Export Cable Corridor combined under a worst-case approach is 7,511,214 m^2 (7.511 km^2).	
Operation and Maintenance		
Changes to the tidal regime Changes to the wave regime Changes to sediment transport and sediment transport pathways	Foundations • 62 x larger 'inverted T' shape gravity base WTG foundations (Model 4), associated base diameter of 55 m, base plate height up to 30 m above seabed, monopole diameter 15 m above the base plate to the water surface; • 2 x 'inverted T' shape gravity base OSP foundations, associated base diameter of 55 m, base plate height up to 20 m above seabed, monopole diameter 15 m above the base plate to the water surface; and	The greatest total in-water column blockage to currents, waves and sediment transport processes is associated with the smaller number (62) of larger WTG gravity base foundations and the larger number (2) of smaller OSP gravity base foundations. This combination was determined via calculations that quantitatively compare the

<table>
<tr><th colspan="3">Table 6.6.1: Design Envelope Parameters Relevant to the Physical Processes and Water Quality Impact Assessment</th></tr>
<tr><th>Potential Pathway Change / Impact</th><th>Realistic Worst Case Scenario</th><th>Justification</th></tr>
<tr><td>Impacts to designated marine and coastal geomorphological features (due to operation)</td><td rowspan="4">• Minimum spacing 1,200 m downwind and 1,050 m crosswind.
<u>Cable burial</u>
• All cables (inter-array, OSP interconnector and export cable) will be buried to a target depth of 1 m. Depending on seabed conditions it may be possible to achieve burial depths of up to 3 m; and
• Where it is not possible to achieve 1 m burial depth, additional cable protection will be required (see below).
<u>Cable protection measures (all)</u>
• Options include rock placement, concrete mattresses, polymer/steel sleeve protection and/ or grout bags;
• Rock berm width 1.5 m and height 1 m. Sloped profile above seabed level;
• Total length (and location) of cables which may potentially require seabed protection to be calculated during FEED but anticipated to be up to 20% of the export cable length (20% of 130 km = 26 km) and up to 0% of the inter-array and interconnector cable length (10% of 275 + 15 km = 29 km); and
• Total area of cable protection for export cables (26 km x 1.5 m = 39,000 m^2) and for inter-array and interconnector cables (29 km x 1.5 m = 43,500 m^2).
<u>Cable crossings</u>
• Up to 6 cable crossings per export cable circuit;
• Area per crossing = 200 m length x 6 m width = 1,200 m^2;
• Total area of all crossings = 14,400 m^2 (2 export cables x 6 cable crossings x 1,200 m^2 per crossing); and
• Rock berm height 1 m in the footprint of the cable crossing. Sloped profile above seabed level.</td><td rowspan="4">blockage presented by a range of minimum and maximum sizes of varying foundation types and numbers.
Of the various possible cable protection measures (including cable crossings), rock placement presents the greatest height of obstacle above the seabed.
Maximum lengths or proportions of cable protection are in addition to the length of protection used at cable crossings.
Includes the activities and infrastructure that are active or present during the operation phase. The impact of construction related sediment and seabed disturbance is separately assessed in relation to the construction phase.</td></tr>
<tr><td>Impacts to recreational surfing venues (due to operation)</td></tr>
<tr><td>Impacts to stratification fronts (due to operation)</td></tr>
<tr><td>Impacts to Smith Bank (due to operation)</td></tr>
<tr><td>Scour of seabed sediments</td><td>The realistic worst case is defined on the basis of the outputs of the scour assessment, which includes all foundation types.</td><td>Each foundation type may produce different scour patterns therefore gravity base, jacket and monopiles are all considered. The combination of foundation type, size and</td></tr>
</table>

Table 6.6.1: Design Envelope Parameters Relevant to the Physical Processes and Water Quality Impact Assessment		
Potential Pathway Change / Impact	**Realistic Worst Case Scenario**	**Justification**
		number producing the greatest area and/ or volume of influence cannot be identified in advance of the assessment and may vary depending on the parameter of interest.
Changes to water quality from chemical release	Synthetic compound, heavy metal and hydrocarbon contamination resulting from up to 85 turbines and two OSPs. Accidental pollution may also result from O&M vessels (including crew supply vessels and jack-up vessels). A typical turbine is anticipated to require grease, synthetic or hydraulic oil, and other operating compounds or materials such as liquid nitrogen, silicone oil and gas. The OSP is expected to require chemicals and other operating compounds such as diesel, water, coolants, oil, batteries and fire suppressant material. Various operation and maintenance vessels will be required over the operation period.	These parameters are considered to represent the maximum adverse scenario with regards to chemicals and vessel movements during the operational period.
Changes to water quality from contaminated sediments	For the Moray West Site as a whole, the greatest total foundation **local scour** footprint is associated with an array of 62 WTG and 2 monopile OSP larger (15 m diameter) monopile foundations (289,920 m², equivalent to only approximately 0.11% of the Moray West Site area). For the Moray West Site as a whole, the greatest total WTG foundation **global scour** footprint is associated with an array of 85 smaller (35 m base diameter) piled jacket WTG foundations and 1 larger piled jacket OSP foundation (355,163 m², equivalent to only approximately 0.16% of the Moray West Site area).	Limited to any maintenance works associated with scour protection or cable reburial maintenance works.
Decommissioning		
Increases in SSC and deposition of disturbed sediment to the seabed within the Moray West Site and Offshore Export Cable Corridor Impacts to Smith Bank (due to decommissioning activities)	• 85 x smaller gravity base WTG foundations (Model 1), 2 x gravity base OSP foundations; • Buried inter-array, interconnector and export cables to be left in situ (but to be determined in consultation with key stakeholders as part of the decommissioning plan and following best practice at the time); and • Scour and cable protection left in-situ.	When removing foundations, it is considered that the greatest disturbance will be associated with the greatest number of relatively large foundations. Other infrastructure assumed to be left in-situ.

Table 6.6.1: Design Envelope Parameters Relevant to the Physical Processes and Water Quality Impact Assessment		
Potential Pathway Change / Impact	**Realistic Worst Case Scenario**	**Justification**
Impacts to designated marine and coastal geomorphological features (due to decommissioning activities	• Removal of export cables from shallow trenches within intertidal / shallow subtidal areas only.	Maximum disturbance of seabed resulting from removal of cable(s). Cables buried more deeply by HDD assumed to be left in-situ.
Changes to water quality from chemical release	Synthetic compound, heavy metal and hydrocarbon contamination resulting from a maximum of 85 turbines and two offshore substations. Various decommissioning vessels (number currently undetermined) will also be active over the decommissioning period. Potential contamination in the intertidal area resulting from machinery use and vehicle movement.	Maximum adverse scenario as per construction phase.
Changes to water quality from contaminated sediments	As per construction scenario in table above.	Assuming worst case of all infrastructure above and below seabed is removed. Maximum adverse scenario as per construction phase.

6.6.2 Embedded Measures

6.6.2.1 Embedded mitigation is already present in some of the activities associated with the potential impacts being assessed, as follows:

- Dredging and drilling of the seabed are common activities, both globally and in UK. The vessels, equipment and methods used have been optimised through design over time to maximise the efficiency of the dredging or drilling process and to minimise potential environmental effects (e.g. potential rates of sediment disturbance and release), thereby reducing the magnitude, extent and duration of potential adverse effects.
- Cable burial into the seabed and transitioning the cable between the offshore and onshore environment at a landfall is a common activity, both globally and in UK. Cable burial tools and techniques will aim to efficiently and rapidly achieve burial of the cable into the seabed whilst maximising sediment cover. Therefore, by design, the majority of sediment in the trench affected area is likely to remain within or near to the trench (for subsequent backfilling) and would therefore not contribute to effects on SSC or sediment deposition elsewhere. Landfall techniques aim to establish long term and stable burial and will therefore minimise any activities that would potentially destabilise or change the affected coastline.
- Scour formation around the base of foundations or exposed sections of cable also presents an engineering risk. More extensive scour formation is likely to be mitigated by the application of scour protection.
- The number, type and dimensions of the foundations used will determine the blockage presented to waves and currents, both locally and by the Moray West Offshore Wind Farm as a whole. However, the design and dimensions of individual foundations also determine the forces exerted on those structures by waves and currents, and the complexity and cost of construction, which will tend to minimise the dimensions of the individual foundations as far as is possible.
- An appropriate Environmental Management Plan (EMP) will be produced and followed to cover the construction, operation and maintenance phase of the Development. This will include planning for accidental spills, address all potential contaminant releases and include key emergency contact details. A Decommissioning Programme will also be developed to cover the decommissioning phase;
- The measures outlined in these documents will be adopted to ensure that the potential for release of contaminants from construction, operation and maintenance, and decommissioning equipment and activities is minimised. In this manner, accidental release of potential contaminants from drilling rigs and other construction / O&M vessels will be strictly controlled, thus providing protection for marine life across all phases of the offshore wind farm development.
- Best-practice techniques including appropriate vessel maintenance would be used at all times to minimise the potential for contamination as outlined in the Marine Pollution Contingency Plan (MPCP) and International Convention for the Prevention of Pollution from Ships (MARPOL).

6.7 Description of Potential Changes to Physical Process Pathways

6.7.1.1 The changes to marine processes in response to the construction, operation and maintenance and decommissioning of the Moray West Development are described in this section. The potential changes are listed in Table 6.6.1 along with the realistic worst case design parameters against which each change has been assessed.

6.7.1.2 As previously stated, the assessments presented within this section only consider potential changes to pathways and as such do not provide a conclusion regarding the magnitude of the impact to a receptor, the sensitivity of a receptor, or the significance of effect. The significance of effects to identified physical processes receptors is considered separately, in Section 6.8. The significance of effect of physical processes changes in relation to other receptors is considered where relevant in other topic Chapters.

6.7.2 Description of Pathway Changes During Construction

Increases in SSC and Deposition of Disturbed Sediments to the Seabed

6.7.2.1 This section provides a combined description of the changes to SSC and the resulting deposition of sediment to the seabed as a result of the following activities:

- Increases in SSC and deposition of disturbed sediments to the seabed due to dredging for seabed preparation prior to gravity-base foundation installation;
- Increases in SSC and deposition of disturbed sediments to the seabed due to the release of drill arisings during piled foundation installation; and
- Increases in SSC and deposition of disturbed sediment to the seabed due to cable installation within the Moray West Site and Offshore Export Cable Corridor.

6.7.2.2 Note that dredging and drilling will not take place in combination, as each are associated with the installation of different foundation types. The realistic worst case scenarios for these activities is described in Table 6.6.1.

6.7.2.3 Full details of the methodologies used to carry out the sediment disturbance assessments, as well as a more detailed description of the nature/extent/duration etc. of the activity specific changes (including ranges of likely outcomes) is provided in Technical Appendix 6.3 (Volume 4): Physical Processes Impact Assessment.

6.7.2.4 Increases in SSC and deposition of disturbed sediments to the seabed (due to the range of construction activities considered) is a potential impact pathway, but no physical processes receptors have been identified that are directly sensitive to this change.

Magnitude of the Change

6.7.2.5 In summary, the activities being assessed (dredging or drilling and cable burial) will cause a disturbance of the local seabed sediments. Due to the nature of the activities, sediment would be put into suspension either by energetic disturbance at or near to the seabed or by release at or near to the sea surface. This will result in a temporary and localised sediment plume, within which SSC is elevated above ambient levels (See Volume 3a - Figure 6.7.1). The assessments undertaken quantify the likely magnitude of increase in SSC (which may vary with time and distance from the activity) and the spatial and temporal patterns of the change (extent, duration, etc.). Over time (duration related to the sediment grain size) the disturbed sediment in suspension will settle back to the seabed. The assessments undertaken also quantify the likely thickness and extent of any sediment deposit that might form.

6.7.2.6 The overall patterns of change in SSC is summarised as follows:

- SSC will be increased by tens to hundreds of thousands of mg/l at the point of sediment release for the duration of the activity;

- In the case of dredging and drilling, the source of the sediment release is static and may last for hours, up to a few days. In the case of cable burial, the source of sediment release is moving and so the local change will be limited in time to a matter of seconds;
- SSC will reduce with time and distance from the source due to dispersion and resettlement of sediment to the seabed. Sands and gravels will settle out faster than finer material. The overall duration of change will depend on the relative proportions of grain sizes present, which may vary by location and activity type;
- If released at the water surface, SSC of low tens of mg/l will be present in a narrow plume (tens to a few hundreds of metres wide), up to one tidal excursion in length (up to ~3.5 to 4.2 km on spring tides, see Volume 3a - Figure 6.7.1, and half that distance on neap tides) aligned to the tidal current downstream from the source;
- If the activity occurs over more than one flood or ebb tidal period, the plume feature may be present in both downstream and upstream directions;
- Outside of the area up to one tidal excursion upstream and downstream of the foundation location, SSC less than 10 mg/l may occur more widely due to ongoing dispersion and dilution of material;
- Following the end of drilling, locally high SSC at the source will recover quickly (within minutes) to background levels as the sediment plume is advected away and coarser sediments or clasts settle back onto the seabed;
- Sufficiently fine sediment may persist in suspension for hours to days or longer, but will become diluted to very low concentrations (<5 mg/l, indistinguishable from natural background levels and variability) within timescales of around one day; and
- Over longer timescales, net movement of any fine grained material persisting in suspension would generally be in an approximate southerly (south-easterly through south-westerly) direction across most of the Moray West Site in accordance with the direction of residual flow in this area.

6.7.2.7 The overall pattern of change in seabed level is summarised as follows:

- In the case of dredging for gravity base foundations (release at or near the water surface):
  - Spoil disposal would form more concentrated sediment deposits on the seabed. The main mass of sediment (90% of the total dredged volume, falling as the active phase of the plume) will initially result in discrete mounds or patches of sediment in the order of tens to hundreds of metres in diameter (depending on the pattern of settlement) and centimetres to a few metres in local thickness.
- In the case of drilling for piled foundations (release at or near the water surface):
  - Deposits of mainly coarse grained (gravel) and clastic sediment deposits will likely be concentrated within an area in the order of approximately 10 to 50 m downstream/upstream and a few tens of metres wide from individual foundations, with a corresponding average thickness in the order of 5 to 10 m; and
  - Deposits of mainly sandy sediment deposits will likely be concentrated within an area in the order of approximately 100 m to 500 m downstream/upstream and tens to one hundred metres wide from individual foundations, with a corresponding average thickness in the order of tens of centimetres to one metre.
- In the case of cable burial (release at or near the seabed surface):
  - Depending on the height to which the material is ejected and the current speed at the time of release, deposition will be spatially limited to within metres (up to 10 m)

downstream of the cable for gravels and within tens of metres (up to one hundred metres) for sands, with a corresponding average thickness in the order of centimetres to tens of centimetres (limited to realistically likely values).

- In all cases, fine grained material will be dispersed widely within the surrounding region and will not settle with measurable thickness;
- The actual shape and thickness of the seabed deposit resulting from the disturbance or release of sediment cannot be predicted accurately in advance and in any case is likely to vary. A range of possible configurations of area and thickness are presented for each activity in Technical Appendix 6.3 (Volume 4): Physical Processes Impact Assessment. From this range, the above examples represent a relatively widely spread deposit which is the maximum design scenario for the area of seabed affected (by a nominal average thickness of 0.05 m); and
- Irrespective of the activity or sediment type, the volumes of sediment being displaced and deposited locally are inherently limited, which also limits the combinations of sediment deposition thickness and extent that might realistically occur. Fundamentally, the maximum area that can be affected by a given average thickness of sediment is limited by the starting volume and any larger area would correspond to a smaller average thickness (and vice versa). Based on the realistic worst case maximum total sediment volumes, the following are the realistic maximum proportions of the Moray West Site that could be covered by a meaningful average thickness of sediment (0.05 m):
    - By dredging all WTG and OSP foundations – A maximum area of 50.04 km^2, equal to approximately 22% of the Moray West Site could potentially be covered by an average thickness of 0.05 m of material;
    - By drilling all WTG and OSP foundations – A maximum area of 18.85 km^2 (approximately 8.4% of the Moray West Site) could potentially be covered by an average thickness of 0.05 m of material; and
    - By burying all inter-array and interconnector cables (assuming 100% displacement of material from the trench) – A maximum area of 26.10 km^2 (approximately 11.6% of the Moray West Site) could potentially be covered by an average thickness of 0.05 m of material.

6.7.2.8 Given that only one foundation type will be installed across the site, the maximum area within the Moray West site that would potentially be covered by an average thickness of 0.05 m of material would be 76.14 km^2 (33.6%). This is based on seabed preparation for the installation of GBS foundations and burial of inter-array and interconnector cables.

6.7.2.9 If multiple activities causing sediment disturbance (such as dredging, drilling or cable installation) are undertaken simultaneously at two or more locations that are aligned in relation to the ambient tidal currents, then there is potential for overlap between the areas of effect on SSC and sediment deposition. The change to SSC in areas of overlap will be additive if the downstream activity occurs within the area of effect from upstream (i.e. sediment is disturbed within the sediment plume from the upstream location). The change to SSC will not be additive (i.e. the changes will be as described for single occurrences only) if the areas of elevated SSC only meet or overlap downstream following advection (i.e. the passive movement of material in suspension by currents) or dispersion of the effects. Sediment deposition will be additive if and where the footprints of the deposits on the seabed overlap, leading to a thicker overall unit.

6.7.2.10 Given that the minimum spacing between foundations is 1,050 m, it is unlikely that sands or gravels put into suspension will be dispersed far enough (i.e. between adjacent foundation locations) to cause any overlapping footprints before being redeposited to the seabed. In general, only relatively fine sediment (e.g. clay, silt and fine sand sized material) is likely to be advected far enough to potentially cause overlapping sediment plumes.

Indentations Left on the Seabed by Jack-up Vessels and Large Anchors

6.7.2.11 Vessels installing WTG and OSP foundations may utilise jack-up legs or a number of anchors to hold station and to provide stability for the working platform. Where legs or anchors have been inserted into the seabed and then removed, an indentation proportional to the dimensions of the object may remain. The volume and dimensions of the depression may reduce over time due to natural movement of the soils and due to infilling in proportion to the rate of sediment transport through the area. Depending upon the nature of the seabed surface sediments, the presence of a depression does not necessarily imply a difference in sedimentary environment in the area of effect. As sediment is not being removed or added, a volume of sediment approximately equal to the volume of the depression will also be locally raised above the original seabed level.

6.7.2.12 Indentations left on the seabed by jack-up vessels and large anchors is a potential impact pathway but no physical processes receptors have been identified that are directly sensitive to this change.

Magnitude of the Change

6.7.2.13 Up to six jack-up legs might be used by some work vessels to hold position and provide stability during operations on-site. A more detailed description of the effect of jack up legs is provided in Technical Appendix 6.3 (Volume 4): Physical Processes Impact Assessment. In summary, jack up legs might impact the seabed as follows:

- The lower end of each of the six jack-up legs will terminate in a ‘spud can’ foot with an area of up to 275 m^2, equivalent to a footprint of 16.5 m square or a circular footprint diameter of 18.7 m. Each leg will penetrate into the seabed between by up to a maximum of 11 m, depending on the local ground conditions;
- The maximum likely dimensions of the depression left by a single leg soon after extraction in loose soils is characterised as a 19 m diameter conical pit, between 0.5 to 5.8 m deep (in the centre) depending on the depth of penetration and soil conditions.;
- The sedimentary texture of the pit surface is likely to be similar to that of the surrounding seabed because no sediment is introduced or removed by the jack-up leg and the sediment veneer is considered to be largely uniform (sand or gravely sand) within at least the upper 5 m of seabed over much of the area;
- Over the short to medium term, the pits will tend to become shallower and less distinct as storm events resuspended the mobile fractions of the raised sediment material around the edges of the pit and either redeposit it into the pit or move it elsewhere. There will be an initial tendency for some sediments being transported through the area to accumulate in the pits if they are sufficiently deep to reduce nearbed current speed and/or wave action locally, however, this tendency will decrease rapidly as the pits flatten; and
- Based on the potential rates of sediment transport associated with a range of combined wave and current conditions normally present within the site, the total volume of collapsed pits up to 19 m wide and 5.8 m deep (up to 536 m^3) could be refilled by ambient sediment transport in the order of 30 to 300 days, assuming that all sediment passing through the footprint of the affected area is retained there. This timescale could be reduced by additional contributions from larger wave events (due to higher transport rates). Overall, it is reasonable to estimate that such pits are likely to be filled by natural sediment transport on time scales in the order of 0.1 to 5 years following construction (depending on the frequency and intensity of storms).

6.7.2.14 An array of four to six anchors might be used by some work vessels to hold position and provide stability during operations on-site. Anchors used by such large ships are typically of smaller dimensions than the jack-up legs described above and exert their force differently on the seabed. The length-scale of the main body of one such anchor is assumed to be in the region of 3 m. Anchors might impact the seabed by the creation of 'anchor scars' as follows:

- The specific design of the anchor stock, crown and flukes, and so the way in which the anchor interacts with the seabed, will vary depending upon the particular design used. Generically, the anchor will be initially deposited onto the seabed under its own weight, causing minimal impact disturbance in its own footprint. The anchor will then be pulled horizontally across the seabed for some distance to allow the flukes and crown to penetrate the seabed. Dragging the anchor may leave a short, shallow furrow. Once embedded in the seabed, a ridge of sediment will have been raised in front of the anchor in the direction of pull, partially accumulated from the furrow and partially pushed up by the horizontal pressure on the seabed from the anchor pull;
- To release the anchor, the connecting wire or chain is tensioned vertically, levering the flukes out of the sediment. The anchor is then retrieved through the water column, either to the main vessel or by an anchor handing vessel for redeployment. The act of removing the anchor in this way will redistribute much of the sediment accumulated back to the seabed around or into any hole remaining;
- The footprint length scale of the anchor scar disturbance remaining soon after removal of an anchor will be approximately similar to the size of the anchor (3 m). The character of the disturbance may be highly variable (chaotic ridges and depressions) within the footprint of effect. In the worst case, the maximum depth of a conical pit with these footprint dimensions (assuming a stable slope angle of 32°) is 0.94 m;
- The sedimentary texture within the anchor scar is likely to be similar to that of the surrounding seabed because no sediment is introduced or removed by the anchor and the sediment veneer is considered to be largely uniform (sand or gravely sand) within the upper 5 m;
- In the short to medium term, the anchor scar will be reworked and flattened to a baseline condition by waves and currents during storm events. No tendency to intercept regional sediment transport is expected because the sediment is essentially only locally redistributed in a small footprint; and
- The total volume of a pit 3 m diameter and 0.94 m deep (2.2 m^3) would be refilled by ambient sediment transport in the order of 20 to 200 hours of active transport at the relatively low but frequently occurring typical sediment transport rates described in the previous section. This timescale would be further reduced (due to higher transport rates) during larger wave events. Therefore, such pits are likely to be entirely filled by natural sediment transport on time scales between a single storm event and 1 year.

6.7.2.15 As stated in Table 6.5.1, indentations left on the seabed by jack-up vessels and large anchors represent a potential impact pathway, rather than a physical processes receptor. Accordingly, no conclusion of impact significance is provided.

6.7.3 Description of Pathway Changes During Operation and Maintenance

<u>Changes to the Tidal Regime</u>

6.7.3.1 The interaction between the tidal regime and the foundations of the Moray West Offshore Wind Farm will result in a general reduction in current speed and an increase in levels of turbulence locally due to frictional drag and the shape of the structure. Resistance posed by the Moray West Offshore Wind Farm (due to the sum of all foundation drag) to the passage of water at a large scale may also distort the progression of the tidal wave, also potentially affecting the phase and height of tidal water levels. The potential for such changes to the tidal regime to occur in response to the presence of the Moray West Offshore Wind Farm is considered in this section.

6.7.3.2 Changes to the tidal regime may also indirectly impact seabed morphology (including bedforms) in a number of ways. In particular, there exists a close relationship between flow speed and bedform type (e.g. Belderson *et al*., 1982) and thus any changes to flows have the potential to alter seabed morphology over the lifetime of the Development. The potential for changes to the tidal regime to affect sediment transport is considered in paragraph 6.7.3.25 *et seq*. The potential for changes to sediment transport to affect Smith Bank is considered in paragraph 6.8.3.46 *et seq*.

Magnitude of the Change

6.7.3.3 The presence of the offshore wind farm during its operation and maintenance phase has the potential to produce an impact on the tidal regime due to interaction between currents and the WTG and OSP foundations. The WTG and OSP foundations have the potential to impact on the following tidal characteristics:

- Water levels;
- Current speed; and
- Current direction.

6.7.3.4 To quantify the likely magnitude and extent of interaction between the operational Moray West Offshore Wind Farm and the hydrodynamic regime, a numerical tidal model (described in Technical Appendix 6.2 (Volume 4): Physical Processes Numerical Modelling) was used to simulate representative spring and neap tidal conditions for both baseline and the 'with Development' scenario. The effect of a particular development scenario is evaluated by finding the absolute and relative differences between the baseline and corresponding Development scenario. Descriptions of the changes found are described below for tidal water level and currents.

6.7.3.5 The potential impact of changes to water levels are summarised as follows:

- The maximum magnitude of effect on tidal water level in any location and at any time during a typical spring-neap tidal cycle is less than 0.001 m; and
- Given the similarity in processes, a similar (low) order of effect on non-tidal (surge) water levels is inferred.

6.7.3.6 The magnitude of the change the Moray West Offshore Wind Farm could have on water levels in both the near-field and the far-field is evidently very small when compared to the natural range of variability in tidal levels (2 to 4 m), non-tidal levels (1 m) and the potential effects of sea level rise (0.08 to 0.14 m), and would not be measurable in practice.

6.7.3.7 The potential impact of changes to currents:

- The potential impact of the Moray West Offshore Wind Farm alone on tidal currents during a representative mean spring tidal cycle is shown in Volume 3a - Figure 6.7.3. Results for neap tidal range conditions are proportionally smaller (around half) than that reported for spring tides. The results show that:
    - The maximum magnitude of impact on tidal current speed in any location and at any time during a typical spring-neap tidal cycle is less than 0.01 m/s;
    - No consistent measureable impact on tidal current direction is expected in any location and at any time during a typical spring-neap tidal cycle;

- Given the similarity in processes, a similar (low) order of impact on non-tidal (surge) current speeds and directions is inferred.

- The magnitude of the impact of the Moray West Offshore Wind Farm on current speed in both the near-field and the far-field is evidently very small when compared to the natural range of variability for tidal currents (0.25 to 0.3 m/s) and surge affected currents (0.39 to 1.17 m/s), and would not be measurable in practice.

6.7.3.8 As stated in Table 6.5.1, changes to the tidal regime represent a potential impact pathway, rather than a physical processes receptor. Accordingly, no conclusion of impact significance is provided.

<u>Changes to the Wave Regime</u>

6.7.3.9 Modification of the wave regime could occur in response to the presence of:

- WTG and OSP foundations; and/ or
- Cable protection measures.

6.7.3.10 The influence of a single foundation on individual waves is not easily measurable in practice, but the combined influence of many structures is generally accepted to be a slight reduction of wave energy (height and period) which may extend across the far-field.

6.7.3.11 Changes to the wave regime is a potential impact pathway. Sensitive physical processes receptors are assessed separately in Section 6.8.

6.7.3.12 Where the wave climate is persistently modified, these changes may potentially alter the frequency of sediment mobilisation and rates of transport and deposition in offshore areas, and/ or the rate and direction of longshore sediment transport (where sediment is present) at exposed coastlines. The potential for changes to the wave regime to change patterns of sediment transport in offshore areas and at adjacent coastlines is considered in paragraph 6.7.3.25 *et seq*. The corresponding potential for changes in waves and sediment transport to impact designated marine and coastal geomorphological features is considered in paragraph 6.8.3.9 *et seq.* The potential for changes to sediment transport to affect Smith Bank is considered in paragraph 6.8.3.46 *et seq*.

6.7.3.13 Changes to the wave regime in coastal locations may also result in a change to the surfing wave climate. The potential for changes to the surfing wave climate to impact recreational surfing venues is considered in paragraph 6.8.3.29 *et se.*

6.7.3.14 This section assesses the potential effect of the Moray West Offshore Wind Farm alone. The potential cumulative effect of the Moray West, Moray East and Beatrice Offshore Wind Farms is assessed separately in paragraph 6.9.4.6 *et seq*.

Magnitude of the Change

6.7.3.15 To quantify the likely magnitude and extent of interaction between the operational Moray West Offshore Wind Farm and the wave regime, a numerical wave model (described in Technical Appendix 6.2 (Volume 4): Physical Processes Numerical Modelling) was used to simulate representative sea state conditions for both baseline and the ‘with Development’ scenario. The effect of a particular development scenario is evaluated by finding the absolute and relative differences between the baseline and corresponding ‘with Development’ scenario. Descriptions of the changes found are described below for wave height, period and direction.

6.7.3.16 The potential effect of the Moray West Offshore Wind Farm alone on significant wave height during a 1:1, 1:10 and 1:50 year return period sea state is shown in Volume 3a - Figure 6.7.4, Figure 6.7.5 and Figure 6.7.6 respectively. The results of the modelling show that:

- The main effect would be to reduce the height of waves passing through the Moray West Site;
- The maximum local reduction in wave height within the site boundary would vary between 0.25 and 0.68 m, or 6 to 9 % of the baseline wave height, depending on the wave direction and return period (based on the 8 directions and 3 return periods tested). It should be noted that the largest proportional reduction is not necessarily associated with the largest absolute reduction in wave height. The greatest absolute effects would be on the largest waves that also pass through the long axis of the Moray West Site (i.e. from 45 and 90 °N). The highest proportional effects would be on largest waves from the southwest and west (215 and 270 °N) while the smallest proportional effects would be on waves from the southeast (125 °N);
- The area of maximum effect on wave height in every case would be relatively small (length scale of order 1 km^2) and would be located where waves have transitioned through the greatest width of the Moray West Site in that orientation;
- The effect would gradually develop from no effect at the upwind edge of the Moray West Site to the maximum value in proportion to the distance travelled through the site, i.e. 50% of the site area will experience less than 50% of the maximum level of effect, and 25%, less than 25% of the maximum effect, etc;
- Behind the Moray West Site, any near-field reduction in wave height would recover towards ambient values at a non-linear rate (i.e. recovering quickly over small distances, but smaller magnitude effects can persist over greater distances). These residual effects would extend in the direction of wave travel (with some lateral spreading);
- The maximum local reduction in wave height at any of the adjacent coastlines within the Moray Firth (including the various designated coastlines and surfing venues in the area) would be in order of centimetres (less than 0.1 m) in comparison to a wave height in the order of several metres, i.e. only a small (not measurable) absolute and relative difference. Only a limited area of coastline downwind of the Moray West Site would be affected at any one time. The time that waves might come from any particular direction (and therefore the area of coastline potentially affected) is limited (details in Technical Appendix 6.1 (Volume 4): Physical Processes Baseline);
- The maximum local effect on wave period in all cases considered would be less than one second. The spatial pattern of the effect is not well defined, would recover with distance from the Moray West Site, and the small magnitude of the effect would not be measurable in practice; and
- There would be no measurable effect on instantaneous wave direction in the near- or far-field.

6.7.3.17 The magnitude of the effect of the Moray West Offshore Wind Farm on waves in the near-field and (especially in) the far-field is small in absolute and relative terms when compared to the natural range of variability for wave height (4 to 9 m) and period (>10 s), and would not be measurable in practice.

6.7.3.18 Any potential effects of the Moray West Offshore Wind Farm on waves will persist for the lifetime of the Development but are of small magnitude, would have only a local effect and do not impact upon any of the identified sensitive physical environmental receptors beyond the range of natural variability.

6.7.3.19 The model results described above consider a conservative description of blockage effects that equally affect the whole wave spectrum (which is a mixture of longer and shorter period waves superimposed upon each other at the same time and location). In practice, relatively shorter and relatively longer waves within the spectrum will interact differently with the obstacles posed by the wind farm foundations. In particular, longer period waves (important for coastal process and recreational surfing) will be even less affected by the wind farm than described above, as explained below.

6.7.3.20 Cylindrical structures or structures with cylindrical members, such as the foundations being considered in the present study, will only interact strongly with waves when the diameter of the structure (D) becomes large relative to the wavelength (L). Slender pile theory shows that wave scattering becomes important when the ratio D/L > 0.2 (e.g. Sumer and Fredsøe, 1997). Waves that are long compared to the size of the structure will more simply pass around it, losing little or no energy. Relatively shorter wavelengths are more likely to impact with the structure and are more likely to be affected by reflection, diffraction or wave breaking; however, such shorter waves are also more likely to be locally wind generated and so recover more rapidly with distance.

6.7.3.21 Foundations in the Moray West Offshore Wind Farm present a physical blockage or obstacle ranging in diameter from a few metres (for jackets) to 15 m (for monopiles and the upper sections of a gravity base structure). Using the above ratio (D/L > 0.2), waves that are 'small' in relation to these obstacles (and hence more susceptible to blockage) are in the order of 10 to 75 m long, corresponding to wave periods of approximately 2 to 5 s. Individual waves passing through the site that are longer than this are 'long' in comparison to the obstacle and will experience little or no blockage from the wind farm foundations. The reduction in significant wave height shown in the modelling results is therefore rather due to a local reduction and downstream recovery in the energy of relatively shorter period waves within the wave spectrum.

6.7.3.22 As such, it is important to note that longer period waves (important for coastal processes and recreational surfing) will be even less affected by the wind farm (if at all) than reported above for the wave spectrum as a whole.

6.7.3.23 In terms of the potential for the cable protection to modify the wave regime, it is considered that any interruption of inshore and nearshore wave processes would be minimal and highly localised on the basis the use additional protection in the Landfall Area will be restricted due to water depth. Where additional protection is required this would be kept to a minimum and would present only a low profile (~ 1.0 m) within the water column relative to the water depth (Table 6.6.1). As such, the cable protection would have minimal potential to affect the passage of waves.

6.7.3.24 As stated in Table 6.5.1, changes to the wave regime represent a potential impact pathway, rather than a physical processes receptor. Accordingly, no conclusion of impact significance is provided.

Changes to Sediment Transport and Sediment Transport Pathways

6.7.3.25 Modification of existing sediment transport pathways could occur in response to changes in the wave and tidal regime resulting from the presence of:

- WTG and OSP foundations; and/ or
- Cable protection measures.

6.7.3.26 The presence of cable protection measures may also have the potential to cause a direct (albeit localised) blockage of sediment transport. The above changes could potentially occur over a range of timescales, depending on location and the specific Development infrastructure that is interacting with the sediment transport regime.

6.7.3.27 Details of the maximum adverse scenario are presented in Table 6.6.1 and a more detailed discussion of the potential for changes to sediment transport and sediment transport pathways is presented in Technical Appendix 6.3 (Volume 4): Physical Processes Impact Assessment.

Magnitude of the Change

6.7.3.28 Impact of foundations on sediment transport at the coast:

- On the basis of the quantitative analysis of potential changes to the wave regime (paragraph 6.7.3.9 *et seq.*), it is found that there will be no measurable reduction in wave height at adjacent coastlines in response to the presence of the WTG and OSP foundations;
- Changes in wave height of this magnitude are small in both relative and absolute terms. Such small differences are not measurable in practice and would be indistinguishable from normal short-term natural variability in wave height (both for individual wave heights and in terms of the overall seastate); and
- Accordingly, these changes are not predicted to have any measurable influence on longshore sediment transport.

6.7.3.29 Impact of foundations on bed load transport:

- Within the Moray West Site and offshore sections of the Offshore Export Cable Corridor, the rate and direction of sediment transport as bedload is dominated by the action and asymmetry of currents (including tide and surge contributions). The nature of the wave regime may also affect the net rate of transport locally;
- Potential changes to currents are described in paragraph 6.7.3.1 *et seq*. In brief, current speed could be reduced in a narrow wake extending downstream from each foundation, but with no measureable effect at a regional scale. This results in limited net difference in the total flow rate of water through the Moray West Offshore Wind Farm, any locally measurable changes would be largely restricted to the footprint of the Moray West Site;
- The extent to which these continuous but localised changes in flow speed could influence rates of bedload transport within, and nearby to, the Moray West Offshore Wind Farm will depend upon the magnitude of change relative to sediment mobilisation thresholds. In places, it is probable that localised flow reductions will lessen the frequency with which sediment particles are mobilised and therefore rates of transport may also be similarly reduced. Conversely, marginally greater rates of sediment transport may be experienced where increased local flow turbulence is found; and
- The overall result of any slight changes in flow speed could potentially be a very small reduction in the net volume of material transported as bedload through the Moray West Site.

6.7.3.30 Impact of foundations on suspended sediment transport:

- As described in paragraph 6.7.3.1 *et seq.*, changes to tidal currents (which control the rate and direction in which suspended sediment is transported) due to the presence of the Moray West Offshore Wind Farm are assessed to be very limited in absolute magnitude and spatially restricted to the Moray West Site plus a small distance downstream in the main flood and ebb directions;
- During large storm events, waves may stir the seabed within shallower parts of the Moray West Site, naturally causing an additional short-term contribution to SSC levels locally. The maximum adverse scenario layout will potentially cause a small reduction in wave heights within and nearby to the Moray West Site and it is therefore possible that there will be a corresponding small reduction in the rate at which sediment is locally re-suspended from the seabed;
- The change described above would only be apparent during larger storm events (if at all) and would potentially slightly reduce SSC from that which would have occurred in the

baseline condition. However, levels of SSC will remain dominated by regional scale inputs that are not affected by the presence of the Moray West Offshore Wind Farm; and

- No measurable changes to SSC outside the range of natural variability are expected to occur within or nearby to the Moray West Site.

6.7.3.31 Impact of cable protection measures on sediment transport:

- Installation of cable protection (such as rock placement, concrete mattresses or grout bags) could result in a local elevation of the seabed profile by up to 1.0 m (Table 6.6.1). Cable protection would be placed onto the seabed surface above the cable and therefore could directly trap sediment, locally impacting down-drift locations;
- Following installation and under favourable conditions, an initial period of sediment accumulation would be expected to occur, creating a smooth slope against the cable protection. The process of wedge formation may take place over a period of a few weeks to months, depending on rates of sediment transport;
- Sandy sediments are transported in two modes: bedload and saltation. Saltation is the process by which sands are moved up into the water column. These suspended sands would be expected to move relatively freely over the top of the cable protection although to begin with would regularly be deposited upon it, filling void spaces. Once any void spaces have been infilled, saltation is expected to be largely unaffected by the presence of the cable protection such that existing transport process (including bed form migration) will remain unaffected;
- The process of void infilling is expected to occur relatively quickly (in the order of a few months). This is due to saltation as well as the anticipated high rates of transport in areas of mobile seabed (which is where much of the cable protection is anticipated);
- Bedload is the process by which sands move while still in contact with the seabed. Bedload will be temporarily affected up until such time that the cable protection is covered by sand and the slope gradient either side has been reduced in response to the accumulation of a sediment wedge with stable slope angles (approximately 30 degrees). Following this, bedload will continue because the slope angle presented by sections of protected cable would be within the natural range of bed slope angles associated with bed forms mapped within the Offshore Export Cable Corridor; and
- Accordingly, for all areas in which cable protection is used (including where sand waves are present), it is not expected that the presence of cable protection measures will continuously affect patterns of sediment transport following the initial period of accumulation. It follows that any changes on seabed morphology away from the cable protection will also be very small.

6.7.3.32 The extent of the cable protection measures does not constitute a continuous blockage along the cable route corridor. Cable protection will only be used on up to 20% of the export cable length (20% of 130 km = 26 km) and up to 10% of the inter-array and interconnector cable length (10% of 275 + 15 km = 29 km).

6.7.3.33 As stated in Table 6.5.1, changes to the sediment transport regime represent a potential impact pathway, rather than a physical processes receptor. Accordingly, no conclusion of impact significance is provided.

Scour of Seabed Sediments

6.7.3.34 The term scour refers here to the development of pits, troughs or other depressions in the seabed sediments around the base of WTG or OSP foundations. Scour is the result of net sediment removal over time due to the complex three-dimensional interaction between the foundation and ambient flows (currents and/or waves). Such interactions result in locally accelerated time mean flow and locally elevated turbulence levels that also locally enhance sediment transport potential. The resulting dimensions of the scour features and their rate of development are, generally, dependent upon the characteristics of the:

- Obstacle (dimensions, shape and orientation);
- Ambient flow (depth, magnitude, orientation and variation including tidal currents, waves, or combined conditions); and
- Seabed sediment (geotextural and geotechnical properties).

6.7.3.35 Based on the existing literature and evidence base, an equilibrium depth and pattern of scour can be empirically approximated for given combinations of these parameters. Natural variability in the above parameters means that the predicted equilibrium scour condition may also vary over time on, for example, spring-neap, seasonal or annual time-scales. The time required for the equilibrium scour condition to initially develop is also dependant on these parameters and may vary from hours to years.

6.7.3.36 Each foundation type may produce different scour patterns and represent different realistic worst-case options depending upon the metric of interest (e.g. maximum scour footprint per foundation, maximum scour footprint within the entire Moray West Site area, maximum volume of eroded sediment per foundation and so on). Accordingly, scour assessment for EIA purposes is provided here for all of the foundation types (GBS, monopiles and jacket). Suction caisson foundations (for jackets and monopiles) have not been explicitly considered in the assessment below because these will fall within the envelope of change associated with the other two foundation types.

6.7.3.37 The concerns under consideration include the seabed area that may become modified from its natural state (potentially impacting sensitive receptors through habitat alteration) and the volume and rate of additional sediment resuspension that may occur as a result of scour. The seabed area directly affected by scour may be modified from the baseline (pre-development) or ambient state in several ways, including:

- A different (coarser) surface sediment grain size distribution may develop due to winnowing of finer material by the more energetic flow within the scour pit;
- A different surface character will be present if scour protection (e.g. rock protection) is used;
- Seabed slopes may be locally steeper in the scour pit; and
- Flow speed and turbulence may be locally elevated.

6.7.3.38 The magnitude of any change will vary depending upon the foundation type, the local baseline oceanographic and sedimentary environments and the type of scour protection implemented (if needed). In some cases, the modified seabed character within a scour pit may not be so different from the surrounding area. However, changes relating to bed slope and elevated flow speed and turbulence close to the foundation are still likely to apply. As such, depending upon the sensitivities of the particular ecological receptor, not all scouring necessarily corresponds to a loss of habitat. This is discussed further in Chapter 7 (Volume 2): Benthic & Intertidal Ecology.

Magnitude of the Change

6.7.3.39 In order to quantify the area of seabed that might be affected by scour, the following provides an estimate of the theoretical maximum depth and extent of scour. This assessment is based upon empirical relationships described in Whitehouse (1998) and is a summary of a more detailed assessment presented in Technical Appendix 6.3 (Volume 4): Physical Processes Impact Assessment. Consideration is also given to the monitoring evidence of scour pit development around foundations within other offshore wind farms. Importantly, the estimates of scour presented in this section are highly conservative as they assume an unlimited depth of erodible sediment and the absence of erosion resistant geology.

6.7.3.40 Results conservatively assume an unlimited depth of erodible sediment to be present, allowing the maximum equilibrium scour depths to form symmetrically around the perimeter of the structure. Derivative calculations of scour extent, footprint and volume assume an angle of internal friction = 32 degrees. Scour extent is measured radially from the structure's edge. Scour footprint therefore excludes the footprint of the structure itself. Scour pit volumes for monopile foundation structures are calculated, as the volume of an inverted truncated cone, minus the volume of the structure itself; scour pit volume for the jacket foundations are similarly calculated but as the sum of that predicted for each the corner piles.

6.7.3.41 In the following section, the term 'local scour' refers to the local response to individual structure members. 'Global scour' refers to a region of shallower, but potentially more extensive scour associated with a multi-member foundation resulting from the change in flow velocity through the gaps between members of the structure and turbulence shed by the entire structure. Global scour does not imply scour at the scale of the Moray West Site.

6.7.3.42 Key findings are summarised below:

- Scour development within the Moray West Site is expected to be dominated by the action of tidal currents;
- Of all of the WTG foundation options under consideration, a 15 m diameter monopile WTG and OSP foundation has the potential to cause the greatest equilibrium local scour depth (19.5 m), footprint (4,530 m^2) and volume (34,224 m^3), but only in areas where the seabed is potentially erodible by the action of scour to that depth;
- The greatest individual WTG foundation global scour footprint is associated with the larger (40 m base length) piled jacket WTG foundation (4,976 m^2), although with a relatively small average depth (1.4 m);
- For the Moray West Site as a whole, the greatest total foundation local scour footprint is associated with 62 WTG and two monopile OSP larger (15 m diameter) monopile foundations (289,920 m^2, equivalent to only approximately 0.11% of the Moray West Site area);
- For the Moray West Site as a whole, the greatest total WTG foundation global scour footprint is associated with 85 smaller (35 m base diameter) piled jacket WTG foundations and one larger piled jacket OSP foundation (355,163 m^2, equivalent to only approximately 0.16% of the Moray West Site area);
- In practice, some locations will have only a limited thickness of more easily erodible sediment overlying more erosion resistant subsoils which will naturally limit the maximum scour depth to less than the predicted value. The measured thickness of potentially mobile sediment in the Moray West Site varies from ~5 to 15 m in the west, up to 30 m in the east. The corresponding footprint and volume of seabed affected by scour would also be reduced, both for individual foundations and for the Moray West Offshore Wind Farm as a whole. The assessment of scour above conservatively assumes an unlimited depth of

mobile sediment and is therefore likely to be an overestimate of what could actually occur; and

- Scour protection would be used to protect the stability of foundations if necessary. Where scour protection is used, primary scour is unlikely to occur, although a small amount of secondary scour may develop at the edges of the scour protection. For monopile and piled jacket foundation types the footprint area of scour protection is similar to (or smaller than) the predicted footprint of local scour. For gravity base foundations, the footprint area of scour protection is larger than the predicted footprint of local scour for this foundation type (due to a relatively smaller predicted depth of scour) but more similar to that for monopiles. At most, the maximum footprint of scour protection is equivalent to only approximately 0.16% of the Moray West Site area (0.22% including the footprint of the foundations).

6.7.3.43 Scour depth can vary significantly under combined current and wave conditions through time (Harris *et al.*, 2010). Monitoring of scour development around monopile foundations in UK offshore wind farm sites suggests that the time-scale to achieve equilibrium conditions can be of the order of 60 days in environments where the seabed is relatively mobile (Harris *et al.*, 2010). These values account for tidal variations as well as the influence of waves. (Near) symmetrical scour will only develop following exposure to both flood and ebb tidal directions.

6.7.3.44 Under waves or combined waves and currents an equilibrium scour depth for the conditions existing at that time may be achieved over a period of minutes, whilst typically under tidal flows alone equilibrium scour conditions may take several months to develop.

6.7.3.45 The greatest influence on local scour depth would arise from the installation of scour protection. If correctly designed and installed, scour protection will essentially prevent the development of local primary scour as described in this section. The dimensions and nature of scour protection may vary between designs but, given its purpose, would likely cover an area of seabed approximately similar to the predicted extent of the scour.

6.7.3.46 Any elevation in SSC as a consequence of scour will be short lived, localised and within the range of natural variability.

6.7.3.47 As stated in Table 6.3.1, scour of seabed sediments represents a potential impact pathway, rather than a physical processes receptor. Accordingly, no conclusion of impact significance is provided.

6.7.4 Description of Pathway Changes During Decommissioning

6.7.4.1 The scope of decommissioning would comprise:

- Dismantling and removing the WTGs;
- Removal of WTGs and OSP foundations and substructures, with piled foundations removed just below the seabed; and
- Disconnecting inter-array and OSP interconnector cables – buried cables will be left in place. Any exposed sections of cable (e.g. following foundation / substructure removal) will be examined to determine whether they require removal or can be re-buried.

6.7.4.2 The turbines would be dismantled and removed from the site in a manner similar to that of their installation. The decommissioning phase may involve fewer activity types and discrete operations than the construction phase as elements of infrastructure such as piled foundations and electrical connections may be left in place. The approach to decommissioning will be reviewed in a Decommissioning Programme which will be prepared for the Development prior to construction and then updated for decommissioning, in line with the requirements of the Energy Act 2004.

Increases in SSC and Deposition of Disturbed Sediment to the Seabed within the Moray West Site and Offshore Export Cable Corridor

6.7.4.3 The following decommissioning activities could potentially give rise to increases in SSC and associated deposition of material with in the Moray West Site and the Offshore Export Cable Corridor:

- Removal of foundation structures (WTGs and OSP(s));
- Cutting off of monopiles or jacket foundation legs; and
- (Possible) removal of cables from the intertidal zone.

6.7.4.4 The removal of WTG and OSP(s) foundations is expected to result in some localised seabed disturbance accompanied by temporary increases in SSC. It is possible that jacket pin-piles could be left in situ although piles would probably be cut off a few metres below the seabed, causing a localised disturbance of the seabed and a temporary increase in SSC.

6.7.4.5 For the purposes of the EIA it has been assumed that all cables will be removed from the intertidal zone during decommissioning. It is probable that equipment similar to that which is used to install the cables could be used to reverse the burial process and expose the cables. Accordingly, the area of seabed impacted during the removal of the cables would be similar as the area impacted during the installation of the cables. Where cables have been buried using HDD, no additional drilling or disturbance of rock will be required, the cables will either be pulled through or cut off and left in-situ.

Magnitude of the Change

6.7.4.6 For all of the above, the changes in SSC and accompanying changes to seabed levels associated with decommissioning activities are expected to be similar to, or less than, that associated with construction. Further information is provided in the construction phase assessment (Section 6.8.2).

6.7.4.7 As stated in Table 6.5.1, change in SSC and accompanying changes to seabed levels represents a potential impact pathway, rather than a physical processes receptor. Accordingly, no conclusion of impact significance is provided.

6.8 Assessment of Potential Effects

6.8.1.1 Potential effects associated with the construction, operation and maintenance and decommissioning of the Development on physical processes and water quality receptors are discussed below. This assessment has been informed by information presented in the previous section (Section 6.7) on potential changes to physical processes (pathway impacts).

6.8.2 Potential Construction Effects

Impacts to Designated Marine Features (due to construction activities)

6.8.2.1 Construction activities are only considered likely to impact designated marine features within one tidal excursion of the Offshore Export Cable Corridor, which includes only a small part of the Moray Firth pSPA and the Southern Trench pMPA (as shown in Volume 3a - Figure 6.4.4). The planned activities offshore have the potential to affect the form and function of the seabed, only in these areas, by sediment disturbance.

6.8.2.2 Other designated marine features listed in Table 6.5.1 are too distant from the locations of foundation and cable installation activities in the Moray West Site and Offshore Export Cable Corridor to be potentially affected by any direct or indirect impacts on SSC, sediment deposition or disturbance of the seabed.

6.8.2.3 The cable will be installed offshore via trenching (using several techniques including ploughing and jetting), depending on the physical and environmental characteristics of the seabed locally. The cables will be buried to a depth of at least 1 m, potentially up to 3 m, depending on characteristics of the seabed.

6.8.2.4 The source/pathways via which morphological receptors in the Moray Firth pSPA and the Southern Trench pMPA designated areas could potentially be impacted during the construction phase mainly relate to the disturbance of sediments from cable burial activities, resulting in localised elevations in SSC and associated changes to seabed levels.

Magnitude of the Impact

6.8.2.5 Cable installation by open cut trenching is considered to represent the realistic worst case in terms of the potential to cause elevated levels of SSC and localised changes in seabed level during the construction phase. A detailed cable installation plan is not yet available, although it is reasonable to assume that an open cut channel may be created by either jetting, trenching by use of a tracked excavator or similar, or ploughing.

6.8.2.6 The potential impact of changes in SSC are summarised as follows:

- Jetting has the potential to cause the greatest volume of material to enter into suspension in the water column. Accordingly, this technique represents the maximum adverse scenario in terms of sediment dispersion;
- The magnitude of potential changes in SSC associated with cable burial by jetting is assessed in paragraph 6.7.2.6;
- Based on the sediment grab samples from the Moray West Offshore Cable Corridor the seabed is characterised by sands and gravels in varying proportions, which will likely form the majority of the sediment being disturbed (See Volume 3a - Figure 6.4.3). The Offshore Cable Corridor does not transect the deeper muddier parts of the Southern Trench pMPA bathymetric feature, but seabed sediment may also contain a higher proportion of fine material (up to 10-20%) where the Offshore Cable Corridor overlaps the designated areas. Sand and gravel sediment types (if disturbed to the point of resuspension) will redeposit rapidly to the seabed (in a matter of seconds to minutes) and will cause only a very localised and temporary effect on SSC. Any fines that are present may persist in suspension for longer, but only at relatively low concentrations due to the relatively low proportion of such sediment present; and
- In shallower parts of the pMPA located in, or near to, the Offshore Cable Corridor, the same sands and any fines present are likely to be also resuspended naturally by occasional storm events, generating a similar or even higher magnitude of naturally occurring SSC than the cable installation activity, but over much larger areas and longer durations.

6.8.2.7 The potential impact of changes in seabed levels are summarised as follows:

- Cable installation via trenching may result in the displacement of some sediment from the trench, forming a local trough or depression. Some of the displaced material will enter into suspension, although, in practice and by design, the majority is expected to remain in or immediately adjacent to the trench, forming a raised mound. Once the cables have been laid it is anticipated that sidecast material would be returned to the trench as backfill, thereby accelerating the natural processes of recovery;
- The dimensions of seabed level changes associated with the cable trench will depend upon several factors including the cable installation method, trench width, cable burial depth and the nature of the excavated material. For immediate use, the maximum trench dimensions are depth 3 m, width 3 m, with a ‘V’ shape profile. If left open for longer, a wider trench (order of 10 m) may be required to accommodate stable side slope angles. The displaced

sediment may form temporary side berms or a sidecast mound with comparable dimensions to the trench (above the seabed level); and

- The trenches and any sidecast mounds are expected to recover to a natural equilibrium state (through tidal currents and wave action) in time following completion of the works.

6.8.2.8 The magnitude of this impact is therefore found to be **low**.

Sensitivity of the Receptor

6.8.2.9 The sensitive receptors are the seabed habitats and water column stratification features that are designated in relation to the Moray Firth pSPA and the Southern Trench pMPA.

6.8.2.10 The designated habitats have a moderate to high capacity to accommodate the very localised, short duration and temporary nature of the effects, which are also likely to be often within the range of natural variability.

6.8.2.11 The receptor is, however, a designated feature of national level importance and so the sensitivity of the receptor is therefore considered to be **moderate**.

Significance of the Effect

6.8.2.12 The magnitude of the impact has been assessed as low, with the sensitivity of the receptor being moderate. Therefore, the significance of the effect on designated coastal features during the construction phase of the Development is minor, which is not significant in EIA terms.

<u>Impacts to Designated Coastal Geomorphological Features (due to construction activities)</u>

6.8.2.13 Construction activities are only likely to impact designated coastal geomorphological features within the export cable Landfall Area. The planned activities in the Landfall Area have the potential to locally impact the Dalradian geological exposures which form the rocky coastline in this area and which are designated as a SSSI.

6.8.2.14 Other designated marine and coastal geomorphological features listed in Table 6.4.1 are too distant (more than one tidal excursion distance) from the locations of foundation and cable installation activities in the Moray West Site and Offshore Export Cable Corridor to be potentially affected by any direct or indirect impacts on SSC, sediment deposition or disturbance of the seabed.

6.8.2.15 The OfTI export cable circuits will make landfall somewhere along the coast between Findlater Castle to Redhythe Point (see Volume 3a - Figure 6.8.1), located to the south of the Moray West Site, on the southern coast of the Moray Firth (see Volume 3a - Figure 6.4.1).

6.8.2.16 The coastline within the Landfall Area is generally characterised as exposed and north or northwest facing. The largest embayment in the Landfall Area is Sandend Bay. The beach in Sandend Bay is backed by a mixture of coastal defences, managed ground and mature vegetated sandy dunes, and is constrained by rocky headlands and underpinned by a bedrock platform.

6.8.2.17 The cable will be either installed via trenching (using several techniques including ploughing and jetting), or horizontal directional drilling (HDD), depending on the physical and environmental characteristics of the preferred landfall location. Where an HDD solution is required, this will involve drilling a deeper duct (typically more than 5 m below the beach or seabed surface) for the cable circuits from a nearby onshore location beneath the cliffs or beach area at the landfall, in an offshore direction to a sub-tidal location a few hundred meters from the coast. The export cable circuits will not be surface laid (and so will not be covered with cable protection) in the Landfall Area. Trenched cables will be buried to a depth of at least 1 m, potentially up to 3 m, depending on characteristics of the seabed.

6.8.2.18 There are a number of source/pathways via which morphological receptors in the Landfall Area could potentially be impacted:

- Direct disturbance of the designated rock features via the use of HDD; or
- Direct disturbance of the designated rock features during trenching.

6.8.2.19 The various impact sources set out above are considered in turn, within the following section. In the design envelope for the Development, the landward limit of the Landfall Area is defined as the Mean High Water Spring (MHWS) mark, however, for completeness, this assessment also considers the potential for impacts on the full extent of the intertidal area and associated coastline such as any beach hinterland, dunes or cliffs that might be affected by changes to the intertidal area. For the purposes of this assessment, the offshore limit of the Landfall Area is considered to be several hundreds of metres offshore (i.e. including the extent of any HDD works and beyond the 'depth of closure', i.e. the water depth beyond which mobile sediments do not normally interact with coastal beaches).

Magnitude of the Impact

6.8.2.20 If, and where, HDD techniques are used, a relatively small diameter borehole will be created sufficiently deep under the ground that it should not be exposed for at least the duration of the operational lifetime of the Development. Depending on the final engineering design, it is possible that the borehole will be made only through the softer overlying Quaternary sediments and may not penetrate or affect the designated rock features of the SSSI in any case.

6.8.2.21 If, and where, the HDD does pass through underlying hard rock geology (which may include the designated features of the SSSI), only the entry and exit holes would potentially be visible at some point during construction, but are likely to then be covered by mobile sediments during the operational lifetime of the Development. The subterranean borehole would only become exposed by weathering of the rock over geological timescales (many thousands of years or longer).

6.8.2.22 Where cable installation by open cut trenching is used, the depth of trenching would be limited by the presence of any underlying hard rock surfaces, i.e. only the overlying Quaternary (sand and gravel) sediments will be affected by trenching. Rock cutting would not be normally required. Rocks in the Landfall Area associated with the SSSI that are normally exposed will not be cut. Rocks that are normally buried under beach sediments may be cut if required, subject to agreement as part of the post consent cable landfall design assessment. Trenching may temporarily and locally expose the underlying rocky surface during construction but this would not adversely affect the designated features.

6.8.2.23 The magnitude of this impact is therefore found to be **negligible**.

Sensitivity of the Receptor

6.8.2.24 The sensitive receptor in the Landfall Area is the Dalradian geological exposures (i.e. the rock material of the coastline) which is within the Cullen to Stake Ness Coast SSSI.

6.8.2.25 The proposed methods for making landfall include trenching through the mobile sediments overlying the designated rocky features, and an option for HDD along part of the route, both of which would cause very limited or no direct or indirect damage to the designated feature.

6.8.2.26 The SSSI designated coastal margin features of the Landfall Area are rocky and (where present) any beach sands overly a hard rock platform which is not sensitive to changes in the distribution of mobile sediment or to local patterns of waves and currents. Therefore, there would be no potential for indirect long term change to the contextual geomorphological setting of the coastline or beaches in the Landfall Area as a whole.

6.8.2.27 The receptor is, however, a designated feature of national level importance and so the sensitivity of the receptor is therefore considered to be **moderate**.

Significance of the Effect

6.8.2.28 The magnitude of the impact has been assessed as **negligible**, with the sensitivity of the receptor being **moderate**. Therefore, the significance of effects on designated coastal features during the construction phase of the Development is **negligible**, which is not significant in EIA terms.

Impacts to Recreational Surfing Venues (due to construction)

6.8.2.29 A list of named surfing venues located within the far field study area is provided in Table 6.4.2 and their general distribution is shown in Volume 3a - Figure 6.4.4. The only surfing venue located within the Landfall Area that could be directly affected during the construction phase is Sandend Beach.

6.8.2.30 The nature of potential construction impacts at this location relate to disturbance of sediments during the local installation of the Offshore Export Cable, which is described in paragraph 6.8.2.1 *et seq*.

Magnitude of the Impact

6.8.2.31 The magnitude of potential impacts on sediments is described in paragraph 6.8.2.5 *et seq*. In summary, trenching works to bury cables may result in the local disturbance or displacement of sediment. This could potentially result in temporary and localised increases in SSC and changes to the seabed and / or beach level. Potential effects on SSC are likely to naturally recover over very short time periods (in the order of minutes to hours). Potential effects on seabed level (due to trenching) would be initially reversed to some extent by the engineering works (by backfilling the trench) and will then recover to a natural equilibrium state over time (faster during larger wave conditions). Where used, HDD will remove the need for surface trenching and will therefore avoid potential impacts on SSC and seabed levels.

6.8.2.32 No significant sediment volume is proposed to be removed from within Sandend Bay as part of the proposed cable installation activities and therefore the future size and shape of any local naturally occurring seabed sedimentary features will not be affected. It is noted that the bedrock platform underlying Sandend Bay which may also control the shape and location of certain seabed features will also not be affected.

6.8.2.33 Other than the temporary local presence of any cable installation equipment, which will have only a very limited temporary, effect on physical processes, there will be no measurable effect of the Development on waves in Sandend Bay during the construction phase. The effect of the Development on waves at all surfing venues during the operational phase is addressed separately in paragraph 6.8.3.29 *et seq*.The magnitude of the potential impacts described above will be noticeable but temporary and localised. The magnitude of the impact is therefore assessed to be **low**.

Sensitivity of the Receptor

6.8.2.34 The receptor has a moderate to low capacity to accommodate the proposed form of change and is not designated but is of regional level importance. The sensitivity of the receptors is therefore found to be **moderate**.

Significance of the Effect

6.8.2.35 The magnitude of the impact has been assessed as **low**, with the maximum sensitivity of the receptor being **moderate**. Therefore, the significance of effects on recreational surfing venues during the operation phase of the Development is **minor**, which is not significant in EIA terms.

Impacts to Smith Bank (due to construction activities)

6.8.2.36 Smith Bank is not designated for protection with respect to any of its physical features and therefore is not directly sensitive to any changes resulting from the above impacts, but the form and function of the seabed could be modified on a local, short-term basis.

6.8.2.37 Potential impacts to Smith Bank during the construction stage relate to:

- Deposition of disturbed sediments to the seabed due to seabed dredging prior to foundation installation (the nature and magnitude of this potential impact is summarised in paragraph 6.7.2.7 and in more detail in Technical Appendix 6.3 (Volume 4): Physical Processes Impact Assessment);
- Deposition of disturbed sediments to the seabed due to the release of drill arisings during foundation installation (the nature and magnitude of this potential impact is described in paragraph 6.7.2.7 and in more detail in Technical Appendix 6.3 (Volume 4): Physical Processes Impact Assessment);
- Direct disturbance of the seabed and deposition of disturbed sediments to the seabed due to cable installation within the Moray West Site and parts of the Offshore Export Cable Corridor on Smith Bank (the nature of this potential impact is described in paragraph 6.7.2.7 and in more detail in Technical Appendix 6.3 (Volume 4): Physical Processes Impact Assessment); and
- Indentations left on the seabed by jack-up vessels and large anchors (the nature and magnitude of this potential impact is described in paragraph 6.7.2.11 *et seq.*).

Magnitude of the Impact

6.8.2.38 In summary, the range of potential impacts could cause:

- Localised deposits of disturbed sediment could form on the seabed surface. The shape, extent and thickness of deposits cannot be predicted accurately and will naturally vary in any case. The limited volumes of material involved mean that the extent and thickness of deposits are jointly limited, i.e. the extent over which a given volume of sediment can accumulate to a certain thickness is limited, and, a more extensive deposit will be on average thinner and vice versa.
- The material being deposited from dredging or cable burial activities will have originated from the nearby seabed (within a few 100 m), so will likely be of similar sediment grain size distribution and would not necessarily change the nature of the seabed where it is deposited. Any redeposited sediment would immediately re-join the natural sedimentary environment and would be available for further transport at the naturally occurring ambient rate. As described in Table 6.6.1, the greatest seabed area that can be impacted by inter-array and interconnector cable installation is 4,350,000 m^2, which is equivalent to approximately 1.9% of the Moray West Site area (225 km^2). The magnitude of this impact is therefore considered to be **low**; and
- It is likely that indentations will be left in the seabed following construction due to the local penetration of jack-up legs and anchors. The shape and diameter of the indentations will correspond closely to the shape and size of the spud cans actually used, however, the depth of the indentations could vary depending on the vessel and local ground conditions. Indentations are likely to recover over time due to natural collapse under gravity and infilling by ambient sediment transport. Following an initial period of recovery, the seabed surface in the indentation is likely to be similar to that of the surrounding seabed. As described in Table 6.6.1, the greatest seabed area that can be impacted by a single use of jack-up spudcans at every foundation is 143,550 m^2, which is equivalent to approximately

0.06% of the Moray West Site area (225 km^2). The magnitude of this impact is therefore considered to be **low.**

6.8.2.39 The magnitude of this impact is therefore considered to be **low**.

Sensitivity of the Receptor

6.8.2.40 The potential impacts could affect the form and function of Smith Bank if and where the disturbance leads to a relatively large change (outside of the range of natural variability) in local or regional water depth, seabed sediment characteristics or sediment transport pathways. However, Smith Bank is not designated for protection with respect to any of its physical features and is considered to have a high capacity to accommodate the predicted changes in form and function described above.

6.8.2.41 The sensitivity of the receptor is therefore found to be **negligible**.

Significance of the Effect

6.8.2.42 The magnitude of the impacts described above has collectively been assessed as **low**, with the maximum sensitivity of the receptor being **negligible**. Therefore, the significance of effects on Smith Bank during the construction phase of the Development is **negligible**, which is not significant in EIA terms.

<u>Changes to Water Quality from Chemical Release</u>

Magnitude of the Impact

6.8.2.43 As identified within Chapter 7 (Volume 2): Benthic and Intertidal Ecology and Chapter 8 (Volume 2): Fish and Shellfish, the number of vessel movements expected as a result of construction activities is a maximum of 25 vessels at any one time in the Moray West Site and along the Offshore Export Cable Corridor during the construction period (36 months). Vessel and machinery movements are also anticipated within the intertidal area of the Landfall Area, in addition to a barge which may anchor in the intertidal zone.

6.8.2.44 Without any embedded mitigation, any pollution caused by the release of hydrocarbons or other pollutants from vessels or machinery could potentially be highly detrimental to the habitats, fish and shellfish communities that are present. The presence of hydrocarbons and other chemicals or toxic substances can result in mortality of all species as it is dispersed through the water column or deposited on the seabed. With the implementation of the embedded mitigation identified within Section 6.6.2, including the application of a Development specific EMP, a MPCP, MARPOL requirements and good vessel maintenance, the risk of pollution can be managed and minimised.

6.8.2.45 The magnitude of impact from an accidental release is considered to be of low frequency and very localised through the application of contingency plans / management systems. The physical processes assessment summarises that dispersal of sediment and other substances within the water will be localised and only have a restricted effect upon the baseline populations of fish and shellfish. For HDD activities, the drilling muds that are used are required to be environmentally friendly and only certain types such as bentonite are approved for use in intertidal / subtidal areas. As such the magnitude is identified as **low**.

Sensitivity of the Receptor

6.8.2.46 The water quality within the outer Moray Firth covering the Moray West Offshore Wind Farm is not given a water quality classification, however the inner waters are currently recorded as being in 'Good' status in 2016, and previously between 2007 and 2013 this was 'High' (https://www.sepa.org.uk/data-visualisation/water-classification-hub/. This indicates that the water quality is likely to be of a similar status within the Moray West Offshore Wind Farm and the Moray West OfTI.

6.8.2.47 The coastal waters within the vicinity of the Landfall Area are also recorded as being of 'Good' status (Section 6.4.2), with a history between 2007 and 2016 of fluctuating between 'Good' and 'High' status. The rivers that feed into the Moray Firth generally follow the pattern of being 'Good' to 'Moderate' status.

6.8.2.48 Although not designated, as the water quality is of a good standard both offshore and inshore, and supports a wide range of fish, shellfish and other invertebrate communities that are dependent upon good water quality and of regional to national importance (e.g. Atlantic salmon (*Salmo salar*), shellfish and other filter feeding species), the sensitivity level of the water quality is considered to be **moderate**.

Significance of the Effect

6.8.2.49 The overall effect on water quality from a chemical release is considered to be **minor** and not significant in terms of EIA

Changes to Water Quality from Contaminated Sediments

Magnitude of the Impact

6.8.2.50 Chapter 7 (Volume 2): Benthic and Intertidal Ecology provides detailed information on the level of contamination that has been identified as being present within the Development (Section 7.4.1). The results of heavy metal analysis for subtidal samples collected as part of site-specific surveys revealed that all heavy metals were found to be present at concentrations below acceptable guidelines, with no samples above UK Cefas Action Levels (ALs) limits, Dutch Quality Standards or Dutch/Canadian Sediment Quality Guideline standards. Polyaromatic Hydrocarbons (PAH) concentrations were also recorded as low and generally below the limit of detection (LOD) for the analytical tests although LODs for Acenaphthene, Acenaphthylene, Dibenzo(ah)anthracene were slightly higher than the Canadian total exceedance level (TEL) values. The same result was recorded for sediment samples collected within the intertidal area (taken from Sandend Bay) demonstrating no unacceptable or significant levels of contamination to be present (Volume 4 - Technical Appendix 7.2: Intertidal Survey Report).

6.8.2.51 As the physical processes assessment has shown that any dispersion of substances within the water column or settlement on the seabed during construction would be localised and temporary over a short-term, any contamination would remain localised to the construction works. As the survey sampling and analysis shows that there is no significant level of contamination present within the seabed in this localised area around the Development and areas where construction will occur, the magnitude of impact on water quality is considered to be **low**.

Sensitivity of the Receptor

6.8.2.52 As identified in Section 6.4.2, the water quality is currently considered to be 'Good' status within the outer Moray Firth and the inner Moray Firth (including the Landfall Area). If contaminants are present within a seabed (such as heavy metals or other toxins) and the seabed becomes disturbed through construction work, most of these contaminants will be released into the water column where they will become dispersed by currents and tidal movements. As the Moray Firth supports sensitive species of fish (including priority marine features (PMFs) such as herring (*Clupea harengus*), Atlantic salmon and sandeel species) and shellfish (such as scallops and *Nephrops*), any contaminants released into the marine and intertidal environments could potentially lead to mortality and/ or changes in populations (e.g. through poor recruitment). In light of this the sensitivity of the water quality to contaminants is considered to be **moderate**.

Significance of the Effect

6.8.2.53 The overall effect upon water quality as a result of potential release of contaminated sediment is considered to be **minor** and not significant in terms of EIA.

6.8.3 Potential Operation and Maintenance Effects

Changes to Water Quality from Chemical Release

6.8.3.1 The potential impacts arising during operation and maintenance will be the same as during construction, albeit at a reduced level due to lower levels of vessel and construction activity. Operational and maintenance activities will continue to require an element of construction works such as cable repairs or reburial and this will be undertaken by various types of vessels (at a reduced level of trips and frequency to those participating in construction). The risk of release or chemicals will remain the same and the embedded mitigation identified in Section 6.6.2 will remain relevant.

Magnitude of Impact

6.8.3.2 The magnitude of impact will be low, as identified in Sections 6.8.2.1 – 6.8.2.2.

Sensitivity of Receptors

6.8.3.3 The sensitivity of receptors will be moderate, as identified in Sections 6.8.2.3 – 6.2.8.5.

Significance of Effect

6.8.3.4 The overall effect will be **minor** and not significant in terms of EIA, as identified in Section 6.8.2.6.

Changes to Water Quality from Contaminated Sediments

6.8.3.5 The potential impacts arising during operation and maintenance will be the same as during construction, albeit at a reduced level due to lower levels of vessel and construction activity. Operational and maintenance activities will continue to require an element of construction works such as cable repairs or reburial and this will be undertaken by various types of vessels (at a reduced level of trips and frequency to those participating in construction). The risk of release or contaminated sediments will remain the same and the embedded mitigation identified in Section 6.6.2 will remain relevant.

Magnitude of Impact

6.8.3.6 The magnitude of impact will be **low**, as identified in Sections 6.8.2.7 – 6.8.2.8.

Sensitivity of Receptors

6.8.3.7 The sensitivity of receptors will be **moderate**, as identified in Section 6.8.2.9.

Significance of Effect

6.8.3.8 The overall effect will be **minor** and not significant in terms of EIA, as identified in Section 6.8.2.10.

Impacts to Designated Marine and Coastal Geomorphological Features (due to operation)

6.8.3.9 A list of all designated marine and coastal geomorphological features within the far field study area is provided in Table 6.4.1.

6.8.3.10 As discussed previously there is potential for the Moray West Offshore Wind Farm foundations (including WTGs and OSPs) to present a blockage to waves and currents, causing a reduction in wave height and current speed that might extend to the various designated marine and coastal geomorphological receptors identified in the Moray Firth. A persistent reduction in wave height or current speed of sufficient magnitude at these locations could cause a change to the normal form and function of the physical environment, both directly in terms of wave and current activity, and indirectly in terms of sediment transport, morphological evolution, locally generated SSC, and the strength or location of stratification front features. Such far field changes have the potential to affect any of the designated marine and coastal geomorphological features within the far field study area.

6.8.3.11 The Offshore Export Cable Corridor extends south from the Moray West Site, making landfall on the southern coast of the Moray Firth (see Volume 3a - Figures 6.4.1 and 6.8.1). The Offshore Export Cable Corridor transects the south eastern part of the Moray Firth pSPA, designated for habitats provided to a range of bird species, and the western edge of the Southern Trench pMPA. The presence of the cable and any cable protection in this offshore area has the potential to change the form and function of the seabed locally.

6.8.3.12 The coastline in the Landfall Area is generally characterised as an exposed northwest facing embayment. The beach is backed by a mixture of coastal defences, managed ground and mature vegetated sandy dunes. The beach is constrained by rocky headlands and underpinned by a bedrock platform. The Dalradian rock exposures of this coastline are designated as part of the Cullen to Stake Ness Coast SSSI.

6.8.3.13 Cables would be buried beneath the seabed offshore to a depth of at least 1 m and potentially up to 3 m depending on characteristics of the seabed. No cable protection will be used in nearshore areas close to the Landfall Area.

6.8.3.14 There are several source/pathways via which morphological receptors could potentially be impacted:

- Changes to the tidal or wave regimes affecting habitat conditions directly (including stratification fronts) or the sedimentary environment indirectly due to the presence of WTG and OSP foundations;
- The presence of cable protection leading to changes to sediment transport;
- Exposure of export cables leading to morphological change; and
- Coastal recession/instability, leading to exposure of cable infrastructure within the intertidal part of the Landfall Area.

6.8.3.15 The various impact sources set out above are considered in turn, within the following section. In the design envelope for the Development, the landward limit of the Landfall Area is defined as the Mean High Water Spring (MHWS) mark, however, for completeness, this assessment also considers the potential for impacts on the full extent of the intertidal area and includes any associated beach hinterland or dunes that might be affected by changes to the intertidal area. For the purposes of this assessment, the offshore limit of the Landfall Area is considered to be several hundreds of metres offshore (i.e. including the extent of any HDD works and beyond the 'depth of closure', i.e. the water depth beyond which mobile sediments do not normally interact with coastal beaches.

Magnitude of the Impact

6.8.3.16 The potential impact of WTG and OSP foundations has been assessed in relation to currents (in paragraph 6.7.3.1 *et seq.*) and waves (in paragraph 6.7.3.9 *et seq.*). The resulting impact on sediment transport has also been assessed (in paragraph 6.7.3.25 *et seq.*). The assessments found that:

- Changes to current speed and direction would not be measurable outside of the local wake from individual foundations. Any effects can only extend as far as one tidal excursion length and so would be largely confined to the extent of the Moray West Site;
- Wave height could be reduced by up to 6 to 14 % (0.25 to 0.68 m) within the Moray West Site, but only intermittently in other locations by some lesser amount due to wave recovery (up to 3-4% in the offshore part of designated areas and less than 1 to 2% (less than 0.1 m) in more distant or shallow coastal locations such as the Landfall Area. There would be no measureable change to wave period or direction. Waves must pass through the Moray West Site before interacting with the receptor for any impact to occur, which limits the proportion of time that any effect could be experienced at a given receptor location. The

change in wave height at designated sites would be small in both absolute and relative terms and is not considered likely to change the local wave climate beyond the range of natural variability;

- Due to the small magnitude of effect on waves and no change to currents, it is concluded that there will be no measurable change to the naturally occurring rates and directions of sediment transport (including levels of SSC) naturally occurring in the identified designated marine and coastal geomorphological feature sites. Therefore, there will also be no consequential change to the naturally occurring seabed type or onward morphological evolution of these sites; and
- Due to the very small magnitude and intermittent effect on waves and no change to currents, it is concluded that there will be no measurable change to the location, form or function of stratification fronts and features offshore of Fraserburgh (which are a designated feature of the Southern Trench pMPA). Potential impacts on designated and non-designated stratification fronts in the Moray Firth are separately assessed in more detail in paragraph Section 6.8.3.35 *et seq*.

6.8.3.17 The potential impact of cable protection measures (where used) was assessed previously in paragraph 6.7.3.31. In summary, whilst any effects may persist for the duration of the operational lifetime of the Development, the capacity of cable protection to cause blockage to sediment transport is fundamentally limited and is unlikely to cause any measurable effect other than very locally to the protection itself.

6.8.3.18 The potential impact of cable exposure leading to morphological change is summarised as follows:

- Following burial, the only way in which the cables could influence hydrodynamics and seabed/ intertidal morphology during operation would be if they became exposed as a consequence of natural morphological change (seabed level lowering to below the level of initial burial for trenched cables). If, and where, HDD techniques are used (in limited parts of the Landfall Area), the cable will be buried more than 5 m below the present day surface and so will likely remain buried throughout the lifetime of the Development without exposure;
- An understanding of the likely temporal variability in seabed level elevation throughout the lifetime of the Development is therefore required to inform the appropriate routing of cables as well as determination of appropriate target burial depths;
- The potential for future seabed variability in offshore parts of the Offshore Export Cable Corridor is not presently known with certainty but is likely to be limited given the low energy nature of the seabed bedforms and substrate types present;
- The potential for future seabed variability in Sandend Bay (the largest embayment within the Landfall Area) is assessed with consideration of the observed longer term morphological behaviour which has historically taken place. Available information from Scotland's National Coastal Change Assessment (Scottish Government *et al.,* 2017) suggests that at Sandend Bay, little horizontal movement in the position of the MHWS contour has occurred since the start of the 20th Century. The only exception to this general observation is in the west of the bay, associated with historic migration of Scattery Burn across the beach. The 'Future Look' provided in Scotland's National Coastal Change Assessment suggests that by 2050, the position of the MHWS will not have appreciably altered from present. The natural processes controlling the historically low levels of morphological variability in the Landfall Area described above will continue to act in the same way following installation of the cables and irrespective of any temporary local disturbance caused;

- Information on morphological variability, both offshore and in the Landfall Area, will be considered as part of the engineering assessment of cable burial depth, which will aim to minimise the risk of exposure. Appropriate consideration will also need to be given to the potential effects of climate change which is expected to lead to mean sea level rise;
- If the export cables are buried at a sufficient depth below the base of the mobile seabed material, the cables will have no potential to influence either hydrodynamics or seabed/ morphology;
- Although highly unlikely to occur, in the event that a section of a cable does become exposed through natural seabed or beach level change, it might then locally influence coastal processes and morphology (causing local scour) at a scale proportional to the diameter of the cable (order of a few tens of centimetres) and the length of the exposed section; and
- Where a cable does become exposed remedial action will be taken. Where sufficient sediment is present the exposed cable section may be mechanically reburied. In the unlikely scenario of cable exposure by significant beach erosion (which is possible but not expected), re-burial in sediment might not be possible and the exposed cable would need either a new rock-cut trench or armouring. This would be achieved using similar methods to that used for the initial installation, with similar potential impacts. Shorter sections of cable exposed by natural local erosion (e.g. during a storm event) may also become reburied through natural processes.

6.8.3.19 The potential impact of coastal recession, leading to exposure of cable infrastructure in the Landfall Area is summarised as follows:

- The cable transition pits and landward HDD exit pits will be located onshore of the intertidal area (above MHWS) and, given the relatively high stability of the coastline within the Landfall Area, are unlikely to be affected by coastline recession during the lifetime of the Development;
- Following consent, a separate cable landfall assessment will be undertaken to inform engineering design. This will take into consideration factors including land elevation, soil conditions and the latest available information regarding any future management policy at the exact location of the landfall.
- Due consideration will also be given to the potential influence of natural rates of recession and climate change (especially sea level rise) on coastal morphology; and
- If, and where, a cable does become exposed, the potential impact is described above in paragraph 6.8.3.17.

6.8.3.20 The two activity types are separately assessed below for magnitude.

6.8.3.21 If localised new rock-cutting or armouring to re-bury exposed cables was required in the event of significant beach erosion, this would result in a noticeable, localised change for the remaining duration of the Development that is largely restricted to the near field of the activity. The magnitude of this impact is therefore assessed to be **moderate**.

6.8.3.22 The magnitude of the other potential impacts described above (changes in sediment processes, tidal and wave regimes) are not discernable from background conditions. The magnitude of these impacts is therefore assessed to be **negligible**.

Sensitivity of the Receptor

6.8.3.23 The two activity types are separately assessed below for sensitivity.

6.8.3.24 Localised new rock-cutting or armouring to re-bury exposed cables in the event of significant beach erosion will only affect areas of rock (the receptors) that are normally covered by sediment and therefore are not designated features of the SSSI. These receptors have a high capacity to accommodate these localised impacts. The sensitivity of these receptors is therefore found to be **low**.

6.8.3.25 With respect to other impact types (changes in sediment processes, tidal and wave regimes), the receptors have the capacity to accommodate the very small magnitude of the assessed changes but are designated features of national importance and so the sensitivity of the receptors is therefore found to be **moderate**.

Significance of the Effect

6.8.3.26 The two activity types are separately assessed below for significance of effect.

6.8.3.27 The magnitude of the impact on the SSSI due to exposure and reburial of the cable has been assessed as **moderate** and the sensitivity of the receptor assessed as **low**. The significance of the effect is **minor**, which is not significant in EIA terms.

6.8.3.28 The magnitude of the impact on designated sites associated with changes in sediment and coastal processes, tidal and wave regimes was assessed as **negligible**, with the maximum sensitivity of the receptor being **moderate**. Therefore, the significance of the effect on designated marine and coastal geomorphological features during the operation phase of the Development is **minor**, which is not significant in EIA terms.

<u>Impacts to Recreational Surfing Venues (due to operation)</u>

6.8.3.29 A list of named surfing venues located within the far field study area is provided in Table 6.4.2 and their general distribution is shown in Volume 3a - Figure 6.4.4.

6.8.3.30 The nature of potential impacts on waves is described in paragraph 6.7.3.9 *et seq*. Potential impacts on water quality are assessed separately.

Magnitude of the Impact

6.8.3.31 The magnitude of potential impacts on waves is described in paragraph 6.7.3.15 *et seq*. In summary:

- Wave height could be reduced by up to 0.25 to 0.68 m locally within the Moray West Site, but only in the order of centimetres (less than 0.1 m) in comparison to a wave height in the order of several metres, i.e. only a small (not measurable) absolute and relative difference, at the locations of the (more distant) recreational surfing venues;
- There would be no measureable change to wave period or direction;
- Waves must pass through the Moray West Site before interacting with the receptor for any impact to occur, which further limits the proportion of time that any effect could be experienced at a given receptor location; and
- The change in wave height at recreational surfing venues would be small in both absolute and relative terms and is not considered likely to change the local wave climate beyond the range of natural variability.

6.8.3.32 The magnitude of the potential impacts described above are not discernible from background conditions. The magnitude of the impact is therefore assessed to be **negligible**.

Sensitivity of the Receptor

6.8.3.33 The receptor has a moderate to high capacity to accommodate the proposed form of change and is not designated but is of regional level importance. The sensitivity of the receptors is therefore found to be **moderate**.

Significance of the Effect

6.8.3.34 The magnitude of the impact has been assessed as **negligible**, with the maximum sensitivity of the receptor being **moderate**. Therefore, the significance of effects on recreational surfing venues during the operation phase of the Development is **negligible**, which is not significant in EIA terms.

Impacts to Stratification Fronts (due to operation)

6.8.3.35 Stratification is a naturally occurring seasonal hydrodynamic feature related to the distribution of sea water temperature and salinity, which influences the availability of nutrients, and the distribution and growth rates of pelagic flora and fauna.

6.8.3.36 Stratification fronts are weakly and seasonally present in the northern part of the outer Moray Firth (in association with stronger current speeds from the Pentland Firth) and offshore of Fraserburgh (associated with stronger offshore currents around this headland). The latter feature is designated as part of the Southern Trench pMPA, which is also assessed in terms of other relevant features in paragraph 6.8.3.9 *et seq.*

6.8.3.37 The tendency for stratification to develop is balanced against the ambient rate of turbulent mixing across the density gradient. Turbulence is developed at the seabed by friction with currents and at the water surface by friction with winds (and any wave breaking). As a result, stratification is more likely to develop in relatively deeper water areas, but may also occur in shallower areas with sufficiently low current speeds and exposure to winds and waves.

6.8.3.38 Stratification (as described above) is a horizontally orientated feature, characterised by vertical gradients in temperature, salinity and/or density. Fronts are vertically orientated features that develop at the transition between areas of stratified and non-stratified water. Fronts are also associated with (typically relatively enhanced) local patterns of nutrient distribution and ecosystem development. Fronts are relatively widespread features within the North Sea and (at certain times during the year) may extend for a distance of several hundred kilometres (e.g. Hill *et al*., 1993; 2005). The strength of a vertical front is also defined by the strength of the (horizontal) gradients in density (temperature and salinity). The position and strength of the vertical front may vary on timescales of weeks to months, and from year to year, due to differences in the factors controlling stratification, including: the rates of warming and fresh water input; the speed of tidal currents (neap vs spring); the short term wind and wave climate; and the balance of these factors in conjunction with the local water depth. The position of the vertical front is also variable on shorter timescales of hours to days as the water body containing the feature is advected back and forth by local (ebb and flood) currents.

6.8.3.39 As currents move water past the individual offshore wind farm foundations, a turbulent wake is formed. Within the turbulent wake, vertical mixing can be enhanced above ambient levels, which could potentially contribute to a local reduction in the strength of vertical stratification. This section considers the potential for foundations within the Moray West Site to influence regional-scale patterns of stratification and any resulting change in the location of fronts.

Magnitude of the Impact

6.8.3.40 A more detailed assessment of the potential for impacts to stratification and front is provided in Technical Appendix 6.3 (Volume 4): Physical Processes Impact Assessment. Based on the available evidence, weak vertical stratification (and so also the presence of any fronts) is expected to occur in or near to the Moray West Site at less than 40 days per year on average. When stratification is present, it is possible that foundations in the Moray West Site may cause some minor decrease in the strength of water column stratification within the array area.

6.8.3.41 Only a small proportion of water passing through the array area will actually interact with individual foundations, causing only partial and localised mixing of any stratification. Numerous repeat passes through the array area would be needed for an initially stratified body of water to become mixed; however, this is unlikely to happen due to displacement of the water body out of the array area over shorter time periods by residual tidal currents. It is therefore unlikely that water which is stratified entering the Moray West Site will become fully mixed.

6.8.3.42 Regional scale patterns of stratification in the Moray Firth and wider North Sea will be unaffected and will continue to be subject to natural processes and variability. The location and physical characteristics of fronts in the Moray Firth are therefore unlikely to be measurably affected and will remain within the range of natural variability.

6.8.3.43 The magnitude of the impact is therefore assessed to be **negligible**.

Sensitivity of the Receptor

6.8.3.44 Stratification and stratification fronts in the Moray Firth have a moderate to high capacity to accommodate the proposed form of change, some of which (in the Southern Trench pMPA) are designated features, and are therefore considered to be of district to regional level importance. The receptor is therefore considered to have a **moderate** sensitivity to potential impacts of the Moray West Offshore Wind Farm during the operational phase.

Significance of the Effect

6.8.3.45 The magnitude of the impact has been assessed as **negligible**, with the maximum sensitivity of the receptor being **moderate**. Therefore, the significance of effects on stratification fronts during the operation phase of the Development is **negligible**, which is not significant in EIA terms.

<u>Impacts to Smith Bank (due to operation)</u>

6.8.3.46 Potential impacts to Smith Bank during the operation stage relate to:

- Changes to the tidal and wave regimes and consequential changes to patterns of sediment transport (the nature of this potential impact is described in paragraph 6.7.3.25 *et seq.*);
- Changes due to scour of seabed sediments (the nature of this potential impact is described in paragraph 6.7.3.34 *et seq.*); and
- Changes due to the presence of foundations, foundation scour protection and cable protection (for inter-array, interconnector and export cables).

6.8.3.47 Smith Bank is not directly sensitive to any changes resulting from the above impacts, but the form and function of the seabed could be modified on a local basis, either continuously or intermittently throughout the operational lifetime of the Development.

6.8.3.48 Smith Bank is not designated for protection with respect to any of its physical features.

Magnitude of the Impact

6.8.3.49 The magnitude of potential impacts to Smith Bank during the operation stage are described in the following sections and paragraphs:

- Changes to the tidal and wave regimes and consequential changes to patterns of sediment transport (paragraph 6.7.3.28 *et seq.*);
- Changes due to scour of seabed sediments (paragraph 6.7.3.39 *et seq.*); and
- Changes due to the presence of foundations, scour protection and cable protection.

6.8.3.50 In summary, the range of potential impacts could cause:

- Negligible change to current speeds and minor changes to wave heights (but not wave period or direction) on the Smith Bank will result in little or no measurable change to the rate and direction of sediment transport. The magnitude of this impact is therefore found to be **negligible**;

- It is likely that scour pits will form in the seabed around the base of the foundations. The equilibrium dimensions of the scour pits has been estimated and reported. The actual dimensions of the scour pits may be limited in some locations by the limited depth of mobile sediment present. The scour pit will form a local depression with relatively steep slopes but does not necessarily imply a change in seabed type. The engineering risk presented by scour may be mitigated by the application of scour protection, which will largely prevent scour from forming. The magnitude of this impact is therefore found to be **low**; and
- The presence of foundations, scour protection and cable protection will change the form and function of the seabed locally within their footprint for the operational lifetime of the Development. As described in Table 6.6.1, the greatest seabed area that can be impacted by foundations is 496,509 m^2, the greatest seabed area that can be impacted by inter-array and interconnector cable protection is 43,500 m^2. The greatest total seabed area that can be impacted by this infrastructure is therefore 931,509 m^2, which is approximately 0.3% of the Moray West Site area (225 km^2). The magnitude of this impact is therefore found to be **low**.

Sensitivity of the Receptor

6.8.3.51 Smith Bank has a high capacity to accommodate the proposed form of change and is not designated for protection with respect to any of its physical features. The sensitivity of the receptor is therefore found to be **negligible**.

Significance of the Effect

6.8.3.52 The magnitude of the impacts described above has been assessed as either **negligible or low**, with the maximum sensitivity of the receptor being **negligible**. Therefore, the significance of effects on Smith Bank during the operation phase of the Development is **negligible**, which is not significant in EIA terms.

6.8.4 Potential Decommissioning Effects

6.8.4.1 The scope of decommissioning would comprise:

- Dismantling and removing the WTGs;
- Removal of WTGs and OSP foundations and substructures, with piled foundations removed just below the seabed; and
- Disconnecting inter-array and OSP interconnector cables – buried cables will be left in place. Any exposed sections of cable (e.g. following foundation / substructure removal) will be examined to determine whether they require removal or can be re-buried.

6.8.4.2 The turbines would be dismantled and removed from the site in a manner similar to that of their installation. The decommissioning phase may involve fewer activity types and discrete operations than the construction phase as elements of infrastructure such as piled foundations and electrical connections may be left in place. The approach to decommissioning will be reviewed in a Decommissioning Programme which will be prepared for the Development prior to decommissioning, in line with the requirements of the Energy Act 2004.

<u>Changes to Water Quality from Chemical Release</u>

6.8.4.3 The potential impacts arising during decommissioning are considered to be the same as during construction as a worst case scenario, albeit at a reduced level due to lower levels of vessel and construction activity. Decommissioning activities will require an element of construction works to remove structures above seabed and this will be undertaken by various types of vessels (at a reduced level of trips to those participating in construction and during a more condensed timeframe). The risk of release or chemicals will remain the same and the embedded mitigation identified in Section 6.6.2 will remain relevant.

Magnitude of Impact

6.8.4.4 The magnitude of impact will be low, as identified in Sections 6.8.2.1 – 6.8.2.2.

Sensitivity of Receptors

6.8.4.5 The sensitivity of receptors will be moderate, as identified in Sections 6.8.2.3 – 6.2.8.5.

Significance of Effect

6.8.4.6 The overall effect will be minor and not significant in terms of EIA, as identified in Section 6.8.2.27.

Changes to Water Quality from Contaminated Sediments

6.8.4.7 The potential impacts arising during decommissioning are considered to be the same as during construction, albeit at a reduced level due to lower levels of vessel and construction activity. Decommissioning activities will continue to require an element of construction works to remove structures above seabed and this will be undertaken by various types of vessels (at a reduced level of trips to those participating in construction and during a more condensed timeframe). The risk of release or contaminated sediments will remain the same and the embedded mitigation identified in Section 6.6.2 will remain relevant.

Magnitude of Impact

6.8.4.8 The magnitude of impact will be **low**, as identified in Sections 6.8.2.7 – 6.8.2.8.

Sensitivity of Receptors

6.8.4.9 The sensitivity of receptors will be **moderate**, as identified in Section 6.8.2.9.

Significance of Effect

6.8.4.10 The overall effect will be **minor** and not significant in terms of EIA, as identified in Section 6.8.2.31.

Impacts to Designated Marine and Coastal Geomorphological Features (due to decommissioning activities)

6.8.4.11 Decommissioning activities are only considered likely to impact designated marine features within one tidal excursion of the Offshore Export Cable Corridor, which includes only a small part of the Moray Firth pSPA and the Southern Trench pMPA (as shown in Volume 3a - Figure 6.4.4). The planned activities offshore have the potential to affect the form and function of the seabed, only in these areas, by sediment disturbance. Other designated marine and coastal geomorphological features listed in Table 6.4.1 are too distant from the locations of foundation and cable installation activities in the Moray West Site and Offshore Export Cable Corridor to be potentially affected by any direct or indirect impacts on SSC, sediment deposition or disturbance of the seabed.

6.8.4.12 The maximum adverse scenario in terms of the potential for impacts to marine and coastal feature receptors would be the removal of cables and / or cable protection, and the removal of cables and associated infrastructure in the Landfall Area. The removal of cables and infrastructure would cause very short-term morphological changes although these would be localised in nature and no greater in magnitude than for the construction phase.

Magnitude of the Impact

6.8.4.13 Should the cable system require removal at the end of its operational life, it will be removed through the same soils and sediments affected during installation. This process could result in short-term elevations in SSC and localised changes in seabed level (i.e. within the near-field). It is anticipated that the working areas for removal will also be restricted to the area used for installation; accordingly, any impacts would be no greater in magnitude than for the construction phase. Further information is provided in relation to the similar construction phase activity assessment (paragraph 6.7.2.1 *et seq.*).

6.8.4.14 If the cables are left in the seabed at the end of the Development lifespan, impacts will be the same as those described previously for the operation phase. Further information is provided in the operation phase assessment (paragraph 6.8.3.9 *et seq.*).

6.8.4.15 The magnitude of impact to the coast is predicted to be **low**. This assessment is based on the fact that any changes would be temporary and restricted to the near-field.

Sensitivity of the Receptor

6.8.4.16 The receptors have the capacity to accommodate the small magnitude of the assessed change but are designated features of national importance and so the sensitivity of the receptors is therefore considered to be **moderate**.

Significance of the Effect

6.8.4.17 The magnitude of the impact has been assessed as **low**, with the maximum sensitivity of the receptor being **moderate**. Therefore, the significance of effects on designated marine and coastal geomorphological features during the decommissioning phase is **minor**, which is not significant in EIA terms.

Impacts to Smith Bank (due to decommissioning activities)

6.8.4.18 Potential impacts to Smith Bank during the decommissioning stage relate to:

- Deposition of disturbed sediments to the seabed due to seabed disturbance by dredging or similar as part of foundation decommissioning (the nature of this potential impact is described in relation to the similar construction activity in paragraph 6.7.2.1 *et seq.*);
- Direct disturbance of the seabed and deposition of disturbed sediments to the seabed due to cable decommissioning within the Moray West Site and parts of the Offshore Export Cable Corridor on Smith Bank (the nature of this potential impact is described in relation to the similar construction activity in paragraph 6.7.2.1 *et seq.*); and
- Indentations left on the seabed by jack-up vessels and large anchors (the nature of this potential impact is described in relation to the similar construction activity in paragraph 6.7.2.11 *et seq.*).

6.8.4.19 Smith Bank is not directly sensitive to any changes resulting from the above impacts, but the form and function of the seabed could be modified on a local, short-term basis.

6.8.4.20 Smith Bank is not presently designated for protection with respect to any of its physical features. It is assumed that this will continue to be the case until the time of decommissioning.

Magnitude of the Impact

6.8.4.21 The magnitude of the potential impacts were assessed to be **low** in relation to similar construction activities in paragraph 6.8.2.38. Given that decommissioning activities will require either a similar or lesser duration and intensity of these activity types (depending on the agreed Decommissioning Plan), the magnitude of the impact will also be similar or less than that previously assessed.

Sensitivity of the Receptor

6.8.4.22 Smith Bank has a high capacity to accommodate the proposed form of change and is not designated for protection with respect to any of its physical features. The sensitivity of the receptor is therefore found to be **negligible**.

Significance of the Effect

6.8.4.23 The magnitude of the impacts has been assessed as **negligible to low**, with the maximum sensitivity of the receptor being **negligible**. Therefore, the significance of effects on Smith Bank during the decommissioning phase of the Development is **negligible**, which is not significant in EIA terms.

6.8.5 Summary of Development Specific Effects

6.8.5.1 Table 6.8.1 below summarises the results of the assessment of effects associated with the Development.

Table 6.8.1: Summary of Development Specific Effects

Potential Impacts	Receptor	Impact Magnitude	Sensitivity of Receptor	Effect Significance	Mitigation (in addition to embedded measures)	Residual Significance
Construction						
Increases in SSC and deposition of disturbed sediments to the seabed due to dredging for seabed preparation prior to foundation installation.	(Pathway not receptor)	N/A	N/A	N/A (marine processes receptors insensitive to change)	None	N/A
Increases in SSC and deposition of disturbed sediments to the seabed due to the release of drill arisings during foundation installation.	(Pathway not receptor)	N/A	N/A	N/A (marine processes receptors insensitive to change)	None	N/A
Increases in SSC and deposition of disturbed sediment to the seabed due to cable installation within the Moray West Site and Offshore Export Cable Corridor.	(Pathway not receptor)	N/A	N/A	N/A (marine processes receptors insensitive to change)	None	N/A
Indentations left on the seabed by jack-up vessels and large anchors.	(Pathway not receptor)	N/A	N/A	N/A (marine processes receptors insensitive to change)	None	N/A
Impacts to designated marine features (due to construction activities).	Designated marine features	Low	Moderate	Minor	None	N/A
Impacts to designated coastal geomorphological features (due to construction activities).	Designated coastal geomorphological features	Negligible	Moderate	Negligible	None	N/A

Table 6.8.1: Summary of Development Specific Effects						
Potential Impacts	**Receptor**	**Impact Magnitude**	**Sensitivity of Receptor**	**Effect Significance**	**Mitigation (in addition to embedded measures)**	**Residual Significance**
Impacts to recreational surfing venues (due to construction activities).	Recreational surfing venues	Low	Moderate	Minor	None	N/A
Impacts to Smith Bank (due to construction activities).	Smith Bank	Low	Negligible	Negligible	None	N/A
Changes to water quality from chemical releases.	Water quality	Low	Moderate	Minor	None	N/A
Changes to water quality from contaminated sediments.	Water quality	Low	Moderate	Minor	None	N/A
Operation and Maintenance						
Changes to the tidal regime.	(Pathway not receptor)	N/A	N/A	N/A (marine processes receptors insensitive to change)	None	N/A
Changes to the wave regime.	(Pathway not receptor)	N/A	N/A	N/A (marine processes receptors insensitive to change)	None	N/A
Changes to sediment transport and sediment transport pathways.	(Pathway not receptor)	N/A	N/A	N/A (marine processes receptors insensitive to change)	None	N/A
Scour of seabed sediments.	(Pathway not receptor)	N/A	N/A	N/A (marine processes receptors insensitive to change)	None	N/A

Table 6.8.1: Summary of Development Specific Effects						
Potential Impacts	**Receptor**	**Impact Magnitude**	**Sensitivity of Receptor**	**Effect Significance**	**Mitigation (in addition to embedded measures)**	**Residual Significance**
Impacts to designated marine and coastal geomorphological features (due to operation).	Designated marine and coastal geomorphological features	Moderate	Low	Minor	None	N/A
Impacts to recreational surfing venues (due to operation).	Recreational surfing venues	Negligible	Moderate	Negligible	None	N/A
Impacts to stratification fronts (due to operation).	Stratification fronts	Negligible	Low	Negligible	None	N/A
Impacts to Smith Bank (due to operation).	Smith Bank	Negligible or Low	Negligible	Negligible	None	N/A
Changes to water quality from chemical releases.	Water quality	Low	Moderate	Minor	None	N/A
Changes to water quality from contaminated sediments.	Water quality	Low	Moderate	Minor	None	N/A
Decommissioning						
Increases in SSC and deposition of disturbed sediment to the seabed within the Moray West Site and Offshore Export Cable Corridor.	(Pathway not receptor)	N/A	N/A	N/A (marine processes receptors insensitive to change)	None	N/A
Impacts to designated marine and coastal geomorphological features (due to decommissioning activities).	Designated marine and coastal geomorphological features	Low	Moderate	Minor	None	N/A

Table 6.8.1: Summary of Development Specific Effects						
Potential Impacts	**Receptor**	**Impact Magnitude**	**Sensitivity of Receptor**	**Effect Significance**	**Mitigation (in addition to embedded measures)**	**Residual Significance**
Impacts to Smith Bank (due to decommissioning activities).	Smith Bank	Negligible to Low	Negligible	Negligible	None	N/A
Changes to water quality from chemical releases.	Water quality	Low	Moderate	Minor	None	N/A
Changes to water quality from contaminated sediments.	Water quality	Low	Moderate	Minor	None	N/A

6.9 Assessment of Cumulative Effects

6.9.1.1 The approach to Cumulative Impact Assessment (CIA) is described in Volume 2, Chapter 5: EIA Methodology.

6.9.2 Projects Requiring Consideration with Respect to Cumulative Effects

6.9.2.1 The other activities or developments that could have cumulative effects on physical processes and water quality are considered to be limited. In addition, impacts upon physical processes will be localised and there is little likelihood of interaction of impact. Therefore, cumulative impacts considered here are with regard to loss of habitat and disturbance and are considered as additive impacts within the wider Moray Firth region in the vicinity of the Development.

6.9.2.2 The projects selected as relevant to the assessment of impacts to physical processes and water quality are based upon an initial CIA screening exercise, consulted upon with MS-LOT and SNH (Moray West (2017b). Each project, plan or activity has been considered and scoped in on the basis of effect–receptor pathway, data confidence and the temporal and spatial scales involved. In particular, projects are included that are within one tidal excursion distance, or that are reasonably likely to overlap spatially in terms of effect on waves. The specific projects scoped into this CIA are presented in Table 6.9.1.

Table 6.9.1: Projects for Cumulative Assessment

Development Type	Project	Status	Location	Data confidence assessment/ Phase
Offshore Wind Farm	Moray East (formerly Telford, Stevenson and MacColl wind farms)	Consent authorised	7.1 km from the Moray West Site	High - Third party project details published in the public domain and confirmed as being 'accurate'
Offshore Wind Farm	Beatrice Offshore Wind Farm	Under construction	0 km from the Moray West Site (boundary shared)	High - Third party project details published in the public domain and confirmed as being 'accurate'
Oil and gas	Decommissioning of the Beatrice Oil Field and Demonstrator Turbines	Scoping	0 km from the Moray West Site (boundary shared)	Production Ceased The decommissioning EIA is currently underway. Plugging of the wells has already commenced. Decommissioning of the main structures (four platforms, pipelines and demonstrator turbines) is expected to occur between 2024 and 2027.

6.9.3 Cumulative Pathway Changes and Effects during Construction

6.9.3.1 Construction of the Moray East (Telford, Stevenson and MacColl) Offshore Wind Farm is due to commence in 2019 for completion in 2021. The Beatrice Offshore Wind Farm, which began construction in 2017, is expected to become fully operational in 2019. Decommissioning of the Beatrice Oil Field is expected to occur between 2024 and 2027 (Repsol Sinopec, 2017).

6.9.3.2 Given that the construction of the Moray West Offshore Wind Farm is not planned to commence until 2022, spanning 36 months and ending in 2024, there will be no temporal overlap of the construction phases of these projects. Given the highly spatially localised nature of predicted pathway changes and potential impacts on physical processes receptors, and lack of temporal overlap there is no requirement to consider potential cumulative pathway changes or impacts on physical processes receptors associated with construction activities for any of these projects. Similarly, in the absence of any likelihood of overlapping decommissioning activity, cumulative decommissioning effects are not considered further.

6.9.3.3 It is not considered that there will be any cumulative effects in relation to water quality as the potential for changes to water quality are identified as being localised in nature, temporary and short term and none of the identified projects will physically overlap with the Development. Cumulative water quality effects did not require assessment for Moray East or the Beatrice Offshore Wind Farm and are not therefore not assessed for the Development.

6.9.4 Cumulative Physical Processes Pathway Changes during Operation

<u>Changes to the Tidal Regime</u>

6.9.4.1 The nature of potential changes to the tidal regime is described in paragraph 6.7.3.1 *et seq.*

Magnitude of the Change

6.9.4.2 The magnitude of potential changes to the tidal regime due to the presence of the Moray West Offshore Wind Farm alone is described in paragraph 6.7.3.3 *et seq.*

6.9.4.3 To quantify the likely magnitude and extent of interaction between the tidal regime and the operational Moray West, Moray East and Beatrice Offshore Wind Farms, the same numerical tidal model (described in Technical Appendix 6.2 (Volume 4): Physical Processes Numerical Modelling) was used to simulate representative seastate conditions for both baseline and the cumulative 'with Development' scenario.

6.9.4.4 The potential cumulative impact of the Moray West, Moray East and Beatrice Offshore Wind Farms on tidal currents during a representative mean spring tidal cycle is shown in Volume 3a - Figure 6.9.1. Results for neap tidal range conditions are proportionally smaller (around half) than that reported here for spring tides. The results show that:

- The maximum magnitude of effect on tidal water levels in any location and at any time during a typical spring-neap tidal cycle is less than 0.001 m;
- The maximum magnitude of effect on tidal current speed in any location and at any time during a typical spring-neap tidal cycle is less than 0.02 m/s (in the Moray East Site) and less than 0.01 m/s in the Moray West Site;
- No consistent measureable effect on tidal current direction is expected in any location and at any time during a typical spring-neap tidal cycle; and
- Given the similarity in processes, a similar (low) order of effect on non-tidal (surge) water levels and current speeds and directions is inferred.

6.9.4.5 As stated in Table 6.5.1, changes to the tidal regime represent a potential impact pathway, rather than a physical processes receptor. Accordingly, no conclusion of impact significance is provided.

<u>Changes to the Wave Regime</u>

6.9.4.6 The nature of potential changes to the wave regime is described in paragraph 6.7.3.9 *et seq.*

Magnitude of the Change

6.9.4.7 The magnitude of potential changes to the wave regime due to the presence of the Moray West Offshore Wind Farm alone is described in paragraph 6.7.3.9 *et seq.*

6.9.4.8 To quantify the likely magnitude and extent of interaction between the wave regime and the operational Moray West, Moray East and Beatrice Offshore Wind Farms, the same numerical wave model (described in Technical Appendix 6.2 (Volume 4): Physical Processes Numerical Modelling) was used to simulate representative sea state conditions for both baseline and the cumulative 'with Development' scenario.

6.9.4.9 The potential cumulative effect of the Moray West, Moray East and Beatrice Offshore Wind Farms on significant wave height during a 1:1, 1:10 and 1:50 year return period sea state is shown in Volume 3a - Figure 6.9.2, Figure 6.9,3 and Figure 6.9.4, respectively. The results of the modelling show that:

- The maximum local reduction in wave height within the three site boundaries would vary between 0.35 and 0.85 m, or 7 to 12% of the local baseline wave height, depending on the wave direction and return period (based on the 8 directions and 3 return periods tested). It should be noted that the largest proportional reduction is not necessarily associated with the largest absolute reduction in wave height. The greatest absolute effects would be on the largest waves that also pass through the long axis of the three Sites (i.e. from 45 and 90 °N). The highest proportional effects would be on largest waves from the southwest and west (215 and 270 °N) while the smallest proportional effects would be on waves from the southeast (125 °N);
- The area of maximum effect on wave height in every case would be relatively small (length scale of order 1 km^2) and would be located where waves have transitioned through the greatest width of the three Sites in that orientation;
- The effect would gradually develop from no effect at the upwind edge of the three Sites to the maximum value in proportion to the distance travelled through the Site, i.e. 50% of the Site area will experience less than 50% of the maximum level of effect, and 25%, less than 25% of the maximum effect, etc;
- Behind the Moray West Site, any near-field reduction in wave height would recover towards ambient values at a non-linear rate (i.e. recovering quickly over small distances but smaller magnitude effects can persist over greater distances). These residual effects would extend in the direction of wave travel (with some lateral spreading);
- The maximum local reduction in wave height at any of the adjacent coastlines within the Moray Firth (including the various designated coastlines and surfing venues in the area) would be in the order of centimetres (less than 0.1 m) in comparison to a wave height in the order of several metres, i.e. only a small (not measurable) absolute and relative difference. Only a limited area of coastline downwind of the Moray West Site would be affected at all at any one time. The time that waves might come from any particular direction (and therefore the area of coastline potentially affected) is limited (details in Technical Appendix 6.1 (Volume 4): Physical Processes Baseline);
- The maximum local effect on wave period in all cases considered would be less than one second. The spatial pattern of the effect is not well defined, would recover with distance from the Moray West Site, and the small magnitude of the effect would not be measurable in practice; and
- There would be no measurable effect on instantaneous wave direction in the near- or far-field.

6.9.4.10 As stated in Table 6.5.1, changes to the wave regime represent a potential impact pathway, rather than a physical processes receptor. Accordingly, no conclusion of impact significance is provided.

Changes to Sediment Transport and Sediment Transport Pathways

6.9.4.11 The nature of potential changes to the tidal regime is described in paragraph 6.7.3.1 *et seq.* The nature of potential changes to the wave regime is described in paragraph 6.7.3.25 *et seq.*

Magnitude of the Change

6.9.4.12 The magnitude of cumulative effects on the tidal regime is described in paragraph 6.9.4.2 *et seq.* The magnitude of cumulative effects on the wave regime is described in paragraph 6.9.4.7 *et seq.* In term of consequential effects on sediment transport, the magnitudes of cumulative effect on the tidal and wave regimes are effectively the same those previously reported for the Moray West Offshore Wind Farm alone.

6.9.4.13 The resulting magnitude of cumulative effect on sediment transport and sediment transport pathways is therefore the same as previously reported for the Moray West Offshore Wind Farm alone (paragraph 6.7.3.28 *et seq.*).

6.9.4.14 As stated in Table 6.5.1, changes to the sediment transport represent a potential impact pathway, rather than a physical processes receptor. Accordingly, no conclusion of impact significance is provided.

6.9.5 Cumulative Impacts on Physical Processes Receptors and Water Quality

Impacts on Water Quality from Chemical Release

Magnitude of the Impact

6.9.5.1 There is potential for the accidental release of pollutants from vessels involved in maintenance activities for both BOWL and Moray East offshore wind farms, and vessels involved in the decommissioning of the Beatrice Oil Field. There is also potential for localised leakages of fluids and lubricants used in the WTGS and OSPs and accidental spills or chemical releases associated with decommissioning activities at the Beatrice Oil Field. However, these projects will all have appropriate measures in place (such as Marine Pollution Contingency Plans) to manage the use of chemicals and other potentially polluting substances and mitigate the risk of an accidental pollution release. The adjacent wind farms will also utilise bunding within offshore installations and so risk of accidental release is likely to be a result of operational and maintenance vessels only. It is extremely unlikely that there would be multiple spills resulting from operation and maintenance activities from Moray West and adjacent projects that would result in cumulative effects given the proposed control measures that will be implemented.

6.9.5.2 Provided published guidelines and best working practices are adhered to, the likelihood of accidental spills are extremely low and, in the event of a spill, the volumes of potential contaminants released would be small and rapidly dispersed thus minimising the likelihood of cumulative effects. The magnitude of any impact is considered to be **low**.

Sensitivity of the Receptor

6.9.5.3 Sensitivity of the receptors will be **moderate** as identified in 6.8.2.3-6.2.8.5.

Significance of the Effect

6.9.5.4 The magnitude of the impact has been assessed as **low**, with the maximum sensitivity of the receptor being **moderate**. Therefore, the significance of the effect of accidental chemical release on water quality is **minor**, which is not significant in EIA terms.

Changes to Water Quality from Contaminated Sediments

Magnitude of the Impact

6.9.5.5 Although there is potential for disturbance of contaminated sediment as a result of activities associated with decommissioning of the Beatrice Oil Field, there is very limited potential for sediment disturbance during operation of the Moray West Offshore Wind Farm, or the BOWL and Moray East offshore wind farms. As noted above, all projects will be required to implement specific measures to minimise the risk of an accidental release of contaminated sediment. The potential magnitude of any impact will therefore be **low**.

Sensitivity of the Receptor

6.9.5.6 Sensitivity of the receptors will be **moderate** as identified in 6.8.2.3-6.2.8.5.

Significance of the Effect

6.9.5.7 The magnitude of the impact has been assessed as **low**, with the maximum sensitivity of the receptor being **moderate**. Therefore, the significance of the effect of accidental chemical release on water quality is **minor**, which is not significant in EIA terms.

Impacts to Designated Marine and Coastal Geomorphological Features (due to operation)

6.9.5.8 The nature of potential impacts to designated marine and coastal geomorphological features is described in paragraph 6.8.3.9 *et seq.*

Magnitude of the Impact

6.9.5.9 The magnitude of cumulative effects on the tidal regime is described in paragraph 6.9.4.2 *et seq.* The magnitude of cumulative effects on the wave regime is described in paragraph 6.9.4.7 *et seq.* The resulting magnitude of cumulative effect on sediment transport is described in paragraph 6.9.4.12 *et seq.*

6.9.5.10 The overall magnitude of the impact on marine and coastal geomorphological features has therefore been assessed as **negligible**.

Sensitivity of the Receptor

6.9.5.11 The receptors have the capacity to accommodate the very small magnitude of the assessed change but are designated features of national importance and so the sensitivity of the receptors is therefore found to be **moderate**.

Significance of the Effect

6.9.5.12 The magnitude of the impact has been assessed as **negligible**, with the maximum sensitivity of the receptor being **moderate**. Therefore, the significance of effects on designated marine and coastal geomorphological features during the operation phase of the Development is **negligible**, which is not significant in EIA terms.

Impacts to Recreational Surfing Venues (due to operation)

6.9.5.13 The nature of potential impacts to waves at recreational surfing venues is described in paragraph 6.7.3.9 *et seq.*

Magnitude of the Impact

6.9.5.14 The magnitude of potential cumulative impacts on waves is described in paragraph 6.9.4.7 *et seq.* In summary:

- Wave height could be reduced by up to 0.35 to 0.85 m within the Moray West, Moray East and Beatrice Sites, but only in the order of centimetres (less than 0.1 m) in comparison to a wave height in the order of several metres, i.e. only a small (not measurable) absolute and relative difference, at the locations of the (more distant) recreational surfing venues;

- There would be no measureable change to wave period or direction;
- Waves must pass through more than one of the three offshore wind farm sites before interacting with the receptor for any cumulative impact to occur, which further limits the proportion of time that any cumulative effect could be experienced at a given receptor location; and
- The change in wave height at recreational surfing venues would be small in both absolute and relative terms and is not considered likely to change the local wave climate beyond the range of natural variability.

6.9.5.15 The magnitude of the potential impacts described above at recreational surfing venues is not discernible from background conditions. The magnitude of the impact is therefore assessed to be **negligible**.

Sensitivity of the Receptor

6.9.5.16 The receptor has a moderate to high capacity to accommodate the proposed form of change and is not designated but is of regional level importance. The sensitivity of the receptors is therefore found to be **moderate**.

Significance of the Effect

6.9.5.17 The magnitude of the impact has been assessed as **negligible**, with the maximum sensitivity of the receptor being **moderate**. Therefore, the significance of effects on recreational surfing venues during the operation phase of the Development is **negligible**, which is not significant in EIA terms.

<u>Impacts to Stratification Fronts (due to operation)</u>

6.9.5.18 The nature of potential impacts to stratification fronts is described in paragraph 6.8.3.35 *et seq.*

6.9.5.19 Stratification fronts are weakly and seasonally present in the northern part of the outer Moray Firth (in association with stronger current speeds from the Pentland Firth) and offshore of Fraserburgh (associated with stronger offshore currents around this headland). The latter feature is designated as part of the Southern Trench pMPA.

Magnitude of the Impact

6.9.5.20 The potential for cumulative changes to the tidal regime is described in paragraph 6.9.4.2 *et seq.* The resulting potential for change to stratification fronts is similar to that described in paragraph 6.8.3.40 *et seq.* Because of the very limited nature of these changes, the potential magnitude of associated impacts to stratification fronts is assessed to be **negligible**.

Sensitivity of the Receptor

6.9.5.21 Stratification and stratification fronts in the Moray Firth have a moderate to high capacity to accommodate the proposed form of change, some of which (in the Southern Trench pMPA) are designated features, and are therefore considered to be of district to regional level importance. The receptor is therefore considered to have a **moderate** sensitivity to potential cumulative impacts during the operational phase of the Development.

Significance of the Effect

6.9.5.22 The magnitude of the impact has been assessed as **negligible**, with the maximum sensitivity of the receptor being **moderate**. Therefore, the significance of effects on stratification fronts during the operation phase of the Development is **negligible**, which is not significant in EIA terms.

Impacts to Smith Bank (due to operation)

6.9.5.23 The nature of potential impacts to Smith Bank is described in paragraph 6.8.3.46 *et seq.*

Magnitude of the Impact

6.9.5.24 Smith Bank could potentially be impacted via changes in sediment transport, caused by modification of the wave and/or tidal regime. The potential for cumulative changes to the tidal regime is described in paragraph 6.9.4.2 *et seq.* whilst potential changes to the wave and sediment transport regimes are described in paragraph 6.9.4.7 *et seq* and 6.9.4.12 *et seq*, respectively. Because of the very limited nature of these changes, the potential magnitude of associated impacts to Smith Bank is assessed to be **low**.

Sensitivity of the Receptor

6.9.5.25 Smith Bank has a high capacity to accommodate the proposed form of change and is not designated for protection with respect to any of its physical features. The sensitivity of the receptor is therefore found to be **negligible**.

Significance of the Effect

6.9.5.26 The magnitude of the impact has been assessed as **low**, with the maximum sensitivity of the receptor being **negligible**. Therefore, the significance of effects on Smith Bank during the operation phase of the Development is **negligible**, which is not significant in EIA terms.

6.9.6 Cumulative Decommissioning Effects

6.9.6.1 Moray West is applying for consent for the Development for a period of 50 years, with the Development expected to be operational for approximately 35 years based depending on the design life of the various components. The operational phase of Moray East Offshore Wind Farm is consented for a period of 25 years, which will result in decommissioning starting in 2047. Beatrice Offshore Wind Farm also has an expected operational period identified within their draft Decommissioning Plan of 25 years, bring the start of decommissioning works to 2044. No overlap in decommissioning activities is therefore identified and as such there will be no cumulative effects resulting from decommissioning.

6.10 References

ABPmer (2017). Moray West Position Paper: Physical Processes Method Statement.

ABPmer (2012). Marine Scotland Licensing and Consents Manual, covering Marine Renewables and Offshore Wind Energy Development. http://www.gov.scot/Resource/0040/00405806.pdf.

ABPmer, Met Office and POL (2008). Atlas of UK Marine Renewable Energy Resources: Atlas Pages. A Strategic Environmental Assessment Report, March 2008. Produced for BERR. Report and associated GIS layers available at: http://www.renewables-atlas.info/.

Belderson, R.H., Johnson, M.A., Kenyon, N.H. (1982). Bedforms. In Stride, A.H. (ed) Offshore tidal sands. Processes and deposits. Chapman and Hall, London, 27-57.

BERR, (2008). Review of Cabling Techniques and Environmental Effects applicable to the Offshore Wind farm Industry.' Department for Business Enterprise and Regulatory Reform in association with Defra.

Beatrice Offshore Windfarm Limited (BOWL) (2012). Beatrice Offshore Wind Farm Environmental Statement.

British Geological Survey (BGS) (1987). Caithness 58N 04W sea bed sediments and Quaternary, 1:250,000 geological map.

BSI, (2015). Environmental impact assessment for offshore renewable energy projects. Standard number PD 6900:2015.

Cefas, (2011). Guidelines for data acquisition to support marine environmental assessments of offshore renewable energy projects. Cefas contract report: ME5403 – Module 15.

COWRIE, (2009). Coastal Process Modelling for Offshore Wind Farm Environmental Impact Assessment.

Defra, (2005). Nature Conservation Guidance on Offshore Wind Farm Development.

Department for Environment, Food and Rural Affairs (Defra), Centre for Environment, Fisheries and Aquaculture Science (Cefas) and Department for Transport (DfT), (2004). 'Offshore wind farms: guidance note for Environmental Impact Assessment in respect of Food and Environmental Protection Act (FEPA) and Coast Protection Act (CPA) requirements: Version 2'.

East Anglia Offshore Wind (2015). East Anglia THREE Environmental Statement Volume 1: Chapter 7 Marine Geology, Oceanography and Physical Processes. Document Reference – 6.1.7.

European Commission (2000). European Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy (Water Framework Directive).

European Commission (2008). European Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive).

Fugro-Emu, (2014). Review of environmental data associated with post-consent monitoring of licence conditions of offshore wind farms.' MMO Project No: 1031.

Harris, J.M., Whitehouse, R.J.S. and Benson, T. (2010). The time evolution of scour around offshore structures. Proceedings of the Institution of Civil Engineers, Maritime Engineering, 163, March, Issue MA1, pp. 3 – 17.

Her Majesty Stationary Office (HMSO) (2003). Water Environment and Water Services (Scotland) Act 2003.

HMSO (2009). The Water Environment (Controlled Activities) (Scotland) Regulations 2011. Scottish Statutory Instrument 2011 No. 209.

Hill, A.E, James,I.D., Linden,P.F., Mathews,J.P., Prandle,D., Simpson,J.H., Gmitrowicz, E.M.,Smeed, D.A.,Lwiza, K.M.M., Durazo,R., Fox,A.D., Bowers, D.G., Weydert, M., (1993). Dynamics of tidal mixing fronts in the North Sea. Philosophical Transactions: Physical Sciences and Engineering. Understanding the NorthSeaSystem, 431-446.

Hill, A.E., James, I.D., Linden, P.F., Matthews, J.P., Prandle, D., Simpson, J.H., Gmitrowicz, E.M., Smeed, D.A., Lwiza, K.M.M., Durazo, R. Fox, A.D. and Bowers, D.G., (2005). Dynamics of tidal mixing fronts in the North Sea. Philospohical Transactions: Physical Sciences and Engineering, 343, pp. 431-446.

Lowe J, Howard T, Pardaens A, Tinker J, Holt J, Wakelin S, Milne G, Leake J, Wolf J, Horsburgh K, Reeder T, Jenkins G, Ridley J, Dye S, Bradley S. (2009). UK Climate Projections Science Report: Marine and coastal projections. Met Office Hadley Centre: Exeter.

Marine Scotland (2017). The Marine Works (Environmental Impact Assessment) (Scotland) Regulations 2017 (As Amended). The Marine Works (Environmental Impact Assessment) Regulations 2007 (As Amended). Scoping Opinion for the Proposed Marine Licence Application for Moray West Offshore Transmission Infrastructure.

Moray East (2012). Moray East Offshore Wind Farm Environmental Statement.

Moray Firth Partnership (2007). Mary Firth Learning Zone website. Available at: http://www.morayfirth-partnership.org/waterquality.html [accessed March 2018].

Moray West (2016). Scoping Report for the Moray West Offshore Wind Farm.

Moray West (2017a). Scoping Report for the Moray West Offshore Transmission Infrastructure.

Moray West (2017b). Position Paper: Approach to Cumulative Impact Assessment.

Navitus Bay Development Ltd, (2014). Navitus Bay Wind Park Environmental Statement. Volume B – Offshore: Chapter 5 – Physical Processes. Document 6.1.2.5.

Office of the Deputy Prime Minister, (2001). Guidance on Environmental Impact Assessment in Relation to Dredging Applications, HMSO, London.

Partrac (2010). Metocean Survey reports and data for the Moray Firth Zone.

Surfers Against Sewage SAS (2009). Guidance on environmental impact assessment of offshore renewable energy development on surfing resources and recreation. https://www.sas.org.uk/wp-content/uploads/sas-guidance-on-environmental-impact-assessment.pdf (Accessed on 13/02/2018).

Scotland's Environment (2018). https://map.environment.gov.scot/sewebmap/ (Accessed March 2018).

Scottish Environment Protection Agency (SEPA) (2018). Water Framework Directive (WFD) classification hub. Available at: https://www.sepa.org.uk/data-visualisation/water-classification-hub/ (accessed March 2018).

Scottish Government *et al.* (2017). Scotland's National Coastal Change Assessment. http://www.dynamiccoast.com/. Accessed on 13/02/2018.

Scottish Government (2015). Scotland's National Marine Plan A Single Framework for Managing Our Seas. http://www.gov.scot/Resource/0047/00475466.pdf . Accessed on 15/02/2018.

Scottish Natural Heritage (2003). Marine Renewable Energy and the Natural Heritage: An Overview and Policy Statement.

Scottish Natural Heritage (2013). A handbook on environmental impact assessment Guidance for Competent Authorities, Consultees and others involved in the Environmental Impact Assessment Process in Scotland.

Soulsby, R. (1997). Dynamics of Marine Sands. Thomas Telford. pp249.

Sumer, B.M. and Fredsøe J. (1997). Hydrodynamics Around Cylindrical Structures. World Scientific.pp530.

Whitehouse, R.J.S., (1998). Scour at marine structures: A manual for practical applications. Thomas Telford, London, 198 pp.

Woolf, D. and Wolf, J. (2013). Impacts of climate change on storms and waves, MCCIP Science Review 2013, 20-26, doi:10.14465/2013.arc03.020-026.

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Chapter 7 Benthic and Intertidal Ecology

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Liability

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Acronyms	
Acronym	**Expanded Term**
BOWL	Beatrice Offshore Wind Farm Ltd.
CoCP	Code of Construction Practice
CPA	Coast Protection Act
CTVs	Crew Transfer Vessels
DDV	Drop Down Video
EDA	East Development Area
EIA	Environmental Impact Assessment
EMF	Electro-magnetic Field
EQS	Environmental Quality Standard
FEPA	Food and Environmental Protection Act
HRA	Habitats Regulations Appraisal
ICES	International Council for the Exploration of the Sea
IMO	International Maritime Organization
kV	Kilovolt
LOD	Limit of Detection
MarESA	Marine Evidence based Sensitivity Assessment
MarLIN	Marine Life Information Network
MHWS	Mean High Water Springs
MINNS	Marine Invasive Non-Native Species
MLWS	Mean Low Water Springs
MPA	Marine Protected Area
MS-LOT	Marine Scotland Licensing Operations Team
MSS	Marine Scotland Science
MW	Megawatt
NERC	Natural Environment and Rural Communities
OSP	Offshore Substation Platform
PAHs	Polyaromatic Hydrocarbons
PEMP	Project Environmental Management Plan
PMF	Priority Marine Features
PSA	Particle Size Analysis
RIAA	Report to Inform Appropriate Assessment
SEA	Strategic Environmental Assessment
SEPA	Scottish Environmental Protection Agency
SNH	Scottish Natural Heritage

Acronyms	
Acronym	**Expanded Term**
SSC	Suspended Sediment Concentrations
TEL	Threshold Effect Level
WTG	Wind Turbine Generator

7 Benthic and Intertidal Ecology

7.1 Introduction

7.1.1.1 This chapter considers the likely significant effects of the construction, operation and maintenance and decommissioning of the Moray West Offshore Wind Farm and associated Offshore Transmission Infrastructure (OfTI) ("the Development") on benthic and intertidal ecology.

7.1.1.2 The specific objectives of this chapter are to:

- Define the legislation, policy and guidance framework that is of relevance to benthic and intertidal ecology;
- Detail the consultation activities and responses that are relevant to, and have informed, this benthic and intertidal impact assessment;
- Describe the benthic and intertidal ecology baseline;
- Describe the assessment methodology and significance criteria used in completing the impact assessment;
- Describe the potential impacts, including direct, indirect and cumulative impacts;
- Describe the mitigation measures proposed to address likely significant effects; and
- Assess the residual effects remaining following the implementation of mitigation.

7.1.1.3 The assessment has been carried out by GoBe Consultants Limited. Appropriately qualified and experienced marine technical specialists from GoBe Consultants have completed the ecological impact assessment (EcIA) with reference to the Chartered Institute for Ecology and Environmental Management (CIEEM) guidance for the completion of marine Environmental Impact Assessment (EIA) (IEEM, 2010).

7.1.1.4 This chapter is supported by:

- EIA Report Volume 4 - Technical Appendix 7.1: Benthic Ecology Survey Report; and
- EIA Report Volume 4 - Technical Appendix 7.2: Intertidal Ecology Survey Report.

7.2 Legislation, Policy and Guidance Framework

7.2.1 Relevant Legislation

7.2.1.1 In undertaking the assessment, the following legislation has been considered:

- The Wildlife and Countryside Act 1981 (as amended);
- Conservation (Natural Habitats, &c.) Regulations 1994 (as amended in Scotland) and the Conservation of Offshore Marine Habitats and Species Regulations 2017 which transpose into UK Law Council Directive 92/43/EEC, on the conservation of natural habitats and of wild fauna and flora (EC Habitats Directive) (and Directive 2009/147/EC on the Conservation of Wild Birds);
- Nature Conservation (Scotland) Act 2004 (as amended);
- Natural Environment and Rural Communities (NERC) Act 2006;
- Marine (Scotland) Act 2010; and
- Wildlife and Natural Environment (Scotland) Act 2011.

7.2.2 Relevant Policy

7.2.2.1 The UK Marine Policy Statement (HM Government, 2011) sets out the framework for preparing marine plans and taking decisions affecting the marine environment. The Scottish Government has produced a National Marine Plan in accordance with these UK policies (Scottish Government, 2015). The plan covers the management of both Scottish inshore waters (out to 12 nm) and offshore waters (12 to 200 nm) and sets out the strategic policies for which management decisions will be made across the main marine sectors including general policies as well as specific policies for offshore wind and marine renewable energy. The following general policies apply to this benthic ecology and intertidal assessment:

- General Policy (GEN) 9 Natural heritage: Development and use of the marine environment must: (a) Comply with legal requirements for protected areas and protected species; (b) Not result in significant impact on the national status of Priority Marine Features (PMFs); and (c) Protect and, where appropriate, enhance the health of the marine area;
- GEN 10 Invasive non-native species: Opportunities to reduce the introduction of invasive non-native species to a minimum or proactively improve the practice of existing activity should be taken when decisions are being made; and
- GEN 13 Noise: Development and use in the marine environment should avoid significant adverse effects of man-made noise and vibration, especially on species sensitive to such effects.

7.2.2.2 Linked to General Policy 9 (above), Scotland has identified a list of 81 PMFs. These PMFs are species and habitats on existing conservation schedules that are considered to have a significant proportion of their population occur in Scotland's seas, and which are under threat or in decline. A number of benthic habitats and species have been identified as PMFs.

7.2.3 Relevant Guidance

7.2.3.1 The following guidance and publications have been used to inform the benthic and intertidal ecology impact assessment methodology:

- Cefas (2004). Offshore Wind Farms: Guidance Note for Environmental Impact Assessment in Respect of Food and Environmental Protection Act (FEPA) and Coast Protection Act (CPA) Requirements: Version 2;
- IEEM (Institute of Ecology and Environmental Management) (2010). Guidelines for Ecological Impact Assessment in Britain and Ireland. Marine and Coastal. Final Document, August 2010;
- European Union Guidance on wind energy development in accordance with the European Union nature legislation (EU, 2011);
- SNH guidance on Habitats Regulations Appraisal (HRA) of Plans (Tyldesley and Associates, 2010);
- Habitats Regulations Appraisal of Draft Plan for Offshore Wind Energy in Scottish Territorial Waters. Appropriate Assessment Information Review (Marine Scotland, 2011);
- SNH advice on marine non-native species (Available on-line at: https://www.nature.scot/professional-advice/land-and-sea-management/managing-coasts-and-seas/marine-non-native-species); and
- Guidance and publications from Scottish Natural Heritage (SNH) and Marine Scotland on Priority Marine Features (PMF) and Marine Protected Area (MPA) search features (SNH, 2012).

7.3 Consultation

7.3.1.1 Moray West has framed its assessment of potential impacts on benthic and intertidal receptors through formal scoping and consultation with key stakeholders.

7.3.1.2 Table 7.3.1 details the key issues raised in relation to benthic and intertidal ecology in the Moray West Offshore Wind Farm Scoping Opinion (August 2016) and the OfTI Scoping Opinion (August 2017). It also summarises other issues / concerns that have been raised during additional consultation activities undertaken as part of the EIA process and how these have been addressed in the preparation of this EIA Report.

Table 7.3.1: Summary of Consultation Relating to Benthic Subtidal and Intertidal Ecology

Consultee and Date of Response	Issue Raised	Moray West Approach
Scoping Responses on Moray West Offshore Transmission Infrastructure (OfTI)		
Marine Scotland Licencing Operations Team (MS-LOT) on behalf of Scottish Ministers (30/08/17) Marine Scotland Science (MSS) (30/08/17)	MSS request further data on the potential presence and distribution of the anemone *Arachnanthus sars*i.	*Arachnanthus sars*i was not found within any samples collected across the benthic or intertidal survey area. This species is therefore not assessed as part of this EcIA.
MS-LOT on behalf of Scottish Ministers (30/08/17) Scottish Natural Heritage (SNH) (06/07/17) MSS (30/08/17)	SNH, MSLOT and MSS have identified the need for the assessment to consider the following impacts: • Increased levels of water column suspended sediment and associated smothering effects on benthic species resulting from construction activities, in particular dredging required to prepare the seabed for OSP gravity base structure (GBS) foundations and cable installation (jetting and ploughing); • Habitat loss should be estimated for the worst-case scenario and potential changes in benthic communities reported; • Habitat change – assessment should consider any reef effects or changes in benthic communities arising from any scour protection used for the offshore export cable or the offshore substation foundation(s); and • Indirect effects on other receptors / prey species through changes to benthic communities.	The impacts of increased suspended sediments and sediment deposition (smothering) as a result of construction are considered within Section 7.7.2. Impacts of temporary and permanent habitat are assessed in Section 7.7.2 (Construction), Section 7.7.3 (Operation) and Section 7.7.4 (Decommissioning). Impacts of habitat change are considered within the operation assessment (Section 7.7.3). Indirect effects on other receptors are considered within other technical chapters of this EIA Report (see Chapters 8, 9 and 10: Fish and Shellfish Ecology, Marine Mammal Ecology, and Ornithology, respectively).
	SNH and MSLOT do not agree with proposals to scope out the following impacts:	The results of a sediment contamination study are presented within Section 7.4.2 for both the subtidal and intertidal areas

Table 7.3.1: Summary of Consultation Relating to Benthic Subtidal and Intertidal Ecology		
Consultee and Date of Response	**Issue Raised**	**Moray West Approach**
	• Accidental release of chemicals (buried contaminated material and from vessels) during construction (installation of substructures and cables) and during operation and maintenance (vessels); • Electromagnetic effects during operation; and • Seabed sediment heating from subsea cables during operation.	as well as within Technical Appendix 7.2. No contaminants were identified. Accidental release from infrastructure installation and from vessels is assessed for all stages of development. This is included within Section 7.7.2 (Construction), Section 7.7.3 (Operation) and Section 7.7.4 (Decommissioning). Both EMF and seabed sediment heating are considered within Section 7.7.3 (Operation).
Scoping Responses on Moray West Offshore Wind Farm		
MS-LOT on behalf of Scottish Ministers (15/08/16) Joint Nature Conservation Committee and SNH (date not specified) Marine Scotland Science (MSS) (30/08/17)	JNCC and SNH agreed with the approach for site -specific baseline surveys building on existing data and information.	Baseline subtidal benthic and intertidal surveys have been undertaken in line with the methods agreed with MS-LOT, MSS and SNH. Survey methods and results are described in Section 7.4 and Technical Appendices 7.1 and 7.2.
	SNH and JNCC recommended that the EIA Report clearly describes the biotopes recorded within the study area with reference also made to any PMFs. SNH and JNCC noted that Ocean Quahog (*Arctica islandica*), a Scottish PMF, is known to be present in the Moray Firth.	Section 7.4 and Technical Appendices 7.1 and 7.2 describe the baseline characteristics including detailed information on biotopes, PMFs and other sensitive species / habitats recorded. The occurrence of PMFs, including *A. islandica* is described in Section 7.4.2.
	SNH and JNCC requested that biotopes/habitat map should be used to inform the final wind farm layout, considering any potential use of scour protection.	Biotope mapping is provided within Technical Appendix 7.1. The mapping has been used to inform the initial layout considerations presented in the EIA Report and will be used to inform the detailed layout design during final design process (see Section 7.7.7 Additional Mitigation)
	SNH and JNCC requested that further consultation be undertaken to agree how gravity base foundations be considered in the ”worst case” assessment for benthic interests.	Chapter 4 provides information on the installation techniques under consideration and was developed through consultation with stakeholders. Table 7.6.1 presents the realistic WCS associated with the use of gravity base structures and an assessment of this included within Section 7.7.2 (Construction) and Section 7.7.3 (Operation).
	SNH and JNCC noted that disturbance to seabed habitats as a result of jack-up placement and the installation of cables may be permanent if rock dump is left	Table 7.6.1 presents the realistic WCS associated with jack-up placement and cable installation and an assessment of this is included within Section 7.7.2

Table 7.3.1: Summary of Consultation Relating to Benthic Subtidal and Intertidal Ecology		
Consultee and Date of Response	**Issue Raised**	**Moray West Approach**
	after being used to stabilise jack-up vessels and requested further dialogue to determine how this is addressed during EIA.	(Construction) and Section 7.7.3 (Operation) following the methodology set out in Chapter 5 which incorporate consideration of the duration of an impact into the assessment.
	SNH and JNCC requested that the approach to impact assessment be discussed following completion of the benthic survey work in order to agree the assessment methodology.	The results of the benthic survey work will be submitted to SNH (who are co-ordinating with JNCC) for review and discussion (Section 7.4.1.3). These results are presented with Technical Appendix 7.1.
	SNH and JNCC advised that potential mitigation measures should be discussed if significant impacts are likely.	Noted. No significant effects have been identified within Section 7.7 of this EIA Report.
	MSS requested that foundation types to be included in the WCS finalised as soon as possible noting that different design options will have different impacts on benthic species and habitats.	Noted. All potential installation and construction techniques have been identified in Chapter 4 of this EIA Report, with the realistic WCS being identified in Table 7.6.1 and assessed in Section 7.7.
	MSS noted that data is required to support the Scoping Report conclusion that increased suspended sediment concentrations would be within natural variability. MSS specifically requested the following information: • Data on local sediment types, locations and their silt content; • Information on potential particle suspension levels expected from dredging operations and modelling of dispersion plumes; • Estimate on accumulation rates and depths; and • Consideration of impact of smothering on sessile, slow-moving and burrowing organisms.	Assessments of increased suspended sediment levels during construction, operation and decommissioning are presented in Sections 7.7.2, 7.7.3 and 7.7.4. Data on sediment types, location and PSA analysis is presented in Technical Appendix 7.1 as well as within Section 7.4. Modelling and further information on plumes is provided within Chapter 6: Physical Processes and Water Quality. Smothering is assessed during all stages of development within Sections 7.7.2, 7.7.3 and 7.7.4.
	MSS requested that the following effects be scoped into the EIA: • Seabed Deposition of Sediment Arisings from Drilling of Jacket Piles and Dredge Material from Seabed Preparation; • Habitat and Associated Community Change; and	Seabed deposition of sediment is discussed alongside increased suspended sediment and smothering during all stages of development, including during installation of infrastructure (Sections 7.7.2, 7.7.3 and 7.7.4).

Table 7.3.1: Summary of Consultation Relating to Benthic Subtidal and Intertidal Ecology		
Consultee and Date of Response	**Issue Raised**	**Moray West Approach**
	• Effects on Physical Processes and Related Biological Changes.	Habitat and community changes are also assessed in Sections 7.7.2, 7.7.3 and 7.7.4. Physical Processes and associated changes are detailed within Chapter 6: Physical Processes and Water Quality, and the results of that modelling and assessment are considered within Section 7.7.2 and 7.7.3 in terms of potential biological changes.

7.4 Baseline Conditions

7.4.1 Baseline Characterisation Approach

Study Area

7.4.1.1 For the purposes of characterising benthic subtidal and intertidal ecology to inform the assessment of the Development, the study area is defined as:

- The Moray West Site: The 225 km^2 site within which the wind turbines, offshore platforms, inter-array cables and interconnector cables will be located (see Volume 3a - Figure 7.3.1);
- The Offshore Export Cable Corridor: which covers a total area of 235 km^2 between the Moray West Site and landfall location (up to Mean Low Water Springs (MLWS)) within which the export cables will be routed (see Volume 3a - Figure 7.3.1); and
- The Landfall Area: which comprises the intertidal area at the proposed Landfall Area, defined as the area between MLWS and Mean High Water Springs (MHWS) (see Volume 3a - Figure 7.3.2). The Landfall Area covers the coastline between Findlater Castle and Redhythe Point on the Aberdeenshire coastline.

Desktop Study

7.4.1.2 Information on the benthic subtidal and intertidal communities within the study area defined above was initially collected through a detailed desktop review of existing reports and datasets. A considerable amount of survey data and other relevant information has previously been acquired within the vicinity of the Development during baseline surveys of the Moray East Offshore Wind Farm and the Beatrice Offshore Wind Farm. In addition, Moray West holds geophysical survey data for a portion of the Moray West Site and Offshore Export Cable Corridor. Existing data sources that were drawn upon to inform the desktop study are summarised in Table 7.4.1.

Table 7.4.1: Existing Baseline Data Relevant to the Development Study Areas		
Dataset	**Coverage**	**Date of Survey**
Benthic Surveys - seabed sampling, video surveillance and scientific trawling (EMU Ltd, 2011)	Moray East Offshore Wind Farm	October 2010

Table 7.4.1: Existing Baseline Data Relevant to the Development Study Areas		
Dataset	**Coverage**	**Date of Survey**
Benthic Surveys - seabed video surveillance and seabed sampling (EMU Ltd, 2012)	Moray East Offshore Export Cable Corridor	July 2011
Benthic Surveys - seabed video surveillance and seabed sampling (Fugro EMU Ltd, 2014)	Moray East Offshore Wind Farm modified Offshore Export Cable Corridor	May 2014
Geophysical survey (Osiris Projects, 2011)	Moray West (coarse grid across the area with approximately 20% coverage)	May to July 2010
Benthic Surveys - seabed sampling, video surveillance and scientific trawling (CMACS Ltd., 2011)	Beatrice Offshore Wind Farm	October to November 2010
Benthic Surveys - seabed video surveillance and seabed sampling (CMACS Ltd, 2012)	Beatrice Offshore Wind Farm Offshore Export Cable Corridor	June 2011

Site Specific Studies

7.4.1.3 In order to provide an up-to-date characterisation of the habitats and species occurring within the Moray West Site and Offshore Export Cable Corridor it was agreed with the MS-LOT that site-specific surveys would be undertaken within the study area (as defined in paragraph 7.4.1.1). All survey scopes and methodologies were developed following consultation with MS-LOT and their advisors and followed standard procedures e.g. Marine Monitoring Handbook procedural guideline 3-9 (JNCC, 2001), Marine Aggregate Levy Sustainability Fund (MALSF) Guidelines for the Conduct of Benthic Studies at Marine Aggregate Extraction Sites (Ware and Kenny, 2011) and other standard guidelines (Limpenny *et al.*, 2010; DEFRA, 2004; Rees *et al.*, 1990; Proudfoot *et al.*, 2003; Cooper & Rees, 2002). Survey planning took into account the available geophysical data coverage of the Moray West Site (see Table 7.4.1 above; Osiris Projects, 2011).

7.4.1.4 Site-specific characterisation surveys were undertaken by suitably qualified marine ecologists from PMSL between May and June 2017, to characterise the benthic ecology throughout the study area (PMSL, 2017a). The survey comprised Drop Down Video (DDV) and benthic grabs (Fauna & particle size analysis (PSA)) at 80 locations within the Moray West Site; and DDV at 28 stations and benthic grabs for PSA at 12 locations along the Offshore Export Cable Corridor. Beam trawls were also collected from ten stations within the Moray West Site and Offshore Export Cable Corridor. In addition to this, contaminant samples were collected from ten locations across the Moray West Site & Offshore Export Cable Corridor (Figure 7.3.1).

7.4.1.5 A site-specific extended Phase 1 intertidal survey was carried out by PMSL in July 2017 in selected sections of the Landfall Area. At the time of survey and of preparation of this chapter, the precise location of landfall works within the Landfall Area was/is yet to be determined. Survey effort to date has therefore focused on the Sandend Bay area; the main stretch of soft sediment shore centrally located within the Landfall Area (PMSL, 2017b). Survey effort was focused in this way because soft sediment shorelines were considered likely to be most susceptible to potential disturbance impacts during cable installation works (noting that where cables are installed in areas of rocky shoreline, they will be installed beneath the surface of the rock by directional drilling methods). Should the final location of landfall works be outwith surveyed areas, it is recognised that there may be a requirement for further pre-construction intertidal survey to confirm the nature of the coastline and that no sensitive features are present (see Section 7.7.7).

7.4.1.6 The scope of the intertidal survey was agreed with MS-LOT. Standard Phase 1 survey methods were followed (Davies *et al.*, 2001; Wyn & Brazier, 2001; Wyn *et al*., 2000). Phase 2 samples were also collected using 0.01 m^2 cores from three transects across each landfall location (three samples were collected per transect to cover the upper, mid and lower shores) (Volume 3a - Figure 7.3.2).

Drop Down Video (DDV) Sampling

7.4.1.7 DDV methods followed standard procedures outlined in Coggan *et al*. (2007), Limpenny *et al*. (2010), and other appropriate guidance e.g. Marine Monitoring Handbook procedural guidance 3.5 (JNCC, 2001), MALSF Guidelines for the Conduct of Benthic Studies at Marine Aggregate Extraction Sites (Ware and Kenny, 2011). The survey utilised a combined video and digital stills camera system with an appropriate lighting system and strobe flash. Digital stills/HD frame grabs were taken at representative habitats at each site and the video system incorporated a laser scaling system (at approximately cobble size) to allow an assessment of scale for sedimentary/biological features.

7.4.1.8 A single drift was undertaken at each station although in some instance additional drifts were undertaken e.g. if conditions were poor or Annex I habitats were potentially present and the most representative video drift at each station subsequently analysed for habitat/species assessment.

7.4.1.9 An assessment of video footage was made in-situ to assess the potential for Annex I habitats (e.g. *Sabellaria spinulosa* reef or stony/cobble reef). These assessments were undertaken with reference to the currently available guidance notes i.e. Gubbay (2007) for potential *S. spinulosa* reefs, and Irving (2009) for potential stony/cobble reefs. At stony habitats, where there was potential for Annex I habitat, several video transects were often employed to clarify habitat type and at one station within the Moray West Site where Annex I stony reef was identified, additional transects either side of the target feature were employed to provide an assessment of the extent of the feature.

Benthic Grab Sampling

7.4.1.10 The benthic grab survey was carried out following standard procedures e.g. Marine Monitoring Handbook procedural guideline 3-9 (JNCC, 2001), MALSF Guidelines for the Conduct of Benthic Studies at Marine Aggregate Extraction Sites (Ware and Kenny, 2011) and other standard guidelines (Limpenny *et al*., 2010; DEFRA 2004; Rees *et al*., 1990; Proudfoot *et al*., 2003; Cooper & Rees, 2002). Single 0.1 m^2 mini-Hamon grab samples were taken at each sampling location to provide quantitative data on the benthic infaunal communities present and also information on the physical characteristics of the sediments present (PSA analysis).

7.4.1.11 Additional samples for contaminants were undertaken at ten stations using a 0.1 m^2 day grab with stainless steel jaws which allows an undisturbed surficial sediment sample to be taken. Contaminant samples were taken with the appropriate stainless steel or plastic scoop and transferred to appropriate containers for storage in a cool box/fridge prior to analysis. These were analysed for contaminants including metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, barium, aluminium and tin) and Polyaromatic Hydrocarbons (PAHs).

Beam Trawl Sampling

7.4.1.12 At each of the ten benthic trawl sample stations a 2 m beam trawl with a minimum 10 mm mesh and 5 mm cod end liner was lowered to the seabed at a predetermined start point and towed for a duration of 10 minutes at 2 to 3 knots with a maximum tow length of 1,000 m. The total volume of the catch was then sorted with the fish species separated from the epifaunal invertebrates. The epifaunal invertebrates and fish species were identified to species level were possible. Where species could not be identified in the field (smaller fish, polychaetes, crustaceans, bryozoa, hydrozoa etc.) samples were retained for laboratory analysis.

Intertidal Sampling

Phase 1 Survey

7.4.1.13 A Phase 1 habitat survey was undertaken in accordance with the Common Standards Monitoring Guidance Procedural Guidelines (JNCC, 2004). Methods for survey followed the standardised Phase 1 mapping methodology (Marine Monitoring Handbook procedural guidance No 3-1 (JNCC, 2001); Wyn & Brazier, 2001; Wyn *et al.*, 2000; Cefas Data Acquisition Guidelines (Judd, 2012)). This involved covering a systematic route within the survey area (i.e. along predefined transect lines) and mapping the distribution of biotopes present.

7.4.1.14 Habitat and biotope boundaries were mapped along a series of five transects across the area with any scale notable habitats adjacent to the transects also recorded where appropriate (e.g. as target notes). Detailed notes on biotope and sediment character/taxa was also recorded in key habitats along each transect on the upper, mid and lower shore and supplemented by occasional dig-overs of representative habitats which entailed digging over approximately 0.1 m^2 of surface sediment from and sieving through a 1 mm sieve to provide a rapid in-situ assessment of benthic fauna. The survey also included a record of sedimentary habitat whereby sediment grain size was assessed in-situ using standardised Wentworth Scale sediment comparison guides.

7.4.1.15 Three transects (SE1, SE2 and SE3), approximately 200 m apart, were utilised to cover the extent of soft sediments in Sandend Bay (Technical Appendix 7.2, Figure 3.1-1) which comprised the majority of intertidal habitat in this area. An additional transect was surveyed in fringing rocky habitats to the west and east of the main beach (transects SE4 and SE5 respectively). If species or biotopes of conservation importance were recorded (or other areas of interest) the boundaries of major biotopes or larger scale topographic features were recorded along the transect.

Phase 2 Quantitative Survey

7.4.1.16 Phase 2 sampling was also undertaken using standard methodologies to obtain quantitative data on intertidal communities. Given that the survey area is predominantly sedimentary this sampling was undertaken using core sampling following Dalkin and Barnett, 2001 – Marine Monitoring Handbook Procedural Guideline 3-6 Quantitative sampling of intertidal sediment species using cores (JNCC, 2001). Sampling was undertaken using 0.01 m^2 cores sieved through a 1 mm sieve with a single sample taken at representative biotopes on the upper mid and low shore on transects SE1, SE2 and SE3. At each sample station, an additional sample was collected for PSA. At the mid shore stations additional sampling for contaminants was also undertaken.

Post-Survey Analysis

7.4.1.17 The PSA data, benthic infaunal grab data, epifaunal DDV and trawl data were subject to both univariate and multivariate analyses using both excel and the PRIMER v6 statistical package (Clark and Warwick, 2001), in order to characterise and describe the benthic communities across the study area. Multivariate analyses allowed sampling locations with similar sediment characteristics and faunal communities to be grouped together using the key species characterising each community. Following this, infaunal and epifaunal biotopes were assigned to each community type (Connor *et al*., 2004), which were then presented spatially across the Moray West Site and Offshore Export Cable Corridor. As well as assessing the raw species data, a number of univariate indices were also calculated for each biotope in order to allow for comparisons to be made between the biotopes identified. Full details of the post-survey analyses and results can be found in the Technical Appendix 7.1: Benthic Survey Report and 7.2: Intertidal Survey Report.

7.4.2 Current Baseline

7.4.2.1 The environmental baseline, including descriptions of sediment type, infauna and epifauna, is presented for the Moray West Site, the Offshore Export Cable Corridor and Landfall Area. A description of important species in the vicinity of the study area is also provided.

Subtidal

Sediment Composition

7.4.2.2 The benthic subtidal sediments of all samples within the Moray West Site and Offshore Export Cable Corridor were classified based on the Folk Classification System (Folk, 1954). PSA determined that the Moray West Site is characterised by a variety of sediment types including gravelly muddy sand, gravelly sand, (slightly gravelly) muddy sand, sand, sandy gravel, muddy sandy gravel and (slightly gravelly) sand. A large proportion of sample stations were classified as (slightly gravelly) sand which tended to have a relatively small amount of gravel (<5%) typically shell fragment/grit or occasional small stones. These (slightly gravelly) sand sediments showed a degree of spatial variation with stations to the west of the site tending to have a modest mud content (up to 10%) whilst (slightly gravelly) sand sediments further east had very low mud contents (<1%). In general, the north and eastern end of the Moray West Site tended to exhibit more variation in sediments with more mixed or coarser sediments present (volume 3a - Figure 7.4.1).

7.4.2.3 Analysis from images and videos collected as part of the DDV sampling campaign corroborate the PSA findings presented above, which revealed that a large area covering much of the western side of the Moray West Site was characterised by extensive areas of rippled (slightly muddy) sand which are broadly classified as **SS.SSa** (Sublittoral sands and muddy sands). Further west of this, the sandy habitats in the eastern side of the Moray West Site appeared to get progressively sandier with a lower mud content and comprised of rippled sand often with shell grit/debris or occasional stones **SS.SSa** (Sublittoral sands and muddy sands). Five stations within the Moray West Site appeared to have somewhat muddier sands with occasional shell debris or stones, but could be generally classified as **SS.SSa** (Sublittoral sands and muddy sands). In some areas of the Moray West Site, primarily in the eastern half of the survey area, a habitat comprising of mixed gravelly sediment was recorded at a number of stations. These habitats comprised of coarse shell gravel and sand with some mud and were often present as areas of gravel 'waves' running through otherwise sandy habitats. In such areas the troughs of the waves often had muddier mixed sediment with stones and these habitats varied from Circalittoral Coarse sediments (**SS.SCS.CCS**) to muddier Circalittoral Mixed sediments (**SS.SMx.CMx**).

7.4.2.4 Other areas of variable, somewhat mixed but heterogenous coarse sediments were also present, particularly towards the eastern fringe of the Moray West Site. These habitats tended to be inherently patchy and rather variable but were typically characterised by mixed sands or sandy gravel with patches of surficial stones or cobble and were predominantly classified as Circalittoral Coarse sediments (**SS.SCS.CCS**).

7.4.2.5 Across the Offshore Export Cable Corridor, PSA characterised sediment types as (slightly gravelly) sand, gravelly sand, gravel, sandy mud and (slightly gravelly) muddy sand. The inshore stations included clean sand or (slightly gravelly) sand with negligible mud content and coarser sediments (gravelly sand, sandy gravel and gravel respectively) with sediment at these stations generally including stones and pebbles. On the middle section of the Offshore Export Cable Corridor (in deeper water) sediments were sandy mud or (slightly gravelly) muddy sand with a quite high mud content (31% to 63% mud) recorded at the stations in the deepest water depths. Outer Offshore Export Cable Corridor sediments tended to be (slightly gravelly) sand with a modest mud content (<10%) and very low quantities of gravel (<5%) (Figure 7.4.2 – Volume 3a).

7.4.2.6 The DDV sampling campaign corroborate the PSA findings presented above, with the inshore areas representing areas of relatively clean Sublittoral sands (**SS.SSA**) and patchy or heterogeneous forms a mosaic of Circalittoral coarse sediments (**SS.SCS.CCS**) or **SS.SMx.CMx** (Circalittoral mixed sediment). One station at the inshore end of the Offshore Export Cable Corridor (C19; see Technical Appendix 7.1 and Figure 7.4.2 (Volume 3a)) was characterised by sand/gravelly sand (**SS.SCS.CCS**) with patchy areas cobbles/pebbles. Along the middle section of the Offshore Export Cable Corridor deep water was characterised by areas of sandy mud or very muddy sand (**SS.SMu)**. Stations with rippled (slightly muddy) sand often with shell debris/grit or occasional small stones **SS.SSa** (Sublittoral sands and muddy sands) were present at the offshore end of the Offshore Export Cable Corridor adjacent to the Moray West Site.

Sediment Contamination

7.4.2.7 The results of the heavy metal analysis for the subtidal samples revealed that all metals were found at concentrations below respective guidelines, with no samples above UK Cefas Action Levels (ALs), Dutch Quality Standards[1] or Canadian Sediment Quality Guidelines[2]. PAH concentrations were also recorded as low and generally below the limit of detection (LOD) for the analytical tests although LODs for Acenaphthene, Acenaphthylene, Dibenzo(ah)anthracene were slightly higher than the Canadian total exceedance level (TEL) values.

Infaunal and Epifaunal Communities

Primary and Derived Biological Parameters

7.4.2.8 An assessment of the biological parameters from benthic grab locations across the Moray West Site revealed that because the predominantly sandy habitats present numbers of taxa, infaunal abundance and diversity were moderate and rather variable. Numbers of taxa ranged from ten taxa per 0.1 m^2 to 49 taxa per 0.1 m^2. Highest numbers of taxa tended to be recorded in areas of more mixed gravelly sediments usually in the centre or east of the Moray West Site, although such habitats also tended to be rather variable in terms of number of taxa. Cleaner (less muddy) sands in the eastern half of the Moray West Site generally tended to exhibit lower numbers of taxa (Technical Appendix 7.1, Figure 4.2-5). Faunal abundance was also rather variable but generally low to moderate with values ranging from 12 individuals per 0.1 m^2 to 454 individuals per 0.1 m^2. There was no clear spatial trend in abundance although the highest abundances tended to occur in mixed gravelly sand or muddy sandy gravels (Technical Appendix 7.1, Figure 4.2-6). A similar pattern was evident with regard to faunal biomass which was highly variable and ranged from 0.028 g per 0.1 m^2 to 140.47 g per 0.1 m^2 (Technical Appendix 7.1, Figure 4.2-7). As described for abundance, highest biomass values tended to be recorded in mixed gravelly sand, sandy gravel or gravelly muddy sand and often reflected the presence of large bodied bivalves such as *Glycymeris glycymeris* or *Polititapes rhomboides* or echinoderms (e.g. *Echinocardium cordatum*) present in these habitats. The majority of stations had relatively high evenness values with values predominantly above 0.8. Shannon's diversity values were generally moderate to high with most stations having values between 3 and 5.

[1] Dutch quality standards (IADC/CEDA, 1997) are internationally recognised for assessing the chemical quality of sediments and are used here as an additional benchmark against which to evaluate sediment quality.

[2] Canadian Interim Sediment Quality Guidelines (SQGs) (CMME, 1999) have also been used given that they are recommended by the Habitats Directive Water Quality Technical Advisory Group (WQTAG078K) in order to protect Natura 2000 sites (Environment Agency, 2004).

Species Composition

7.4.2.9 A wide variety of taxa were recorded from the benthic grab survey with 352 taxa recorded in total although many of these were present in low numbers and only recorded at a few stations. In terms of abundance annelid worms (predominantly polychaetes) were the most dominant phyla (Table) accounting for 35% of the total abundance followed by mollusca (24.6% of total abundance) with arthropoda, echinodermata and other phyla accounting for 10.7%, 15% and 14% respectively. In terms of biomass, molluscan taxa accounted for 63.65% of total biomass followed by echinoderms (31.94%) with other phyla accounting for the remaining biomass. Annelid polychaetes accounted for 42% of the total number of taxa with arthropods and molluscs each accounting for 21%.

Table 7.4.2: Composition by Phyla

Phyla	Abundance	% Abundance	Biomass (g)	% Biomass	No. of Taxa	% of Taxa
Annelida	1,648	35.31	16.35	3.35	149	42.33
Arthropoda	500	10.71	1.98	0.41	74	21.02
Echinodermata	703	15.06	155.84	31.94	20	5.68
Mollusca	1,149	24.62	310.56	63.65	73	20.74
Other	667	14.29	3.17	0.65	36	10.23

7.4.2.10 The top ten dominant taxa ranked by abundance and biomass are provided in Table 7.4.3 and Table 7.4.4. In terms of abundance the pea urchin *Echinocyamus pusillus* was the most abundant taxa and accounted for 9.88% of the total abundance and this species was also the most ubiquitous and was recorded at 65% of the survey stations. Other key taxa included nematode worms, *Spiophanes bombyx, Lumbrineris aniara,* juvenile Ophiuroidea spp., *Asbjornsenia pygmaea, Thracia villosiuscula, Abra prismatica, Venus casina, Spisula elliptica, Aonides paucibranchiata*, Phoronida sp., Nemertea, *Bathyporeia pelagica, Prionospio fallax* and *Fabulina fabula* which collectively accounted for 50% of the total abundance, although the majority of these with the exception of *Spiophanes bombyx* and *Lumbrineris aniara* were present at less than 40% of the survey stations. A wide variety of other taxa were recorded in lower numbers.

Table 7.4.3: Top Ten Infaunal Taxa by Abundance

Taxa	Total Abundance	Mean Abundance	Cumulative % of Total Abundance	No. of Samples	% of Samples
Echinocyamus pusillus	461	5.76	9.88	65	81
Nematoda	388	4.85	18.19	10	13
Spiophanes bombyx	203	2.54	22.54	59	74
Lumbrineris aniara	174	2.18	26.27	46	58
Ophiuroidea spp. (juvenile)	138	1.73	29.23	35	44
Asbjornsenia pygmaea	118	1.48	31.75	24	30
Thracia villosiuscula	114	1.43	34.20	36	45
Abra prismatica	93	1.16	36.19	34	43
Venus casina	92	1.15	38.16	27	34

Table 7.4.3: Top Ten Infaunal Taxa by Abundance					
Taxa	**Total Abundance**	**Mean Abundance**	**Cumulative % of Total Abundance**	**No. of Samples**	**% of Samples**
Spisula elliptica	90	1.13	40.09	30	38

7.4.2.11 In terms of biomass, molluscs were the main contributor with the bivalves *Glycymeris glycymeris* and *Polititapes rhomboides* along with the sea potato *Echinocardium cordatum* accounting for 79% of total biomass, although the bivalves listed above were recorded at very few stations but included some very large specimens. Other taxa such as *Clausinella fasciata*, Pharidae sp., *Chamelea striatula*, *Dosinia lupinus*, Echinoidea sp. and *Gari fervensis* cumulatively accounted for 90% of the biomass although most of these taxa with the exception of *Echinocardium cordatum* and *Clausinella fasciata* were present at less than 10% of the stations. Taxa which had moderate biomass contributions but were more widespread included *Antalis entalis*, *Spisula elliptica*, *Venus casina*, *Lanice conchilega*, *Cochlodesma praetenue*, *Lumbrineris aniara* and *Euspira nitida* which were present at 10% to 58% of the stations.

Table 7.4.4: Top Ten Infaunal Taxa by Biomass					
Taxa	**Total Biomass**	**Mean Biomass**	**Cumulative % of Total Biomass**	**No. of Samples**	**% of Samples**
Glycymeris glycymeris	167.93	2.0991	34.42	2	3
Echinocardium cordatum	147.52	1.8439	64.65	15	19
Polititapes rhomboides	73.50	0.9188	79.72	4	5
Clausinella fasciata	17.37	0.2171	83.28	11	14
Pharidae sp.	7.77	0.0971	84.87	2	3
Chamelea striatula	6.92	0.0865	86.29	8	10
Dosinia lupinus	6.51	0.0813	87.62	4	5
Echinoidea sp. (damaged)	6.06	0.0757	88.86	2	3
Gari fervensis	5.75	0.0719	90.04	42	53
Antalis entalis	4.06	0.0507	90.87	16	20

7.4.2.12 Multivariate analysis of the abundance data which was carried out in order to describe the main patterns and assemblages within the Moray West Site, demonstrated that 15 different "faunal groups" were identified using the Similarity Profile Analysis (SIMPROF) routine within the PRIMER multivariate analysis software package. The main separation between groups was between groups A, B and C and the remaining groups which were separated at 12% similarity.

7.4.2.13 A summary of the groups described in the Moray West Benthic Survey Report (Technical Appendix 7.1) are described in Table 7.4.5, as well as a description of the associated biotopes. The spatial distribution of these groups is presented in Figure 4.2-10 of Technical Appendix 7.1.

7.4.2.14 Overall, the infaunal communities present within the Moray West Site and OfTI Site comprise variations of the Sublittoral sand (SSA) and Circalittoral coarse (or mixed) sediment (CCS or CMX) habitat complexes with rather transitional biotopes which are often poorly aligned to existing biotopes. A summary of the biotope distribution for the survey stations including biotope designations derived from DDV within the Moray West Site and OfTI Site are provided in Figure 4.2-11 of Technical Appendix 7.1.

Table 7.4.5: Summary of Faunal Groups Identified from Multivariate Analysis

Group	No. of Stations	Sediment Types	Mean % Gravel	Mean % Sand	Mean % Mud	Mean Depth (m CD)	Characteristic Taxa	Biotope Description
Group A (Average similarity: 21.14%)	4	Sandy Gravel, Muddy Sandy Gravel	43.30	54.42	2.27	39.8	*Echinocyamus pusillus, Aponuphis bilineata, Lumbrineris aniara, Gnathia oxyuraea, Timoclea ovata*, Nemertea, *Chaetozone zetlandica, Platyhelminthes* sp., *Scoloplos armiger, Polynoidae* sp.	These samples were rather variable and don't exhibit communities which are clearly correlated to existing biotopes, but are essentially variations of SS.SCS.CCS (Circalittoral coarse sediment) biotopes. Given the presence of lumbrinerids and robust bivalves such as *Timoclea ovata*, this faunal group is most likely a variant of **SS.SCS.CCS.MedLumVen** (*Mediomastus fragilis*, *Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel).
Group B (Average similarity: 38.29%)	5	Muddy Sandy Gravel, Gravelly Muddy Sand, Sandy Gravel, Gravelly Sand	32.48	61.45	6.07	43.4	Nematoda, *Echinocyamus pusillus, Aonides paucibranchiata, Notomastus* spp., *Ophiuroidea* spp. (juvenile), Nemertea, *Pisione remota, Lanice conchilega, Grania* sp., *Aponuphis bilineata*	These stations are variants of SS.SCS.CCS (Circalittoral coarse sediment) or SS.SMx (Sublittoral mixed sediment) depending on mud content. A number of these stations from cleaner sandy gravel/gravelly sand (shell gravel) include taxa such as *Echinocyamus pusillus, Aonides paucibranchiata* and *Pisione remota* and one of the stations also included a specimen of the European lancelet *Branchiostoma lanceolatum* and as such resemble the biotope **SS.SCS.CCS.Blan** (*Branchiostoma lanceolatum* in circalittoral coarse sand with shell gravel).
Group C (Average similarity: 29.67%)	4	Sandy Gravel, Slightly Gravelly Sand, Gravelly Sand	18.14	81.19	0.67	37.3	*Asbjornsenia pygmaea, Spisula elliptica*, Nematoda, *Glycera lapidum* agg., *Ophelia borealis, Aonides paucibranchiata, Urothoe marina, Echinocyamus pusillus, Leptocheirus hirsutimanus, Golfingia* sp.	Corresponds well with the biotope **SS.SCS.ICS.MoeVen** (*Moerella* spp. with venerid bivalves in infralittoral gravelly sand). **SS.SCS.ICS.MoeVen** is classified as a Scottish PMF, although the biotope recorded here appears to be in somewhat deeper water than outlined under the original biotope description.

Table 7.4.5: Summary of Faunal Groups Identified from Multivariate Analysis								
Group	**No. of Stations**	**Sediment Types**	**Mean % Gravel**	**Mean % Sand**	**Mean % Mud**	**Mean Depth (m CD)**	**Characteristic Taxa**	**Biotope Description**
Group D	1	Gravelly Sand	6.61	89.48	3.91	43.8	*Bathyporeia pilosa, Thracia villosiuscula, Lumbrineris aniara, Nephtys kersivalensis, Eumida sanguinea,* Polynoidae sp., *Owenia fusiformis, Euclymene oerstedii, Cheirocratus* sp., Ophiuroidea spp. (juvenile)	Group are not a particularly good match for any specific biotope and are considered rather transitional or intermediate communities within **SS.SSa** (Sublittoral sands and muddy sands).
Group E	1	Slightly Gravelly Sand	0.01	92.34	7.65	49.2	Amphiuridae sp. (juvenile), *Magelona alleni, Prionospio fallax, Spiophanes bombyx, Bathyporeia sarsi, Goniada maculata, Oxydromus flexuosus, Nephtys kersivalensis,* Copepoda sp., *Ampelisca tenuicornis*	Group are not a particularly good match for any specific biotope and are considered rather transitional or intermediate communities within **SS.SSa** (Sublittoral sands and muddy sands).
Group F (Average similarity: 30.50%)	3	Sand, Slightly Gravelly Sand	1.21	93.12	5.67	48.7	Copepoda sp., *Diplocirrus glaucus,* Phoronida sp., *Bathyporeia pelagica, Venus casina, Glycinde nordmanni, Lanice conchilega, Phaxas pellucidus*	Group are not a particularly good match for any specific biotope and are considered rather transitional or intermediate communities within **SS.SSa** (Sublittoral sands and muddy sands).
Group G (Average similarity: 36.16%)	24	Gravelly Sand, Slightly Gravelly Sand	4.69	94.82	0.49	38.5	*Echinocyamus pusillus, Spiophanes bombyx, Gari fervensis, Bathyporeia pelagica, Spisula elliptica, Asbjornsenia pygmaea, Crenella decussata, Abra prismatica, Thracia villosiuscula,* Ophiuroidea spp. (juvenile)	This community is considered to be a variant of **SS.SSa.CFiSa.EpusOborApri** (*Echinocyamus pusillus*, *Ophelia borealis* and *Abra prismatica* in circalittoral fine sand) although it lacks a significant population of *Ophelia borealis* and is perhaps transitional with **SS.SCS.ICS.MoeVen.**
Group H (Average similarity: 48.41%)	2	Slightly Gravelly Muddy Sand, Slightly Gravelly Sand	1.21	90.82	7.97	47.6	*Magelona alleni,* Edwardsiidae sp., *Venus casina, Thracia villosiuscula, Spiophanes bombyx, Echinocardium cordatum, Fabulina fabula, Antalis entalis*	A variant of **SS.SSa.IMuSa.FfabMag** (*Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand).
Group I (Average similarity: 32.49%)	3	Slightly Gravelly Sand, Gravelly Sand	5.75	87.30	6.94	43.8	*Spiophanes bombyx, Clausinella fasciata, Lumbrineris aniara, Thracia villosiuscula, Diplocirrus glaucus, Ampelisca tenuicornis, Phaxas pellucidus, Nucula nitidosa, Bathyporeia gracilis, Edwardsia claparedii*	A transitional or intermediate variant of **SS.SSa.IMuSa.FfabMag** (*Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand).

Table 7.4.5: Summary of Faunal Groups Identified from Multivariate Analysis								
Group	**No. of Stations**	**Sediment Types**	**Mean % Gravel**	**Mean % Sand**	**Mean % Mud**	**Mean Depth (m CD)**	**Characteristic Taxa**	**Biotope Description**
Group J (Average similarity: 37.16%)	4	Slightly Gravelly Sand, Slightly Gravelly Muddy Sand	0.50	90.20	9.30	46.9	*Phaxas pellucidus, Antalis entalis, Diplocirrus glaucus, Prionospio fallax, Lumbrineris aniara, Chaetozone setosa,* Phoronida sp., Copepoda sp., *Abra prismatica*, Paguridae sp. (juvenile/larvae)	A variant of **SS.SSa.IMuSa.FfabMag** (*Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand).
Group K (Average similarity: 40.07%)	2	Slightly Gravelly Sand	1.23	96.52	2.25	42.4	*Echinocyamus pusillus,* Copepoda sp., *Thracia villosiuscula*, Ophiuroidea spp. (juvenile), *Fabulina fabula, Chamelea striatula, Euspira nitida*	A variant of **SS.SSa.IMuSa.FfabMag** (*Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand).
Group L	1	Slightly Gravelly Sand	0.75	93.33	5.92	46.8	*Echinocyamus pusillus, Magelona filiformis, Prionospio fallax, Diplocirrus glaucus, Phaxas pellucidus, Nothria conchylega, Owenia fusiformis, Spiophanes bombyx, Ampharete lindstroemi, Lanice conchilega*	Stations are classified as **SS.SSa** (Sublittoral sands and muddy sands) but include low numbers of species which are characteristic of biotopes such as **SS.SSa.CFiSa.EpusOborApri** and **SS.SSa.IMuSa.FfabMag**. Samples also include low numbers of *Amphiuridae brittlestars* and *Owenia fusiformis* so also have some correlation to **SS.SSa.OSa.OfusAfil** (*Owenia fusiformis* and *Amphiura filiformis* in offshore circalittoral sand or muddy sand) and are likely to be intermediate variants of these biotopes.
Group M	1	Slightly Gravelly Muddy Sand	1.21	86.25	12.55	46.0	*Prionospio fallax, Lumbrineris aniara, Diplocirrus glaucus, Thracia villosiuscula, Bathyporeia gracilis,* Amphiuridae sp. (juvenile), *Venus casina, Chaetozone setosa, Gari fervensis, Nephtys kersivalensis*	Stations are classified as **SS.SSa** (Sublittoral sands and muddy sands) but include low numbers of species which are characteristic of biotopes such as **SS.SSa.CFiSa.EpusOborApri** and **SS.SSa.IMuSa.FfabMag**. Samples also include low numbers of *Amphiuridae brittlestars* and *Owenia fusiformis* so also have some correlation to **SS.SSa.OSa.OfusAfil** (*Owenia fusiformis* and *Amphiura filiformis* in offshore circalittoral sand or muddy sand) and

Table 7.4.5: Summary of Faunal Groups Identified from Multivariate Analysis								
Group	**No. of Stations**	**Sediment Types**	**Mean % Gravel**	**Mean % Sand**	**Mean % Mud**	**Mean Depth (m CD)**	**Characteristic Taxa**	**Biotope Description**
								are likely to be intermediate variants of these biotopes.
Group N (Average similarity: 46.65%)	2	Gravelly Sand	8.15	86.77	5.08	42.5	*Lumbrineris aniara, Venus casina, Spiophanes bombyx, Bathyporeia pelagica, Urothoe elegans, Abra prismatica, Thracia villosiuscula, Echinocyamus pusillus, Gari fervensis*, Phoronida sp.	A variant of **SS.SSa.CFiSa.EpusOborApri (***Echinocyamus pusillus*, *Ophelia borealis* and *Abra prismatica* in circalittoral fine sand) with elements of coarser sediment biotopes (e.g. **SS.SCS.CCS.MedLumVen**).
Group O (Average similarity: 39.40%)	23	Gravelly Sand, Slightly Gravelly Sand, Slightly Gravelly Muddy Sand, Gravelly Muddy Sand	3.12	91.19	5.69	46.2	*Echinocyamus pusillus, Spiophanes bombyx,* Phoronida sp., *Lumbrineris aniara, Prionospio fallax, Diplocirrus glaucus, Urothoe elegans, Abra prismatica, Magelona alleni, Fabulina fabula*	Samples are most closely associated with the biotope **SS.SSa.CFiSa.EpusOborApri** (*Echinocyamus pusillus*, *Ophelia borealis* and *Abra prismatica* in circalittoral fine sand) but are likely to be a deeper intermediate variant with **SS.SSa.IMuSa.FfabMag** (*Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand).

Description of Biotopes

7.4.2.15 As described above, multivariate and univariate statistical analyses were undertaken on the benthic grab data and faunal groups and subsequent biotopes were described (Table 7.4.5). It was concluded that the infaunal communities present within the Moray West Site are variations of the Sublittoral sand (SSA) and Circalittoral coarse (or mixed) sediment (CCS or CMX) habitat complexes with rather transitional biotopes which are often poorly aligned to existing biotopes. Many of these biotopes are currently being refined/revised as part of an ongoing project managed by JNCC which will hopefully clarify such communities in future surveys.

7.4.2.16 In addition to this DDV data was collected across the Moray West Offshore Export Cable Corridor, which were subsequently analysed in order to characterise the communities present. The outputs of the DDV analyses were used, together with environmental variables (e.g. depth and sediment type), to assign infaunal and epifaunal biotopes.

7.4.2.17 Table 7.4.6 provides a summary of the DDV study and subsequent biotope descriptions. A full description of these findings are presented within the Benthic Survey Report (Technical Appendix 7.1).

7.4.2.18 A summary of the biotope distribution for the survey stations including biotope designations derived from DDV along the Offshore Export Cable Corridor are provided in Figure 4.2-11 of Technical Appendix 7.1.

Table 7.4.6: Summary of Analyses Recorded During the DDV Campaign, Including Biotope Description					
Location	**No. of Stations**	**Station Numbers[3]**	**Sediment Type**	**Taxa in >25% of Recorded Habitats**	**Biotope Description**
Offshore Export Cable Corridor (inshore)	3	C13, C17, C21	Rippled sand	*Asterias rubens* (75% O-F), Ammodytidae (75% R-F), Brachyura (33% R), Ctenophora (33% R), *Necora puber* (33% O), *Pagurus bernhardus* (33% R), *Pleuronectes platessa* (33% R)	**SS.SSa** (Sublittoral sands and muddy sands).
Offshore Export Cable Corridor (inshore)	4	C15, C16, C18 & C24	Coarse mixed sediments with pebbles, cobble or boulders	*Asterias rubens* (100% O-C), *Corella parallelogramma* (100% F-A), *Crossaster papposus* (100% R-F), Hydrozoa/Bryozoa (100% A), *Lanice conchilega* (100% R-A), *Lithothamnion* spp. (100% C-A), *Nemertesia antennina* (100% F-A), Serpulidae (100% A), *Actiniaria* (75% O-R), *Antedon bifida* (75% O-F), *Ascidiella aspersa* (75% O-C), *Echinus esculentus* (75% O-C) , *Henricia* (75% R-O), Majoidea (75% R-O), *Munida rugosa* (75% O-A), *Ophiura* (75% O-C), Pectinidae (50% R-O), *Pholis gunnellus* (50% R), *Rhodophyta - filamentous* (50% O-F), *Rhodophyta - foliose* (50% F)	More diverse areas resembled somewhat sheltered inshore variants of rocky biotopes such as **CR.HCR.XFa.SpNemAdia** (Sparse sponges, *Nemertesia* spp. and *Alcyonidium diaphanum* on circalittoral mixed substrata) or a variant of **SS.SMx.CMx.FluHyd** (*Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment) albeit lacking *Flustra foliacea*. Some areas also resembled an inshore variant of **CR.MCR.EcCr.FaAlCr.Pom** (Faunal and algal crusts with *Pomatoceros triqueter* and sparse *Alcyonium digitatum* on exposed to moderately wave-exposed circalittoral rock) or in very barren areas a more stable variant of **SS.SCS.CCS.PomB** (*Pomatoceros triqueter* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles). Patches of brittlestars were also recorded in other adjacent stations but at this station a number of video deployments indicated a quite extensive brittlestar bed on mixed sediment. **SS.SMx.CMx.OphMx** (*Ophiothrix fragilis* and/or *Ophiocomina nigra* brittlestar beds on sublittoral mixed sediment).

[3] See Figure 3.1 of Appendix 7.1 for location of sample stations.

Table 7.4.6: Summary of Analyses Recorded During the DDV Campaign, Including Biotope Description					
Location	**No. of Stations**	**Station Numbers[3]**	**Sediment Type**	**Taxa in >25% of Recorded Habitats**	**Biotope Description**
Offshore Export Cable Corridor (inshore)	1	C19	Coarse sand/gravelly sand with cobble & brittlestars	*Ophiocomina nigra* (S-C), *Ophiothrix fragilis* (S-C), *Ascidiella aspersa* (A), *Lithothamnion* spp. (A), *Ophiura* (A), Serpulidae (A), *Alcyonium digitatum* (C), Ascidiacea (C), Hydrozoa/Bryozoa (C), *Munida rugosa* (F), *Nemertesia antennina* (F), *Asterias rubens* (O), *Corella parallelogramma* (O), *Echinus esculentus* (O), *Lanice conchilega* (O), *Actiniaria* (R), *Brachyura* (R), *Crossaster papposus* (R)	**SS.SMx.CMx.OphMx** (*Ophiothrix fragilis* and/or *Ophiocomina nigra* brittlestar beds on sublittoral mixed sediment).
Offshore Export Cable Corridor (inshore and one site offshore)	5	C3, C14, C20, C21 & C22	Variable mixed coarse sediment including sand or gravelly sand with stones, gravel or cobble	Hydrozoa/Bryozoa (100% R-A), Serpulidae (100% O-C), *Lithothamnion* spp. (100% R-C), *Lanice conchilega* (100% R-F), Pectinidae (66% R-O), *Asterias rubens* (50% O-C), *Corella parallelogramma* (50% R-O), *Munida rugosa* (50% R-C), *Securiflustra securifrons* (50% R-O), *Callionymus lyra* (33% R), Ctenophora (33% R-O), *Flustra foliacea* (33% R-O), *Henricia* (33% R), *Nemertesia antennina* (33% R), *Porania pulvillus* (33% R-F)	Stations could to be a variant of biotopes such as **SS.SSa.IFiSa.ScupHyd** (*Sertularia cupressina* and *Hydrallmania falcata* on tide-swept sublittoral sand with cobbles or pebbles) or even an impoverished **SS.SMx.CMx.FluHyd** (*Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment) but were too variable/patchy to derive a definitive biotope.
Offshore Export Cable Corridor (along middle deep water section)	5	C8, C9, C10, C11 & C12	Sandy mud/muddy sand with burrows/pits	*Pennatula phosphorea* (80% R-A), Hydrozoa/Bryozoa (40% R), *Virgularia mirabilis* (50% R), *Eledone cirrhosa* (25% R), *Pleuronectes platessa* (25% R)	**SS.SMu.CFiMu.SpnMeg** (Seapens and burrowing megafauna in circalittoral fine mud). This biotope is classified as a Scottish PMF.

Table 7.4.6: Summary of Analyses Recorded During the DDV Campaign, Including Biotope Description

Location	No. of Stations	Station Numbers[3]	Sediment Type	Taxa in >25% of Recorded Habitats	Biotope Description
Offshore Export Cable Corridor	2	C6 & C7	Muddy sand (often with shell fragments/debris)	*Pennatula phosphorea* (100% O-F), Hydrozoa/Bryozoa (100% F), *Alcyonium digitatum* (100% R), *Callionymus lyra* (100% R), *Eledone cirrhosa* (100% R), *Antalis entalis* (50% R), *Astropecten irregularis* (50% R), Pectinidae (50% R), *Pleuronectes platessa* (50% R)	Habitat been classified as a somewhat sandier and uncertain variant of **SS.SMu.CFiMu.SpnMeg** (seapens and burrowing megafauna in circalittoral fine mud). This biotope is classified as a Scottish PMF.
Offshore Export Cable Corridor (offshore end)	9	C1, C2, C4, C5, C23, C25, C26, C27, C28	Rippled (slightly muddy) sand often with shell debris/grit	Hydrozoa/Bryozoa (80% R-O), *Ophiura* (60% R-A), *Pennatula phosphorea* (50% R-O), *Antalis entalis* (40% R-O), *Asterias rubens* (40% R), *Callionymus lyra* (40% R), *Astropecten irregularis* (30% R)	Densities of sea pens were not high enough to qualify as a sea pen biotope although may be an intermediate variant with **SS.SSa** (Sublittoral sands and muddy sands).
Offshore Export Cable Corridor (offshore end)	1	C26	Muddy shell gravel or muddy gravelly sand with shell debris	Hydrozoa/Bryozoa (O), *Antalis entalis* (R), Asteroidea (R), *Lanice conchilega* (R), *Microchirus variegatus* (R)	**SS.SMx.CMx** (Circalittoral mixed sediment).
Moray West Site (covering much of western side)	36	W1, W2, W8, W9, W10, W11, W12, W14, W15, W16, W17, W18, W19, W21, W22, W23, W24, W27, W29, W30, W31, W32, W33, W35, W36, W37, W38, W39, W42, W43, W46, W74, W75, W76, W77, W78	Rippled (slightly muddy) sand often with shell debris/grit	*Asterias rubens* (73% R-F), Hydrozoa/Bryozoa (54% R-C*), Pagurus bernhardus* (32% R-F), *Astropecten irregularis* (27% R), *Ophiura* (27% R-O), *Callionymus lyra* (24% R)	**SS.SSa** (Sublittoral sands and muddy sands).
Moray West Site	5	W3, W13, W25, W26, W52	Muddy sand (often with shell fragments/debris)	*Asterias rubens* (80% R-O), Hydrozoa/Bryozoa (80% R-F), *Pagurus bernhardus* (50% R), Pleuronectidae (50% R)	**SS.SSa** (Sublittoral sands and muddy sands).

Table 7.4.6: Summary of Analyses Recorded During the DDV Campaign, Including Biotope Description					
Location	**No. of Stations**	**Station Numbers[3]**	**Sediment Type**	**Taxa in >25% of Recorded Habitats**	**Biotope Description**
Moray West Site	11	W7, W34, W35, W44, W45, W47, W57, W58, W62, W68, W69	Variable (slightly muddy) sand or gravelly sand often with some stones/pebbles/shell	*Asterias rubens* (100% R-C), Hydrozoa/Bryozoa (82% R-F), *Astropecten irregularis* (45% R), *Pagurus bernhardus* (45% R-O), *Alcyonium digitatum* (27% R), *Neptunea antiqua* (27% R-O), *Pleuronectes platessa* (27% R)	**SS.SSa** (Sublittoral sands and muddy sands) or possibly **SS.SCS.CCS** (Circalittoral coarse sediments).
Moray West Site (particularly to the eastern half)	11	W6, W8, W20, W28, W35, W39, W43, W50, W51, W72, W79)	Mixed (muddy) shell gravel or muddy gravelly sand with shells/stones	Hydrozoa/Bryozoa (82% R-C), *Adamsia palliata* (73% R-C), *Asterias rubens* (73% R-C), *Pagurus prideaux* (73% R-C), *Pagurus bernhardus* (55% R-C), *Ophiura* (36% R-O), *Callionymus lyra* (27% R), Serpulidae (27% R-O)	**SS.SCS.CCS** (Circalittoral coarse sediments) to **SS.SMx.CMx** (muddier Circalittoral mixed sediments).
Moray West Site (eastern fringe)	7	W4, W5, W6, W60, W63, W67, W72	Variable coarse/mixed sediments with sand or sandy gravel and patchy stones/cobble	*Asterias rubens* (88% R-F), Hydrozoa/Bryozoa (75% O-A), *Pagurus bernhardus* (63% R), *Alcyonium digitatum* (50% R-C), Serpulidae (50% R-A), *Echinus esculentus* (38% R-C), *Callionymus lyra* (25% R), *Lithothamnion* spp. (25% R-F), *Myoxocephalus scorpius* (25% R), *Nemertesia antennina* (25% R), Paguridae (25% O), Pleuronectidae (25% R-O)	**SS.SCS.CCS** (Circalittoral coarse sediments).

Table 7.4.6: Summary of Analyses Recorded During the DDV Campaign, Including Biotope Description					
Location	**No. of Stations**	**Station Numbers[3]**	**Sediment Type**	**Taxa in >25% of Recorded Habitats**	**Biotope Description**
Moray West Site	1	W39	Mixed coarse sediment with cobbles & small boulder	Barnacles (SA), *Munida rugosa* (A), Hydrozoa/Bryozoa (C), *Nemertesia antennina* (F), *Alcyonium digitatum* (O), *Asterias rubens* (O), *Lithothamnion* spp. (O), *Ophiothrix fragilis* (O), Serpulidae (C), *Antedon bifida* (R), *Brachyura* (R), *Cancer pagurus* (R), *Corella parallelogramma* (R), *Crossaster papposus* (R), *Eledone cirrhosa* (R), *Eupolymnia nebulosa* (R), *Luidia ciliaris* (R), *Ophiura* (R), Pectinidae (R), *Phrynorhombus norvegicus* (R), *Pleuronectes platessa* (R), Pleuronectidae (R)	**SS.SMx.CMx** (Circalittoral mixed sediments) with a smaller area with more consolidated cobbles/boulder is likely to be a transitional **SS.SMx.CMx** habitat with rather impoverished sediment influenced variants of circalittoral rock biotopes such as **CR.HCR.FaT** (Very tide-swept faunal communities), **CR.HCR.XFa** (Mixed faunal turf communities) or **CR.MCR.EcCr** (Echinoderms and crustose communities. This habitat, whilst not particularly large and somewhat patchy, comprised primarily clast supported cobble or boulder and had sufficient area/elevation and dominance by epifaunal taxa to be considered potential Annex I stony reef following guidance in Irving (2009). The location of this low-grade potential Annex I feature is presented in Figure 4.2-11 of Technical Appendix 7.1.

Epifaunal Communities

7.4.2.19 The following section describes the epibenthic communities across the study area. As described previously, epibenthic beam trawl samples were collected from ten stations within the Moray West Site and Offshore Export Cable Corridor (See Figure 3-1 of Appendix 7.1). The epibenthic data are semi quantitative and samples across the survey area have been compared to give an indication of the relative abundance of the different species.

7.4.2.20 Many fish species were recorded within the epifaunal data; these have been discussed in brief here. However, fish are considered further within Chapter 8: Fish and Shellfish Ecology and Chapter 11: Commercial Fisheries.

7.4.2.21 The most dominant enumerated invertebrate taxa from the trawl survey were *Balanus crenatus* and *Asterias rubens* which accounted for 62% of the total abundance and were widely distributed. Other numerically important invertebrates were *Pagurus prideaux*, *Adamsia palliata*, *Ophiura*, *Echinus esculentus* and *Astropecten irregularis* which collectively accounted for 79% of the total abundance. A range of other taxa were also present including *Ophiothrix fragilis*, *Hyas coarctatus*, *Anomia ephippium*, *Ascidiella scabra*, *Echinocardium cordatum*, *Galathea intermedia*, *Psammechinus miliaris*, *Pagurus bernhardus*, *Spirobranchus triqueter*, *Luidia sarsii*, *Macropodia rostrata* and *Eunereis longissima*. Echinoderms and a variety of decapod crustacea (primarily crabs) were generally the most numerous species along with a variety of other polychaete, crustacean and mollusc taxa. Prawns and shrimps were present in relatively low numbers (notably prawns such as *Pandalina brevirostris* and the pink shrimp *Pandalus montagui*). A wide variety of other taxa were also present in lower numbers and in total 121 invertebrate taxa were recorded from the trawl survey.

7.4.2.22 A variety of colonial or encrusting epifaunal taxa were also recorded across the study area, which were not enumerated (qualitative taxa). These taxa included dead man's fingers (*Alcyonium digitatum*), hornwrack (*Flustra foliacea*) and the hydrozoan *Hydrallmania falcata,* which were all present at over 80% of the trawl stations. A variety of other taxa including hydroids, bryozoans and sponges were also present including species such as *Suberites carnosus*, *Alcyonidium diaphanum*, *Alcyonidium parasiticum*, *Hydractinia echinata*, *Nemertesia*, Bougainvilliidae, *Tubulipora*, *Securiflustra securifrons*, Sertulariidae and *Sertularia cupressina*.

7.4.2.23 In terms of fish species, flatfish such as dab (*Limanda limanda*) and plaice (*Pleuronectes platessa*) were most numerous followed by dragonet (*Callionymus lyra*) and these taxa were recorded at all the trawl stations. Other fish species recorded in moderate numbers included pogge (*Agonus cataphractus*), lemon sole (*Microstomus kitt*) and grey gurnard (*Eutrigla gurnardus*) which were recorded at over 80% of the trawl stations. Other numerically important fish species included thick-backed sole (*Microchirus variegatus)*, crystal goby (*Crystallogobius linearis)*, juvenile Gadidae, Solenette (*Buglossidium luteum)*, short-spined sea scorpion (*Myoxocephalus scorpius)*, juvenile Pleuronectiformes and Mediterranean scaldfish (*Arnoglossus laterna)* along with a variety of goby species. Other fish species were recorded in low numbers including angler fish (*Lophius piscatorius*), Norwegian topknot (*Phrynorhombus norvegicus*), and sandeel (*Ammodytes*) whilst elasmobranchs such as the cuckoo ray (*Leucoraja naevus*) and lesser spotted dogfish (*Scyliorhinus canicula*) were also occasionally recorded.

7.4.2.24 Multivariate analysis of the quantitative trawl dataset (invertebrates and fish) was carried out to describe the main patterns and assemblages within the Moray West Site and Offshore Export Cable Corridor, which demonstrated that six different groups were identified using the SIMPROF routine.

7.4.2.25 Group A included four trawl stations (W4, W6, W58 and W68) located in the mixed coarser sediments within the north east of the Moray West Site and were characterised by a diverse number of invertebrates such as *Asterias rubens*, *Pagurus prideaux*, *Adamsia palliata*, *Psammechinus miliaris*, *Hyas coarctatus*, *Anomia ephippium* and *Ascidiella scabra* with relatively low numbers of fish such as dab (*Limanda limanda*), plaice (*Pleuronectes platessa*) and pogge (*Agonus cataphractus*).

7.4.2.26 Group B included a single trawl station (W8) at the southern end of the Moray West Site characterised by *Pagurus prideaux*, *Adamsia palliata*, *Ophiura ophiura*, *Pseudoprotella phasma*, *Balanus crenatus* and moderate numbers of juvenile Gadidae, dragonet (*Callionymus lyra*) and dab (*Limanda limanda*).

7.4.2.27 Groups C (W44 and W48) and D (W30, W22 and W33) were located in the middle and north of the Moray West Site and were characterised by moderately high numbers of *Balanus crenatus* (particularly in Group C) along with *Asterias rubens* and dab (*Limanda limanda*) with a variety of other fish and invertebrate taxa e.g. *Astropecten irregularis*, plaice (*Pleuronectes platessa*), *Eunereis longissima*, *Spirobranchus triqueter*, *Pagurus prideaux*, *Adamsia palliata* and *Galathea intermedia* in group C or *Ophiura ophiura*, *Echinocardium cordatum*, *Pagurus prideaux*, *Astropecten irregularis*, *Adamsia palliata*, dragonet (*Callionymus lyra*) and plaice (*Pleuronectes platessa*) in group D.

7.4.2.28 Group E comprised two trawl stations (W40 and W59) to the east of the Moray West Site and were characterised by moderate numbers of *Asterias rubens*, dab (*Limanda limanda*), plaice (*Pleuronectes platessa*) and *Ophiura ophiura* with a variety of other taxa in relatively low numbers.

7.4.2.29 Group F included three stations (W2, W12 and W61) and were characterised by *Asterias rubens*, *Balanus crenatus* and dab (*Limanda limanda*), along with other taxa in lower densities such as *Ophiura ophiura*, plaice (*Pleuronectes platessa*), *Astropecten irregularis*, dragonet (*Callionymus lyra*), pogge (*Agonus cataphractus*) and solenette (*Buglossidium luteum*).

7.4.2.30 Overall the results of multivariate analysis on the epibenthic trawl data indicate relatively high similarity between trawls (all trawls exhibiting >40% similarity), with many groups containing similar taxa and differences between groups primarily reflecting variation in rank dominance of invertebrates/fish rather than distinct changes in epifaunal assemblage which probably reflects (in part) variation in heterogeneity of the seabed habitats. As described for the infaunal dataset a degree of spatial separation in trawl groups was evident which correlated to variations in sediment type, namely sand or slightly muddier sand in the east and middle of the site and coarser or more heterogenous habitats to the north and extreme east of the site.

7.4.2.31 The spatial distribution of these groups is presented within Figure 4.2-10 of Technical Appendix 7.1.

7.4.2.32 A full description of the subtidal habitats and communities present is provided in Technical Appendix 7.1: Benthic Ecology Survey Report.

Protected Habitats and Species

7.4.2.33 The Benthic Survey Report (Technical Appendix 7.1) identified four habitats or biotopes of conservation interest during the Moray West Site and Offshore Cable Corridor survey. These included the PMF **SS.SMu.CFiMu.SpnMeg** 'Seapens and burrowing megafauna in circalittoral fine mud' and **SS.SCS.ICS.MoeVen** 'Moerella spp. with venerid bivalves in infralittoral gravelly sand' and potential Annex I stony reef, and **SS.SSa.CFiSa.EpusOborApri** (or transitional with this biotope) '*Echinocyamus pusillus*, Ophelia borealis and *Abra prismatica* in circalittoral fine sand' a component of the Offshore subtidal sands and gravel PMF.

7.4.2.34 **SS.SMu.CFiMu.SpnMeg** was located at five sites within the Offshore Export Cable Corridor. Two other sites within the Offshore Export Cable Corridor also demonstrated attributes that were characteristic of this feature. This PMF habitat is widespread across the southern half of the Moray Firth and is also relatively widespread across the waters surrounding Scotland. This particular biotope is a qualifying feature of the proposed Southern Trench Nature Conservation Marine Protected Area (NC MPA) and the Offshore Export Cable Corridor passes through this proposed NC MPA (Section 7.4.2.40).

7.4.2.35 **SS.SCS.ICS.MoeVen** was recorded at four stations to the north-east of the Moray West Site. The biotope recorded is in somewhat deeper water than outlined under the original biotope description, although this was originally based on relatively little data and more recent surveys currently being analysed with JNCC and SNH indicate that it has a wider depth range than initially described.

7.4.2.36 **SS.SSa.CFiSa.EpusOborApri** (or transitional with this biotope) were recorded at 47 stations, throughout the Moray West Site, but absent in the shallower waters of the Offshore Export Cable Corridor. This biotope is a component of the offshore subtidal sands and gravels PMF. Sand and gravel sediments are the most common subtidal habitat around the coast of the British Isles and are abundant in the offshore waters of Scotland, but in offshore waters >20m are an also an Annex 1 feature.

7.4.2.37 At one station within the Moray West Site (located to the south / south-east) a small patch of large cobbles / small boulders was recorded, which was approximately 20 m wide. This habitat, whilst not particularly large and somewhat patchy, comprised primarily clast supported cobble or boulder and had sufficient area/elevation and dominance by epifaunal taxa to be considered potential Annex I stony reef following guidance in Irving (2009). The location of this low-grade potential Annex I feature is presented in Figure 4.2-11 of Technical Appendix 7.1.

7.4.2.38 Mixed coarse stony/cobble habitats inshore were widespread and rather variable but also included patches of more consolidated cobble or small boulder which may be considered small scale examples of transitional or low grade stony reef although they tended to lack significant elevation or topographic distinctness and were relatively small scale (<5 m^2). The location of this low-grade potential Annex I feature is presented in Figure 4.2-11 of Technical Appendix 7.1.

7.4.2.39 It should be noted that these conservation features have also been encountered during surveys at other locations within the Moray Firth or elsewhere around the Scottish coastline. Whilst of conservation interest, the PMF habitats are not considered to be particularly sensitive to impacts associated with the Development, and where disturbed, would be expected to recover over a relatively short period (as discussed within Sections 7.7.2 to 7.7.4 of this EIA Report).

7.4.2.40 A number of species of conservation interest were also noted during the survey. The arctic quahog (*Arctica Islandica*) and the flame shell (*Limaria hians*) form PMF habitats, although they were only recorded at single stations and in very low numbers which do not constitute the PMF habitat. Sandeels (a PMF species) were also recorded during trawl and video surveys.

7.4.2.41 The Southern Trench is a distinct bathymetric feature comprising an enclosed seabed basin of at least 250 m deep 10 km north of the Fraserburgh coastline, which is traversed by the Offshore Export Cable Corridor. The Southern Trench is currently proposed as a Nature Conservation Marine Protected Area (NC MPA), for which the MPA would cover an area roughly between Buckie and Peterhead, following the coastline round and extending out to approximately the 12 nm limit. The Southern Trench MPA proposal has been submitted to the Scottish Ministers for consideration and it was announced in February 2018 by the Scottish Government that public consultation on the site would soon proceed. Once the Scottish Ministers approve a NC MPA for public consultation, then the location is given policy protection as if it were designated and it will become known as a 'possible MPA'. Whilst the Southern Trench is currently still a proposed, rather than possible, MPA, it has been considered in this EIA in anticipation of it being progressed to public consultation very shortly.

7.4.2.42 Burrowed mud has been recorded at a high resolution across and beyond the Southern Trench shelf sill during the MSS Norway lobster (*Nephrops norvegicus*) fisheries surveys in 2008 - 2010 and a MSS East Coast PMF survey in 2011 (both unpublished). Shelf deeps are also present, which is another proposed protected feature of the MPA. A study into the presence of PMFs within the Southern Trench (Hirst *et al.*, 2012) reported the observation of two PMFs: 'burrowed mud' and the 'white cluster anemone' (*Parazoanthus anguicomus*). 'Sea pens with burrowing megafauna', (**SS.SMu.CFiMu.SpnMeg**) biotope was observed inside and outside of the Southern Trench 'shelf deep' covering an estimated total area of 225.85 km^2, although sea pens (*Pennatula phosphorea*) were seen in low numbers. The site specific surveys identified the **SS.SMu.CFiMu.SpnMeg** biotope at three stations within the proposed Southern Trench MPA and at two further stations outside the site.

Landfall and Intertidal Habitat

7.4.2.43 The Landfall Area is comprised of rocky shores backed by cliffs and occasional sandy bays. Rocky shores dominate from Findlater Castle in the west until the soft sediment shore of Sandend Bay is reached in the centre of the Landfall Area. Moving east, smaller bays intercept rocky promontories towards Redhythe Point. Information gathered via desktop research has not identified any sites of marine ecological importance in the intertidal zone within the Landfall Area (Bennett and McLeod, 1998; Marine Scotland NMPI, accessed March 2018). Rocky shores are typically exposed or moderately exposed to wave action and considered representative of the Moray Firth, with moderately rich fauna on the lower shore (where boulders, cobbles, rock pools and bedrock at varying inclinations are present) and the upper shore being generally poor in species diversity. Sedimentary shores are typically comprised of clean sand or muddy sand and support communities again typical of the Moray Firth, dominated by polychaetes, amphipods and bivalves (Bennett and McLeod, 1998).

7.4.2.44 The text immediately below describes the results of site-specific survey undertaken at Sandend Bay; the findings of which are consistent with the general description of the Landfall Area in paragraph 7.4.2.42 above.

Sediment Composition

7.4.2.45 The intertidal habitats recorded at Sandend Bay, located within the Landfall Area were predominantly characterised by well sorted medium sands with low gravel and silt content (<1%).

Sediment Contamination

7.4.2.46 Three mid shore stations from Sandend Bay were sampled for contaminants including metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, barium, aluminium and tin) and polycyclic aromatic hydrocarbons (PAHs). A summary of the results of the contaminant analysis are provided in Table 12 of Technical Appendix 7.2 (Intertidal Survey Report). All metals were found at concentrations below respective guidelines (where available) with no samples above UK Cefas Action Levels (ALs), Dutch Quality Standards (IADC/CEDA, 1997) or Canadian Sediment Quality Guidelines (CMME, 1999). PAH concentrations were also low below the LOD for the analytical tests although LODs for Acenaphthene, Acenaphthylene, Dibenzo(ah)anthracene were slightly higher than the Canadian TEL values.

Intertidal Communities

7.4.2.47 Intertidal habitats were relatively dynamic and were represented by somewhat sparse benthic invertebrate communities characterised by amphipod crustaceans, occasional isopods and polychaetes such as Nephtyidae species, *Scolelepis* species and occasionally *Arenicola marina*.

7.4.2.48 Figure 4.2-1 of Technical Appendix 7.2 presents a map of the biotopes identified across Sandend Bay. Typical biotopes included **LS.LSa.MoSa** (Barren or amphipod-dominated mobile sand shores) or **LS.LSa.MoSa.BarSa** (Barren littoral coarse sand) on the upper shore and **LS.LSa.MoSa.AmSco.Sco** (*Scolelepis* spp. in littoral mobile sand) or relatively impoverished variants of **LS.LSa.FiSa.Po** (Polychaetes in littoral fine sand) on the mid and lower shore. Some areas of cobbles/stones were also present in some areas on the mid to upper shore adjacent to transect SE3 which included the biotope **SS.LCS** (Littoral coarse sediments) or **LR.FLR.Eph.EphX** (Ephemeral green and red seaweeds on variable salinity and/or disturbed eulittoral mixed substrata) whilst areas of sand covered rock lower down the shore near to transect SE3 included examples of **LR.FLR.Eph.Ent** (*Enteromorpha* spp. on freshwater-influenced and/or unstable upper eulittoral rock) or sparse **LR.HLR.MusB.Sem** (*Semibalanus balanoides* on exposed to moderately exposed or vertical sheltered eulittoral rock).

7.4.2.49 Areas of littoral rock were primarily restricted to the eastern and western fringes of the bay which included a variety of biotopes including SS.LCS (Littoral coarse sediments), **LR.FLR.Eph.Ent** (*Enteromorpha* spp. on freshwater-influenced and/or unstable upper eulittoral rock) or **LR.FLR.Lic** (Lichens or small green algae on supralittoral and littoral fringe rock) on the upper shore whilst mid shore rocky habitats tended to be dominated by barnacles, *Littorina* spp. and limpets with sparse fucoid or red algae coverage (e.g. *Mastocarpus stellatus*) and formed variants of the biotope **LR.HLR.MusB.Sem** (*Semibalanus balanoides* on exposed to moderately exposed or vertical sheltered eulittoral rock) often with rockpools with a variety of algal species including biotopes such as **LR.FLR.Rkp.Cor.Cor** (coralline crusts and *Corallina officinalis* in shallow eulittoral rockpools) or **LR.FLR.Rkp.G** (green seaweeds (*Enteromorpha* spp. and *Cladophora* spp.) in shallow upper shore rockpools).

7.4.2.50 Other biotopes included **LR.HLR.FR.Coff.Coff** (*Corallina officinalis* and *Mastocarpus stellatus* on exposed to moderately exposed lower eulittoral rock) and **LR.LLR.F.Pel** (*Pelvetia canaliculata* on sheltered littoral fringe rock) with the latter primarily evident on transect SE4. Sand influenced rock biotopes were also present in lower shore rock habitats in sand such as **LR.MLR.BF.Rho** (*Rhodothamniella floridula* on sand-scoured lower eulittoral rock) often with **LR.FLR.Eph.Ent** (*Enteromorpha* spp. on freshwater-influenced and/or unstable upper eulittoral rock) and biotopes dominated by *Fucus serratus* (**LR.MLR.BF.Fser** (*Fucus serratus* on moderately exposed lower eulittoral rock) or *Fucus spiralis* **LR.LLR.F.Fspi.FS** (*Fucus spiralis* on full salinity sheltered upper eulittoral rock) were also recorded near transect SE5 on the lower and upper shore respectively.

7.4.2.51 Overall the biotopes recorded in Sandend Bay represent typical communities for moderately exposed sandy beaches and rocky habitats and no species or habitats of conservation importance were noted.

7.4.2.52 A full description of the intertidal habitats and communities present is provided in Technical Appendix 7.2: Intertidal Survey Report.

7.4.3 Future Baseline

7.4.3.1 The baseline environment is not static and will exhibit some degree of natural change over time, with or without the Development in place, due to naturally occurring cycles and processes. Therefore, when undertaking impact assessments, it will be necessary to place any potential impacts in the context of the envelope of change that might occur naturally over the timescale of the Development.

7.4.3.2 Further to potential change associated with existing cycles and processes, it is necessary to take account of potential impacts of climate change on the marine environment. Variability and long-term changes on physical influences may bring direct and indirect changes to benthic habitats and communities in the mid to long term future (UK Offshore Energy Strategic Environmental Assessment 3 (OESEA3), 2016). A strong base of evidence indicates that long-term changes in the benthic ecology may be related to long-term changes in the climate or in nutrients (OESEA3, 2016), with climatic process driving shifts in abundances and species composition of benthic communities (Marine Climate Change Impacts Partnership (MCCIP), 2015). However, as noted in Chapter 6, changes in climate change are expected to have any measureable influence on the distribution of seabed sediments present in the Moray West Site or along the Offshore Export Cable Corridor during the lifetime of the Development.

7.4.3.3 Studies of the benthic ecology over the last three decades have shown that biomass has increased by at least 250% to 400%, opportunistic and short-lived species have increased and long-living sessile animals have decreased (Krönke, 1995; Krönke, 2011). Modelling sea surface temperature in relation to climate change in the UK has shown that the rate of temperature increase over the previous 50 years has been greater in waters off the east coast of the UK compared to the west and this is predicted to continue for the next 50 years (MCCIP, 2013). As such, the baseline in the Moray West Site and Offshore Export Cable Corridor described in Section 7.4.2 is a 'snapshot' of the present benthic ecosystem within a gradual yet continuously changing environment. Any changes that may occur during the lifetime of the Development should be considered in the context of both greater variability and sustained trends occurring on national and international scales in the marine environment.

7.5 Assessment Methodology

7.5.1 Impacts Identified as Requiring Assessment

7.5.1.1 Table 7.5.1 lists all potential impacts on benthic and intertidal ecology identified as requiring consideration as part of the assessment. This list of impacts is based on expert judgement and reflects responses provided by statutory consultees and other stakeholders in the offshore wind farm and OfTI Scoping Opinions. The assessment also takes into account impact assessment approaches described in the various guidance documents and publications listed in Section 7.2.3 and further comments received as part of ongoing community consultation activities.

Table 7.5.1: Impacts on Benthic and Intertidal Ecology Requiring Assessment

Potential Impact	Nature of Impact (direct or indirect)	Inter-Relationships with Other EIA Topics / Receptors
Construction Impacts		
Temporary habitat loss / habitat disturbance (subtidal)	Direct Indirect	Chapter 6: Physical Processes and Water Quality Chapter 8: Fish and Shellfish Ecology
Temporary habitat loss/habitat disturbance (intertidal)	Direct Indirect	Chapter 6: Physical Processes and Water Quality Chapter 8: Fish and Shellfish Ecology
Increased suspended sediment concentrations (SSC)/sediment deposition (subtidal)	Direct and Indirect	Chapter 6: Physical Processes and Water Quality Chapter 8: Fish and Shellfish Ecology

Table 7.5.1: Impacts on Benthic and Intertidal Ecology Requiring Assessment		
Potential Impact	**Nature of Impact (direct or indirect)**	**Inter-Relationships with Other EIA Topics / Receptors**
Increased suspended sediment concentrations (SSC)/sediment deposition (intertidal)	Direct and Indirect	Chapter 6: Physical Processes and Water Quality Chapter 8: Fish and Shellfish Ecology
Noise and vibration	Direct Indirect	Chapter 8: Fish and Shellfish Ecology Chapter 9: Marine Mammals
Accidental and controlled discharges	Indirect	Chapter 6: Physical Processes and Water Quality Chapter 8: Fish and Shellfish Ecology
Risk of introduction of MINNS	Direct	Chapter 8: Fish and Shellfish Ecology
Operation and Maintenance (O&M) Impacts		
Long term habitat loss	Direct Indirect	Chapter 6: Physical Processes and Water Quality Chapter 8: Fish and Shellfish Ecology
Accidental and controlled discharges	Direct Indirect	Chapter 8: Fish and Shellfish Ecology
Scouring of benthic habitats at foundations and around cables	Direct Indirect	Chapter 6: Physical Processes and Water Quality Chapter 8: Fish and Shellfish Ecology
Creation of new substrate and habitat	Direct	Chapter 8: Fish and Shellfish Ecology
Electromagnetic fields (EMF)	Direct	Chapter 8: Fish and Shellfish Ecology
Seabed sediment heating from subsea cables	Direct	Chapter 8: Fish and Shellfish Ecology
Risk of introduction of MINNS	Direct	Chapter 8: Fish and Shellfish Ecology
Decommissioning Impacts		
Habitat loss / habitat disturbance	Direct Indirect	Chapter 6: Physical Processes and Water Quality Chapter 8: Fish and Shellfish Ecology
Increased suspended sediment concentrations (SSC)/sediment deposition	Direct Indirect	Chapter 6: Physical Processes and Water Quality Chapter 8: Fish and Shellfish Ecology
Noise and vibration	Direct Indirect	Chapter 8: Fish and Shellfish Ecology Chapter 9: Marine Mammals
Accidental and controlled discharges	Direct Indirect	Chapter 8: Fish and Shellfish Ecology
Risk of introduction of MINNS	Direct	Chapter 8: Fish and Shellfish Ecology

7.5.2 Scoped Out Impacts

7.5.2.1 In accordance with the scoping reports produced in 2016 and 2017 (Moray West, 2016 & Moray West 2017) and in line with the scoping opinions received from MS-LOT in August 2016 and August 2017, no potential impacts have been scoped out of the assessment.

7.5.3 Assessment Approach and Criteria

7.5.3.1 The general approach to the assessment of impacts is detailed in Chapter 5 EIA Methodology. This is a two-stage process involving the application of specific criteria to defining the sensitivity of the receptors and the magnitude of the potential impacts. Specific criteria developed to inform the assessment of impacts on benthic and intertidal ecology associated with the construction, operation and maintenance and decommissioning of the Development is described below.

Sensitivity Criteria

7.5.3.2 The sensitivities assigned to different species or biotopes (receptors) are presented in Table 7.5.2 below and are based on the Marine Life Information Network (MarLIN) Marine Evidence based Sensitivity Assessment (MarESA) four-point scale (high – medium – low – not sensitive) classifications. The scale takes account of the tolerance and recoverability (resilience) of a species or biotope in response to a stressor. Specific benchmarks (duration and intensity) are defined for the different impacts for which sensitivity has been assessed. (e.g. suspended sediment and smothering, habitat loss / change and disturbance / abrasion, etc.). Detailed information on benchmarks used and definitions of resistance and resilience can be found on the MarLIN website (https://www.marlin.ac.uk/).

7.5.3.3 For the purposes of this assessment, four sensitivity categories have been defined. The categories are assigned based on the on the four MarLIN MarESA categories which considered tolerance and recoverability and with consideration of the importance or value of the receptor, as detailed in Table 7.5.2.

Table 7.5.2: Sensitivity Criteria for Benthic and Intertidal Ecology

Sensitivity	Definition
High	Nationally and internationally important receptors with high vulnerability and low or no recoverability. Regionally important receptors with high vulnerability and no ability for recovery. Equivalent to MarLIN MarESA sensitivity category 'High'. The habitat or species is noted as exhibiting 'None' or 'Low' resistance (tolerance) to an external factor, whether that arises from natural events or human activities, and is expected to recover only over very extended timescales i.e. >25 years or not at all (resilience is 'Very Low'); OR The habitat or species is noted as exhibiting 'None' or 'Low' resistance (tolerance) to an external factor, whether that arises from natural events or human activities, and is expected to recover only over very extended timescales i.e. > 10 or up to 25 years (resilience is 'Low').
Moderate	Nationally and internationally important receptors with medium vulnerability and medium recoverability. Regionally important receptors with medium to high vulnerability and low recoverability. Locally important receptors with high vulnerability and no ability for recovery. Equivalent to MarLIN MarESA sensitivity category 'Medium'. The habitat or species is noted as exhibiting 'None' or 'Low' resistance (tolerance) to an external factor, whether that arises from natural events or human activities, and is expected to recover over medium timescales i.e. > 2 or up to 10 years (resilience is 'Medium'); OR

Table 7.5.2: Sensitivity Criteria for Benthic and Intertidal Ecology	
Sensitivity	**Definition**
	The habitat or species is noted as exhibiting 'None' resistance (tolerance) to an external factor, whether that arises from natural events or human activities, and is expected to recover over <2 years (resilience is 'High'); OR The habitat or species is noted as exhibiting 'Medium' resistance (tolerance) to an external factor, whether that arises from natural events or human activities, and is expected to recover over medium to very long timescales, i.e. > 2 years or up to 25 years or not at all (resilience is 'Medium', 'Low' or 'Very Low').
Low	Nationally and internationally important receptors with low vulnerability and high recoverability. Regionally important receptors with low vulnerability and medium to high recoverability. Locally important receptors with medium to high vulnerability and low recoverability. Equivalent to MarLIN MarESA sensitivity category 'Low'. The habitat or species is noted as exhibiting 'Low' or 'Medium' resistance (tolerance) to an external factor, whether that arises from natural events or human activities, and is expected to recover over <2 years (resilience is 'High'); OR The habitat or species is noted as exhibiting 'High' resistance (tolerance) to an external factor, whether that arises from natural events or human activities, but is expected to recover over medium to very long timescales, i.e. > 2 years or up to 25 years or not at all (resilience is 'Medium', 'Low' or 'Very Low').
Negligible	Receptor is not vulnerable to impacts regardless of value/importance. Locally important receptors with low vulnerability and medium to high recoverability. Equivalent to MarLIN MarESA sensitivity category 'Not Sensitive'. The habitat or species is noted as exhibiting 'High' resistance (tolerance) to an external factor, whether that arises from natural events or human activities, and is expected to recover over short timescales, i.e. < 2 years (resilience is 'High').

<u>Magnitude of Impact</u>

7.5.3.4 The magnitude of the impact has been considered in terms of the spatial extent, duration and timing (seasonality and / or frequency of occurrence) of the impact in question. Expert judgment has been employed to consider and evaluate the likely impact on the species, population or habitat identified. The definitions of magnitude of impact are provided in Table 7.5.3.

Table 7.5.3: Definitions of the Magnitude of Impact on Benthic and Intertidal Receptors	
Magnitude	**Definition**
High	Total loss or major alteration to key elements/features of the baseline conditions. Impact occurs over a large scale or spatial extent (define extent) resulting in widespread, long term or permanent changes in site characteristics or affecting a large proportion of receptor population. Impact will occur repeatedly or continuously over a long period of time.
Moderate	Partial loss or alteration to one or more key elements/features of the baseline conditions. Impact occurs over a medium scale or spatial extent (define extent) with short to medium term change to site characteristics or affecting a moderate proportion of the receptor population. Impact will occur repeatedly or continuously over a moderate period of time or at moderate intensity for short periods of time.
Low	Minor shift away from the baseline conditions.

Table 7.5.3: Definitions of the Magnitude of Impact on Benthic and Intertidal Receptors	
Magnitude	**Definition**
	Impact is localised and temporary or short term (define extent) with detectable change to site characteristics or noticeable change to small proportion of the receptor population. Low frequency impact occurring occasionally or intermittently and at low intensity
Negligible	Very slight change from baseline conditions. Impact is highly localised and short term resulting in very slight / imperceptible changes to site characteristics / receptors population. Full rapid recovery is expected.

<u>Significance Criteria</u>

7.5.3.5 The significance of an effect on benthic and intertidal ecology is determined by correlating the magnitude of the impact and the sensitivity of the receptor. The particular method employed for this assessment is presented in Table 7.5.4. Where there is a range in potential effect significance as presented in Table 7.5.4, the final assessment is based upon expert judgement.

7.5.3.6 For the purposes of this assessment, any resulting effect with a significance level of minor or less has been concluded to be not significant in terms of the EIA Regulations.

Table 7.5.4: Effect Significance				
Sensitivity of Receptor	**Magnitude of Impact**			
	Negligible	**Low**	**Moderate**	**High**
Negligible	Negligible	Negligible or Minor	Negligible or Minor	Minor
Low	Negligible or Minor	Negligible or Minor	Minor	Minor or moderate
Moderate	Negligible or Minor	Minor	Moderate	Moderate or Major
High	Minor	Minor or moderate	Moderate or Major	Major

7.5.3.7 Embedded measures (as described in Section 7.6.2) have been referred to and included in the initial assessment of significance of an effect. If an identified impact requires further mitigation then the residual effect is evaluated. If no further mitigation is required, is likely to have a positive ameliorating effect or if no further mitigation is practicably achievable, then the assessment of significance of an effect would remain as the initial assessment.

7.5.4 Data Limitations

7.5.4.1 There were no limitations to data collection during the site-specific surveys. Sampling to characterise the intertidal and subtidal benthic study area of the Moray West Site and Offshore Export Cable Corridor was successfully completed at all the proposed sampling locations, using a variety of techniques including DDV and benthic grab sampling and within the correct seasonal conditions.

7.5.4.2 Although the sampling design and collection process provided robust data on the benthic communities present, interpreting these data by classifying and grading biotopes has three main limitations:

- It is often difficult to interpolate data collected from discrete sample locations to cover the whole benthic ecology study area and to define the precise extent of each biotope;

- Benthic communities generally show a transition from one biotope to another and therefore, boundaries of where one biotope ends and the next begins cannot be defined with absolute precision; and
- The classification of the community data into biotopes is not always straightforward, as some communities do not readily fit the available descriptions in the biotope classification system. In these instances, it has been highlighted were habitats are more likely to be variants or transitional versions of current biotopes.

7.5.4.3 As a consequence of the limitations described above, the charts presenting biotopes (Volume 3a - Figures 7.4.3 and 7.4.4) should not be interpreted as definitive nor should the habitats be considered to be fixed. However, biotope descriptions do represent a robust characterisation of the receiving environment.

7.5.4.4 There are also limitations inherent within the MarESA sensitivity assessments. These include the assessments not being site specific and consequently there may be differences in sensitivity within a species in different habitats. These limitations are included within the confidence score assigned to the MarESA assessment, for which the full details and rationale are provided on the MarLIN website, and in the assessment summaries.

7.5.4.5 The overall confidence in the evidence used for the MarESA sensitivity assessments is assessed for three categories: the quality of the evidence/ information used; the degree to which the evidence is applicable to the assessment; and the degree of concordance (agreement) between the available evidence. A 'low' confidence score can be applied for the different categories if:

- For quality of the evidence – the assessment is based on expert judgement (i.e. insufficient scientific or grey literature);
- For applicability of the evidence – the assessment is based on proxies for the pressure (e.g. based on natural disturbance events rather than anthropogenic); and
- For the degree of concordance of the evidence – the available evidence does not agree on direction or magnitude of the impact or recoverability.

7.5.4.6 The confidence of the sensitivity assessment is based on the confidence of the assessments for the resilience and resistance of each habitat. If the confidence for the resilience or resistance assessment is 'low' or 'not relevant' then the corresponding confidence for the sensitivity assessment will also be low. This is of particular relevance to the quality of the evidence, as evidence will only be available if studies have been undertaken.

7.5.4.7 However, despite the above uncertainties, it should be noted that there is robust primary data available on the benthic communities present in the study area. Therefore, the sensitivities of the habitats present are understood and the data can be used to validate the assessments of the potential impacts within this chapter. As such, the available evidence base is sufficiently robust to underpin the assessment presented here.

7.6 Design Envelope Parameters

7.6.1 Realistic Worst Case Design Scenario

7.6.1.1 As identified in Chapter 4 Development Description, Moray West is considering a range of potential construction methods and design options for the Development. The Design Envelope presented in Chapter 4 presents the range (minimum and maximum) of design parameters for each of the options under consideration e.g. substructure type or turbine model.

7.6.1.2 In order to determine potential impacts of the various options it is necessary to define the 'realistic worst case scenario'. The realistic worst case scenario represents, for any given receptor and potential impact on that receptor, various options in the Design Envelope that would result in the greatest potential for change to the receptor in question.

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

7.6.1.4 Table 7.6.1 presents the realistic worst case scenario for potential impacts on benthic and intertidal ecology during construction, operational and maintenance and decommissioning phases of the Development and provides justification as to why the options and design parameters identified are considered to be the realistic worst case scenario.

Table 7.6.1: Design Envelope Parameters Relevant to the Benthic and Intertidal Impact Assessment		
Potential Impact	**Realistic Worst Case Scenario**	**Justification**
Construction		
Temporary habitat loss / habitat disturbance (subtidal)	The maximum area of temporary habitat loss and disturbance across the Moray West Site has been quantified based on the following: • Area of seabed preparation (125 m diameter dredge-affected area) required for installation of gravity base structure foundations (based on 55 m diameter gravity base for Model 4 turbines) (see Chapter 4 Description of Development Table 4.4.6). The resulting area of disturbance per foundation is 12,272 m^2. Therefore, for 62 foundations the maximum area of disturbance would be 1,043,120 m^2 (1.043 km^2); • Seabed disturbance within the area of seabed preparation (125m diameter dredge-affected area) required for two small offshore substation platforms (OSPs) using gravity base foundation (55 m diameter). Total area of seabed disturbance amounts to 24,544 m^2; • Jack up vessel seabed footprint for 85 WTG and 2 OSP foundations, based on a maximum jack up barge footprint of 1,650 m^2 (275 m^2 per spud can and maximum 6 legs per jack-up), the maximum disturbance would be 143,550 m^2; • Installation of up to 275,000 m inter-array cables (with worst case trench affected width of 15 m) of 4,125,000 m^2 (4.125 km^2); • Installation of up to 15,000 m of OSP interconnector cabling (with worst case trench affected width of 15 m) of 225,000 m^2 (0.225 km^2); and • Seabed disturbance would occur over a 36 month period. The maximum area of temporary habitat loss and disturbance across the Offshore Export Cable Corridor has been quantified based on the following: • Installation of export cable circuits within up to two trenches, each 65,000 m in length and 15 m width. Which would result in a maximum disturbed area of 1,950,000 m^2 (1.95 km^2) and would occur over a six-month period (within the overall 36 month construction period). The overall total footprint of disturbance of the Moray West Site and Offshore Export Cable Corridor combined under a worst-case approach is 7,511,214 m^2 (7.511 km^2).	The worst case scenario is associated with the largest spatial footprint and area of seabed disturbance. This is based on maximum dredged area required for installation of the large diameter GBSs required for the larger Model 4 WTGs (maximum 62) and installation of two small OSPs, resulting in the installation of up to 64 substructures, in additional to maximum length of inter-array, OSP interconnector and export cable circuits. With regard to seabed disturbance associated with the jack-up barges this is based on installation of the maximum number of WTGs (85) and two small OSPs on the basis that the footprints associated with the jack-up barges are the same for all WTG models.
Temporary habitat loss /	<u>Open cut trenching in the Landfall Area</u>	The maximum design scenario is

Table 7.6.1: Design Envelope Parameters Relevant to the Benthic and Intertidal Impact Assessment		
Potential Impact	**Realistic Worst Case Scenario**	**Justification**
habitat disturbance (intertidal)	• Up to two cable trenches through mobile sediments in intertidal areas; • Burial depth of maximum 3 m below seabed (to be confirmed by cable burial risk assessment); • Trench affected width of up to 15 m; and • Trenches to be open for a period of days to a few weeks. Horizontal Directional Drilling (HDD) in the Landfall Area • Underground routing of up to two cable circuits requiring no surficial sediment disturbance; • May be used as an alternative to open cut trenching in the Landfall Area (between the onshore side and extending typically no further than 2 km offshore); • Cable transition and HDD exit pits will be located onshore (above MHWS) and sufficiently set back to avoid any interaction with the beach during construction and during the operational lifetime of the Development; and • The cable will enter the marine environment (HDD punch out) in the subtidal area.	associated with open-cut trenching through the intertidal.
Increased suspended sediment concentrations (SSC) / sediment deposition (subtidal)	The worst-case scenario would involve the maximum amount of sediment disturbance which is identified as follows: • The total maximum excavation requirement within the Moray West Site would be 2,411,663 m^3 based on an excavated seabed preparation area of 85 m diameter and 5 m depth for GBSs for 85 Model 1 WTGs; • The total maximum excavation requirements are for one large OSP and would be 90,478 m^3 based on seabed preparation of 120 m diameter and 8 m depth (total excavated area for two small OSPs based on 95 m diameter and 5 m depth is 70,880 m^3); • The total maximum excavation requirement for gravity base foundations within the Moray West Site would be 2,502,141 m^3 (2,411,663 m^3 for 85 WTG foundations and 90,478 m^3 for one large OSP); • Maximum excavated area for the inter-array cables (total length 275,000 m) based on a maximum trench width of 3 m, maximum burial depth of 3 m and assuming a 'V-shaped' trench is 1,237,500 m^3 (275 km x 3 m x 3 m x 0.5);	For single WTGs, the worst case scenario in terms of excavated material for installation of GBS foundations is for the Model 4 WTGs with an excavated seabed volume of 35,441 m^3 based on excavated area of 95 m diameter x 5 m depth. Total excavated area for one Model 1 WTG is 28,373 m^3 based on 85 m diameter x 5 m depth. However, worst case scenario for total volume of excavated material across the site (for WTGs) = 2,411,663 based on 85 Model 1 WTGs. Total for 62 Model 4 WTGs = 2,197,348 m^3). Of the methods proposed for inter-array

Table 7.6.1: Design Envelope Parameters Relevant to the Benthic and Intertidal Impact Assessment		
Potential Impact	**Realistic Worst Case Scenario**	**Justification**
	• Maximum excavated area for the OSP interconnector cables (total length up to 15,000 m) based on a maximum trench width of 3, maximum burial depth of 3 m and a 'V-shaped' trench is 67,500 m^3; and • Maximum excavated area for the offshore export cables (total length 130,000 m (130 km) based in two circuits at 65 km each) based on a maximum V-shaped trench width of 3 and maximum burial depth of 3 m is 585,000 m^3. Therefore, the total maximum excavated sediment required for seabed preparation for gravity base foundations (WTGs and OSPs), cable installation within the Moray West Site and cable installation along the export cable route would be up to 4,392,141 m^3 (4.4 km^2). • The maximum cable laying rate is likely to be 1,000 m/hr. The installation of cables would be spread across six months for the inter-array cables, three months for the OSP interconnector cables and six months for the offshore export cables.	and export cable installation, jetting results in the greatest volume of sediment dispersed as it is assumed that 100% of the sediment is liquidised, whereas for any other method less sediment would be suspended. Predicted increases in suspended sediment and sediment deposition assumes the greatest number and length of cables and the greatest burial depth.
Increased suspended sediment concentrations (SSC) / sediment deposition (intertidal)	<u>Open cut trenching in the Landfall Area</u> • Up to two cable trenches through mobile sediments in intertidal areas; • Burial depth of maximum 3 m below seabed (to be confirmed by cable burial risk assessment); • Trench affected width of up to 15 m; and • Trenches to be open for a period of days to a few weeks. <u>Horizontal Directional Drilling (HDD) in the Landfall Area</u> • Underground routing of up to two cable circuits requiring no surficial sediment disturbance; • May be used as an alternative to open cut trenching in the Landfall Area (between the onshore side and extending typically no further than 2 km offshore); • Cable transition and HDD exit pits will be located onshore (above MHWS) and sufficiently set back to avoid any interaction with the beach during construction and during the operational lifetime of the Development; and • The cable will enter the marine environment (HDD punch out) in the subtidal area.	The maximum design scenario is associated with open-cut trenching through the intertidal.

Table 7.6.1: Design Envelope Parameters Relevant to the Benthic and Intertidal Impact Assessment		
Potential Impact	**Realistic Worst Case Scenario**	**Justification**
Noise and vibration	Maximum duration of piling (based on pin-piles with 3,000 kJ hammer energy) is nine months. The spatial WCS is 85 x monopiles at 5000kJ hammer energy over five months. The temporal WCS is 85 x 4 pin-piled jacket structures (340 pin-piles) at 300kJ hammer energy over nine months.	The maximum adverse scenario for foundation installation is monopile foundation as these may require a hammer energy up to 5,000 kJ, and while the pin-pile jacket foundation would involve more piles and consequently a longer piling time, the maximum hammer energy is lower and therefore the noise and vibration impacts arising from the installation of the monopiles will have more impact and be of greater significance.
Accidental and Controlled Discharges	Synthetic compound, heavy metal and hydrocarbon contamination may be released accidentally as a result of offshore infrastructure installation and the presence of various construction vessels during the construction period (up to 25 at any one time, comprising of installation, support, transport and cable lay vessels, tugs, cranes and barges). Water-based drilling muds associated with drilling to install foundations and HDD may also be required. Grout may be required to secure joints between offshore structures. There may also be potential contamination of intertidal habitats resulting from machinery use and vehicle movement.	These parameters are considered to represent the maximum adverse scenario with regards to vessel movement during construction.
Risk of introduction of MINNS	The greatest risk of introduction of MINNS would be from vessel ballasting and biofouling. Various construction vessels will be present during the construction period (exact number is currently unavailable but will comprise of installation, support, transport and cable lay vessels, tugs, cranes and barges).	These parameters are considered to represent the maximum adverse scenario with regards to vessel movement and ballasting during construction.
Operational		
Long term habitat loss	This is the largest seabed footprint that will be required for the Development and includes scour protection. Under the worst case scenario, the size of the maximum footprint is based on the following:	The maximum design scenario is associated with the largest spatial footprint of installed infrastructure. The

Table 7.6.1: Design Envelope Parameters Relevant to the Benthic and Intertidal Impact Assessment		
Potential Impact	**Realistic Worst Case Scenario**	**Justification**
	• 45 m diameter gravity base foundations and scour protection calculated as 5,675 m^2 per foundation. For 85 foundations the maximum area of disturbance would be 482,333 m^2. • Foundations and scour protection for two small OSPs will have a footprint of 14,176 m^2 based on a maximum requirement for scour protection to extend out over a 95 m diameter area (including the 55 m diameter gravity base foundation) (7,088 m^2 per foundation); • A worst-case measure of 10% of the total inter-array cable length is predicted to require cable protection. This would result in 27,500 m of the inter-array cables requiring protection. Assuming 3m wide concrete mattress protection is used this would result in a footprint of up to 82,500 m^2; • A worst-case measure of 10% of the total OSP interconnector cabling is predicted to require cable protection. This would result in 1,500 m of the inter-array cable requiring protection, resulting in a footprint of up to 4,500 m^2; and • Protection associated with 15 cable crossings for inter-array cables requiring rock protection extending 200 m in length and 6 m in width will result in a footprint of up to 18,000 m^2. Total footprint across the Moray West Site which could be subject to habitat loss during operation is therefore 545,516 m^2. • A worst- case measure of 20% of the total export cable length is predicted to require cable protection. This would result in 26,000 m of the export cable affording protection, resulting in a footprint of up to 78,000 m^2; and • Protection associated with six cable crossings for export cables resulting in a footprint of up to 7,200 m^2. Total footprint across the Offshore Export Cable Corridor which could be subject to habitat loss during operation is therefore 85,200 m^2. The overall total footprint which could be subject to permanent habitat loss would therefore be 630,716 m^2. There may be the need to perform maintenance operations on electrical cables during the lifetime of the Development.	maximum design scenario is associated with gravity base foundations for 85 WTGs (each gravity base will have a 45 m diameter and associated 85 m scour protection) and the construction of two OSPs with 55 m diameter gravity base foundations and 95 m scour protection (including foundation). This assumes that scour protection is required for all foundations. The maximum adverse scenario for long-term habitat loss also includes the use of cable protection along 10% of the inter-array cables and along 20% of the export cable. The maximum adverse scenario for habitat loss associated with cable crossings comprises 15 crossings of inter-array cables and six crossings of export cables.

Table 7.6.1: Design Envelope Parameters Relevant to the Benthic and Intertidal Impact Assessment		
Potential Impact	**Realistic Worst Case Scenario**	**Justification**
Accidental and Controlled Discharges	Synthetic compound, heavy metal and hydrocarbon contamination resulting from up to 85 turbines and two OSPs. Accidental pollution may also result from O&M vessels (including crew supply vessels and jack-up vessels). A typical turbine is anticipated to require grease, synthetic or hydraulic oil, and other operating compounds or materials such as liquid nitrogen, silicone oil and gas. The OSP is expected to require chemicals and other operating compounds such as diesel, water, coolants, oil, batteries and fire suppressant material. Various operation and maintenance vessels will be required over the operation period.	These parameters are considered to represent the maximum adverse scenario with regards to chemicals and vessel movements during the operational period.
Scouring of benthic habitats at foundations and around cables	For the Moray West Site as a whole, the greatest total local scour footprint is associated with 62 x 15 m diameter monopile foundations (for Model 4 WTGs) and one large (15 m diameter) OSP monopile foundation (284,265 m²), equivalent to only approximately 0.11% of the Moray West Site. For the Moray West Site as a whole, the greatest total WTG foundation global scour footprint is associated with an array of 85 smaller (35 m base diameter) piled jacket WTG foundations and 1 larger piled jacket OSP foundation (355,163 m²), equivalent to only approximately 0.16% of the Moray West Site.	Full justification of the worst-case scenarios can be found within Technical Appendix 6.3: Physical Processes Impact Assessment.
Creation of new substrate and habitat	The introduction of new hard structures with a maximum surface area of 686,709 m^2 provided by the following Development infrastructure: • Gravity base foundations for 85 WTGs and scour protection (482,333 m^2); • Gravity base foundations for two OSPs and scour protection (14,176 m^2); • Inter-array cable protection 10% (82,500 m^2); • Interconnector cable protection 10% (4,500 m^2); • Offshore export cable protection 20% (78,000 m^2); and • Crossings (25,200 m^2).	Maximum scenario for introduced hard substrate is the greatest number of GBS and scour / cable protection.
EMF	To inform the assessment of impacts associated with EMF the following worst case scenario parameters are considered: • The maximum length of inter-array (up to 72.5 kV of alternating current) cables would be up to 275,000 m; • The maximum length of OSP interconnector cables (up to 400 kV) would be 15,000 m; and • The maximum length of offshore export cable circuits (up to 400 kV) would be 130,000 m (two circuits of 65,000 m).	The maximum adverse scenario is associated with the use of 85 turbines and 2 OSPs as this results in the greatest length of inter-array cable and two export cables as this results in the longest total length of export cable.

Table 7.6.1: Design Envelope Parameters Relevant to the Benthic and Intertidal Impact Assessment		
Potential Impact	**Realistic Worst Case Scenario**	**Justification**
Seabed sediment heating from subsea cables	Refer to EMF impact above.	Refer to EMF impact above.
Risk of introduction of MINNS	The greatest risk of introduction of MINNS would be from vessel ballasting and biofouling. Various operation and maintenance vessels will be required over the operation period.	These parameters are considered to represent the maximum adverse scenario with regards to vessel movement and ballasting during operation.
Decommissioning		
Temporary habitat loss / habitat disturbance	The maximum area of disturbance during decommissioning is based on: • Removal of 85 turbines with 45m diameter gravity base foundations and scour protection calculated at 5,675 m^2 per foundation with a combined footprint of 482,333 m^2; • Removal of two OSPs and scour protection (14,176 m^2); • The footprint of the jack-up barge removing 87 foundations (85 WTGs and 2 OSPs), maximum jack up barge footprint of 1,650 m^2 (275 m^2 per spudcan and maximum 6 legs per jack-up). The maximum disturbance would be 143,550 m^2; • Removal of 275,000 m of inter-array cables, would result in 4,125,000 m^2 disturbance; • Removal of 15,000 m of inter OSP cabling, would result in 225,000 m^2 disturbance; and • Removal of 130,000 m of export cables, would result in 1,950,000 m^2 disturbance. Total decommissioning footprint of disturbance within the Moray West Site and Offshore Export Cable Corridor during decommissioning would be approximately 6,940,059 m^2 (6.940 km^2).	Maximum adverse scenario as per the construction phase and assumes the removal of all WTG (85) and OSP (two) foundations, scour protection, inter-array, OSP interconnector and export cables. The removal of cables is considered to be the worst-case, however, the necessity to remove cables will be reviewed at the time, after consideration of the environmental impact of the removal operation and the safety of the cables left *in situ*.
Increased suspended sediments concentrations (SSC) / sediment deposition	As per details in construction impact (above) for increased suspended sediment concentration and sediment deposition (although predicted to be much less in reality due to lower impact of decommissioning activities involved e.g. no dredging of seabed).	Maximum adverse scenario as per the construction phase and assumes the removal of all WTG and OSP foundations and associated inter-array, interconnector and export cables.
Noise and vibration	Noise created by the removal of foundations using cutting machinery.	Based on application of cutting equipment to remove foundations.

Table 7.6.1: Design Envelope Parameters Relevant to the Benthic and Intertidal Impact Assessment		
Potential Impact	**Realistic Worst Case Scenario**	**Justification**
Accidental and Controlled Discharges	Synthetic compound, heavy metal and hydrocarbon contamination resulting from a maximum of 85 turbines and two offshore substations. Various decommissioning vessels (number currently undetermined) will also be active over the decommissioning period. Potential contamination in the intertidal area resulting from machinery use and vehicle movement.	Maximum adverse scenario as per construction phase.
Risk of introduction of MINNS	The greatest risk of introduction of MINNS would be from vessel ballasting and biofouling. There will various vessels present during decommissioning activity, although the exact number is unknown and will be defined within the Decommissioning Plan as far as possible.	These parameters are considered to represent the maximum adverse scenario with regards to vessel movement and ballasting (if required) during decommissioning.

7.6.2 Embedded Measures

7.6.2.1 As part of the Development design process, a number of embedded mitigation measures have been proposed to reduce the potential for impacts on benthic and intertidal ecology. These measures are considered standard industry practice for this type of development and have therefore been considered in the assessment presented in Section 7.7 below. Assessment of sensitivity, magnitude and therefore significance includes implementation of these measures.

7.6.2.2 The embedded mitigation measures relating to benthic and intertidal ecology are summarised below:

- Careful cable corridor selection has taken place for the Offshore Export Cable Corridor to avoid, as far as possible, European and nationally designated sites that are present along the coastline considered for landfall, the proposed Southern Trench MPA as well as PMFs and other species/habitats of conservation importance;
- A detailed cable routing study and Cable Burial Risk Assessment (CBRA) will be undertaken post consent (based on results from post-consent geophysical and geotechnical surveys). The presence of sensitive benthic habitats/species and species/habitats of conservation importance will be a key consideration in the detailed design of the final cable routes;
- Cable design incorporates burial of the cables to a minimum target depth of 1 m as far as possible in order to reduce the potential impacts of EMF, reducing the need for cable protection and the amount of introduced hard substrate (albeit that artificial substrate can be beneficial in term of benthic habitat creation). Where burial is not possible, cables will be protected;
- To minimise the extent of any unnecessary habitat disturbance, material displaced as a result of cable burial activities will be back filled, where possible, in order to promote recovery;
- Cable specifications will be used that reduce EMF emissions as per industry standards and best practice such as the relevant IEC (International Electrotechnical Commission) specifications;
- An appropriate Environmental Management Plan (EMP) will be produced and followed to cover the construction, operation and maintenance phases of the Development. This will include planning for management of MINNS; and
- An appropriate Marine Pollution and Contingency Plan (MPCP) will be produced and followed to cover the construction, operation and maintenance phases of the Development. This will include planning for accidental spills, address all potential contaminant releases and include pollution event response protocols.

7.7 Assessment of Potential Effects

7.7.1.1 Impacts arising from the construction, operation and maintenance and decommissioning of the Development have the potential to impact upon benthic habitats and species. This may occur directly (e.g. as a result of physical disturbance) or indirectly (e.g. through changes to hydrodynamic conditions).

7.7.1.2 Any impacts which alter the baseline condition of the habitat may have potential impacts not only on associated benthic species, but across the whole trophic chain (e.g., displacement of reproductive faunal and floral populations and prey/food items). Therefore, the potential impacts, appropriate to each phase and area, associated with the Development are investigated and assessed in relation to benthic and intertidal habitats and associated faunal communities.

7.7.1.3 A key component of the impact assessment has been the application of peer-reviewed information on biological sensitivity to various anthropogenic impacts, including those associated with offshore wind farm development (e.g. habitat physical disturbance, increased suspended sediment). This information is available on the MarLIN website, as well as in the current literature specific to this subject and includes Wilhelmsson *et al*. (2010); BERR (2008); OSPAR (2008b, 2009) and Cefas (2009). This literature provides an overview of vulnerability of benthic and aquatic marine life to the specific potential environmental impact of offshore wind farm development, based on field and experimental studies as well as theoretical models.

7.7.2 Potential Construction Effects

7.7.2.1 The impacts from construction of the Development have been assessed on benthic and intertidal ecology in the Moray West benthic study area. The potential environmental impacts arising from construction of the Development are listed in Table 7.6.1, along with the Design Envelope against which each construction impact phase impact has been assessed.

7.7.2.2 A description of the significance of effect upon benthic and intertidal receptors caused by each identified impact is provided below.

<u>Temporary Habitat Loss / Habitat Disturbance (Subtidal)</u>

Magnitude of Impact

7.7.2.3 As detailed in Table 7.6.1 above, during construction direct temporary loss/disturbance of subtidal habitat within the Moray West Site and Offshore Export Cable Corridor will occur as a result of the installation of WTG and OSP substructures and associated seabed preparation works, use of jack-up barges within the Moray West site to install substructures, WTGs and OSPs, installation of inter-array, OSP interconnector and export cables, and the potential use of anchor placements associated with these operations.

7.7.2.4 The total maximum area of temporary subtidal habitat loss and disturbance due to construction activities (described in Table 7.6.1) is predicted to be approximately 7,511,214 m^2. This equates to 1.64% of the total seabed area within the wider Moray West Site and Offshore Export Cable Corridor area (459 km^2). This is based on the installation of up to 64 gravity base structure foundations (for 62 WTGs and 2 smaller OSPs) which have the largest footprint on the seabed (direct and associated seabed preparation works, including dredging) and are therefore considered the worst case scenario.

7.7.2.5 Activities resulting in the temporary habitat loss of subtidal habitats will occur intermittently throughout the construction period (36 months). Once seabed preparation works are complete and all WTG and OSP substructures and cables have been installed, any disturbance to the seabed and associated habitats will cease, allowing benthic species to start to recolonize previously disturbed areas. Therefore, given the temporary nature of the impact, and that the total area of subtidal habitat affected during construction is less than 1.7% of the total seabed area within the Moray West Site and along the Offshore Export Cable Corridor, the overall magnitude of the impact is considered to be **low**.

Sensitivity of the Receptor

7.7.2.6 With the exception of the biotopes identified in Section 7.7.2.7, the species and habitats identified during the benthic characterisation surveys are typical of the wider region of the surrounding area. The biotopes that have the greatest distribution across the benthic study area (Figure 4.2-11 of Technical Appendix 7.1: Benthic Survey Report) have a low sensitivity to temporary habitat loss and disturbance (Table 7.7.1 below) due to the opportunistic nature of the characterising species to recruit rapidly and where they are damaged characterising species may recover or recolonise quickly. At locations where biotopes have a moderate sensitivity, these are expected to recover quickly where baseline sediment conditions are retained as the impact will be localised and of a short-term duration.

7.7.2.7 Specifically, and as identified in Technical Appendix 7.1: Benthic Survey Report, all biotopes, apart from **SS.SCS.CCS.MedLumVen** and **SS.SMu.CFiMu.SpnMeg** have been assessed according to the MarESA criteria as having a high or medium recoverability (resilience) to direct disturbance. With the exception of the potential Annex I stony reef habitat and the PMFs of **SS.SMu.CFiMu.SpnMeg** (also a qualifying feature of the Southern Trench pMPA) and **SS.SCS.ICS.MoeVen**, the subtidal habitats directly affected by temporary habitat loss and disturbance are considered to all have a low to moderate sensitivity to disturbance of this nature. For the potential Annex I stony reef that was recorded within the Moray West Site, this feature was recorded at only one location and was not determined to meet with the established definitions of 'stony reef'. This habitat is therefore determined to be of low sensitivity. The PMF habitats of **SS.SMu.CFiMu.SpnMeg** and **SS.SCS.ICS.MoeVen** are considered to be of moderate sensitivity due to their national conservation value. This sensitivity is strengthened for **SS.SMu.CFiMu.SpnMeg** due to its current status as a pMPA qualifying feature.

7.7.2.8 Other species present within the seabed habitats that are of moderate sensitivity include the PMF species of Arctic quahog, flame shell and sandeels (sandeels are addressed further in Chapter 8: Fish and Shellfish Ecology).

7.7.2.9 Experience from the marine aggregates industry (e.g. van Moorsel & Waardenburg, 1991; Kenny & Rees, 1996; Sardá *et al*., 2000; Boyd *et al*., 2004, 2005; Desprez 2007; Barrio–Frojan, 2008; and Hill *et al*., 2011) shows that recovery of the benthic ecology follows a general pattern of succession of colonisation once seabed disturbances abate, but that the rate at which this is achieved typically depends upon a number of factors including the prevailing hydrodynamic and sediment transport regime, the severity of the original impact and the nature of the baseline community and surrounding populations. As assessed in Chapter 6: Physical Processes and Water Quality, it is estimated that it will take up to five years for the pits created by the legs of jack–up barges to flatten and disappear subject to the frequency of large wave events and associated seabed erosion and sediment resuspension rates.

7.7.2.10 With respect to physical impacts associated with cable installation, recovery of seabed habitats within these timescales would appear reasonable as the same dynamic processes would also erode and infill the linear trench marks and associated sediment berms remaining on the seabed post cable installation. BERR (2008) suggests that in sand and gravel sediments ploughed or jetted trenches are rapidly infilled following cable installation suggesting rapid restitution of seabed habitats although in more cohesive clay sediments with limited ambient sediment transport for infilling, recovery may take longer or a permanent scar may exist on the seabed.

Table 7.7.1: Sensitivity Assessment for Temporary Habitat Loss / Habitat Disturbance				
Biotope Code	**Biotope Name**	**MarESA Sensitivity Category**	**Assessment Confidence**	**Assessment sensitivity (as defined in Section 7.5.2)**
SS.SCS.ICS.MoeVen	*Moerella* spp. with venerid bivalves in infralittoral gravelly sand.	Low (based on medium resistance and high resilience)	Confidence in the quality of the evidence is high, in the applicability is medium and the agreement confidence is low.	Moderate (due to national conservation value)
SS.SMx.CMx.OphMx	*Ophiothrix fragilis* and/or *Ophiocomina nigra* brittlestar beds on sublittoral mixed sediment.	Medium (based on low resistance and medium resilience)	Confidence in the quality of the evidence is high, in the applicability is high and the agreement confidence is high.	Moderate
SS.SCS.CCS.MedLumVen	*Mediomastus fragilis, Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel.	Low (based on a high resistance and low resilience)	Confidence in the quality of the evidence is high, in the applicability is medium and the agreement confidence is low.	Low
SS.SSa.CFiSa.EpusOborApri	*Echinocyamus pusillus, Ophelia borealis* and *Abra prismatica* in circalittoral fine sand.	Low (based on medium resistance and high resilience)	Confidence in the quality of the evidence is low, in the applicability is low and the agreement confidence is low.	Low
SS.SMx.CMx.FluHyd	*Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment.	Medium (based on low resistance and medium resilience)	Confidence in the quality of the evidence is medium, in the applicability is medium and the agreement confidence is medium.	Moderate
CR.HCR.XFa.SpNemAdia	Sparse sponges, *Nemertesia* spp. and *Alcyonidium diaphanum* on circalittoral mixed substrata.	Medium (based on low resistance and medium resilience)	Confidence in the quality of the evidence is medium, in the applicability is medium and the agreement confidence is medium.	Moderate
CR.MCR.EcCr.FaAlCr.Pom	Faunal and algal crusts with *Spirobranchus triqueter* and sparse *Alcyonium digitatum* on exposed to moderately wave-exposed circalittoral rock.	Low (based on medium resistance and high resilience)	Confidence in the quality of the evidence is high, in the applicability is high and the agreement confidence is high.	Low
SS.SSa.IMuSa.FfabMag	*Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand.	Low (based on medium resistance and high resilience)	Confidence in the quality of the evidence is low, in the applicability is low and the agreement confidence is low.	Low

Table 7.7.1: Sensitivity Assessment for Temporary Habitat Loss / Habitat Disturbance

Biotope Code	Biotope Name	MarESA Sensitivity Category	Assessment Confidence	Assessment sensitivity (as defined in Section 7.5.2)
SS.SMu.CFiMu.SpnMeg	Seapens and burrowing megafauna in circalittoral fine mud.	Medium (based on medium resistance and low resilience)	Confidence in the quality of the evidence is medium, in the applicability is low and the agreement confidence is low.	Moderate (due to being a pMPA qualifying feature and of national conservation value)

7.7.2.11 Since a key aim of the selected cable installation techniques will be to retain as much of the original sediment as possible for backfilling, to achieve the required burial depth, then it is reasonable to suggest that potential release of sediments will be limited and associated impacts of installation of inter–array cables on local benthic communities will be of low magnitude and local spatial scale. Backfilling and / or retention of sediment within the trenches will facilitate the subsequent restitution of seabed habitats following installation of the inter–array cables.

7.7.2.12 Recolonization of affected areas by benthic fauna will be via passive import of larvae and active migration of adults from adjacent non-affected areas. Full recovery of communities to baseline conditions will depend upon the rate at which the habitat recovers in terms of its particle size characteristics and stability, although partial recovery of fauna will occur very quickly as a result of settlement of species whose particular traits include high fecundity and mobility as well as tolerance to unstable sediment conditions during periods of infilling.

Significance of the Effect

7.7.2.13 The magnitude of the impacts have been assessed as **low**, with the maximum sensitivity of the receptors as **moderate**. Therefore, the significance of effects from direct disturbance occurring as a result of construction related activities is **minor**, which is **not significant** in EIA terms.

7.7.2.14 The MarESA assessments identify that the confidence for the sensitivity of the specified habitats **SS.SSa.CFiSa.EpusOborApri** and **SS.SSa.IMuSa.FfabMag** to temporary loss / disturbance is low. For both these habitats the low confidence is associated with the resistance measure, with high confidence associated with the recovery (resilience) of the habitats. Both these habitats have been assessed as having a medium resistance to this impact, therefore while the confidence of the resistance of this habitat to this impact is low, this provides a relatively conservative assessment of the impacts and therefore an appropriately robust assessment of the overall significance of effect on the other habitats. As such, the assessment of effects as not significant remains valid.

7.7.2.15 No specific mitigation is required as there are no significant effects as a result of the construction of the Development. However, best practice measures in relation to the potential Annex I habitat and proposed MPA qualifying features are presented in Section 7.7.5.

<u>Temporary Habitat Loss / Habitat Disturbance (Intertidal)</u>

Magnitude of Impact

7.7.2.16 Disruption to intertidal habitats will occur as a result of cable laying and installation. The cable construction corridor for surface trenching is usually no wider than 3 m either side of the export cables (BERR, 2008) (see Chapter 4: Description of Development). The corridor will support vehicle traffic, provide adequate space for cable assembly, sufficient space for excavation of the cable trenches as well as sufficient space for the removed sediment. The intertidal cable may, however be installed through horizontal directional drilling, which will limit the footprint of any habitat disturbance.

7.7.2.17 Once seabed preparation works are complete and all WTG and OSP substructures and cables have been installed, any disturbance to the seabed and associated habitats will cease, allowing intertidal species to start to recolonize previously disturbed areas. Therefore, given the temporary nature of the impact, and that the total area of intertidal habitat affected during construction is minimal, the overall magnitude of the impact is considered to be **low**.

Sensitivity of Receptor

7.7.2.18 The species and habitats identified during the intertidal characterisation surveys (**LS.LSa.MoSa.BarSa**, **LS.LSa.MoSa.AmSco.Eur**, **LS.LSa.MoSa.AmSco.Sco** and **LS.LSa.FiSa.Po**) are typical of the wider region of the surrounding area. All the intertidal biotopes identified have been assessed according to the MarESA criteria as having a high resilience to direct disturbance and were therefore classified as being either not sensitive or having a low sensitivity (Table 7.7.2).

7.7.2.19 While it is likely that the characterising species of the intertidal biotopes would be damaged or removed by the physical impacts of the trench excavation in the intertidal area, a high proportion of the intertidal species that characterise these biotopes are highly mobile and/or opportunistic in nature and are therefore able to recolonise disturbed habitat quickly.

7.7.2.20 For the purpose of this assessment, the intertidal species and habitats are considered to have **negligible to low** sensitivity.

Table 7.7.2: Sensitivity Assessment for the Intertidal Habitats to Temporary Habitat Loss / Disturbance				
Biotope Code	**Biotope Name**	**MarESA Sensitivity Assessment**	**Assessment Confidence**	**Assessment Sensitivity (as defined in Section 7.5.2)**
LS.LSa.MoSa.BarSa (upper shore)	Barren littoral coarse sand	Not sensitive (based on high resistance and high resilience).	Confidence in the quality of the evidence is high, in the applicability is medium and the agreement confidence is low.	Negligible
LS.LSa.MoSa.AmSco.Eur (upper shore)	*Eurydice pulchra* in littoral mobile sand	Very low sensitivity (based on low intolerance and high recoverability).	Confidence in the quality of the assessment is moderate.	Low
LS.LSa.MoSa.AmSco.Sco (mid shore)	*Scolelepis* spp. in littoral mobile sand	Low sensitivity (based on low resistance and high resilience).	Confidence in the quality of the evidence is high, in the applicability is low and the agreement confidence is high.	Low
LS.LSa.FiSa.Po (mid shore & an impoverished version in the low shore)	Polychaetes in littoral fine sand	Low sensitivity (based on low resistance and high resilience).	Confidence in the quality of the evidence is high, in the applicability is medium and the agreement confidence is medium.	Low

Significance of Effect

7.7.2.21 The magnitude of the impact has been assessed as **low** on the basis that the impact is of temporary duration, reversible, and localised, with the maximum sensitivity of the intertidal receptors being **low**. Therefore, the significance of effects from direct disturbance occurring as a result of export cable installation activities in the intertidal area is **negligible or minor**, which is **not significant** in EIA terms.

7.7.2.22 The MarESA assessments (Table 7.7.2) identify that the confidence for the sensitivity of the specified habitats to habitat loss / disturbance is moderate to high. The significance of effect has been assessed based on the lowest resistance score of 'low sensitivity' and is therefore considered to be precautionary.

7.7.2.23 No mitigation is required as there are no significant effects as a result of the construction of the Development.

<u>Increased Suspended Sediment Concentrations (SSC) /Sediment Deposition (Subtidal)</u>

7.7.2.24 Temporary increases in suspended sediment concentrations (SSC) and associated sediment deposition are expected from the installation of WTG and OPS foundations, any associated seabed preparation works (dredging required for gravity base structure (GBS) foundations), and installation of the inter-array, OSP interconnector and export cables. The processes of dredging and drilling (monopiles) are separate construction techniques as each are associated with the installation of different foundation types. As such they will not take place in combination and construction will occur using either dredging or drilling.

7.7.2.25 Increased SSC and sediment deposition has the potential to affect benthic ecology through blockage to the sensitive filter feeding apparatus of certain species and / or smothering of sessile species upon deposition of the sediment.

Magnitude of Impact

7.7.2.26 Table 7.6.1 presents the maximum design scenario associated with increases in SSC and deposition associated with construction activities. A summary of the relevant findings, as detailed in Chapter 6: Physical Processes and Water Quality, is presented below.

7.7.2.27 Due to the nature of the seabed preparation and installation activities, sediment would be put into suspension either by energetic disturbance at or near to the seabed or by release at or near to the sea surface. This will result in a temporary and localised sediment plume, within which SSC is elevated above ambient levels. The assessments undertaken (and presented in Chapter 6: Physical Processes and Water Quality) quantify the likely magnitude of increase in SSC (which may vary with time and distance from the activity) and the spatial and temporal patterns of the change (extent, duration, etc). Over time (duration related to the sediment grain size) the disturbed sediment in suspension will settle back to the seabed. The assessments undertaken also quantify the likely thickness and extent of any sediment deposit that might form.

7.7.2.28 The overall patterns of change in SSC is summarised as follows:

- SSC will be increased by tens to hundreds of thousands of mg/l at the point of sediment release for the duration of the activity;
- In the case of dredging or drilling, the source of the sediment release is static and may last for hours, up to a few days. In the case of cable burial, the source of sediment release is moving and so the local change will be limited in time to a matter of seconds;
- SSC will reduce with time and distance from the source due to dispersion and resettlement of sediment to the seabed. Sands and gravels will settle out faster than finer material. The

overall duration of change will depend on the relative proportions of grain sizes present, which may vary by location and activity type;

- If released at the water surface, SSC of low tens of mg/l will be present in a narrow plume (tens to a few hundreds of metres wide), up to one tidal excursion in length (up to ~3.5 to 4.2 km on spring tides, and half that distance on neap tides) aligned to the tidal current downstream from the source;
- If the activity occurs over more than one flood or ebb tidal period, the plume feature may be present in both downstream and upstream directions;
- Outside of the area up to one tidal excursion upstream and downstream of the foundation location, SSC less than 10 mg/l may occur more widely due to ongoing dispersion and dilution of material;
- Following the end of drilling or dredging, locally high SSC at the source will recover quickly (within minutes) to background levels as the sediment plume is advected away and coarser sediments or clasts settle back onto the seabed;
- Sufficiently fine sediment may persist in suspension for hours to days or longer, but will become diluted to very low concentrations (<5 mg/l, indistinguishable from natural background levels and variability) within timescales of around one day; and
- Over longer timescales, net movement of any fine grained material persisting in suspension would generally be in an approximate southerly (south-easterly through south-westerly) direction across most of the Moray West Site in accordance with the direction of residual flow in this area.

7.7.2.29 The overall pattern of change in seabed level is summarised as follows:

- In the case of dredging (release at or near the water surface):
  - Spoil disposal would form more concentrated sediment deposits on the seabed. The main mass of sediment (90% of the total dredged volume, falling as the active phase of the plume) will initially result in discrete mounds or patches of sediment in the order of tens to hundreds of metres in diameter (depending on the pattern of settlement) and centimetres to a few metres in local thickness;
- In the case of drilling (release at or near the water surface):
  - Deposits of mainly coarse grained (gravel) and clastic sediment deposits will likely be concentrated within an area in the order of approximately 10 to 50 m downstream/upstream and a few tens of metres wide from individual foundations, with a corresponding average thickness in the order of 5 to 10 m;
  - Deposits of mainly sandy sediment deposits will likely be concentrated within an area in the order of approximately 100 m to 500 m downstream/upstream and tens to one hundred metres wide from individual foundations, with a corresponding average thickness in the order of tens of centimetres to one metre;
- In the case of cable burial (release at or near the seabed surface):
  - Depending on the height to which the material is ejected and the current speed at the time of release, deposition will be spatially limited to within metres (up to 10 m) downstream of the cable for gravels and within tens of metres (up to one hundred metres) for sands, with a corresponding average thickness in the order of centimetres to tens of centimetres (limited to realistically likely values);

- In all cases, fine grained material will be dispersed widely within the surrounding region and will not settle with measurable thickness;
- The actual shape and thickness of the seabed deposit resulting from the disturbance or release of sediment cannot be predicted accurately in advance and in any case is likely to vary. A range of possible configurations of area and thickness are presented for each activity in Technical Appendix 6.3 (Volume 4): Physical Processes Impact Assessment. From this range, the above examples represent a relatively widely spread deposit which is the maximum design scenario for the area of seabed affected (by a nominal average thickness of 0.05 m); and
- Irrespective of the activity or sediment type, the volumes of sediment being displaced and deposited locally are inherently limited, which also limits the combinations of sediment deposition thickness and extent that might realistically occur. Fundamentally, the maximum area that can be affected by a given average thickness of sediment is limited by the starting volume and any larger area would correspond to a smaller average thickness (and vice versa). Based on the realistic worst case maximum total sediment volumes, the following are the realistic maximum proportions of the Moray West Site that could be covered by a meaningful average thickness of sediment (0.05 m):
    - By dredging all WTG and OSP foundations – A maximum area of 50.04 km^2, equal to approximately 22% of the Moray West Site area could potentially be covered by an average thickness of 0.05 m of material.
    - By drilling all WTG and OSP foundations – A maximum area of 18.85 km^2 (approximately 8.4% of the Moray West Site area) could potentially be covered by an average thickness of 0.05 m of material.
    - By burying all inter-array and interconnector cables (assuming 100% displacement of material from the trench) – A maximum area of 26.10 km^2 (approximately 11.6% of the Moray West Site area) could potentially be covered by an average thickness of 0.05 m of material.

7.7.2.30 Given that only one foundation type will be installed across the site, the maximum area within the Moray West site that would potentially covered by an average thickness of 0.05 m of material would be 76.14 km^2 (33.6%). This is based on seabed preparation for the installation of GBS foundations and burial of inter-array and interconnector cables.

7.7.2.31 The impact to subtidal benthic receptors from seabed preparation and installation activities is predicted to be of regional spatial extent (i.e. within kilometres of the Development), of short to medium term (i.e. construction phase of up to 36 months) and intermittent duration, and reversible to baseline conditions following cessation of activities. It is also predicted that the impact will affect benthic receptors indirectly and therefore, the magnitude is considered to be **low**.

Sensitivity of the Receptor

7.7.2.32 The subtidal habitats in this region are accustomed to high levels of SSC that occur naturally and consequently are able to tolerate variations in SSC and also sediment deposition. The communities that characterise these biotopes are predominantly infaunal mobile species or sessile species including polychaetes and venerid bivalves, many of which are suspension or deposit feeders and capable of tolerating high levels of SSC and localised events of sediment deposition. The recoverability of such communities is likely to occur as a result of the combination of recruitment from surrounding unaffected areas and larval dispersal and recovery is likely to occur within two to ten years depending on the depth of burial (with areas that are affected by lighter levels of deposition typically recovering within two years; based on the MarESA assessments).

7.7.2.33 Of the biotopes identified as present across the study area, none are considered to have a high sensitivity to increased SSCs using the MarESA assessments and all are considered to have low to medium sensitivity to smothering by sediment deposition using both MarESA and FEAST (Table 7.7.3). Assuming an average deposited sediment layer of thickness of up to 0.05 m across a maximum of 30% of the Moray West Site, based on information presented in Table 7.7.3 it is concluded that the sensitivity of biotopes within the Moray West Site to increased SSCs and smothering is considered to be **low to moderate**.

Table 7.7.3: Sensitivity Assessment for the Subtidal Benthic Biotopes for Increased SSC and Associated Sediment Deposition (Smothering)				
Biotope Code	**Biotope Name**	**MarESA Sensitivity Assessment**	**Assessment Confidence**	**Assessment Sensitivity (as defined in Section 7.5.2)**
SS.SCS.ICS.MoeVen	*Moerella* spp. with venerid bivalves in infralittoral gravelly sand	Low sensitivity to changes in SSC Low sensitivity to light smothering (<5 cm) Medium sensitivity to heavy smothering (5 – 30 cm)	Confidence in the quality of the evidence is high for SSC, in the applicability is low and the agreement confidence is low. The confidence in the quality of the evidence is high for light smothering, although the applicability is low and agreement of the evidence is medium. Confidence in the quality of the evidence is high for heavy smothering, although the applicability is low and agreement of the evidence is low.	Low to Moderate
SS.SMx.CMx.OphMx	*Ophiothrix fragilis* and/or *Ophiocomina nigra* brittlestar beds on sublittoral mixed sediment	Not sensitive to changes in SSC Medium sensitivity to light smothering (<5 cm) Medium sensitivity to heavy smothering (5 – 30 cm)	Confidence in the quality of the evidence is medium for SSC, in the applicability and agreement of confidence is also medium. The confidence in the quality of the evidence is medium for light smothering, the applicability and agreement of the evidence is also medium. Confidence in the quality of the evidence is high for heavy smothering, although the applicability is low and agreement of the evidence is low.	Negligible to Moderate
SS.SCS.CCS.MedLumVen	*Mediomastus fragilis, Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel	Low sensitivity to changes in SSC Low sensitivity to light smothering (<5 cm) Medium sensitivity to heavy smothering (5 – 30 cm)	Confidence in the quality of the evidence is high for SSC, in the applicability is low and the agreement confidence is low. The confidence in the quality of the evidence is high for light smothering, although the applicability is low and agreement of the evidence is medium. Confidence in the quality of the evidence is high for heavy smothering, although the applicability and agreement of the evidence low.	Low to Moderate

Table 7.7.3: Sensitivity Assessment for the Subtidal Benthic Biotopes for Increased SSC and Associated Sediment Deposition (Smothering)				
Biotope Code	**Biotope Name**	**MarESA Sensitivity Assessment**	**Assessment Confidence**	**Assessment Sensitivity (as defined in Section 7.5.2)**
SS.SSa.CFiSa.EpusOborApri	*Echinocyamus pusillus, Ophelia borealis* and *Abra prismatica* in circalittoral fine sand	Low sensitivity to changes in SSC Low sensitivity to light smothering (<5 cm) Medium sensitivity to heavy smothering (5 – 30 cm)	Confidence in the quality of the evidence is low for SSC, in the applicability is low and the agreement confidence is low. The confidence in the quality of the evidence is high for light smothering, although the applicability is low and agreement of the evidence is medium. Confidence in the quality of the evidence is high for heavy smothering, although the applicability and agreement of the evidence low.	Low to Moderate
SS.SMx.CMx.FluHyd	*Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment	Not sensitive to changes in SSC Not sensitive to light smothering (<5 cm) Low sensitivity to heavy smothering (5 – 30 cm)	Confidence in the quality of the evidence is medium for SSC, in the applicability is medium and the agreement confidence is low. The confidence in the quality of the evidence is medium for light smothering and the applicability and agreement of the evidence is medium. Confidence in the quality of the evidence is medium for heavy smothering and the applicability and agreement of the evidence is medium.	Negligible to Low
CR.HCR.XFa.SpNemAdia	Sparse sponges, *Nemertesia* spp. and *Alcyonidium diaphanum* on circalittoral mixed substrata	Not sensitive to changes in SSC Not sensitive to light smothering (<5 cm) Low sensitivity to heavy smothering (5 – 30 cm)	Confidence in the quality of the evidence is medium for SSC, in the applicability is medium and the agreement confidence is low. The confidence in the quality of the evidence is medium for light smothering and the applicability and agreement of the evidence is medium. Confidence in the quality of the evidence is medium for heavy smothering and the applicability and agreement of the evidence is medium.	Negligible to Low

Table 7.7.3: Sensitivity Assessment for the Subtidal Benthic Biotopes for Increased SSC and Associated Sediment Deposition (Smothering)				
Biotope Code	**Biotope Name**	**MarESA Sensitivity Assessment**	**Assessment Confidence**	**Assessment Sensitivity (as defined in Section 7.5.2)**
CR.MCR.EcCr.FaAlCr.Pom	Faunal and algal crusts with *Spirobranchus triqueter* and sparse *Alcyonium digitatum* on exposed to moderately wave-exposed circalittoral rock	Not sensitive to changes in SSC Not sensitive to light smothering (<5 cm) Low sensitivity to heavy smothering (5 – 30 cm)	Confidence in the quality of the evidence is high for SSC, in the applicability and the agreement confidence is high. The confidence in the quality of the evidence is low for light smothering and the applicability and agreement of the evidence is low. Confidence in the quality of the evidence is low for heavy smothering and the applicability and agreement of the evidence is low.	Negligible to Low
SS.SSa.IMuSa.FfabMag	*Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand	Low sensitivity to changes in SSC Low sensitivity to light smothering (<5 cm) Medium sensitivity to heavy smothering (5 – 30 cm)	Confidence in the quality of the evidence is low for SSC, in the applicability and the agreement confidence is low. The confidence in the quality of the evidence is high for light smothering and the applicability is low and agreement of the evidence is medium. Confidence in the quality of the evidence is high for heavy smothering and the applicability and agreement of the evidence is low.	Low to Moderate
SS.SMu.CFiMu.SpnMeg	Seapens and burrowing megafauna in circalittoral fine mud	Not sensitive to changes in SSC according to MarESA. Not sensitive to light smothering (<5 cm) Not sensitive to heavy smothering (5 – 30 cm) according to MarESA. Medium sensitivity to heavy smothering according to FEAST.	Confidence in the quality of the evidence is medium for SSC, in the applicability and the agreement confidence is low and medium. The confidence in the quality of the evidence is low for light smothering and the applicability and agreement of the evidence is low. Confidence in the quality of the evidence is low for heavy smothering and the applicability and agreement of the evidence is low.	Minor

Significance of the Effect

7.7.2.34 The magnitude of the impact has been assessed as **low,** with the maximum sensitivity of the receptors being **moderate**. Therefore, the significance of effect from changes in SSC occurring as a result of cable installation activities in the subtidal area is **minor**, which is **not significant** in EIA terms.

7.7.2.35 The MarESA assessments identify that some aspects of the confidence for the sensitivity of the specified habitats to changes in SSC and for sediment deposition (smothering) is low for all habitats. For the majority of habitats, the quality of the evidence is deemed medium to high, apart from **SS.SSa.IMuSa.FfabMag**, which has a low confidence in the quality of the evidence for changes to SSC's and **SS.SMu.CFiMu.SpnMeg** which has a low confidence in impacts from SSC's and smothering. The significance of effect has been assessed based on the lowest resistance score of medium. Therefore, while the confidence score is low, the assessment is using the most conservative sensitivity. Although **SS.SMu.CFiMu.SpnMeg** is a qualifying features of the pMPA, the nature of this biotope (burrowed muds) indicates that it, and it's communities, can tolerate fine sediments.

7.7.2.36 No mitigation is required as there are no significant effects as a result of the construction of the Development.

Increased Suspended Sediment Concentrations (SSC)/Sediment Deposition in the Intertidal Area

Magnitude of Impact

7.7.2.37 Temporary increases in SSC and associated sediment deposition in the intertidal area are expected from the cable installation works. Cable installation by open cut trenching is considered to represent the realistic worst case in terms of the potential to cause elevated levels of SSC and localised changes in seabed level during the construction phase (Table 7.6.1). The relevant findings presented in Chapter 6: Physical Processes and Water Quality are summarised below.

7.7.2.38 The potential impact of changes in SSC are summarised as follows:

- Where cable installation is carried out above the level of the water, there will be very limited potential for the disturbed material to enter into suspension in the water column. However, where cable installation is carried out below the water surface, jetting has the potential to cause the greatest volume of material to enter into suspension in the water column. Accordingly, this technique represents the maximum adverse scenario in terms of sediment dispersion;
- Based on the sediment grab samples from the Landfall Area, the seabed is characterised by sands and gravels in varying proportions, which will likely form the majority of the sediment being disturbed. These sediment types (if disturbed to the point of resuspension) will redeposit rapidly to the seabed (in a matter of seconds to minutes) and will cause only a very localised and temporary effect on SSC. Any fines that are present may persist in suspension for longer, but only at relatively low concentrations due to the very low proportion of such sediment present; and
- In the shallow waters near the Landfall Area, the same sands and any fines present are likely to be resuspended naturally by occasional storm events, generating a similar or even higher magnitude of naturally occurring SSC than the cable installation activity, but over much larger areas and longer durations.

7.7.2.39 The potential impact of changes in seabed levels (including the presence of cable protection) are summarised as follows:

- Cables in the Landfall Area will not be surface laid and therefore no surface mounted cable protection will be required. Cable installation via trenching in nearshore and intertidal areas may result in the displacement of some sediment from the trench, forming a trough or depression. Some of the displaced material will enter into suspension, although, in practice and by design, the majority is expected to remain in or immediately adjacent to the trench, forming a raised mound. Once the cables have been laid it is anticipated that sidecast material would be returned to the trench as backfill, thereby accelerating the natural processes of recovery;
- The dimensions of seabed level changes associated with the cable trench near and in the Landfall Area will depend upon several factors including the cable installation method, trench width, cable burial depth and the nature of the excavated material. For immediate use, the maximum trench dimensions are depth 3 m, width 3 m, with a 'V' shape profile. If left open for longer, a wider trench (order of 10 m) may be required to accommodate stable side slope angles. The displaced sediment may form temporary side berms or a sidecast mound with comparable dimensions to the trench (above the seabed level); and
- Given that the trenches and any sidecast mounds would only be present for a relatively short period of time (maximum of a few weeks), any resulting changes in the wider distribution of beach sediments would be localised, of limited magnitude, and would recover to a natural equilibrium state (through tidal inundation and wave action) rapidly following completion of the works.

7.7.2.40 The potential impact of cable protection measures and/or any ancillary structures used for cable installation in the Landfall Area is summarised as follows:

- Cables will be buried below the seabed by trenching or HDD and cable protection will not be used in nearshore areas. Therefore, there would be no interaction with the naturally occurring patterns of waves or currents. There is therefore no potential for cable protection measures to affect naturally occurring patterns of sediment transport or morphological change in the Landfall Area during the construction phases of the Development; and
- No large ancillary structures are anticipated to be required in the nearshore environment, other than the temporary presence of cable lay vessels, which have little or no potential to impact the coastal morphology. The shallow nature of the site and the presence of easily mobilised sandy seabed sediments mean that any residual depressions from jack-up legs and anchors would be rapidly infilled and smoothened by normal sediment transport processes.

7.7.2.41 Once seabed preparation works are complete and cables have been installed, any disturbance to the intertidal area will cease, allowing species to start to recolonize previously disturbed areas. Therefore, given the temporary nature of the impact, and the relatively small intertidal area affected, the overall magnitude of the impact is considered to be **negligible to low**.

Sensitivity of the Receptor

7.7.2.42 The species and habitats identified during the intertidal characterisation surveys (**LS.LSa.MoSa.BarSa**, **LS.LSa.MoSa.AmSco.Eur**, **LS.LSa.MoSa.AmSco.Sco** and **LS.LSa.FiSa.Po**) (see Table 7.7.4 below) are typical of the wider region of the surrounding area. The intertidal biotopes recorded during intertidal survey and expected to be encountered throughout the Landfall Area are considered to have negligible to low vulnerability to the effects of sediment re-suspension and smothering by 5 cm of sand (MarLIN benchmark), owing to their high tolerance and adaptability to the continual turbulence naturally occurring within this zone from storm events and/or hydrodynamic exposure (tides and wave action).

7.7.2.43 In addition, owing to the ephemeral nature of the floral and faunal organisms typically found in this intertidal zone, recoverability of these biotopes is likely to be very rapid following cessation of disturbance. For the purpose of this assessment, the intertidal species and habitats are considered to have negligible to low sensitivity for increased SSC and associated sediment (smothering).

Table 7.7.4: MarESA Assessment for the Sedimentary Intertidal Biotopes for Increased SSC and Associated Sediment Deposition (Smothering)				
Biotope Code	**Biotope Name**	**MarESA Sensitivity Assessment**	**Assessment Confidence**	**Assessment Sensitivity (as defined in Section 7.5.2)**
LS.LSa.MoSa.BarSa (upper shore)	Barren littoral coarse sand	Not sensitive to changes in SSC Not sensitive to light smothering (<5 cm)	Confidence in the quality of the evidence is high for SSC, in the applicability is medium and the agreement confidence is low. The confidence in the quality of the evidence is high for light smothering, in the applicability is medium and the agreement confidence is low.	Negligible
LS.LSa.MoSa.AmSco.Eur (upper shore)	*Eurydice pulchra* in littoral mobile sand	Not relevant to increase in SSC Not sensitive to light smothering (<5cm)	Confidence in the quality of the evidence is low for SSC and smothering as the assessment has been derived from sources that only cover aspects of the biology of the species (or biotope) or from a general understanding of the species or biotope.	Negligible
LS.LSa.MoSa.AmSco.Sco (mid shore)	*Scolelepis* spp. in littoral mobile sand	Low sensitivity to changes in SSC Not sensitive to light smothering (<5 cm)	Confidence in the quality of the evidence is low for SSC, in the applicability and the agreement confidence is also low. The confidence in the quality of the evidence is high for light smothering, in the applicability is medium and the agreement confidence is high.	Negligible to Low
LS.LSa.FiSa.Po (mid shore & an impoverished version in the low shore)	Polychaetes in littoral fine sand	Not sensitive to changes in SSC Not sensitive to light smothering (<5 cm)	Confidence in the quality of the evidence is low for SSC, in the applicability and the agreement confidence is also low. The confidence in the quality of the evidence is low for light smothering, in the applicability and the agreement confidence is also low.	Negligible

Significance of the Effect

7.7.2.44 The magnitude of the impact has been assessed as **negligible** to **low**, with the maximum sensitivity of the receptors being **low**. Therefore, the significance of effect from changes in SSC and associated sediment deposition occurring as a result of cable installation activities in the intertidal area is **negligible to minor,** which is **not significant** in EIA terms.

7.7.2.45 A low confidence score was attributed to a number of specific assessments within the MarESA assessments, with this predominantly due to the information sources being based on expert judgement, being based on proxies for pressures (e.g. natural disturbance events) or that there is a low degree of concordance between studies. However, the intertidal zone within the Landfall Area experiences sediment transported in during storm surges and consequently, the habitats will have a tolerate to these events which are similar to the increased suspended sediments/sediment deposition impacts associated with cable installation. As such, the assessment of the significance of effects as not significant remains valid.

7.7.2.46 No mitigation is required as there are no significant effects as a result of the construction of the Development.

Noise and Vibration

Magnitude of Impact

7.7.2.47 The piling of foundations will result in the generation of underwater noise (both sound pressure and particle motion) which will extend out from the source, travelling both through the water column and through the sediment.

7.7.2.48 The available literature on the impact of noise and vibration on benthic species is increasing. However, the current available agreed metrics for noise modelling do not comprehensively incorporate the impacts of particle movement, which is of greater importance when considering the impacts on benthic species, rather than sound pressure which has been used so far (Hawkins and Popper, 2016). Additionally, the majority of studies have so far focused on crustaceans or molluscs (e.g. Edmonds *et al*., 2016; Roberts *et al*., 2016; Roberts & Elliott, 2017), and less is understood about the impacts on the polychaetes that are the dominant Phyla at the Moray West Site.

7.7.2.49 It is acknowledged that marine invertebrates are likely to suffer injurious and possibly lethal impacts from anthropogenic high intensity noise (i.e. piling). However, it is not possible to assess the impact of this in a meaningful way at this stage without any modelling currently available for these species or any studies focusing on polychaetes as the dominant taxa characterising the Moray West Site and Offshore Export Cable Corridor. Consideration of the impact on larger shellfish species is given in Chapter 8: Fish and Shellfish Ecology. Furthermore, while it is possible that noise from piling may have similar impacts on the eggs/larvae of benthic invertebrates, the area of ensonification for which this happens is in the order of metres from the piling location and consequently, the magnitude of this impact would be **negligible**.

Sensitivity of the Receptor

7.7.2.50 The MarESA sensitivity assessments for the habitats and species identified during the benthic characterisation surveys for changes in underwater noise detail that this impact is not relevant in most cases. For the biotopes **SS.SMx.CMx.FluHyd** and **CR.HCR.XFa.SpNemAdia** the impact was classified as not sensitive and therefore for the purposes of the assessment, the sensitivity of all benthic receptors is considered to be negligible. As detailed above, consideration of the impact on larger shellfish species is given in Chapter 8: Fish and Shellfish Ecology.

Significance of the Effect

7.7.2.51 Consequently, the scarcity of available evidence for the impacts of noise on benthic invertebrates, in particular polychaetes, means it is not possible to carry out a detailed assessment of the impacts of noise. Consideration of the MarESA sensitivity assessment suggest that the potential effects associated with the construction and operation of the Development will be **not significant**.

7.7.2.52 No mitigation is required as there are no significant effects as a result of the construction of the Development.

Accidental and Controlled Discharges

7.7.2.53 During construction, in addition to the controlled discharge of substances / chemicals required for certain activities e.g. discharge of water based muds during piling and any HDD activities at the landfall and leachates from cements and/or grouts used in construction, there is also the potential for accidental release of hydrocarbons (e.g. diesel fuels) from construction vessels. The release of these potential contaminants may lead to impacts on the benthic communities through toxic effects resulting in a reduction in benthic diversity, abundance and biomass.

Magnitude of Impact

7.7.2.54 The number of vessels expected to be present within the Development as a result of construction activities is up to 25 at any one time over the construction period (i.e. up to 36 months). Large construction vessels may contain large quantities of diesel oil, but any accidental spill from vessels, vehicles, machinery or from construction activities would be subject to immediate dilution and rapid dispersal in the high energy environment found within the subtidal parts of the Offshore Export Cable Corridor and Moray West Site.

7.7.2.55 Vehicle and machinery movements are also anticipated within the intertidal area of the Offshore Export Cable Corridor. The magnitude of the effect is dependent on the quantities of potential pollutants such as diesel oil carried by the construction vessels and intertidal vehicles/machinery. The majority of these potential sources of pollution in the intertidal zone will be relatively small in size which immediately reduces the potential magnitude of any spill. Although a spill in the intertidal at low water would directly affect benthic habitats, it would be easy to contain and the extent limited.

7.7.2.56 Given the embedded measures (as described in Section 7.6.2; i.e. adherence to an MPCP) it is considered that the likelihood of accidental release is extremely low.

7.7.2.57 In terms of controlled discharges, there is a risk to intertidal benthic receptors from water based drilling mud (i.e., bentonite) used as a lubricant during the process of installing the export cable circuits where HDD installation techniques are utilised. Management of controlled releases will be subject to measures set out in an EMP (as described in Section 7.6.2). On this basis, impacts to surrounding intertidal receptors will be minimal.

7.7.2.58 The risk of impact from accidental discharges to subtidal benthic receptors is predicted to be of local to regional spatial extent, short term duration, intermittent and reversible. The magnitude is therefore, considered to be **negligible**.

7.7.2.59 The risk of impact from accidental discharges or controlled discharges to intertidal benthic receptors is predicted to be of local spatial extent, short term duration, intermittent and reversible. The magnitude is therefore, considered to be **negligible** particularly with the embedded mitigation measures in place.

Sensitivity of Receptor

7.7.2.60 Crustaceans are widely reported as intolerant to synthetic chemicals (Budd, 2008a) and there is varying evidence of individual sensitivities of species to impacts such as major oil spills and to tributyltin (TBT), although both of these are highly unlikely impacts with respect to the Development. Subtidal sediments in moderate to high energy environments, such as those characteristic of the Moray West Site and along the Offshore Export Cable Corridor, are generally less vulnerable to this sort of pollution than intertidal habitats and the hydrodynamic regime in the offshore parts of the Development area would also lead to high dispersion and breakdown of pollutants, which would be expected to reduce the probability of a severe pollution event (Elliott *et al*., 1998). Together with the predicted rapid dilution and dispersal, the sensitivity to the levels of pollution likely to occur is likely to be low.

7.7.2.61 Intertidal sediments are generally more susceptible to chemical pollution than rocky shorelines. The relatively low dispersion within these areas may result in them acting as sinks for pollutants and heavy metals as a result of them becoming adsorbed onto fine sediments and organic particulates in these areas (Clark, 1997). According to the MarESA assessments the intertidal benthic biotopes seen in the Landfall Area are demonstrated as not having high sensitivity to a range of chemical pressures typical of chemical pollution associated with construction related activities. The MarESA assessment of the subtidal biotopes were demonstrated as not being sensitive to the same range of chemical pressures, therefore having a negligible sensitivity. For the purpose of this assessment, the intertidal species and habitats are considered to have negligible to high sensitivity to pollutants, with subtidal species and habitats considered to have negligible sensitivity to pollutants.

Significance of Effect

7.7.2.62 As Moray West will adhere to published guidelines, best working practices and with the inclusion of the embedded mitigation measures the risk of an accidental spill and the volumes of potential contaminants released would be small and rapidly dispersed to concentrations below which deleterious effects would be expected.

7.7.2.63 The maximum sensitivity is deemed **high** for intertidal receptors and **negligible** for subtidal receptors. The effect of accidental release of pollutants on intertidal benthic receptors will therefore be of **minor** significance and of **negligible** significance for subtidal receptors. Both assessments are **not significant** in EIA terms.

Risk of Introduction of Marine Invasive Non-Native Species (“MINNS”)

7.7.2.64 MINNS are a major threat to biodiversity. They can have negative impacts on native species due to growing very large and very fast and can quickly become the dominant species (SNH, 2016). This presents significant challenges in terms of ecosystems and biodiversity.

Magnitude of Impact

7.7.2.65 The biggest risk during construction is the introduction or spread of MINNS in ballast water and biofouling from construction vessels. The number of vessels expected to be present within the Development as a result of construction activities is up to 25 at any one time over the construction period (i.e. up to 36 months).

7.7.2.66 Subtidal biotopes within the Moray West Site are more likely to be at greater risk of impact by the introduction of MINNS on the basis that the Moray West Site will be subject to much higher volumes of construction vessel traffic than the Offshore Export Cable Corridor. Due to the size of the turbines, there may be a requirement to source specialist construction vessels internationally. This further increases the potential risk of the introduction and spread of MINNS.

7.7.2.67 Although there is potential that the introduction and spread of MINNS could have long term and potentially irreversible impacts (depending on whether the MINNS can be eradicated) on subtidal biotopes, the potential risk of introduction and spread of MINNS will be minimised through adherence to an EMP (see Section 7.6.2). The magnitude of the potential impact is therefore considered to be **negligible**.

Sensitivity of the Receptor

7.7.2.68 Where MINNS are introduced to an area e.g. through discharge of ballast water or biofouling, these can may predate on, and compete with, existing native species (Inger *et al*., 2009). This can result in a change in species biodiversity leading to changes in the composition and structure of existing habitats. Depending on the species introduced, this could lead to the complete loss of certain species and creation of new habitats.

7.7.2.69 The MarESA sensitivity assessments identified **SS.SCS.ICS.MoeVen**, **SS.SCS.CCS.MedLumVen**, **SS.SSa.CFiSa.EpusOborApri** and **SS.SSa.IMuSa.FfabMag** as having high sensitivity to the introduction or spread of MINNS and therefore **high** sensitivity for the purpose of this assessment. The lack of evidence for other biotopes did not allow for a firm conclusion to be made regarding sensitivity. However, the availability of introduced hard substrate would provide new habitat resource for any introduced MINNS to establish local populations, therefore habitats **CR.MCR.EcCr.FaAlCr.Pom**, **CR.HCR.XFa.SpNemAdia**, **SS.SMx.CMx.FluHyd** and **SS.SMx.CMx.OphMx** are considered to be of medium sensitivity and therefore **moderate** sensitivity for the purposes of this assessment. Due to the national conservation value of **SS.SMu.CFiMu.SpnMeg** (which is considered by the MarESA sensitivity assessment to be of medium sensitivity), for the purposes of this assessment the biotope is considered to be of **high** sensitivity.

Significance of the Effect

7.7.2.70 There is little evidence from other offshore wind farm developments within the North Sea of MINNS species having any adverse effects on key species and habitats. An EMP that includes measures to reduce the risk of the introduction and spread of MINNS in vessel ballast water and biofouling during construction forms part of the embedded measures for the Development (Section 7.6.2). It is predicted that although the sensitivity of habitats are considered to be a maximum of **high** sensitivity the magnitude is considered to **negligible**. The effect will, therefore, be of **minor adverse** significance, which is **not significant** in EIA terms.

7.7.2.71 No further mitigation is required following on from the embedded mitigation described above, as there are no significant effects as a result of the construction of the proposed development.

7.7.3 Potential Operational Effects

7.7.3.1 Moray West is applying for consent for 50 years. The Development is expected to operate for at least 35 years, taking into account current design life of the various components of the Development

<u>Long Term Habitat Loss</u>

Magnitude of Impact

7.7.3.2 The presence of the WTG and OSP foundations and the associated scour protection, along with the cable protection measures used at cable crossings and areas where burial is not possible, will lead to a change of habitat from a sedimentary habitat to hard substrate. This will be a permanent change and is therefore considered an impact of the operational phase of the Development. It is assessed here as habitat loss and a potential adverse impact, although it is noted that this also comprises potential beneficial impacts (providing new habitats for different faunal assemblages to colonise).

7.7.3.3 As described Table 7.6.1, the greatest habitat loss will occur from the installation of the gravity base foundations and associated scour protection, and maximum extents of cable protection and cable crossings. This would result in a total habitat loss of 630,716 m^2 which equates to 0.14 % of the Moray West Site and Offshore Export Cable Corridor combined.

7.7.3.4 The impact is predicted to be of long term duration, continuous and irreversible during the lifetime of the Development. However, given its small spatial scale and localised nature within the study area, overall impact magnitude is considered to be **negligible**.

7.7.3.5 For the biotope **SS.SMu.CFiMu.Spn.Meg** which forms approximately 225 km^2 of the pMPA (Section 7.4.2.41), the magnitude of impact resulting from the Offshore Export Cable Corridor is considered to be negligible due to the limited presence of this habitat within the Development.

7.7.3.6 Requirements for the installation of additional cable protection measures at the landfall will be dependent on the location of the final landfall. However, these are expected to be minimal on the basis that the cables will be brought ashore using one of two techniques (open cut trench or HDD). Given that both techniques result in burial of cable in ground, any requirement for additional cable protection will be minimal and long-term habitat loss in in the intertidal area is considered highly unlikely.

Sensitivity of the Receptor

7.7.3.7 While the sedimentary biotopes will be lost within these discrete areas, it is considered likely that some of the characterising species will remain as epifauna on the various hard substrates. All the subtidal biotopes have a high sensitivity to habitat loss/change to a different seabed type as this counts as a complete loss of the old habitat and consequently there can be no recovery of habitat. However, some species may remain/recolonise the hard substrate through recruitment from neighbouring areas.

7.7.3.8 The Offshore Export Cable Corridor traverses through a part of the Southern Trench pMPA and will potentially result in permanent loss of **SS.SMu.CFiMu.Spn.Meg**. The extent of this habitat biotope was limited to certain areas along the Offshore Cable Corridor but as it is a qualifying feature of the pMPA, it is given a **high** sensitivity.

7.7.3.9 The MarESA assessments identified that all subtidal benthic biotopes have a high sensitivity to the introduction of hard substrate, with the assessments having high a confidence in all cases.

Significance of the Effect

7.7.3.10 It is predicted that the sensitivity of the receptors is considered to be **high** and the magnitude is deemed to be **negligible**. The effect will, therefore, be of **minor significance**, which is **not significant** in EIA terms.

7.7.3.11 No mitigation is required as there are no significant effects as a result of the operation of the proposed development.

Accidental and Controlled Discharges

7.7.3.12 There is a risk that an accidental discharge, similar to that described in Section 7.7.2, may be released from vessels and machinery (primarily fuels and lubricating fluids) during the operation and maintenance phase as well as from the turbines and OSP(s) (the typical contents of which are described in Chapter 4: Description of the Development).

Magnitude of Impact

7.7.3.13 The magnitude of the impact is entirely dependent on the nature of the pollution incident but the Strategic Environmental Assessment (SEA) carried out by the Department of Energy and Climate Change (DECC, 2011c) recognised that, "renewable energy developments have a generally limited potential for accidental loss of containment of hydrocarbons and chemicals, due to the relatively small inventories contained on the installations (principally hydraulic, gearbox and other lubricating oils, depending on the type of installation)".

7.7.3.14 A typical turbine is likely to contain grease, hydraulic oil, gear oil, nitrogen and transformer silicon/ester oil and the design of the nacelle, tower and hub will ensure that any leaks are adequately contained by internal bunding, reducing the risk to the marine environment. The concentrations of zinc and aluminium released into the marine environment from sacrificial anodes are likely to be minimal and well below the Environmental Quality Standard (EQS).

7.7.3.15 A potential for accidental spills will also occur as a result of the various round trips to port per year by maintenance and operational vessels which are anticipated over the lifetime of the Development. However, as the majority of these vessels will be crew/supply vessels they will be typically small and will therefore be carrying only small amounts of potential contaminants. Although larger operational and maintenance vessels may contain larger quantities of potential pollutants (e.g., jack up vessels) such as diesel oil, movements of these vessels will be far fewer in comparison to smaller vessels.

7.7.3.16 An impact upon benthic ecology receptors would only be realised if an incident occurs where the fuel is accidentally released. Given embedded mitigation (as described in section 7.6.2) it is considered that the likelihood of accidental release is extremely low.

7.7.3.17 The impact is predicted to be of local to regional spatial extent, short term duration, intermittent and reversible. It is predicted that the impact would affect benthic receptors directly and/or indirectly but that the potential volume of pollutant released is small. The magnitude is therefore, considered to be **negligible**.

Sensitivity of Receptor

7.7.3.18 As described within paragraphs 7.7.2.60 to 7.7.2.61, the intertidal benthic biotopes seen within the Landfall Area are typically demonstrated as being negligible to having high sensitivity to a range of chemical pressures typical of chemical pollution associated with operation and maintenance related activities. The MarESA assessment of the subtidal biotopes were demonstrated as not being sensitive to the same range of chemical pressures, therefore having a negligible sensitivity.

Significance of Effect

7.7.3.19 Provided published guidelines and best working practices are adhered to, the likelihood of an accidental spill is extremely low (**negligible** magnitude) and, in the event of a spill, the volumes of potential contaminants released would be small and rapidly dispersed to concentrations below which deleterious effects would be expected.

7.7.3.20 The maximum sensitivity is deemed **high** for intertidal receptors and **negligible** for subtidal receptors. The effect of accidental release of pollutants on intertidal benthic receptors will therefore be of **minor** significance and of **negligible** significance for subtidal receptors. Both assessments are **not significant** in EIA terms.

Scouring of Benthic Habitats at Foundations and Around Cables

Magnitude of Impact

7.7.3.21 Potential for scour development at WTG and OSP foundations and around cable protection within the Development has been considered within Chapter 6: Physical Processes and Water Quality and are summarised below.

7.7.3.22 Note that the term 'local scour' refers to the local response to individual structure members. 'Global scour' refers to a region of shallower, but potentially more extensive scour associated with a multi-member foundation resulting from the change in flow velocity through the gaps between members of the structure and turbulence shed by the entire structure. Global scour does not imply scour at the scale of the Moray West Site.

- Scour development within the Moray West Site is expected to be dominated by the action of tidal currents;
- Of all of the WTG foundation options under consideration, a 15 m diameter monopile WTG and OSP foundation has the potential to cause the greatest equilibrium local scour depth (19.5 m), footprint (4,530 m^2) and volume (34,224 m^3), but only in areas where the seabed is potentially erodible by the action of scour to that depth;
- The greatest individual WTG foundation global scour footprint is associated with the larger (40 m base length) piled jacket WTG foundation (4,976 m^2), although with a relatively small average depth (1.4 m);
- For the Moray West Site as a whole, the greatest total local scour footprint is associated with 62 x 15 m diameter monopile foundations (for Model 4 WTGs) and one large (15 m diameter) OSP monopile foundation (284,265 m^2), equivalent to only approximately 0.11% of the Moray West Site area;
- For the Moray West Site as a whole, the greatest total global scour footprint is associated with 85 smaller (Model 2) pin-pile jacket WTG foundations and two pin-pile jacket OSP foundations (355,163 m^2), equivalent to only approximately 0.16% of the Moray West Site area;
- In practice, some locations will have only a limited thickness of more easily erodible sediment overlying more erosion resistant subsoils which will naturally limit the maximum scour depth to less than the predicted value. The measured thickness of potentially mobile sediment in the Moray West Site varies from ~5 to 15 m in the west, up to 30 m in the east. The corresponding footprint and volume of seabed affected by scour would also be reduced, both for individual foundations and for the array as a whole. The assessment of scour above conservatively assumes an unlimited depth of mobile sediment and is therefore likely to be an overestimate of what could actually occur; and
- Scour protection would be used to protect the stability of foundations if necessary. Where scour protection is used, primary scour is unlikely to occur, although a small amount of secondary scour may develop at the edges of the scour protection. For monopile and piled jacket foundation types the footprint area of scour protection is similar to (or smaller than) the predicted footprint of local scour. For gravity base foundations, the footprint area of scour protection is larger than the predicted footprint of local scour for this foundation type (due to a relatively smaller predicted depth of scour) but more similar to that for monopiles. At most, the maximum footprint of scour protection is equivalent to only approximately 0.16% of the Moray West Site area (0.22% including the footprint of the foundations).

7.7.3.23 Although the impact from scouring is predicted to be of long term duration, continuous, and irreversible for the lifetime of the Development, it is expected to be of local spatial extent (i.e. restricted to the surrounding area of foundations and cable protection). It is predicted that the impact will affect the subtidal benthic receptors directly. The magnitude of impact is therefore, considered to be **negligible**.

Sensitivity of Receptor

7.7.3.24 Subtidal biotopes are likely to be affected by increased scour surrounding OSP foundations and cable protection associated with the Development. All subtidal biotopes identified within the Moray West Site and Offshore Export Cable Corridor were assessed as being not sensitive to local water flow changes, according to the MarESA sensitivity assessments, apart from **SS.SMu.CFiMu.SpnMeg** which was recoded as having a **high** sensitivity (medium confidence score).

7.7.3.25 Sea pen biotopes such as **SS.SMu.CFiMu.SpnMeg** occur in low energy environments with weak to very weak tidal streams (Connor *et al.,* 2004), which are a prerequisite for the fine mud sediments in which the sea pens occur (Hughes, 1998a). An increase in flow, leading to scouring is likely to have a detrimental impact to sea pens and may alter the sediment type in the long-term. For the purposes of this assessment, **SS.SMu.CFiMu.SpnMeg** are considered to be of **high** sensitivity.

7.7.3.26 The other subtidal biotopes that characterise the Moray West Site and Offshore Export Cable Corridor are known to occur in areas subject to moderately strong water flows and therefore changes in the water flow may alter the topography of the habitat and may cause some shifts in abundance. Therefore, the sensitivity of these biotopes is considered to be **negligible**.

Significance of the Effect

7.7.3.27 Benthic species in the area are tolerant to a certain degree of instability, as well as fluctuating levels of local water flow changes, suspended sediments and variable sediment deposition rates arising from scour and/or small changes in the local wave and tide regime. The magnitude of effect is considered to be **negligible** and the sensitivity of the biotopes (excluding **SS.SMu.CFiMu.SpnMeg**) are considered to be **negligible** therefore the effect on these biotopes is considered to be of **negligible** or **minor significance**. Subtidal biotope **SS.SMu.CFiMu.SpnMeg** is considered to have a **high** sensitivity, although due to the localised and small scale extent of the impact (**negligible** magnitude), the significance of the effect is considered to be **minor** which is **not significant** in EIA terms.

7.7.3.28 No mitigation is required, as there are no significant effects as a result of the operation of the proposed development.

<u>Creation of New Substrate and Habitat</u>

Magnitude of Impact

7.7.3.29 When assessing the colonisation of introduced substrate it is important to note that any introduced substrate is considered to be a change from the existing environment presented in Section 7.4.2 and therefore cannot be considered to be beneficial in ecological terms.

7.7.3.30 All Development infrastructure that has a sub sea-surface element would represent a potential substrate for colonisation by marine fauna and flora, including species that may not currently be found within the existing environment. Hard substrates introduced by the Development would include foundations and scour protection for WTGs, OSPs, and cable protection. It is difficult to calculate the exact area of introduced substrate due to its 3- dimensional nature, but under the worst case scenario, which assumes the maximum amount of introduced substrate, the area of introduced substrate would be approximately 686,709 m^2 (see Table 7.6.1).

7.7.3.31 Studies of operational wind farms in the North Sea have found that widespread colonisation of sub-sea surfaces occurs. Lindeboom *et al*. (2011) demonstrated that at the Egmond aan Zee Offshore Wind Farm in Dutch waters, new hard substrate led to the establishment of new faunal communities and new species. Clear biological zones were evident with mussels dominating the foundations between 7 and 10 m deep while below 10 m depth foundations were colonised by tubes of the small crustacean *Jassa* sp. and anemones (*Metridium* senile, *Sargartia* spp. and *Diadumene cincta*). During surveys, 33 species were found to have colonised the monopiles and 17 species on the scour protection after two years of monitoring (Lindeboom *et al*., 2011).

7.7.3.32 Monitoring at Horns Rev 1 Offshore Wind Farm in Danish waters showed that the sub-surface structures were colonised by 11 species of algae and 65 invertebrate taxa within two years of the completion. In addition, mobile invertebrates (decapods and molluscs) were found on the scour protection and sessile species had settled on the monopiles.

7.7.3.33 Monitoring at the Alpha Ventus Wind Farm in German waters, which uses jacket foundations, found that the edible mussel (*Mytilus edulis)* contributed the largest part of the biomass (75%) on the upper 5 m of wind turbine foundations whilst deeper areas of foundations were dominated by the amphipod *Jassa* sp (ICES, 2012).

7.7.3.34 Gravity base structures and associated scour protection are likely to represent the worst-case scenario as they have the greatest surface area and therefore the most potential for changing the biodiversity. Lindeboom *et al.* (2011) found that new hard substrate introduced by the construction of the Egmond aan Zee Offshore Wind Farm acts as a new type of habitat with a higher biodiversity of benthic organisms and indicated a possible increased use of the area by the benthos, fish, marine mammals and some bird species. Neither the surrounding soft sediment benthic community nor bivalve recruitment was found to be affected by the wind farm during the first year of operation.

7.7.3.35 Cable protection used to protect the inter-array, interconnector cable and export cables (as defined in Table 7.6.1) would also be colonised by the species and communities discussed above.

7.7.3.36 The change of habitat from sedimentary seabed to hard substrate would result in potential increases in the diversity and biomass of the marine community of the area through colonisation of the structures. However, there is likely to be only a small interaction between the remaining available seabed and the introduced hard substrate and any interactions would be highly localised.

7.7.3.37 Given the localised nature of habitat alteration, the magnitude of the effect is considered to be **low**.

Sensitivity of Receptor

7.7.3.38 Sensitivity of the receptors is difficult to assess but due to their ubiquity in the region and the scale of these changes in relation to the communities present in the wider area, it is unlikely that the changes would result in any significant broad scale community or biodiversity changes. The sensitivity of the receptor is therefore considered to be **moderate** at the worst.

Significance of the Effect

7.7.3.39 The magnitude of the impact is considered to be **low** and the sensitivity of the biotopes are considered to be **moderate**, therefore the effect is considered to be of **minor** significance, which is **not significant** in EIA terms.

7.7.3.40 Confidence in the accuracy of this assessment is low (as it is difficult to predict exactly what species would colonise the structures) and therefore a precautionary rating has been used when assigning the sensitivity of the impact.

7.7.3.41 No mitigation is required, as there are no significant effects as a result of the operation of the proposed development.

Electromagnetic Fields (EMF)

7.7.3.42 The transport of electricity through export, inter-array and OSP interconnector cables has the potential to emit a localised EMFs which could potentially affect the sensory mechanisms of some benthic species. EMFs have both electric (E) measured in volts per metre (V m-1) and magnetic components (B) measured in micro tesla (µT). While the direct electric (E) field is mostly blocked with the use of conductive sheathing, the magnetic (B) field can penetrate most materials and therefore are emitted into the marine environment with the resultant induced electric (iE) field.

Magnitude of Impact

7.7.3.43 Modelling undertaken by Normandeau *et al*., (2011) found that the intensity of EMF emissions was roughly a direct function of cable voltage (ranging from 33 kV to 345 kV). The predicted magnetic (B) fields were found to be strongest directly above the cables and dissipated rapidly on the vertical and horizontal axis.

7.7.3.44 Results from the EMF Modelling Report undertaken as part of the Moray East ES 2012 (Moray East 2012) found that where subsea cables (33, 66 and 220 kV) are buried to 1 m depth, the predicted magnetic (B) field strength at the seabed is expected to be well below the earth's magnetic field (assumed to be approximately 50 µT in the North Sea) (Tasker *et al.*, 2010).

7.7.3.45 The Moray East ES 2012 EMF Modelling Report (Moray East 2012) concluded that, for 220 kV export cables, a significant reduction in the magnetic (B) field is expected to occur within 5 m (vertical within the water column) from the seabed (assuming 1 m burial depth) and up to a few metres either side of the cable (horizontal within the seabed).

7.7.3.46 These findings are similar to the results from the EMF strength calculations made as part of the EIA for the planned subsea cable towards the Borssele Offshore Wind Farm (Witteveen & Bos, 2016). The calculations were based on four 220 kV AC cables buried to depths of 1 m, 3 m and 6 m with 200 m separation distances between the cables. The calculations indicate that for 1 m depth, the magnetic flux density quickly decreases to less than 1 µT at a distance of 5 m from the cable (Rijkswaterstaat & Verkeer en Leefomgeving, 2016).

7.7.3.47 Although the evidence indicates that cable burial is the most effective way to reduce exposure of electromagnetic sensitive species to EMF emissions, it is not always possible due to seabed characteristics. Where burial is not an option, embedded mitigation measures such as mattresses or rock placement will be used increase the distance between the cables and electromagnetic sensitive species.

7.7.3.48 Although there is potential for EMF emissions to affect benthic receptors directly and occur for the duration of the Development, any emissions will be of limited strength (e.g. well below the North Sea natural magnetic field of 50 µT) and will be highly localised in terms of spatial extent. The magnitude of any potential impacts is therefore expected to be **low**.

Sensitivity of Receptor

7.7.3.49 The current literature suggests that EMF influenced behavioural and physiological impacts in benthic invertebrates, if any are observed, will be closely related to the proximity of the individual to the source.

7.7.3.50 Evidence for sensitivity to EMFs comes from physiological and behavioural studies on a small number of marine invertebrates and no direct evidence of impacts to invertebrates from undersea cable EMFs exists. Biological effects studies have demonstrated responses to magnetic fields in the development of echinoderm embryos and in cellular processes in a marine mussel, however at intensity fields far greater than those expected from undersea cables (Normandeau *et al.,* 2011). Very few studies have investigated electroreception in invertebrates, with only limited evidence of it in freshwater crayfish. Magnetoreception has been slightly more extensively studied and biogenic magnetite (i.e., naturally occurring iron-rich crystals in organisms) has long been known in marine molluscs. Recent investigation of the magnetic sense in molluscs and arthropods has demonstrated that the nudibranch *Tritonia diomedea*, the isopod *Idotea baltica basteri* and the Caribbean spiny lobster *Panulirus argus* appear to use geomagnetic cues to orientate relative to the shoreline (Normandeau *et al*., 2011).

7.7.3.51 All subtidal benthic biotopes could be affected by EMF, however, there is limited evidence available to confirm whether or not they will be affected. A study of macrobenthos over and around the SwePol HVDC cable, connecting Sweden and Poland, did not find any obvious change in the species composition, abundance, or biomass one year after construction, suggesting that the magnetic field in the vicinity of the cable did not affect benthic resources (Andrulewicz *et al.*, 2003). Despite this, and due to the low confidence in the assessment of sensitivity due to a lack of data, a precautionary approach has been taken to the conclusion of sensitivity. The sensitivity of subtidal benthic biotopes is therefore considered to be **low**.

Significance of Effect

7.7.3.52 The impact is predicted to be highly localised and of **low** magnitude and the sensitivity of the subtidal and intertidal benthic receptors is conservatively assessed as **low**. The significance of the effect of EMF on benthic receptors will therefore be **negligible or minor**, which is **not significant** in EIA terms.

7.7.3.53 No mitigation is required, as there are no significant effects as a result of the operation of the proposed development.

<u>Seabed Sediment Heating from Subsea Cables</u>

Magnitude of Impact

7.7.3.54 A certain amount of energy gets lost as heat when electricity is transported through subsea cables. This heat loss has the potential to cause an increase in temperature on the cable surface, potentially warming the surrounding ambient environment. Subsea cables installed on the sea floor do not heat up their surroundings due to the constant flow of water dissipating the thermal energy (Worzyk, 2009). However, buried subsea cables may result in sediment that is slightly warmer in the immediate vicinity (Worzyk, 2009).

7.7.3.55 The current suggestion is that the thermal effect is a small increase in temperature within a few centimetres of the cable (Boehlert and Gill, 2010). A study for the BritNed interconnector indicated that during the summer the immediate sediment temperature may increase between 0.5°C and 5.5°C through localised heating when the cable is buried at a depth of 1 m. At a burial depth of 3 m the increase in temperature was calculated to be between less than 0.5°C to 1.8°C. A field experiment on subsea power cables from Nysted offshore wind farm found the maximum temperature difference between control sites and cable sites was 2.5 °C and the mean difference was 0.8 °C (Meißber *et al*., 2006).

7.7.3.56 The only organisms likely to be affected by warming are burrowing species, as the water column will dissipate any surface temperature increase caused by subsea cables (NSN Link Limited, 2014). The temperature increase will be small and highly localized, with most bottom dwelling organisms found within the top layers of the seabed (Borrmann, 2006).

7.7.3.57 It is currently assumed that a permanent increase in the seabed temperature will lead to changes of seabed characteristics (e.g., alteration of redox, O2, sulphide profiles, changes of nutrient profiles and increase in bacterial activity) (Meißner and Sordyl, 2006). These in turn may impact on the physiology, reproduction or even mortality of certain benthic species, but also alter benthic communities because of changes in emigration/immigration patterns (OSPAR, 2009).

7.7.3.58 There is a significant lack of field data on the impact of thermal radiation on benthic habitats. However, it is clear that the impact is predicted to be highly localised and of **low** magnitude.

Sensitivity of Receptor

7.7.3.59 The sensitivity of benthic receptors is assessed as **low**, based on the available evidence. It is thought that the majority of benthic burrowing infauna would be able to move away from the areas that are impacted by any seabed sediment heating.

Significance of Effect

7.7.3.60 The impact is predicted to be highly localised and of **low** magnitude and the sensitivity of the subtidal and intertidal benthic receptors is conservatively assessed as **low**. The significance of the effect of seabed sediment heating from subsea cables on benthic receptors will therefore be **negligible or minor,** which is **not significant** in EIA terms.

7.7.3.61 No mitigation is required, as there are no significant effects as a result of the operation of the proposed development.

Risk of Introduction of Marine Invasive Non-Native Species ("MINNS")

7.7.3.62 In addition to the potential for the introduction and spread of MINNS from vessels involved in maintenance activities (ballast water and biofouling) there is also potential for the colonisation of hard structures (e.g. WTG and OSP substructures, scour protection and cable protection) by MINNS and for these hard structures to be used as stepping stones enabling further spread of MINNS.

Magnitude of Impact

7.7.3.63 Up to 686,709 m² of new hard substrate habitat (foundations, cable protection and scour protection) will be created in the Moray West Site and along the Offshore Export Cable Corridor. There will also be regular vessel movements associated with maintenance activities, which will contribute to the risk of introduction or spread of MINNS in ballast water and biofouling.

7.7.3.64 As with impacts during construction, subtidal biotopes within the Moray West Site are more likely to be at greater risk of impact by the introduction of MINNS. This is on the basis that the majority of the new surface area available for colonisation will be associated with the turbines and inter-array and OSP interconnector cables located within the Moray West Site. Most maintenance activities will also be concentrated within the Moray West Site. However, there is also potential for subtidal and intertidal biotopes located along the Offshore Export Cable Corridor to also be affected where there is potential for the colonisation of cable protection.

7.7.3.65 Although there is potential that the introduction and spread of MINNS could have long term and potentially irreversible impacts (depending on whether the MINNS can be eradicated) on subtidal and intertidal biotopes, the potential risk of introduction and spread of MINNS will be minimised through adherence to an EMP (see Section 7.6.2). The magnitude of the potential impact is therefore considered to be **negligible**.

Sensitivity of the Receptor

7.7.3.66 The introduction of hard substrate into a predominantly sediment area can facilitate the spread of non-native species which may predate on, and compete with, existing native species (Inger *et al*., 2009). Recent studies have demonstrated the potential for offshore renewable energy devices to act as ecological 'stepping stones', facilitating the spread of pelagic larval particles that would otherwise have been lost offshore and allowing the transgression of natural biogeographical boundaries (Adams *et al*., 2014). However, there is little evidence from post construction monitoring undertaken to date to suggest that the hard structures associated with offshore wind farms provide any new or unique opportunities for MINNS species which could facilitate their introduction (Linley *et al*., 2007).

7.7.3.67 A study by Kerckhof *et al.* (2011) of colonisation of Belgian offshore wind farm structures found that creating a new intertidal habitat in an offshore environment resulted in MINNS constituting a major part (approximately one third) of the intertidal colonists.

7.7.3.68 The sedimentary biotopes within the Moray West Site and Offshore Export Cable Corridor are considered more sensitive to impacts by the introduction of MINNS as the installation of hard surfaces associated with the Development will essentially introduce a new type of habitat. As such, there will only be a limited local epifaunal community which will be able to colonise the new habitat resource, therefore any introduced MINNS will face minimal competition and will be more likely to establish local populations. According to MarLIN sensitivity review (De-Bastos and Marshall, 2016; Tillin, 2016a; Tillin, 2016b; Tillin and Rayment, 2016), some biotopes within these habitats are sensitive to colonisation by MINNS, including *C. mutica, D. vexillum* and in *particular C. fornicata*.

7.7.3.69 The MarESA sensitivity assessments identified **SS.SCS.ICS.MoeVen**, **SS.SCS.CCS.MedLumVen**, **SS.SSa.CFiSa.EpusOborApri** and **SS.SSa.IMuSa.FfabMag** as having high sensitivity to the introduction or spread of MINNS and therefore high sensitivity for the purpose of this assessment. The lack of evidence for other biotopes did not allow for a firm conclusion to be made regarding sensitivity, however the availability of introduced hard substrate would provide new habitat resource for any introduced MINNS to establish local populations, therefore habitats **CR.MCR.EcCr.FaAlCr.Pom**, **CR.HCR.XFa.SpNemAdia**, **SS.SMx.CMx.FluHyd** and **SS.SMx.CMx.OphMx** are considered to be of medium sensitivity and therefore **moderate** sensitivity for the purposes of this assessment. Due to the national conservation value of **SS.SMu.CFiMu.SpnMeg** (which is considered by the MarESA sensitivity assessment to be of medium sensitivity), for the purposes of this assessment the biotope is considered to be of **high** sensitivity.

Significance of the Effect

7.7.3.70 There is little evidence from other offshore wind farm developments within the North Sea of MINNS species having any adverse effects on key species and habitats. An EMP that includes measures to reduce the risk from MINNS forms part of the embedded measures for the Development (Section 7.6.2). It is predicted that although the sensitivity of habitats are considered to be a maximum of **high** sensitivity the magnitude is considered to **negligible**. The significance of the effect will therefore be **minor adverse**, which is **not significant** in EIA terms.

7.7.3.71 No further mitigation is required following on from the embedded mitigation described above, as there are no significant effects as a result of the construction of the proposed development.

7.7.4 Potential Decommissioning Effects

Temporary Habitat Loss / Habitat Disturbance

Magnitude of Impact

7.7.4.1 Temporary loss / disturbance of the subtidal and intertidal habitat within the Development area associated with decommissioning activities is likely to be similar or the same as that described for the same activities during the construction phase in paragraphs 7.7.2.3 to 7.7.2.21. However, it should be noted that this approach is considered precautionary as there is no statutory requirement for decommissioned cables to be removed. Therefore, cables may be left buried in place or alternatively partially removed by pulling the cables back out of the ducts (Chapter 4: Description of Development). Such details will be included within the Decommissioning Programme which will be developed to minimise environmental disturbance and will be updated throughout the lifetime of the Development to account for changing best practice.

7.7.4.2 The total maximum area of temporary habitat disturbance due to jack-up vessels and infrastructure removal during decommissioning is 1,157,559 m^2. This equates to 0.51% of the Moray West Site and Offshore Export Cable Corridor. The impacts will be temporary and only a single event will occur at each location; therefore, the magnitude of the impact is assessed as **low**.

Sensitivity of Receptor

7.7.4.3 The sensitivities of the species to disturbance are described in paragraph 7.7.2.6.

Significance of Effect

7.7.4.4 The magnitude of the impact has been assessed as **low**, with the maximum sensitivity of the receptors being **moderate**. Therefore, the significance of effects from direct disturbance occurring as a result of decommissioning activities is **minor**, which is **not significant** in EIA terms.

Loss of Habitat from Removal of Introduced Hard Substrate

7.7.4.5 As detailed in paragraphs 7.7.3.29 to 7.7.3.41, hard substrate introduced from the Development will become colonised by epifauna. The removal of the foundations during decommissioning would therefore remove these species and associated habitats they create.

7.7.4.6 The removal of the foundations will result in a permanent loss of 65,600 m^2 of hard substrate. The impacts will be strictly localised. Therefore, based on the information available at the time of writing, the expected magnitude of impact is **low**.

7.7.4.7 While the removal of the substrate will result in localised declines in biodiversity, areas of bare habitat, lost during construction, will be exposed and will be open to recolonization by the original benthic species. It is expected that the baseline benthic communities will recover in these areas to their pre-construction state based on the recovery rates for disturbed sediment, which would equate to a maximum sensitivity for the baseline habitats of **moderate**.

7.7.4.8 The magnitude of the impact has been assessed as **low**, with the maximum sensitivity of the receptors being **moderate**. Therefore, the significance of effects from the removal of the hard substrate during decommissioning activities is **minor**, which is **not significant** in EIA terms.

Increased Suspended Sediment Concentrations/Sediment Deposition

7.7.4.9 Increases in SSC and sediment deposition from the decommissioning works will be similar to that for construction and are of a similar magnitude. The magnitude of the impact and the sensitivities of the benthic habitats to SSC and sediment deposition are described in detail in paragraph 7.7.2.24 *et seq*. and for the intertidal habitats in paragraph 7.7.2.37*.*

7.7.4.10 The magnitude of the impact has been assessed as **low**, with the maximum sensitivity of the receptors being **low** (for both the subtidal and intertidal). Therefore, the significance of effect from changes in SSC or sediment deposition occurring as a result of decommissioning activities in the subtidal and intertidal area is **negligible** to **minor**, which is **not significant** in EIA terms.

Noise and Vibration

7.7.4.11 The effects of noise and vibration on benthic subtidal and intertidal ecology during the decommissioning phase is considered to be less than those considered for construction (7.7.2.47 et seq.) where the main source of high intensity noise is piling, which would not occur during the decommissioning phase.

7.7.4.12 The magnitude of the impact has been assessed as **low**. Consideration of the MarESA sensitivity assessment suggest that the potential effects associated with the decommissioning of the Development will be **low**. Therefore, the significance of effect from noise and vibration are considered to be **negligible** to **minor**, which is **not significant** in EIA terms.

Accidental and Controlled Discharges

7.7.4.13 The impact of the accidental release of pollutants on benthic subtidal and intertidal ecology during the decommissioning phase is considered to be the same or similar to the effects from construction, which are described in detail in paragraphs 7.7.2.53 *et seq*.

7.7.4.14 The significance of this effect is negligible on subtidal receptors and **minor adverse** on intertidal receptors, which is **not significant** in EIA terms.

Risk of Introduction of Marine Invasive Non-Native Species ("MINNS")

7.7.4.15 There will be vessel movements associated with decommissioning activities, which will contribute to the risk of introduction or spread of MINNS in ballast water. As described within the construction impact assessment for the risk of introduction to MINNS (paragraphs 7.7.2.65 to 7.7.2.70), the application of best practice measures including a biosecurity plan, a PEMP (Section 7.7.7) and vessels complying with the IMO ballast water management guidelines will ensure that the risk of potential introduction and spread of MINNS will be minimised.

7.7.4.16 The impact on subtidal biotopes for decommissioning activities is predicted to be the same as detailed within the construction phase of the Development (paragraphs 7.7.2.65 to 7.7.2.70), although the total vessel movements are less and there will be no introduction of hard substrate, only removal. It is predicted that although the sensitivity of habitats are considered to be a maximum of **high** sensitivity the magnitude is considered to **negligible**. The effect will, therefore, be of **minor adverse significance**, which is **not significant** in EIA terms.

7.7.4.17 It should be noted that the approach to decommissioning will be reviewed in a Decommissioning Programme which will be prepared for the Moray West Site and Offshore Export Cable Corridor prior to construction, in line with the requirements of the Energy Act 2004.

7.7.5 Additional Mitigation

7.7.5.1 The assessment of benthic and intertidal ecology has not identified any significant effects that specifically require additional mitigation to be identified in order to reduce the level of significance. However, some additional mitigation measures have been identified that will ensure that benthic ecology and intertidal aspects remain fully assessed and considered during the final design stages of the Development.

7.7.5.2 Additional mitigation measures are identified as follows:

- Should the final location of the landfall works lie outwith surveyed intertidal areas, it is acknowledged that further survey of the final location may be required pre-construction in order to confirm the nature of the intertidal habitats present in the works area;
- In relation to the small area of potential Annex I habitat recorded in the site specific benthic survey of the Moray West Site, Moray West will seek to confirm the extent of this feature following further geophysical survey, which will be undertaken pre-construction. At present, Moray West would propose micro-siting of infrastructure to avoid this feature;
- Further discussion with MS-LOT, MSS and SNH will take place as part of the post-application consultations and setting of consent conditions to determine the requirement for and scope of any monitoring. Any project-specific monitoring requirements will be confirmed within any Project Environmental Monitoring Programme (PEMP) required to be approved prior to construction commencing.

7.7.6 Summary of Development Specific Effects

7.7.6.1 Table 7.7.5 below summarises the conclusions from the assessment of impacts during construction, operation and maintenance and decommissioning phases of the Development on benthic and intertidal ecology. The results presented in the table take into account both embedded, and where relevant, any additional mitigation that has been identified to mitigate potentially significant effects and identifies the resulting residual effects.

Table 7.7.5: Summary of Development Specific Effects						
Potential Impact	**Receptor**	**Impact Magnitude**	**Sensitivity of Receptor**	**Effect Significance**	**Mitigation (in addition to embedded measures)**	**Residual Significance**
Construction						
Temporary habitat loss / habitat disturbance (subtidal)	Benthic and intertidal habitats and species	Low	Low - moderate	Minor adverse	Confirmation of the presence/extent of any Annex I habitat, and avoidance where present and as practicable.	Minor adverse
Temporary habitat loss / habitat disturbance (intertidal)		Low	Negligible - low	Negligible – minor adverse	N/A	N/A
Increased SSC / sediment deposition (subtidal)		Low	Low - moderate	Minor adverse	N/A	N/A
Increased SSC / sediment deposition (intertidal)		Negligible - low	Negligible - low	Negligible – minor adverse	N/A	N/A
Noise and vibration		Negligible	Negligible	No impact - negligible	N/A	N/A
Accidental and controlled discharges		Negligible	Negligible - high	Negligible – minor adverse	N/A	N/A
Risk of introduction of MINNS		Negligible	High	Minor adverse	N/A	N/A
Operation and Maintenance						
Long term habitat loss	Benthic and intertidal habitats and species	Negligible	High	Minor adverse	N/A	N/A
Accidental and controlled discharges		Negligible	Negligible - high	Negligible – minor adverse	N/A	N/A
Scouring of benthic habitats at foundations and around cables		Negligible	Negligible - high	Negligible – minor adverse	N/A	N/A

Table 7.7.5: Summary of Development Specific Effects						
Potential Impact	**Receptor**	**Impact Magnitude**	**Sensitivity of Receptor**	**Effect Significance**	**Mitigation (in addition to embedded measures)**	**Residual Significance**
Creation of new substrate and habitat		Low	Moderate	Minor adverse	N/A	N/A
EMF		Low	Low	Negligible – minor adverse	N/A	N/A
Seabed sediment heating from cables		Low	Low	Negligible – minor adverse	N/A	N/A
Risk of introduction of MINNS		Negligible	High	Minor adverse	N/A	N/A
Decommissioning						
Temporary habitat loss / habitat disturbance	Benthic and intertidal habitats and species	Low	Moderate	Minor adverse	N/A	N/A
Loss of habitat from removal of introduced hard substrate		Low	Moderate	Minor adverse	N/A	N/A
Increased SSC / sediment deposition		Low	Low	Negligible – minor adverse	N/A	N/A
Noise and vibration		Low	Low	Negligible – minor adverse	N/A	N/A
Accidental and controlled discharges		Negligible	Negligible - high	Negligible – minor adverse	N/A	N/A
Risk of introduction of MINNS		Negligible	High	Minor adverse	N/A	N/A

7.8 Assessment of Cumulative Effects

7.8.1 Introduction

7.8.1.1 The approach to the Cumulative Impact Assessment (CIA) upon benthic and intertidal receptors for the Development follows that set out in Chapter 5: EIA Methodology.

7.8.2 Projects Considered for Cumulative Assessment

7.8.2.1 The projects selected as relevant to the assessment of impacts to benthic and intertidal ecology are based upon an initial CIA screening exercise, consulted upon with MS-LOT and SNH (Moray West (2017b). Each project, plan or activity has been considered and scoped in on the basis of effect–receptor pathway, data confidence and the temporal and spatial scales involved. The specific projects scoped into this CIA are presented in Table 7.8.1.

7.8.2.2 The cumulative study area for benthic and intertidal ecology covers the Moray Firth area.

Table 7.8.1: Projects for Cumulative Assessment

Development Type	Project	Status	Location	Data Confidence Assessment/ Phase
Offshore Wind Farm	Moray East Offshore Wind Farm (Telford, Stevenson and MacColl Offshore Wind Farms)	Consented – to be commissioned by 2022 Up to 186 WTGs.	0 km from the Moray West Site (boundary shared)	High - Third party project details published in the public domain and confirmed as being 'accurate'
Offshore Wind Farm	Beatrice Offshore Wind Farm	Under construction 84 WTGs.	0 km from the Moray West Site (boundary shared)	High - Third party project details published in the public domain and confirmed as being 'accurate'
Oil and gas	Decommissioning of the Beatrice Oil Field and Demonstrator Turbines	Scoping The decommissioning EIA is currently underway. Plugging of the wells has already commenced. Decommissioning of the main structures (four platforms, pipelines and demonstrator turbines) is expected to occur between 2024 and 2027.	0 km from the Moray West Site (boundary shared)	High - Third party project details published in the public domain and confirmed as being 'accurate'

7.8.3 Cumulative Construction Effects

7.8.3.1 The Moray East (Telford, Stevenson and MacColl) Offshore Wind Farm is to be installed between 2019 and 2021 and expected to be operational by 2022. The Beatrice Offshore Wind Farm began construction in in 2017 and the wind farm is expected to become fully operational in 2019. Decommissioning of the Beatrice Oil Field is expected to occur between 2024 and 2027 (Repsol Sinopec, 2017). Given that the construction of the Moray West Site and the Offshore Export Cable is not planned to commence until 2022, spanning 36 months and ending in 2024, there will be no temporal overlap of the construction phases of these projects. Therefore, there is no requirement to consider potential cumulative impacts associated with construction activities for any of these projects.

7.8.4 Cumulative Operational Effects

<u>Cumulative Long-Term Habitat Loss</u>

7.8.4.1 The impact of long term habitat loss due to the presence of infrastructure will last for the duration of projects until decommissioning takes place.

7.8.4.2 The maximum area of habitat that will be lost due to the presence of the Moray East (Telford, Stevenson and MacColl) infrastructure is calculated to be 3.76 km^2 (based upon a worst case scenario of the originally consented project), which accounts for 1.27% of the total area of the three proposed wind farm sites. The effect is assessed as being of **minor** significance (Moray Offshore Renewables Ltd., 2012) and not significant.

7.8.4.3 At Beatrice Offshore Wind Farm the maximum area of habitat loss was predicated to be 3.8 km^2, which equates to 2.9% of the Beatrice wind farm site. The effect is assessed as being of **minor** significance (Beatrice Offshore Wind Farm Ltd., 2012) and not significant.

7.8.4.4 Combined with the Development the total area of habitat loss that would occur if all three projects are constructed represents a minimal proportion (< 5%) of the total area consented or under application for consent for all of the projects. The magnitude of the impact is therefore likely to be **negligible**. Based on the evidence presented within the Environmental Statements for these projects and the understanding of the benthic habitats that characterise each development area, the sensitivity of the benthic receptors is considered to be **low**. Consequently, the cumulative effect of habitat loss caused by the wind farm developments is considered to be **negligible** and therefore **not significant** in EIA terms.

<u>Accidental and Controlled Discharges</u>

7.8.4.5 As detailed in Section 7.7.3, under the Development alone assessment the risk of accidental release / spillage of chemicals and other potentially polluting substances will be managed by the implementation of a project Marine Pollution Contingency Plan which will outline measures to minimise risk of accidental release in the first instance. Any other plans and projects in the Moray Firth, including neighbouring wind farms and oil and gas installations, will have similar plans in place to manage chemical usage and mitigate the risk of accidental release. Adjacent wind farms will also utilise bunding within offshore installations and so risk of accidental release is likely to be a result of operational and maintenance vessels only. It is extremely unlikely that there would be multiple spills resulting from operation and maintenance activities from Moray West and adjacent projects that would result in cumulative effects given the proposed control measures that will be implemented.

7.8.4.6 Provided published guidelines and best working practices are adhered to, the likelihood of accidental spills are extremely low and, in the event of a spill, the volumes of potential contaminants released would be small and rapidly dispersed thus minimising the likelihood of cumulative effects. The magnitude of any impact is considered to be **negligible**.

7.8.4.7 As described within paragraphs 7.7.2.60 to 7.7.2.61, the maximum sensitivity is deemed **high** for intertidal receptors and **negligible** for subtidal receptors. The cumulative effect of accidental release of pollutants on intertidal benthic receptors will therefore be of **minor** significance and of **negligible** significance for subtidal receptors and **not significant** in EIA terms.

Scouring of Benthic Habitats at Foundations and Around Cables

7.8.4.8 Based on conclusions from Chapter 6: Physical Processes and Water Quality, potential effects of scouring around foundations and cables are highly localised and will be restricted to impacts within the footprint of each wind farm and within a few metres of the export cables. It was concluded in Section 7.7.3 that potential effects of scouring on benthic habitats and species will therefore also be highly localised and of small spatial extent and are therefore considered to be minor and not significant. Given the limited potential for scour to extend beyond the boundaries of each of the wind farms, or within a few metres of the export cables, potential cumulative impacts are considered to be of **negligible** magnitude.

7.8.4.9 The sensitivity of the biotopes recorded within the Moray West Site and Moray West OfTI vary from **negligible** to **high** 7.7.3.24 to 7.7.3.26. The cumulative effects of Scouring of Benthic Habitats at Foundations and Around Cables will therefore be of **negligible** to **minor** significance and not significant in EIA terms.

Cumulative Creation of New Substrate and Habitat

7.8.4.10 An area approximately the size of the area of habitat loss will be created by the installation of infrastructure associated with the Moray West, Moray East (Telford, Stevenson and MacColl) and Beatrice Offshore Wind Farm projects. It is expected that some of the common epifauna initially lost in the footprint of the project infrastructure will recolonise the introduced substrate. The overall effect of installing the infrastructure will be the replacement of areas of the existing predominantly sandy or slightly gravelly biotopes with communities typical of harder substrates.

7.8.4.11 The total area of new hard substrate that would be present if all three projects are constructed represents a minimal proportion of the total area consented or under application for consent for all of the projects. The magnitude of the impact is therefore likely to be **negligible**. Based on the evidence presented within the Environmental Statements for these projects and given that the colonising communities are likely to largely constitute species that are common on hard substrates in the northern North Sea, the sensitivity of the benthic receptors is considered to be **low**. Consequently, the cumulative effect of habitat creation caused by the wind farm developments is considered to be **negligible** and therefore **not significant** in EIA terms.

EMF

7.8.4.12 Potential effects of EMF on benthic habitats and species will be highly localised, limited to within a few metres from the inter-array, OSP interconnector and export cables. Although none of the projects considered within Table 7.8.1 have inter-array or OSP interconnector cables that overlap or are positioned within close proximity of one another (< 100 m in distance), there will be a requirement for inter-array and OSP interconnector cables within the Moray West Site to cross the Beatrice export cables which will run south through the centre of the Moray West Site linking the Beatrice offshore wind farm site to landfall on the south coast of the Moray Firth. There is also likely to be a requirement for the Moray West offshore export cables to have to cross the Beatrice export cables.

7.8.4.13 Where cable crossings occur, there is potential for an increase in the levels of EMF emitted at those crossing points. However, it is expected that the materials required to construct the crossing and ensure long term protection of both cables, will increase the distance between the receptor and the source thus reducing the likelihood of detection. As any cumulative EMF emissions will be highly localised (limited to crossing points only) and are expected to be partially mitigated where they pass through cable protection materials, the potential for cumulative EMF to affect benthic habitats and species is **low**. With a sensitivity of benthic habitats and species of **low** to **moderate** (see Section 7.7.3.49 to 7.7.3.51) and a magnitude of **low**, the overall cumulative effect is considered to be **negligible** to **minor** and not significant in EIA terms.

<u>Seabed Sediment Heating from Cables</u>

7.8.4.14 As detailed above in Sections 7.7.3.54 to 7.7.3.56, heating of cables is highly localised and detectable within a few centimetres of the cable only where it is buried within sediments. Where cables are surface laid water flow over the cable results in loss of thermal energy. As with cumulative impacts in relation to EMF there is potential for cumulative interactions where the Moray West inter-array, OSP interconnector or offshore export cables cross the Beatrice offshore export cable. However, where there are cable crossings the installation of the materials required to construct the crossing and ensure long term protection of both cables will increase the distance between any benthic receptors and the cable surface to a distance where an increase in temperature is unlikely to be detectable. The magnitude of cumulative impacts from seabed sediment heating from cables will be **negligible**. The sensitivity of benthic receptors to increased seabed temperatures is considered to be **low**. Therefore, the significance of the cumulative effect of seabed sediment heating from subsea cables on benthic receptors will therefore be **negligible** and not significant in EIA terms.

<u>Risk of Introduction of MINNS</u>

7.8.4.15 The Development, along with the adjacent Moray East and Beatrice Offshore Wind Farms, will result in an increase in new hard substrate which could serve as a potential stepping stone for the colonisation of MINNS. Vessel movements associated with the operation and maintenance requirements of the adjacent projects will also increase the risk of introduction of MINNS. However, all projects will implement an EMP which will set out mitigation measures to minimise the risk of introduction of MINNS in line with relevant international standards and procedures. Therefore, the magnitude of the introduction of MINNS is considered to be **negligible**. As detailed within Sections 7.7.3.66 to 7.7.3.69, the sensitivity of biotopes within the Moray West Site and along the Offshore Export Cable Corridor to the introduction of MINNS are considered to have a **high** sensitivity. Therefore, the cumulative effect of the introduction of MINNS on benthic receptors is considered to be **minor** and not significant in EIA terms.

7.8.5 Cumulative Decommissioning Effects

7.8.5.1 Moray West is applying for consent for the Development for a period of 50 years, with the Development expected to be operational for approximately 35 years based depending on the design life of the various components. The operational phase of Moray East Offshore Wind Farm is consented for a period of 25 years, which will result in decommissioning starting in 2047. Beatrice Offshore Wind Farm also has an expected operational period identified within their draft Decommissioning Plan of 25 years, bring the start of decommissioning works to 2044. No overlap in decommissioning activities is therefore identified and as such there will be no cumulative effects resulting from decommissioning.

7.9 Potential Effects on Protected Sites

7.9.1.1 As noted in Section 7.4, the Offshore Export Cable Corridor traverses through the Southern Trench pMPA (SNH, 2014). Along with minke whale, fronts and shelf deeps, one of the proposed qualifying features for the designation is the habitat biotope SS.SMu.CFiMu.SpnMeg 'Seapens and burrowing megafauna in circalittoral fine mud' (burrowing mud). Potential impacts upon this biotope may therefore occur as a result of the cable laying, operation and maintenance, although the effects on this biotope have been assessed above as **not significant** in terms of EIA.

7.9.1.2 The site of the proposed MPA is extensive in size, covering an area between Buckie and Peterhead extending out to sea over deep water approximately 10 km from the coastline. As there will be no significant effects upon the SS.SMu.CFiMu.SpnMeg biotope, it is concluded that there will be no significant effects upon the pMPA overall. Further assessment of this pMPA is also included within Chapter 6: Physical Processes and Water Quality and Chapter 9: Marine Mammal Ecology.

7.9.1.3 A Habitats Regulation Appraisal (HRA) for benthic habitats associated with the Moray Firth SAC and its qualifying feature of subtidal sandbanks has been undertaken as a separate exercise, within a Report to Inform and Appropriate Assessment (RIAA). Potential effects on this SAC associated with changes to physical processes have been assessed within Chapter 6: Physical Processes and Water Quality.

7.10 References

Adams, T.P., Miller, R.G., Aleynik, D. and Burrows, M.T. (2014) Offshore marine renewable energy devices as stepping stones across biogeographical boundaries. Journal of Applied Ecology 51, 33-338.

Andrulewicz, E.D., Napierska, D. and Otremba, Z. (2003). The environmental effects of the installation and functioning of the submarine SwePol Link HVDC transmission line: a case study of the Polish marine area of the Baltic Sea. Journal of Sea Research 49:337-345.

Barrio Froján, C. R. S., Boyd, S. E., Cooper, K. M., Eggleton, J. D. and Ware, S. (2008). Long– term benthic responses to sustained disturbance by aggregate extraction in an area off the east coast of the United Kingdom. Estuarine, Coastal and Shelf Science, Volume 79: 204–212.

Beatrice Offshore Windfarm Limited. 2012. Beatrice Offshore Wind Farm Environmental Statement.

Bennett, T.L. & McLeod, C.R. 1998. East Scotland (Duncansby Head to Dunbar) (MNCR Sector 4). In: Marine Nature Conservation Review. Benthic marine ecosystems of Great Britain and the north-east Atlantic, ed. by K. Hiscock, 123–154. Peterborough, Joint Nature Conservation Committee. (Coasts and seas of the United Kingdom. MNCR series.)

Blanchard, M. (1997) Spread of the slipper limpet Crepidula fornicata (L.1758) in Europe. Current state and consequences. Scientia Marina, 61, Supplement 9, 109-118. De Montaudouin & Sauriau, 1999

Bohn, K., Richardson, C.A. & Jenkins, S.R., (2015) The distribution of the invasive non-native gastropod Crepidula fornicata in the Milford Haven Waterway, its northernmost population along the west coast of Britain. Helgoland Marine Research, 69 (4), 313. (Valentine *et al*., 2007)

Boyd, S.E., Cooper, K.M., Limpenny, D.S., Kilbride, R., Rees, H.L., Dearnaley, M.P., Stevenson, J., Meadows, W.J. & Morris, C.D. (2004). Assessment of the re–habilitation of the seabed following marine aggregate dredging.SCi. Ser. Tech. Rep., CEAFS Lowestoft, 121:154pp.

Boyd, S. E., Limpenny, D. S., Rees, H. L. & Cooper, K. M. (2005). The effects of marine sand and gravel extractions on the macrobenthos at a commercial dredging site (results 6 years post–dredging). ICES Journal of Marine Science, Volume 62: 145–162.

Buchanan, J.B., (1964). A comparative study of some of the features of the biology of Amphiura filiformis and Amphiura chiajei (Ophiuroidea) considered in relation to their distribution. Journal of the Marine Biological Association of the United Kingdom, 44, 565-576.

Budd, G.C. (2008a) Nephtys cirrosa and Bathyporeia spp. in infralittoral sand. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme. Plymouth: Marine Biological

Association of the United Kingdom. [cited 15/11/2013]. Available from: http://www.marlin.ac.uk/habitatsensitivity.php?habitatid=154&code=2004.

BERR (Department of Business, Enterprise and Regulatory Reform) (2008). Review of Cabling Techniques and Environmental Effects Applicable to the Offshore Wind Farm Industry. Technical Report from BERR to the Department of Enterprise & Regulatory Reforms (BERR) in association with DEFRA. Available online from: http://webarchive.nationalarchives.gov.uk/+/http://www.berr.gov.uk/files/file43527.pdf

Boehlert GW and Gill AB (2010) Environmental and Ecological effects of ocean renewable energy development: a current synthesis. Oceanography, 23(2): pp 68-81

Borrmann CB (2006) Wärmeemission von Stromkabeln in Windparks – Laboruntersuchungen zum Einfluss auf die benthische Fauna. Thesis for a diploma, Rostock University and Institute of Applied Ecology Ltd, 82 pp.

Centre for Environment, Fisheries and Aquaculture Science (Cefas) (2009) Strategic Review of Offshore Wind Farm Monitoring Data Associated with FEPA Licence Conditions. Benthic Ecology Contract. ME1117. (Bioconsult, 2006).

Cefas. (2009) Strategic Review of Offshore Wind Farm Monitoring Data Associated with FEPA Licence Conditions – Benthic Ecology.

Cefas. (2009) Strategic Review of Offshore Wind Farm Monitoring Data Associated with FEPA Licence Conditions – Benthic Ecology.

CCME (1999) Canadian sediment quality guidelines for the protection of aquatic life: Summary tables. In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers for the Environment, Winnipeg.

Clark, R.B. (1997) Marine Pollution, 4th ed. Oxford: Clarendon Press.

CMACS Ltd (2010) Beatrice Offshore Wind Farm Benthic Technical Report. Report to BOWL. October 2011. Available from: http://marine.gov.scot/datafiles/lot/bowl/ES/ES%20Volume%204%20-%20Annexs/

CMACS Ltd. (2012) Beatrice Offshore Wind Farm Cable Route Benthic Technical Report. Report to BOWL. February 2012. Available from: http://marine.gov.scot/datafiles/lot/bowl/ES/ES%20Volume%204%20-%20Annexs/

Coggan, R., Mitchell, A., White, J., and Golding, N. 2007a.Recommended operating guidelines (ROG) for underwater video and photographic imaging techniques. Mapping European Seabed Habitats (MESH) Project output. 32 pp.

Connor, D.W., Dalkin, M.J., Hill, T.O., Holt, R.H.F. & Sanderson, W.G. (1997a) Marine biotope classification for Britain and Ireland. Vol. 2. Sublittoral biotopes. Joint Nature Conservation Committee, Peterborough, JNCC Report no. 230, Version 97.06., Joint Nature Conservation Committee, Peterborough, JNCC Report no. 230, Version 97.06.

Connor, D.W., J.H. Allen, N.Golding, K.L.Howell, L.M. Lieberknecht, K.O. Northen And J.B. Reker (2004) The Marine Habitat Classification for Britain and Ireland Version 04.05. In: JNCC (2015) The Marine Habitat Classification for Britain and Ireland Version 15.03 [Online]. [Date accessed: 11/10/2017]. Available from: jncc.defra.gov.uk/MarineHabitatClassification

Cooper K.M. & Rees, H.L. (2002). National Marine Biological Control Scheme (NMBAQC): Review of Standard Operating Procedures. NMBAQC/CEFAS Science Series, Aquatic Environment Protection: Analytical Methods No.13. 57pp. ICES/OSPAR 2000 & DEFRA 2004b).

De-Bastos, E. & Marshall, C.E. (2016) Mysella bidentata and Thyasira spp. in circalittoral muddy mixed sediment. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. Available from: http://www.marlin.ac.uk/habitat/detail/374

Dalkin, M. and Barnett, B. (2001). Procedural Guideline No. 3-6 - Quantitative sampling of intertidal sediment species using cores. In Davies J., Baxter J., Bradley M., Connor D., Khan J., Murray E., Sanderson W., Turnbull C. & Vincent M. 2001. Marine Monitoring Handbook, 405 pp.

Department for Energy and Climate Change (DECC) (2011c). Offshore Energy Strategic Environmental Assessment: OESEA2 Environmental Report – Future Leasing/Licensing for Offshore Renewable Energy, Offshore Oil and Gas, Hydrocarbon Gas and Carbon Dioxide Storage and Associated Infrastructure. Department for Energy and Climate Change, February 2011. URN 10D/1024.

DEFRA. 2004 (a). Guidance note for Environmental Impact Assessment; In respect of FEPA and CPA requirements. Version 2.

Desprez, M., Pearce, B. & Le Bot, S. (2010). The biological impact of overflowing sands around a marine aggregate extraction site: Dieppe (Eastern English Channel). ICES Journal of Marine Science, Volume 67, Issues 2: 270–277.

Edmonds, N.J., Firmin, C.J., Goldsmith, D., Faulkner, R.C & Wood, D.T. (2016). A review of crustacean sensitivity to high amplitude underwater noise: Data needs for effective risk assessment in relation to UK commercial species. Marine Pollution Bulletin, 108, pp. 5-11.

Elliott, M., Nedwell, S., Jones, N.V., Read, S.J., Cutts, N.D. and Hemingway, K.L. (1998) Intertidal sand and mudflats and subtidal mobile sandbanks (Vol. II) An overview of dynamic and sensitivity for conservation management of marine SACs. Prepared by the Scottish Association for Marine Science for the UK Marine SACs Project.

EMU Ltd. (2011) Technical Appendix 4.2 A - Benthic Ecology Characterisation Survey (Wind Farm Sites). 11/J/1/03/1730/1169 Available from:
http://marine.gov.scot/datafiles/lot/morl/Environmental_statement/Volumes%208%20to%2011%20-%20Technical%20Appendices/Volume%2010%20Part%201%20-%20Biological%20Environment%20Technical%20Appendices/

EMU Ltd. (2012) Technical Appendix 4.2 B - Benthic Ecology Characterisation Survey (Transmission Infrastructure)
http://marine.gov.scot/datafiles/lot/morl/Environmental_statement/Volumes%208%20to%2011%20-%20Technical%20Appendices/Volume%2010%20Part%201%20-%20Biological%20Environment%20Technical%20Appendices/

Environment Agency (2004) Assessment of sediment contaminants in estuaries. Report WQTAG078K for Habitats Directive Technical Advisory Group on Water Quality.

European Union (2011) Guidance Document – Wind energy developments and Natura 2000. Available from: http://ec.europa.eu/environment/nature/natura2000/management/docs/Wind_farms.pdf

Folk, R.L., (1954). The distinction between grain size and mineral composition in sedimentary rock nomenclature. Journal of Geology 62 (4), 344–359

Fugro EMU Ltd. (2014) Technical Appendix 4.1A Subtidal Ecology Characterisation. Modified Transmission Infrastructure. Available from:

http://marine.gov.scot/datafiles/lot/morl/MORL_Modified_Offshore_Transmission_Infrastructure/Environmental_statement/Volume%205%20-%20Technical%20Appendicies/

Gubbay. (2007). Defining and managing Sabellaria spinulosa reefs: report of an inter-agency workshop 1-2 May, 2007. Joint Nature Conservation Committee Report No. 405. 22pp. JNCC, Peterborough. ISSN 0963-8091.

Gill, A. B. and Bartlett, M. (2010). Literature review on the potential effects of electromagnetic fields and subsea noise from marine renewable energy developments on Atlantic salmon, sea trout and European eel. Scottish Natural Heritage, Commissioned Report No. 401. (Sutton and Boyd, 2009).

Groenewold, S. & Fonds, M., (2000). Effects on benthic scavengers of discards and damaged benthos produced by the beam-trawl fishery in the southern North Sea. ICES Journal of Marine Science, 57 (5), 1395-1406.

Hawkins, A.D. & Popper, A.N. (2016). A sound approach to assessing the impact of underwater noise on marine fishes and invertebrates. ICES Journal of Marine Science, 74 (3), pp. 635-651.

Hill, J.M., Marzialetti, S. & Pearce, B. (2011). Recovery of seabed resources following marine aggregate extraction. Marine Aggregate Levy Sustainability Fund (MALSF). Science Monograph Series: No. 2. MEPF reference: MEPF 10 / P148.

Hirst, N.E., Clark, L. & Sanderson, W.G. (2012). The distribution of selected MPA search features and Priority Marine Features off the NE coast of Scotland. Scottish Natural Heritage Commissioned Report No.500.132pp

HM Government (2011). UK Marine Policy Statement. HM Government, Northern Ireland Executive, Scottish Government, Welsh Assembly Government. March 2011.

Hughes, D.J., (1998a). Sea pens & burrowing megafauna (volume III). An overview of dynamics and sensitivity characteristics for conservation management of marine SACs. Natura 2000 report prepared for Scottish Association of Marine Science (SAMS) for the UK Marine SACs Project., Scottish Association for Marine Science. (UK Marine SACs Project). Available from: http://www.ukmarinesac.org.uk/publications.htm

IADC/CEDA (1997) Environmental aspects of dredging - conventions, codes and conditions: marine disposal. International Association of Dredging Companies (IADC), & Central Dredging Association (CEDA), Netherlands, 1-71.

ICES (2012) Report of the Workshop on Effects of Offshore Wind Farms on Marine Benthos - Facilitating a closer international collaboration throughout the North Atlantic Region (WKEOMB)

Inger, R., Attril, M.J., Bearhop, S., Broderick, A.C., Grecian, W.J., Hodgson, D.J., Mills, C., Sheehan, E., Votier, S.C., Witt, M.J., and Godley, B.J. (2009) Marine renewable energy: potential benefits to biodiversity? An urgent call for research. Journal of Applied Ecology. 46. 1145-1153.

Joint Nature Conservation Committee (JNCC) (2001). Marine Monitoring Handbook. Procedural Guideline No. 3-1 In situ intertidal biotope recording; Procedural Guideline No. 3-5 Identifying biotopes using video recordings; & Procedural Guideline No. 3-9 Quantitative sampling of sublittortal sediment biotopes and species using remote-operated grabs. March 2001.

Judd, A. (2012) Guidelines for data acquisition to support marine environmental assessments for offshore renewable energy projects. Cefas contract report: ME5403 –Module 15.

Kenny, A. J. & Rees, H. L. (1996). The effects of marine gravel extraction on the macrobenthos: results 2 years post–dredging. Marine Pollution Bulletin, Volume 32 Issue 8 / 9: 615–622.

Kerckhof, F., Degraer, S., Norro, A. and Rumes, B. (2011) Offshore intertidal hard substrata: a new habitat promoting non-indigenous species in the Southern North Sea: an exploratory study, in: Degraer, S. *et al.* (Ed.) (2011) Offshore wind farms in the Belgian part of the North Sea: Selected findings from the baseline and targeted monitoring. 27-37.

Kröncke I (1995) Long-term changes in North Sea benthos. Senckenberg Marit 26, 73-80.

Kröncke I (2011) Changes in Dogger Bank macrofauna communities in the 20th century caused by fishing and climate. Estuarine, Coastal and Shelf Science 94: 234-245.

Limpenny D S, Foster-Smith R L. Edwards T M, Hendrick V J, Dieseng M, Eggleton J D, Meadows W J, Crutchfield Z, Pfeifer S, and Reach I S, (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

Lindeboom, H.J., Kouwenhoven, H.J., Bergman, M.J.N, Bouma, S., Brasseur, S., Daan, R., Fijn, R.C., de Haan, D., Dirksen, S., van Hal, R., Hille Ris Lambers, R., ter Hofstede, R., Krijgsveld, K.L., Leopold, M., and Scheidat, M. (2011) Short-term Ecological Effects of an Offshore wind farm in the Dutch Coastal Zone; a compilation, Environmental Research Letters, 6 035101.

Linley E.A.S., Wilding T.A., Black K., Hawkins A.J.S. and Mangi S. (2007) Review of the reef effects of offshore wind farm structures and their potential for enhancement and mitigation. Report from PML Applications Ltd and the Scottish Association for Marine Science to the Department for Business, Enterprise and Regulatory Reform Contract No: RFCA/005/0029P (BERR).

Marine Climate Change Impacts Partnership (2013) Marine Climate Change Impacts Report Card 2013 http://www.mccip.org.uk/annual-report-card/2013/

Marine Climate Change Impacts Partnership (2015) Marine climate change impacts; implications for the implementation of marine biodiversity legislation. (Ed.) Frost M, Bayliss-Brown G, Buckley P, Cox M, Stoker B & Withers Harvey N. Summary Report. MCCIP, Lowestoft, 16pp. doi:10.14465/2015.mb100.001-016.

Marine Scotland NMPI (2018). National Marine Plan Interactive. [online] Available at: https://marinescotland.atkinsgeospatial.com/nmpi/

Meißner K, Schabelon H, Bellebaum J, and Sordyl H (2006) Impacts of submarine cables on the marine environment: a literature review. Federal Agency of Nature Conservation/ Institute of Applied Ecology Ltd.

Moray West (2016). Moray Offshore Renewables Ltd. Developing Wind Energy In The Outer Moray Firth. Environmental Impact Assessment Scoping Report. Western Development Area Offshore Wind Farm Infrastructure: Offshore Wind Turbines, Foundations / Substructures and Inter-Array Cables. May 2016.

Moray West (2017). Moray West Offshore Wind Farm. Moray West Offshore Transmission Infrastructure. Scoping Report. May 2017.

NIRAS (2015) Subsea Cable Interactions with the Marine - Environment Expert review and Recommendations Report. [online] Available at: https://renewables-grid.eu/fileadmin/user_upload/Files_RGI/RGI_Publications/RGI_Subsea_cables_report.pdf [Accessed Jan 2012]

Normandeau (Normandeau Associates, Inc.), Exponent Inc., T. Tricas, T. and Gill, A. (2011). Effects of EMFs from Undersea Power Cables on Elasmobranchs and Other Marine Species. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Regulation, and Enforcement, Pacific OCS Region, Camarillo, CA.OCS Study BOEMRE 2011-09. [online] Available at: <http://www.gomr.boemre.gov/PI/PDFImages/ESPIS/4/5115.pdf.> [Accessed 24 January 2012].

Osiris Projects 2011. MORL Offshore Windfarm Geophysical Survey Report, Volume 2A.

OSPAR (2008b). Background Document on potential problems associated with power cables other than those for oil and gas activities. Publication Number: 370/2008. Available online from: http://www.ospar.org/documents/dbase/publications/p00370_Cables%20background%20doc.pdf

OSPAR (2009). Assessment of the environmental impacts of cables. Biodiversity Series Publication Number: 437/2009. Available online from: http://qsr2010.ospar.org/media/assessments/p00437_Cables.pdf

PMSL (2017a) Moray West Offshore Wind Farm Benthic Survey Report.

PMSL (2017b) Moray West Offshore Wind Farm Intertidal Survey Report.

Proudfoot *et al.* (2003) Proceedings of NMBAQC Processing Requirements Protocol for Marine Macrobenthic Samples.

Rees, H.L., D.C. Moore, T.H. Pearson, M. Elliott, M. Service, J. Pomfret & D. Johnson. (1990). Procedures for the Monitoring of Marine Benthic Communities at UK Sewage Sludge Sites, Department of Agriculture and Fisheries for Scotland, Aberdeen.

Roberts, L., Harding, H.R., Voellmy, I., Bruintjes, R., Simpson, S.D., Radford, A.N., Breithaupt, T. & Elliott, M. (2016). Exposure of benthic invertebrates to sediment vibration: From laboratory experiments to outdoor simulated pile-driving. Proceedings of Meetings on Acoustics, 27, DOI: 10.1121/2.0000324.

Sardá, R., Pinedo, S., Gremare, A. & Taboada, S. (2000). Changes in the dynamics of shallow sandy–bottom assemblages due to sand extraction in the Catalan Western Mediterranean Sea. ICES Journal of Marine Science, Volume 57: 1446–1453.

Scottish Government (2015). Scotland's National Marine Plan. A Single Framework for Managing Our Seas. www.gov.scot/Resource/0047/00475466.pdf.

Scottish Natural Heritage (2014). Scottish MPA Project. Data confidence assessment. Southern Trench MPA Proposal.

Tasker, M.L., Amudin, M., Andre, M., Hawkins, A., Lang, W., Merck, T., Scholik-Schlomer, A., Teilmann, J., Thomsen, F., Werner, F. and Zakharia, M. (2010). Marine Strategy Framework Directive. Task Group 11 Report. Underwater noise and other forms of energy. April 2010.

Tillin, H.M. (2016a) Echinocyamus pusillus, Ophelia borealis and Abra prismatica in circalittoral fine sand. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. Available from: http://www.marlin.ac.uk/habitat/detail/1131

Tillin, H.M. (2016b) Nephtys cirrosa and Bathyporeia spp. in infralittoral sand. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. Available from: http://www.marlin.ac.uk/habitat/detail/154

Tillin, H.M. & Rayment, W., (2016). Fabulina fabula and Magelona mirabilis with venerid bivalves and amphipods in infralittoral compacted fine muddy sand. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. Available from: http://www.marlin.ac.uk/habitat/detail/142

Tyler-Walters, H. and Marshall, C. (2008). Muddy sand shores. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 18/10/2012]. Available from: http://www.marlin.ac.uk/habitatbenchmarks.php?habitatid=21&code=2004.

UK Offshore Energy Strategic Environmental Assessment 3 (OESEA3) (2016).

van Moorsel, G. W. N. M. & Waardenburg, H. W. (1991). Short–term recovery of geomorphology and macrobenthos of the Klavebank (North Sea) after gravel extraction. Bureau Waardenburg.

Ware and Kenny (2011) Guidelines for the Conduct of Benthic Studies at Marine Aggregate Extraction Sites (2nd edition). Marine Aggregate Levy Sustainability Fund, MALSF, Lowestoft.

Wilhelmsson, D. and Malm, T. (2008) Fouling assemblages on offshore wind power plants and adjacent substrata. Estuarine, Coastal and Shelf Science, vol. 79:3, pp.459-466

Worzyk T (2009) Submarine Power Cables: Design, Installation, Repair, Environmental Aspects. Springer Science & Business Media, 11 Aug 2009 Technology & Engineering. 313 pp

Wyn, G. and Brazier, P. (2001). Procedural Guideline No. 3-1 - In situ intertidal biotope recording. In Davies J., Baxter J., Bradley M., Connor D., Khan J., Murray E., Sanderson W., Turnbull C. & Vincent M. 2001. Marine Monitoring Handbook, 405 pp.

Wyn, G., Brazier, D. P. and McMath, A. J. (2000). CCW handbook for marine intertidal Phase 1 survey and mapping. CCW Marine Sciences Report: 00/06/01.

MORAY WEST
OFFSHORE WINDFARM

Offshore EIA Report

Moray Offshore Windfarm (West) Limited

Chapter 8 Fish and Shellfish Ecology

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Acronyms	
Acronym	**Expanded Term**
AC	Alternating Current
ASA	Acoustical Society of America
AST	Atlantic Salmon Trust
BAP	Biodiversity Action Plan
BERR	Department for Business, Enterprise and Regulatory Reform
BOWL	Beatrice Offshore Wind Farm Limited
CBRA	Cable Burial Risk Assessment
Cefas	Centre for Environment, Fisheries and Aquaculture Science
CIEEM	Chartered Institute for Ecology and Environmental Management
CPA	Coast Protection Act
DC	Direct Current
DP	Dynamically Positioned
EcIA	Ecological Impact Assessment
EIA	Environmental Impact Assessment
EMF	Electromagnetic Field
EU	European Union
FEPA	Food and Environment Protection Act
FRS	Fisheries Research Services
GBS	Gravity Base Structures
HRA	Habitats Regulations Appraisal
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
ICES	International Council of the Exploration of the Sea
IEEM	Institute of Ecology and Environmental Management
IHLS	International Herring Larvae Survey
IMARES	Institute for Marine Resources and Ecosystem Studies
IUCN	International Union for Conservation of Nature
JNCC	Joint Nature Conservation Committee
MCZ	Marine Conservation Zone
MHWS	Mean High Water Springs
MINNS	Marine Invasive and Non-Native Species
MMO	Marine Management Organisation
MPA	Marine Protected Area
MS-LOT	Marine Scotland Licensing Operations Team

Acronyms	
Acronym	**Expanded Term**
MSS	Marine Scotland Science
MSW	Multi-Sea-Winter
NERC	Natural Environment and Rural Communities
NRMSD	National Research and Monitoring Strategy for Diadromous Fish
OFTI	Offshore Transmission Infrastructure
OSP	Offshore Substation Platform
PEMP	Project Environmental Management Plan
PMF	Priority Marine Feature
SAC	Special Area of Conservation
SEA	Strategic Environmental Assessment
SFF	Scottish Fishermen's Federation
SPA	Special Protection Area
SPL	Sound Pressure Level
SNH	Scottish Natural Heritage
SSC	Suspended Sediment Concentration
TAC	Total Allowable Catch
UK	United Kingdom
UNEP	United Nations Environment Programme
WTG	Wind Turbine Generator

8 Fish and Shellfish Ecology

8.1 Introduction

8.1.1.1 This chapter considers the likely significant effects of the construction, operation and maintenance and decommissioning of the Moray West Offshore Wind Farm and associated Offshore Transmission Infrastructure (OfTI) ("the Development") on fish and shellfish ecology.

8.1.1.2 The specific objectives of this chapter are to:

- Define the legislation, policy and guidance framework that is of relevance to fish and shellfish ecology;
- Detail the consultation activities and responses that are relevant to, and have informed, the assessment of effects on fish and shellfish ecology;
- Describe the fish and shellfish ecology baseline;
- Describe the assessment methodology and significance criteria used in completing the impact assessment;
- Describe the potential effects, including direct, indirect and cumulative effects;
- Describe the mitigation measures proposed to address likely significant effects; and
- Assess the residual effects remaining following the implementation of mitigation.

8.1.1.3 Both the Environmental Impact Assessment (EIA) OfTI Scoping Opinion (Marine Scotland, 2017a) and the Habitat Regulations Appraisal (HRA) Screening Opinion (Marine Scotland, 2017b) determined that potential effects on diadromous migratory fish that are a qualifying interest of a European Special Area of Conservation (SAC) should be considered through the Environmental Impact Assessment (EIA) process rather than the Habitat Regulations Appraisal (HRA) process. This assessment therefore considers potential effects on SAC qualifying interests (such as Atlantic salmon). However, it does not assess the effects of the Development on the integrity of the SAC sites. Further information on the HRA process is provided in the Report to Inform and Appropriate Assessment (RIAA) (Moray West, 2018).

8.1.1.4 The assessment has been carried out by an appropriately qualified fisheries specialist employed at GoBe Consultants Ltd. and the ecological impact assessment (EcIA) has been completed with reference to the Chartered Institute for Ecology and Environmental Management (CIEEM) guidance for the completion of marine EIA (IEEM, 2010).

8.2 Legislation, Policy and Guidance Framework

8.2.1 Relevant Legislation

8.2.1.1 In undertaking the assessment, the following legislation has been considered:

- Convention for the Protection of the Marine Environment of the North-East Atlantic (the 'OSPAR Convention') 1992
- The Convention on the Conservation of European Wildlife and Natural Habitats (the Bern Convention; 1979);
- The Wildlife and Countryside Act 1981 (as amended);
- Council Directive 92/43/EEC on The Conservation of Natural Habitats and of Wild Flora and Fauna;
- The Conservation (Natural Habitats, &c.) Regulations 1994 (Habitats Regulations) and the Conservation of Offshore Marine Habitats and Species Regulations 2017 (Offshore Habitats Regulations);

- Salmon and Freshwater Fisheries (Consolidation) (Scotland) Act 2003;
- Nature Conservation (Scotland) Act 2004 (as amended);
- Natural Environment and Rural Communities (NERC) Act 2006;
- Eel EU Regulation (EU 1100/2007); and
- Wildlife and Natural Environment (Scotland) Act 2011.

8.2.2 Relevant Policy

8.2.2.1 The UK Marine Policy Statement (HM Government, 2011) sets out the framework for preparing marine plans and taking decisions affecting the marine environment. The Scottish Government has produced a National Marine Plan in accordance with these UK policies (Scottish Government, 2015). The plan covers the management of both Scottish inshore waters (out to 12 nm) and offshore waters (12 to 200 nm) and sets out the strategic policies for which management decisions will be made across the main marine sectors including general policies, offshore wind and marine renewable energy. The following general policies apply to this fish and shellfish ecology assessment:

- General Policy (GEN) 9 Natural heritage: Development and use of the marine environment must:
    - (a) Comply with legal requirements for protected areas and protected species;
    - (b) Not result in significant impact on the national status of Priority Marine Features (PMFs); and
    - (c) Protect and, where appropriate, enhance the health of the marine area.
- GEN 13 Noise: Development and use in the marine environment should avoid significant adverse effects of man-made noise and vibration, especially on species sensitive to such effects.

8.2.2.2 Within the Offshore Wind and Marine Renewable Energy section of the National Marine Plan, there is a policy stating that "marine planners and decision makers must ensure that renewable energy projects demonstrate compliance with Environmental Impact Assessment and Habitats Regulations Appraisal legislative requirements."

8.2.2.3 The National Marine Plan also provides a framework for contributing to effective management of Marine Protected Areas (MPAs) and for contributing to improvement in the status of PMFs and their associated habitats, species and ecosystems (Tyler-Walters *et. al.,* 2016). MPAs are clearly defined, legally protected geographical areas, designated for their nature conservation, historic or research and demonstration interests. The network of nature conservation MPAs comprise SACs, Special Protection Areas (SPAs) and Marine Conservation Zones (MCZs) as well as newly identified MPAs. PMFs are species and habitats included on existing conservation lists (such as Annex I habitats, Annex II species or Scottish Biodiversity List features) that have been assessed against criteria determining whether 1) a significant proportion of their population occur in Scotland's seas; 2) whether they are under threat or decline; and 3) what functional role they play. All the features passing the criteria are considered important components of the biodiversity of Scottish seas and are included within the list of PMFs.

8.2.2.4 Scotland has identified a list of 81 PMFs, which include a number of fish and shellfish species (Tyler-Walters *et. al.,* 2016). The basis for their designation is to assist with the identification and designation of MPAs and these species of conservation importance are specifically considered within nature conservation planning and decision-making.

8.2.3 Relevant Guidance

8.2.3.1 The following guidance documents have also been considered with respect to assessing effects on fish and shellfish:

- Offshore Wind Farms. Guidance Note for EIA in Respect of FEPA (Food and Environment Protection Act 1985) and CPA (Coast Protection Act 1949) Requirements (Cefas *et al.*, 2004);
- Guidance on Environmental Considerations for Offshore Wind Farm Development (OSPAR, 2008);
- Guidelines for Ecological Impact Assessment in Britain and Ireland: Marine and Coastal. Final Document. August 2010 (CIEEM, 2010);
- Strategic Environmental Assessment (SEA) of Draft Plan for Offshore Wind Energy in Scottish Territorial Waters: Volume 1. Environmental Report (Marine Scotland, 2010);
- Habitats Regulations Appraisal (HRA) of Draft Plan for Offshore Wind Energy in Scottish Territorial Waters. Appropriate Assessment Information Review (Marine Scotland, 2011);
- Guidelines for Ecological Impact Assessment in the UK and Ireland. Terrestrial, Freshwater and Coastal (CIEEM, 2016); and
- European Commission (1999). Guidelines for the Assessment of Indirect and Cumulative Impacts as well as Impact Interactions.

8.3 Consultation

8.3.1.1 Moray West has framed its assessment of potential effects on fish and shellfish through consultation with key stakeholders.

8.3.1.2 Table 8.3.1 details the key issues raised in relation to fish and shellfish in the Moray West Offshore Wind Farm Scoping Opinion (August 2016) and the OfTI Scoping Opinion (August 2017) and summarises other issues / concerns that have been raised during additional consultation activities undertaken as part of the EIA process and how these have been addressed in the preparation of this EIA Report.

Table 8.3.1: Issues Raised During Consultation

Date / Consultee	Issue Raised	Moray West Approach
16 August 2016 Marine Scotland Science (MSS) Scoping Opinion (Offshore Wind Farm Infrastructure & Offshore Transmission infrastructure)	Agreement on the proposed datasets to identify baseline characteristics for the fish and shellfish ecology and the relevant construction/ operation/decommissioning impacts.	Details of the datasets used to inform the baseline characteristics for fish and shellfish ecology are provided in Section 8.4.
	The scoping report provides a good and comprehensive list of marine fish species for consideration however it does not seem to clearly identify whether these species are to be scoped in or out of the EIA.	All species identified within the baseline characterisation as being, or potentially being present, within the Development are scoped into the assessment.
	Up-to-date information on the distribution of the various life stages of the diadromous fish species, including salmon, sea trout and eels, and the likely impacts of underwater noise on these species should be included.	Up-to-date information requested by MSS has been provided in Section 8.4.2. The impacts of underwater noise on these species is considered in Section 8.7.1.
	Request for review of information on where salmon found in the locality of the development	A list of SACs where Atlantic Salmon are a qualifying interest is provided

Table 8.3.1: Issues Raised During Consultation		
Date / Consultee	**Issue Raised**	**Moray West Approach**
	site have originated from, or are destined for, should be considered before selecting which salmon Special Areas of Conservation (SACs) are taken forward in the assessment.	in Table 8.4.4. and illustrated in Figure 8.4.1 (Volume 3a). The identification of these sites has been based on the most up to date information available at the time the assessment was undertaken and advice provided by MS-LOT in the HRA Screening Opinion (MS-LOT, 2017).
	Include an updated authoritative view on the likely distribution of the various life stages of the diadromous fish species, including salmon, sea trout and eels, in the development locality, whether they are likely to be close to the coast or offshore, and the extent to which they are likely to be in the immediate vicinity of the development, and swimming depths, based as far as possible on real information for the locality or elsewhere. In the case of salmon and sea trout this should include updated information on the likely origin / destination of fish using the area.	Up to date literature review and baseline characterisation is provided for these species in Section 8.4.2.
	Updated information requested, bringing in the latest knowledge, on the likely impacts of underwater noise on diadromous fish and their behaviour, and appropriate mitigation to minimise impacts of pile driving noise during construction.	Up to date literature review and baseline characterisation is provided for these species in Section 8.4.2, along with updated information on criterial used for pile driving and underwater noise (including particle motion).
	A wide range of diadromous species are potentially present in the Moray Firth area. I would note that there are few records of shad or smelt in the area	Noted and included in the baseline characterisation (Section 8.4.2).
16 August 2016 Scottish Fishermen's Federation (SFF) Scoping Opinion (Offshore Wind Farm Infrastructure)	Request to use the latest advice from International Council of the Exploration of the Sea (ICES) on any development operations during spawning seasons for the species identified, with attention given to squid (*Loligo forbesi*) and scallop spawning and nursery grounds.	Spawning and nursery grounds are considered further in Section 8.4.2 (Baseline) and 8.7.1 (Construction).
	Given that the Smith Bank is a major scallop fishery the SFF would seek clarity on the claim that the suspension of sediment during this development will only have a minor impact on Scallop survival rates.	Assessment of the potential effects of increased suspended sediment concentration and sediment deposition on scallop is set out in Section 8.7.1.
16 August 2016 SNH Scoping Opinion (Offshore Wind Farm Infrastructure & Offshore	SNH has reviewed the advice given at application stage for the EDA in relation to diadromous fish and freshwater pearl mussels as qualifying interests of Special Areas of Conservation (please see response to MORL, 8th July 2013). On the basis of this advice, and because MORL have committed to an extensive monitoring programme in support of the National Research and Monitoring Strategy	Due to other consultees wishing assessment of these SAC features and to reflect the HRA Screening Opinion, SAC fish interests have not been scoped out and are presented in Section 8.7.

Table 8.3.1: Issues Raised During Consultation		
Date / Consultee	**Issue Raised**	**Moray West Approach**
Transmission infrastructure)	for Diadromous Fish, we wish to discuss whether SAC fish interests can be scoped out of assessment for the WDA.	
30 August 2017 Marine Scotland – Licensing Operations Team Scoping Opinion (Offshore Transmission infrastructure)	Request for further consideration of impact of sediment on scallops and Nephrops, with definition of spatial extent of fisheries identified from commercial fisheries data.	This is considered in Section 8.4.2 (Baseline) and Section 8.7.1 (Construction). Commercial fisheries presented in Chapter 11 of this Offshore EIA Report.
	Habitat loss should be considered for fish and shellfish and the effects of potential changes in benthic communities reported.	This impact is considered in Section 8.7.1 (Construction) and 8.7.2 (Operation).
	Request to consider particle motion in addition to sound pressure in relation to underwater noise impacts on fish and shellfish receptors.	This impact is considered in Section 8.7.1 (Construction).
	The Scottish Ministers do not agree that effects from operational noise, electromagnetic effects and seabed sediment heating can be scoped out of the assessment.	These impacts have not been scoped out and are considered in full in Section 8.7.2 (Operation).
	If gravity bases, or other bases that require substantial seabed preparation works, are scoped into the project, then we would consider that loss of foraging habitat for marine mammals will require assessment, and that this should be coordinated with the assessments for fish ecology.	The extent of habitat loss from GBSs is set out in Table 8.6.1. The effect of loss of foraging upon marine mammals is set out in Chapter 9 (Marine Mammal Ecology).
	Smothering effects on less mobile fish and shellfish species as well as the eggs of species which spawn in the area from increased water column suspended sediments as a result of construction activities, particularly dredge activities to prepare the seabed for gravity base structures and cable burial, requires consideration in the EIA report. Advice from MSS and comments from SFF require that further consideration on this effect on scallops and Nephrops is provided.	An assessment of increased suspended sediment concentrations and sediment deposition on all fish and shellfish is provided in Section 8.7.1 (Construction).
30 August 2017 MSS Scoping Opinion (Offshore Transmission infrastructure)	Request consideration of recent publications on the spawning areas of cod (González-Irusta & Wright 2015), haddock (*Melanogrammus aeglefinus*) (González-Irusta & Wright 2016) and whiting (*Merlangius merlangus*) (González-Irusta & Wright 2017).	Spawning areas for cod, haddock and whiting have been defined using datasets from Coull *et al.* (1998) and Ellis *et al.* (2010), in line with standard industry practice. Information from these more recent papers has been reviewed and where relevant, has been provided within Section 8.4.2.
	Updating information on the distribution of the various life stages of diadromous fish species.	Up to date information on diadromous fish species is provided in Section 8.4.2 (Baseline).
	Consideration of further research and monitoring relating to diadromous fish and how this can contribute to the National Research and Monitoring Strategy for Diadromous Fish.	No further site-specific monitoring is required due to no significant effects being identified (Section 8.7.4). Following award of any future

Table 8.3.1: Issues Raised During Consultation		
Date / Consultee	**Issue Raised**	**Moray West Approach**
		consents Moray West will consider opportunities for monitoring in the context of the National Research and Monitoring Strategy for Diadromous Fish.
	Consideration of the long range movements of salmon and how the development may have the potential to impact on salmon populations associated with rivers substantial distances from the development site.	Up to date information on diadromous fish species is provided in Section 8.4.2 (Baseline).
30 August 2017 SNH Scoping Opinion (Offshore Transmission infrastructure)	SNH advise that potential impacts to migratory fish and freshwater pearl mussels (*Margaritifera margaritifera*) are considered through the EIA rather than a HRA.	Potential impacts on migratory fish are considered within Section 8.7 (Impact assessment). Potential impacts on freshwater pearl mussels are discussed in Section 8.4.2, noting that impacts on freshwater pearl mussel are synonymous with the assessment on migratory salmonids.
	SNH has identified the need to consider potential smothering from sediment release (including the release of buried contaminants).	This impact is considered in Section 8.7.1 (Construction).
	The applicant should also consider the extent of habitat loss in respect of marine fish and shellfish.	Habitat loss during construction and operation is considered in Sections 8.7.1 and 8.7.2. Table 8.6.1 sets out the worst case scenarios for habitat loss.
	SNH recommend that Electromagnetic Fields (EMF) and seabed sediment heating impacts to fish and shellfish species are included and assessed in the Offshore EIA Report.	These impacts have not been scoped out and are considered in full in Section 8.7.2 (Operation).
	Consideration of any reef effects or creation of habitat arising from any scour protection used for the offshore export cable or Offshore Substation Platform(s) (OSP(s)) should be given.	This impact is considered in Section 8.7.2 (Operation).
	SNH agree that changes to tides and current speeds can be scoped out of the assessment.	Changes to tides and current speeds has been scoped out of the assessment, in line with the statements made by SNH and MS-LOT during the scoping process.
	Operational noise from OSP equipment, vessels and underwater maintenance: we note the inconsistency in approach in considering the potential effect of underwater noise originating from operating OSP equipment, vessel and underwater maintenance. We therefore suggest these effects are scoped into the EIA report for further consideration.	These effects are scoped in and are assessed in Section 8.7.2 (Operation).
	Particle motion: we highlight that there is growing awareness of this potential impact, but consider	A detailed literature review of particle motion is included in Section 8.7.1.

Table 8.3.1: Issues Raised During Consultation		
Date / Consultee	**Issue Raised**	**Moray West Approach**
	that this is at very early scientific understanding to undertake a detailed assessment.	
30 August 2017 SFF Scoping Opinion (Offshore Transmission infrastructure)	SFF expect habitat loss/disturbance, the increase in sediments (suspended and deposited), scarring effects and creation of substrate/habitats to be assessed for both OSP and OFTI.	These impacts are considered in full in Section 8.7.1 (habitat loss/disturbance & suspended sediments), and Section 8.7.2 (habitat creation).
	Further information should be provided in relation to scallops and Nephrops.	Baseline information in relation to scallops and Nephrops is provided in Section 8.4.2. Commercial fisheries for these species are discussed in Chapter 11 of this Offshore EIA Report.

8.4 Baseline Conditions

8.4.1 Baseline Characterisation Approach

8.4.1.1 With respect to characterising the existing environment in terms of fish and shellfish ecology, and informing the impact assessment, the following four main aspects have been taken into account:

- Commercial importance of fish and shellfish species;
- Presence of spawning and nursery grounds;
- Key prey species for sea birds, marine mammals and fish; and
- Presence of PMFs and other species of conservation importance, including migratory species.

8.4.1.2 It should be noted that certain species are relevant within more than one of the aspects given above and as a result, some overlap is to be expected.

Study Area

8.4.1.3 The study area used for the assessment of the fish and shellfish receptors is shown in Volume 3a - Figure 8.4.1. The study area is defined as the Moray Firth, but with a focus on the most relevant International Council for the Exploration of the Seas (ICES) statistical rectangles. The Moray West Site is located in ICES Division IVA (Northern North Sea). Fisheries data are recorded, collated and analysed by ICES statistical rectangles within each division. ICES statistical rectangles create a gridding system that allows standardisation of areas of the sea for data analysis purposes and these are used to inform management policy and decisions for key commercial fish and shellfish species (http://www.ices.dk/marine-data/maps/Pages/ICES-statistical-rectangles.aspx).

8.4.1.4 A total of four ICES rectangles cover the Development (44E6, 44E7, 45E6 and 45E7). The Moray West Site is situated within ICES rectangles 45E6 and 45E7, while the Offshore Export Cable Corridor is located in ICES rectangles 44E7 and 44E6. As only a very small area of the Offshore Export Cable Corridor is located in ICES rectangle 44E6 (Volume 3a - Figure 8.4.1), commercial fisheries landings data for this particular ICES rectangle is not used to inform the assessment as this would not accurately reflect the commercial fish and shellfish species affected by such a small area of the Development. The species present within ICES rectangles 44E7, 45E6 and 45E7 are considered fully representative for the Offshore Export Cable Corridor. Landings data and fisheries statistics from the ICES rectangles have been used to inform the baseline description of the key receptor species that may be impacted by the Development. The wider Moray Firth is used to assess the potential effects at a population level (i.e. species with further extending spawning and nursery grounds).

8.4.1.5 In the case of diadromous migratory species, given the uncertainties in relation to migratory pathways, the geographical scope of assessment has been based on the proximity of the Moray West Site to rivers, taking particular account of those which are designated SACs. In addition, a national context has also been provided. Rivers designated as SACs in the Moray Firth and the wider area are shown in Volume 3a - Figure 8.4.1.

Source of Information

8.4.1.6 The Development is located within the former Moray Firth Zone, for which extensive data and knowledge regarding fish and shellfish ecology is already available. This data/knowledge has been acquired through zonal studies and from the surveys and characterisations undertaken for Moray East Offshore Wind Farm. The Development is also located in close proximity to the Beatrice Offshore Wind Farm for which extensive data is available. It was therefore proposed that the Moray West fish and shellfish characterisation be completed using a combination of desktop data and information sources, and survey data collected as part of the characterisations of the Moray East Offshore Wind Farm, the former Moray Firth Zone, and the Beatrice Offshore Wind Farm. Over the series of meetings conducted between Moray West, MSS, MS-LOT and SNH, it was agreed that this approach was appropriate and sufficient for the purposes of characterising the fish and shellfish ecology of the Development.

8.4.1.7 The key data sources used to inform the characterisation of the fish and shellfish baseline are summarised in Table 8.4.1 below. Table 8.4.1 lists the sources of existing data as described above, along with additional, more recent data and research that has been collated to provide up to date baseline characterisation to inform the impact assessment. The baseline characterisation also draws upon information provided on commercial fisheries within the EIA Report (Volume 2) – Chapter 11: Commercial Fisheries.

Table 8.4.1: Summary of Key Information Sources

Dataset	Coverage	Date
Existing Datasets		
Hydrodynamic modelling	Moray East and Moray Zone	2012
Benthic Surveys (grabs trawls and video, EMU Ltd)	Moray East	October 2010
Sandeel surveys (MORL, 2012)	Moray Zone	Jan – Mar 2012
Cod survey report (MORL, 2012)	Moray Zone	Feb – Mar 2013
Beatrice Offshore Wind Farm (BOWL) herring larval surveys (BOWL, 2014, 2016a, 2016b)	BOWL site	2014 – 2015

Table 8.4.1: Summary of Key Information Sources		
Dataset	**Coverage**	**Date**
BOWL cable route benthic surveys	BOWL cable route	2012
BOWL sandeel survey (BOWL, 2014b)	BOWL site	2013
BOWL cod spawning survey (BOWL, 2015)	BOWL site	2014
Moray East scoping and Environmental Impact Assessment (EIA) data. Moray East (MORL,2010 & 2012)	Moray East	2014
BOWL scoping and EIA data. BOWL (2010 & 2012)	BOWL site	2010 & 2012
Additional Data and Published Research		
Spawning grounds of Atlantic cod (*Gadus morhua*) in the North Sea. ICES Journal of Marine Science, 73(2), 304-315 González-Irusta *et. al.,* 2015.	North Sea	2015
Spawning grounds of haddock (*Melanogrammus aeglefinus*) in the North Sea and West of Scotland. Fisheries Research, 183, 180-191. González-Irusta *et. al.,* 2016.	North Sea	2016
Spawning grounds of whiting (*Merlangius merlangus*). Fisheries Research, 195, 141-151. González-Irusta *et. al.,* 2017	North Sea	2017
International Council for the Exploration of the Sea (ICES) publications (e.g. International Herring Larval Survey)	UK	Various
Marine Management Organisation (MMO) landings data by ICES rectangle	UK	Various
Fisheries Sensitivity Maps in British Waters. Edition 1. Summer 1998. Coull *et al.* (1998)	UK	1998
Spawning and Nursery Grounds of Selected Fish Species in UK Waters. Sci. Ser. Tech. Rep., Cefas Lowestoft, 147: 56 pp. ICES, (2009) Report of the ICES Advisory Committee 2009. ICES Advice, 2009. Book 6, 236 pp. Ellis *et al.* (2012)	UK	2012
Scottish Marine and Freshwater Science Volume 5 Number 10: Updating Fisheries Sensitivity Maps in British Waters. Aires *et. al.* (2014)	UK	2014
Mapping spawning and nursery areas of species to be considered in Marine Protected Areas (Marine Conservation Zones)	UK	2010
Overview of Region 3 North-east Scotland: Cape Wrath to St. Cyrus. Peterborough JNCC (Coastal Directories Series). Barne *et al.* (1996)	North-East Scotland	1996
Electromagnetic field and subsea noise reviews Armstrong *et al.* (2015), Godfrey *et al.* (2014), Gill, A. B. *et al.* (2010)	UK	2010, 2014 and 2015

Table 8.4.1: Summary of Key Information Sources		
Dataset	**Coverage**	**Date**
The marine life information network (MarLIN) 'evidence base' MarLIN (2011)	UK	2011
SNH SiteLink Interactive Website (SNH, 2017)	Scotland	2017
Marine Scotland interactive mapping database. Marine Scotland (2017)	Scotland	2017

8.4.2 Current Baseline

Introduction

8.4.2.1 The baseline conditions for the fish and shellfish receptors is described below, following a review of the existing datasets along with the additional, more recent data and published research that is available, as set out within Table 8.4.1. The key baseline information illustrating fish and shellfish distribution is presented in Volume 3a - Figures 8.4.2 to 8.4.9.

Commercially Important Fish and Shellfish Species

8.4.2.2 Landings data for the ICES statistical rectangles provides an overview of the key species of commercial value that may be present. At a Development specific level, the sediment type will affect the distribution of certain species. As has been described in Chapter 6: Physical Processes, muddy substrates dominate in the inner and southern parts of the Moray Firth, whilst sand, gravelly sand and to a lesser extent sandy gravel and slightly gravelly sand, are prevalent in the northern and central areas of the Moray Firth including the area of the Development.

8.4.2.3 The Moray Firth supports a number of commercial fish and shellfish species. The principal commercial species present in the study area are shown in Volume 3a – Figure 11.4.5 (Chapter 11: Commercial Fisheries), based on the value of annual average (2012-2016) landings by species and ICES rectangle. In accordance with Chapter 11: Commercial Fisheries, landings data for this five year period have been analysed to allow general trends in the data to be identified and provide an overview of fishing activity.

8.4.2.4 ICES Division Iva (within which the Moray West Site is located) is noted for importance with crab, king scallop and squid. Scallops, lobster (*Homarus gammarus*), *Nephrops* and edible crab (*Cancer pagurus*) are the principal shellfish species landed. Haddock accounts for the majority of the fish landings, with some whiting also landed. The relative contribution of different species to the total landings value varies depending on the ICES rectangle under consideration.

8.4.2.5 The highest average value in annual landings in the study area occur within ICES rectangle 44E7 (£4,250,613). The highest recorded values in this ICES rectangle are of *Nephrops*, followed by squid (a seasonal fishery) and haddock. Within the Moray West Site, ICES rectangle 45E6 has highest landings derived from lobsters, scallops and edible crabs, with ICES rectangle 45E7 recording the highest landings of scallops, haddock and squid. Elasmobranch species (sharks and rays) constitute a small percentage of the landings value, in the study area, being included under the category “other” in EIA Report Volume 3a - Figure 11.4.5 (Chapter 11: Commercial Fisheries).

8.4.2.6 The annual average landings values (2007 to 2016) by species for the study area are presented in Technical Appendix 11.1 (Volume 4): Commercial Fisheries Technical Report – Figures 3.5 to 3.7 and 3.12 to 3.15 and also presented in Figure 11.4.5 (Volume 3a). This is summarised in the following sections for fish and shellfish species in each of the ICES rectangles that make up the study area. In summary, haddock accounts for the majority of the fish landings whilst the principal shellfish species landed are *Nephrops*, squid, lobsters and scallops. A detailed characterisation of the commercial fisheries activity in relation to the Development is provided in Appendix 11.1 (Volume 4): Commercial Fisheries Technical Report.

Key Commercial Shellfish Species

8.4.2.7 In ICES rectangle 44E7 (where the Offshore Export Cable Corridor is located), *Nephrops* are the main shellfish species landed from the study area, accounting for 42.7 % of total shellfish landings in value (average 2007-2016) (Chapter 11 Commercial Fisheries - Section 11.4). Squid and scallops account for 27.2 % and 6.6 % of the total shellfish landings value, respectively. Combined together, these three species account for 91 % of the total shellfish landings value from ICES rectangle 44E7 and 77 % of the total landings value (fish and shellfish included).

8.4.2.8 In ICES rectangle 45E6 (where the western part of the Moray West Site is located), lobster are the main shellfish species landed by value from the study area, accounting for 35.8 % of total shellfish landings (average 2007-2016) (Chapter 11 Commercial Fisheries - Section 11.4). Scallops account for 26.7 % of the total shellfish landings value, with these two species accounting for 59.2 % of the total landings value (fish and shellfish). Edible crab is the third highest value species, comprising 20.5 % of the total shellfish landings value. Within this ICES rectangle, shellfish comprise 95 % of the total landings value.

8.4.2.9 In ICES rectangle 45E7 (where the eastern part of the Moray West Site is located), scallops are the main shellfish species landed by value from the study area, accounting for 73.4 % of total shellfish landings (average 2007-2016) (Chapter 11 Commercial Fisheries - Section 11.4). Squid account for 17.1 % of the total shellfish landings value. These two species account for 90.5 % of the total shellfish landings value and for 68.6 % total landings value (fish and shellfish).

Key Commercial Fish Species

8.4.2.10 As shown in Figure 11.4.5 (Volume 3a) and Figures 3.5 to 3.7 and 3.12 -3.15 of the Commercial Fisheries Technical Report (Volume 4 - Technical Appendix 11.1) haddock accounts for the vast majority of fish landings by value in the study area (54.8 % in 44E7, 72.4 % in 45E6, and 71.3 % in 45E7) followed by monkfish or anglerfish (*Lophius piscatorius* or *L. budegassa*), herring, cod, mackerel (*Scomber scombrus*) and whiting. For ICES rectangle 44E7 the key commercial species are haddock, monkfish or anglerfish, mackerel and whiting. For ICES rectangle 45E6, the key species are haddock, monkfish or angler fish and cod. For ICES rectangle 45E7, the key species are haddock, monkfish or anglerfish, herring, cod, whiting, megrim and mackerel.

<u>Characteristics of Key Shellfish Species in Study Area</u>

8.4.2.11 The following section describes the key characteristics of the main shellfish species identified as being present in the study area. This includes information on species distribution, abundance and lifecycle. None of the shellfish species listed not afforded any protection or assigned any conservation status under international or national legislation.

Scallops

8.4.2.12 The king scallop is the main species of scallop in Scottish waters (Howell *et al.*, 2006). They can be found on a variety of substrate types, from rocks and stones to fine silty mud. They are most abundant in areas with rocky outcrops or boulders on silty sand mixed with shell substrates at depths of 15-75 m (Pawson, 1995; Franklin *et al.*, 1980). Queen scallops occur in much the same areas as king scallops, but usually in somewhat deeper water, down to 200 m or more. They are also landed from the study area, although to a lesser extent than king scallops.

8.4.2.13 Volume 3a - Figure 11.4.5 (Chapter 11: Commercial Fisheries) shows that scallops are more established within the northern area of the Moray Firth, with the highest scallop landings recorded in ICES rectangle 45E7, where the eastern part of the Moray West Site is located.

8.4.2.14 Scallops have an aggregated distribution within their geographical range. Where the population is sufficiently abundant to support a commercial fishery, such areas are referred to as “grounds“ and are usually widely separated by areas that are environmentally unsuitable for the species. The absolute size of grounds may vary substantially from a few km^2 to a few thousand km^2 (Brand 2006). Scallop grounds are located in areas of the Moray Firth, including the Smith Bank, the southern and western coastlines and in eastern, offshore areas (Appendix 11.1: Commercial Fisheries Technical Report). Scallop grounds appear to be absent from areas characterised by muddy sand substrates, where *Nephrops* are more prevalent.

8.4.2.15 Within each ground there are usually a number of areas of several km^2, where scallop abundance is higher than elsewhere, these are referred to as “beds”. Beds may be permanent aggregations, precise in their location and separated by areas that are unsuitable for scallops, or they may be temporary aggregations that vary in their location from year to year, resulting from uneven settlement or early survival. In addition, within each bed the distribution of scallops may be aggregated into “patches”, the scale of which is generally measured in terms of tens or hundreds of m^2 (Brand, 2006).

8.4.2.16 The scallop fishery is cyclical and is often left to recover from intensive fishing periods while the fleet targets grounds elsewhere (Appendix 11.1: Commercial Fisheries Technical Report). In the Moray Firth, scallop stock levels are considered to be currently stable (Appendix 11.1: Commercial Fisheries Technical Report).

8.4.2.17 In Scottish waters, scallops spawn for the first time in the autumn of their second year, and subsequently spawn each year in the spring or autumn (Keltz & Bailey, 2010). Following external fertilisation, eggs remain on or near the sea bed for a number of days and then develop into free swimming larvae (veliger larvae[1]) that migrate towards the sea surface, and spend three weeks or more in the water column (Keltz & Bailey, 2010; Pawson, 1995). Pelagic veliger larvae eventually descend towards the seabed where they develop into pediveliger[2] larvae (Pawson, 1995; Franklin *et al.*, 1980). It is at this stage of the larval cycle that substrate preference is of most importance with larvae alternatively swimming and crawling over the seabed testing surfaces upon which to settle (Franklin *et al.*, 1980). When a suitable settling surface such as algae, hydroids or bryozoans is found the scallop anchors itself by means of sticky threads (byssus threads) from a gland at the base of the foot (Franklin *et al.*, 1980). The larvae then undergo a complete metamorphosis of internal anatomy and become what is termed “spat”. It then feeds until the shell is strong and thick enough for the scallop to inhabit sand and gravel on the sea bed (Franklin *et al.*, 1980). Spat (juvenile scallops) settlement and/or survival appear to be extremely irregular, with certain age classes often entirely absent from a population. It has been suggested that a minimum of spawning adults is necessary to ensure good recruitment of spat, and productive spawning areas may therefore be more restricted than the overall distribution of the species would indicate (Pawson, 1995).

[1] A veliger is the planktonic larval stage of many kinds of sea snails and freshwater snails, as well as most bivalve molluscs (clams) and tusk shells.

[2] Pediveliger is used to describe the later development stages of veliger.

Nephrops

8.4.2.18 Figure 11.4.5 (Volume 3a – Chapter 11: Commercial Fisheries) shows that *Nephrops* are more established in the southern area of the Moray Firth, with the largest landings occurring in ICES rectangles 44E6 and 44E7 (where the Offshore Export Cable Corridor is located). The Moray West Site (ICES rectangles 45E6 and 45E7) have low landings of *Nephrops* in relation to other shellfish.

8.4.2.19 Throughout their distribution, *Nephrops* are found at depths ranging from 15 m to more than 800 m. They are more commonly found in Scottish waters at depths ranging between a few metres to 500 m[3].

8.4.2.20 *Nephrops* distribution is dependent upon the availability of seabed habitats composed of fine cohesive mud in which they can construct burrows, although the precise nature of the sediment can vary markedly. Sediment type also appears to affect the structure of *Nephrops* populations, with areas of fine sediment being characterised by the presence of large *Nephrops* and low population densities, and areas of coarser sediment showing higher population densities and *Nephrops* smaller in size (Howard, 1989).

8.4.2.21 Although an important fishery to the study area in terms of landings, the Moray Firth *Nephrops* fishery is on a much smaller scale compared to fisheries in the Minches and the Fladen Grounds (Southhall & Hambrey, 2005). *Nephrops* in the Moray Firth, as suggested by landings statistics and consultation with local fishermen, are principally distributed in the southern area of the Moray Firth, not within the Moray West Site (Appendix 11.1: Commercial Fisheries Technical Report).

8.4.2.22 *Nephrops* spend most of their time in burrows, only coming out to feed and look for a mate (Keltz & Bailey, 2010). In Scottish waters, spawning occurs from August to November (Keltz & Bailey, 2010; Howard, 1989).

8.4.2.23 Females carry eggs under their tails (described as being "berried") until they hatch from late April to August (Howard, 1989). The egg-berried females stay in their burrows during egg incubation (Howard, 1989). Larvae develop in the plankton before settling to the seabed six to eight weeks later as juveniles (Keltz & Bailey, 2010). The juveniles enter the burrows of adults and remain there for approximately one year (Howard, 1989).

8.4.2.24 The study area falls within the *Nephrops* spawning and nursery areas defined by Coull *et al.* (1998) (Volume 3a - Figure 8.4.2). Given the substrate requirements of this species, it is unlikely that spawning will occur throughout the Development and will be focused within specific areas of suitable habitat. Muddy substrates dominate in the inner and southern areas of the Moray Firth, whilst sand and gravelly sands are prevalent in the northern and central areas of the Moray Firth, including the Moray West Site. It is therefore likely that there will not be significant *Nephrop*s spawning grounds within the Moray West Site or wider study area.

Squid

8.4.2.25 Figure 11.4.5 (Volume 3a – Chapter 11: Commercial Fisheries) shows that squid are most present in the vicinity of the Offshore Export Cable Corridor and Moray West Site (ICES rectangles 44E6, 44E7and 45E7), with the highest value landings coming from the southern area of the Moray Firth. A substantial proportion of Scottish squid landings come from the Moray Firth (Young *et al.*, 2006).

[3] http://www.gov.scot/Topics/marine/marine-environment/species/fish/shellfish/nephrops

8.4.2.26 Squid is typically found on the continental shelf and offshore banks. Although spawning grounds have not yet been documented, it is very likely that the Moray Firth includes spawning grounds for this species (Young *et al.*, 2006). Fishermen have reported finding squid eggs off Burghead and Buckie during the months of May and June in waters 5 to 6 m deep. Eggs have also been encountered on lobster creels shot on hard ground in the Moray Firth (Young *et al.*, 2006).

8.4.2.27 In Scottish waters spawning occurs over an extended period from December to June, with peak spawning reported from December to March (Lum-Kong *et al.*, 1992; Pierce *et al.*, 1994; Boyle *et al.*, 1995; Collins *et al.*, 1997). The winter breeding cohort appears to spawn in inshore waters and some evidence suggests that the spawning grounds of the summer breeders are also inshore (Viana *et al.*, 2009). All individuals are semelparous[4] and die after spawning (Rocha *et al.*, 2001). Recruitment of juvenile squid to the adult population has been reported to peak in spring (April) and in autumn (July to October) (Boyle *et al.*, 1995; Viana *et al.*, 2009; Pierce *et al.*, 1994), the latter being the main recruitment period (Viana *et al.*, 2009).

8.4.2.28 The main Scottish fishery for squid occurs in coastal waters and usually exhibits a marked seasonal peak around October and November, corresponding to the occurrence of pre-breeding squid. In the Moray Firth, a directed fishery for squid has developed in late summer and autumn in coastal waters between Troup Head and Spey Bay in the south of the Moray Firth, with additional activity recorded on parts of the Smith Bank and along the north coast (Young *et al.*, 2006; Campbell & McLay; 2007).

8.4.2.29 At the beginning of the season, catches are best in shallow water over hard (even rocky) ground close inshore, in depths of around 10 m. As the season progresses, the fishery gradually moves further offshore to a sandy/muddy bottom in waters of around 55 m depth (Young *et al.,* 2006). The fishing activity varies seasonally, depending upon the arrival of the species in the Moray Firth.

8.4.2.30 Historically, the importance of this fishery used to vary from year to year, but now its importance to the demersal trawler fleet is of increased value since restrictions were imposed on whitefish and *Nephrops* stocks. A range of vessels have diversified into this fleet from ports as distant as the west coast, the Orkneys and Shetland.

Crab

8.4.2.31 In the Moray Firth, crabs are mainly targeted in coastal waters located to the south and west of the Moray West Site (Figure 11.4.5 – Volume 3a Chapter 11: Commercial Fisheries). Landings values for edible crab are particularly high in ICES rectangle 45E6 (covering the north west extents of the Moray West Site). For the other three ICES rectangles that make up the study area the landings values for crab are comparatively low.

8.4.2.32 Edible crabs are found around the Scottish coast on the lower shore and shallow sub-littoral areas and in offshore waters at depths of up to 200 m (Mill *et al.*, 2009; Pawson, 1995). They are often associated with rocky reefs but also inhabit mixed coarse grounds and soft sediments (muddy sand) particularly offshore (Hall, 1993). Adult female crabs undertake seasonal inshore and offshore migrations of 20 to 70 km (Ungfors *et al.*, 2007; Jones *et al.*, 2010).

8.4.2.33 Velvet crabs are fast moving, swimming species which inhabit grounds from the intertidal areas down to about 80 m, but are most commonly found at depths of about 25 m (Norman & Jones, 1992). They are typically found in areas of hard substratum where rocky reef and boulders provide crevices for shelter (Jessop *et al.*, 2007). Females are thought to move offshore during the winter (Norman & Jones, 1993), however, long distance migrations such as those observed in edible crabs, have not been recorded for this species (Kinnear & Mason, 1987).

[4] An organism that reproduces just once during its lifetime, after which its death is inevitable.

Lobster

8.4.2.34 Lobster is found on rocky grounds from the intertidal zone to depths up to 200 m, although most commonly in waters less than 30 m (Pawson, 1995; Mill *et al.*, 2009; Howard & Nunny, 1983). Unlike edible crabs, lobsters are not thought to undertake extensive migrations and will only move a few miles along the shore (Pawson, 1995; Smith *et al.*, 2001; Thomas, 1955; Keltz & Balley, 2010). However, recent studies off the north-east coast of England have indicated seasonal offshore movements of berried females (Keltz & Balley, 2010).

8.4.2.35 Lobsters are mainly targeted in coastal waters of the Moray Firth (Figure 11.4.5 - Volume 3a Chapter 11: Commercial Fisheries). Lobster landings are greatest from ICES rectangle 45E6, although they are also landed in smaller numbers along the southern Moray Firth coastline.

Whelk

8.4.2.36 Whelk inhabit the littoral / subtidal zone and the landings values within the study area are relatively low, with no landings recorded in ICES rectangle 45E7 (location of the majority of the Offshore Export Cable Corridor) between 2012 - 2016. Between 2007 – 2016, whelks have been recorded in average landings value data for ICES rectangle 45E6 (Technical Appendix 11.1 (Volume 4) – Figure 3.15). MSS has confirmed that this is not a species of commercial importance within the study area.

<u>Characteristics of Key Fish Species in Study Area</u>

8.4.2.37 The following section describes the ecology of key fish species identified as being present in the study area. This includes information on species distribution, lifecycle, key spawning and / or nursery grounds and conservation status of the species. The species likely to be present have been identified through site-specific survey, literature review and other data gathering exercises. These are set out within the Scoping Report (Moray West, 2017) and further refined through the Scoping Opinion (MS-LOT, 2017).

Demersal Species

8.4.2.38 Demersal fish are species that dwell (live and feed) at or near the bottom of the sea and comprise of bottom feeders. They are typically represented by species including flatfish, eels, cod, haddock and sharks.

<u>*Haddock*</u>

8.4.2.39 Immature and adult haddock are found in northerly areas of the North Sea (Hedger *et al.*, 2004). Shoals are typically found in colder waters at depths from 40 to 300 m, over rock, sand, gravel or shells (ICES, 2011b; FAO, 2011). Haddock shoals show a preference for depths between 75 and 125 m, bottom temperatures greater than 6° C and salinities greater than 35.5 ppt (Hedger *et al.*, 2004).

8.4.2.40 Figure 11.4.5 (Volume 3a – Chapter 11: Commercial Fisheries) shows that haddock is the most important fish species landed by weight in the study area, with greatest landings in weight occurring in the north east of Moray Firth (eastern extents of the Moray West Site). Haddock landings are low in the south of the Moray Firth in the areas where *Nephrops* fishing grounds exist.

8.4.2.41 The Development does not overlap with haddock spawning grounds as defined by Coull *et al.* (1998) (Volume 3a - Figure 8.4.5). The Moray West Site falls within haddock nursery grounds, as defined by Coull *et al.* (1998) (Volume 3a - Figure 8.4.5).

8.4.2.42 Results of international ichthyoplankton surveys carried out in 2004 found high concentrations of haddock eggs in and off the Moray Firth (ICES, 2005b). Similarly, significant spawning concentrations were noted historically to be located east of the Moray Firth (Gibb *et al.*, 2004).

8.4.2.43 Surveys conducted by the FRS in 1999 found haddock spawning in both coastal and offshore areas (Gibb *et al.*, 2004). The highest densities of mature and spawning haddock were found in depths of around 100 m and most fish were associated with areas of mud or sand with few being caught in areas of harder substrate (Gibb *et al.*, 2004).

8.4.2.44 Spawning takes place between February and May (Coull *et al.*, 1998), at depths of 50 to 150 m (FAO, 2011; Fillina *et al.*, 2009), with peak spawning occurring in March and April (Coull *et al.*, 1998; Fillina *et al.*, 2009). Haddock are serial spawners, releasing their eggs in batches over the spawning season (Gibb *et al.*, 2004, Fillina *et al.*, 2009). The eggs are laid at the bottom and after fertilisation rise into the water column where subsequent larval development occurs (Page & Frank, 1989).

8.4.2.45 Haddock are capable of producing a wide range of sounds (Wahlberg & Westerberg, 2005). Sounds produced by males during the spawning season are thought to serve to bring male and female fish together. In addition, it has been suggested that the sounds play a role in synchronising the reproductive behaviour of males and females (Hawkins & Amorim, 2000).

8.4.2.46 Haddock is not afforded any protection or assigned any conservation status under international or national legislation.

Monkfish

8.4.2.47 Monkfish, also called anglerfish, occur in shallow waters to depths of approximately 1,000 m on muddy/gravelly bottoms of the continental shelf (CEFAS 2011). *L. piscatorious* is usually caught at depths between 20 and 150 m, whereas *L. budegassa* occurs mostly at depths greater than 100 m. Spawning takes place largely in deep waters, from February to August, off the edge of the continental shelf and recruitment occurs in relatively inshore areas such as the Moray Firth and along the Norwegian coast in the northern North Sea (ICES 2009c, Pawson 1995).

8.4.2.48 Monkfish are recorded within the landings data in the eastern extents of the Moray Firth (covering the majority of the Offshore Export Cable Corridor and eastern area of the Moray Firth Site), within ICES rectangles 44E7, 45E6 and 45E7.

8.4.2.49 Monkfish (anglerfish) is listed as a PMF species and has been identified as a threatened species requiring conservation action under the UK Biodiversity Action Plan (i.e. a UKBAP species).

Whiting

8.4.2.50 Whiting is widely distributed throughout the North Sea, Skagerrak and Kattegat (ICES 2011b). The species is typically found near the seafloor in waters from 10 to 200 m, but may move into midwater in the pursuit of prey (ICES 2011b).

8.4.2.51 Figure 11.4.5 (Volume 3a – Chapter 11: Commercial Fisheries) shows that within the Moray Firth landings values for whiting are comparatively low. Similar to monkfish, this species is recorded within the landings data in the eastern extents of the Moray Firth (covering the majority of the Offshore Export Cable Corridor and eastern area of the Moray Firth Site), within ICES rectangles 44E7 and 45E7.

8.4.2.52 The Development is located in the vicinity of whiting spawning grounds defined by Coull *et al.* (1998). Ellis *et al.* (2010a) low intensity spawning grounds overlap with the eastern part of the Moray West Site and the Offshore Export Cable Corridor and the Development overlaps with a high intensity nursery ground. The spawning and nursery grounds as defined by Coull *et al.* (1998) and Ellis *et al.* (2010a) are illustrated in Volume 3a - Figure 8.4.6.

8.4.2.53 Spawning occurs between February and June. Females release their eggs in numerous batches over a period that may last up to fourteen weeks (Teal *et al.*, 2009). Eggs are pelagic and take about ten days to hatch (Russel, 1976).

8.4.2.54 Whiting is also listed as a PMF and UKBAP species.

Cod

8.4.2.55 Cod is found from shallow coastal waters to the edge of the continental shelf (200 m depth) and beyond with catches reported from depths of 600 m (ICES, 2011b; Hedger *et al.*, 2004). Hedger *et al.* (2004) found that the greatest abundances of mature cod were in depths less than 50 m or greater than 150 m (along the Norwegian Trench) spanning the entire temperature and salinity range of the North Sea. Cod in the Moray Firth is believed to be a sedentary residential population that provides year-round site fidelity (Wright *et al.*, 2007).

8.4.2.56 Cod was historically commercially targeted in the Moray Firth. A series of quota reductions in the 1980s restricted the fishermen's ability to legally land cod, rendering the fishery presently unviable in the Moray Firth (Appendix 11.1: Commercial Fisheries Technical Report). Landings values for this species are therefore relatively low within the study area, with landings occurring in ICES rectangles 45E6 and 45E7 between 2007 - 2016.

8.4.2.57 The cod population of the Moray Firth has been found to be genetically distinct from other North Sea populations (Hutchinson *et al.*, 2001). Cod spawn between January and April, with peak spawning taking place from February to March mainly in the evening and during the night (ICES, 2005a; Coull *et al.*, 1998). Eggs are pelagic and hatch over a period of two to three weeks, depending on water temperature (Wright *et al.*, 2003). Male cod are known to produce a drumming sound during the spawning season (Nordeide & Kjellsby, 1999; Fudge and Rose, 2009) and it has been suggested that the sounds are used to defend territories and attract females during spawning (Brawn, 1961).

8.4.2.58 The Development falls within a low intensity cod spawning area as defined in Coull *et al.,* (1998). Spawning grounds are shown in Volume 3a - Figure 8.4.4 together with larvae and eggs densities recorded in recent surveys (Ellis *et al.*, 2010a). In addition, the Moray Firth has been defined as a high intensity nursery ground for cod.

8.4.2.59 In the North Sea Egg survey (2004) significant numbers of eggs were found off the Moray Firth and to the east of the Shetland Islands (Fox *et al.*, 2008). It has been suggested that passive transport of early life history stages could lead to a substantial advection of cod eggs and larvae from Shetland south to the Scottish east coast (Heath & Gallego, 1997). Little cod spawning activity was observed in a spawning area survey carried out in March 2008 by the Fisheries Research Services (FRS) in the Moray Firth, during which relatively low numbers of running females were caught (Gibb *et al.*, 2008).

8.4.2.60 In 2002, the University of Aberdeen consulted 25 fishermen on the location and timing of cod spawning. Fishermen reported that significant aggregations of spawning fish were found to the east of Shetland. In addition, they identified the north-east coast of Scotland between Fraserburgh and Banff (located within ICES rectangle 44E7) as a traditional cod spawning area, but one which is no longer used by the species. They commented that the stock in this area had been fished out in the early 1990s by seine netters and had not recovered since (Gibb *et al.*, 2008).

8.4.2.61 Gibb *et al.,* (2007) mapped the density distribution of 0-group cod (less than one year old) in the North Sea and west coast of Scotland, in 2001 and 2002 to 2004. The combined survey data shows that, whilst 0-group cod occur over much of the studied region, the majority are confined to a few small coastal areas and overall densities are scarce, with median densities around 10 cod km^{-2}. Substantially elevated densities of more than 100 cod km^{-2} were only found within the Moray Firth, the Clyde and isolated sites off Mull in the Minch, west of Scotland, Shetland and St Andrews Bay, east of Scotland. In general terms sheltered areas (especially around Shetland) were found to have high juvenile abundance in comparison to exposed coastlines.

8.4.2.62 In relation to cod spawning in the vicinity of the Development, cod spawning surveys were undertaken across the Moray East Site in 2013 with low numbers of spawning cod encountered. Cod were recorded in low numbers at 35 out of 58 stations with a maximum of 9 individuals caught at a single station, with a total of 23 spawning cod caught throughout the survey. The relatively low numbers recorded in the survey suggest that there are not extensive cod spawning areas in the Moray Firth Zone.

8.4.2.63 Similarly, results from cod spawning surveys undertaken at the Beatrice Offshore Wind Farm (located to the north-east of the Moray West Site) in 2014 also indicated relatively low abundance of spawning cod across the Beatrice Offshore Wind Farm site with only 7 stations out of the 40 stations sampled during two trips considered to indicate a “spawning” area (>75 spawning cod/km^2).

8.4.2.64 In light of the significant decline in the North Sea cod population, in addition to being listed as a PMF and UKBAP species, cod is also afforded protection under the OSPAR Convention and is included in the International Union for Conservation of Nature (IUCN) Red List of Threatened Species, under which it is current assigned vulnerable status.

Plaice

8.4.2.65 Plaice are generally found in shallow waters less than 50 m deep. Juveniles are found in shallow coastal waters and outer estuaries. As they grow older they gradually move into deeper water (ICES, 2011b).

8.4.2.66 The results of a tagging study in the Central North Sea conducted by Hunter *et al.* (2003) showed directed seasonal migrations of plaice from winter spawning grounds to summer feeding grounds 250 km to the north. The timing of the migration was considered to be synchronous and characterized by a 100% spawning site fidelity.

8.4.2.67 Figure 11.4.5 (Volume 3a – Chapter 11: Commercial Fisheries) shows that plaice are not a key commercial fishery within the Moray Firth.

8.4.2.68 The Moray West Offshore Wind Farm partly overlaps plaice spawning grounds in the south as defined by Coull *et al.* (1998). The study area and surroundings have been identified by Ellis *et al.* (2010a) as a low intensity spawning and nursery ground (Volume 3a - Figure 8.4.5).

8.4.2.69 The distribution of spawning grounds is shown in Volume 3a - Figure 8.4.5 together with larvae and egg densities including those recorded during the 2004 North Sea Egg survey, as provided in Ellis *et al.* (2010a).

8.4.2.70 Spawning takes place between December and March with peak spawning occurring in February/March (Rijnsdorp, 1989; Simpson, 1959; Harding *et al.*, 1978). During spawning pelagic eggs are released in batches (Rijnsdorp, 1989; Armstrong *et al.*, 2001; Murua & Saborido-Rey, 2003). Plaice rarely spawn beyond the 50 m depth contour (Harding *et al.,* 1978). Females spawn over a period of four to six weeks (Rijnsdorp, 1989) and pelagic larvae hatch between seven to 21 days depending on temperature (Fox *et al.*, 2003).

8.4.2.71 The results of the North Sea Egg survey (2004) showed that plaice eggs north of the Dogger Bank were scarce except for isolated patches off Flamborough Head, off the Firth of Forth, the Moray Firth and to the east of the Shetland Isles (ICES, 2005b). Concerns have however been raised, that the timing of the more northerly cruises may have been a little late to capture the peak of plaice egg production (ICES, 2005b). Assuming spawning is relatively continuous, the density of eggs should be indicative of the spawning grounds although up to three days drift and dispersion may have occurred (ICES, 2005b).

8.4.2.72 Although not a PMF species, plaice is a UKBAP species and is also listed in The International Union for Conservation of Nature (IUCN) Red List[5] as a species of least concern.

Pelagic Species

8.4.2.73 Pelagic fish are species that inhabit (live and feed in) the sea, within the water column or near the surface. They are either coastal (inhabiting the shallower and sunlit waters of the continental shelf waters) or oceanic (inhabiting the deeper and more vast waters offshore from the continental shelf). Typical species include shoaling fish such as herring and whitefish, as well as individual predator species.

Herring

8.4.2.74 Figure 11.4.5 (Volume 3a – Chapter 11: Commercial Fisheries) shows that herring are not a key commercial fishery within the landings statistics for the Moray Firth, with landings values limited to the northern extents of the Moray Firth (ICES rectangles 45E6 and 45E7).

8.4.2.75 Herring is a migratory species targeted by a seasonal fishery. Adult herring migrate considerable distances in large shoals to feeding and spawning grounds (Munro *et al.*, 1998). Juvenile fish generally remain up to two years in nursery areas before joining adult fish on their migration.

8.4.2.76 Herring spawn off the Scottish and English east coast, migrate east to the Skagerrak and Kattegat where they overwinter and then move to the feeding grounds in the Fladen Grounds and Viking Bank before returning to the spawning grounds. In the Moray Firth juveniles are present throughout the year, whilst adults are more prevalent during the spawning season.

8.4.2.77 North Sea herring is divided into four sub-stocks on the basis of areas used for spawning. The sub-stocks relevant to the Development are the Orkney/Shetland stock which spawns off the Scottish east coast and in Orkney/Shetland waters, and the Buchan stock which spawns off the eastern Aberdeenshire coast.

8.4.2.78 Herring are demersal spawners and show a high preference for coarse grounds and high energy environments when selecting spawning grounds (Keltz & Bailey, 2010; de Groot, 1980; Maucorps, 1969; Munro *et al.*, 1998; Parrish *et al.*, 1959; Blaxter, 1985). Females deposit sticky eggs in single batches directly on to the seabed on a substrate of coarse sand, gravel, small stones or rocks (Keltz & Bailey, 2010; Munro *et al.*, 1998; Hodgson, 1957).

8.4.2.79 Spawning of both the Orkney/Shetland and Buchan sub-stocks occurs between August and September (Coull *et al.*, 1998) and shoals of herring arrive at traditional spawning grounds in a series of waves, where they congregate (Lambert, 1987). It has been suggested that herring are able to discriminate sources of sound emitted by various sediment types, each being characterised by its own specific noise spectrum. Herring would in this way be able to use the sound characteristics of the seabed as a clue to recognise their spawning sites in addition to homing (Enger, 1967).

8.4.2.80 Herring larvae hatch in approximately three weeks, depending on sea temperature (Keltz & Bailey, 2010; Maucorps, 1969; Munro *et al.*, 1998; Hodgson, 1957). Hatched larvae measure between 6 and 10 mm and depend on their yolk-sac until first feeding (Hodgson, 1957). Once this has been absorbed larvae become pelagic and feed on plankton. They are then passively carried by prevailing currents before arriving at the nursery grounds (Keltz & Bailey, 2010; Maucorps, 1969; Munro *et al.*, 1998; Hodgson, 1957).

[5] The IUCN Red List of Threatened Species provides taxonomic, conservation status and distribution information on plants, fungi and animals that have been globally evaluated and determined to be at risk of extinction. The list highlights those plants and animals that are facing a higher risk of global extinction (i.e. those listed as Critically Endangered, Endangered and Vulnerable).

8.4.2.81 Herring larvae from the Orkney/Shetland stock drift south into nursery grounds in the Moray Firth and east to nursery grounds in the Skagerrak and Kattegat. Herring larvae of the Buchan stock drift south into nursery grounds in the Firth of Forth and east to Skagerrak and Kattegat nursery grounds. Heath *et al.* (1989) found that herring larvae from a spawning site at Clythness in the Moray Firth drifted from the spawning grounds at a rate of 1-2 km/day.

8.4.2.82 Herring spawning grounds as presented in Ellis *et al.* (2010a), including larval densities recorded in the 2008 International Herring Larvae Survey (IHLS), and the grounds as defined in Coull *et al. (*1998) are presented in Volume 3a - Figure 8.4.3. In addition, Volume 3a - Figure 8.4.3 shows the extent of herring nursery grounds, together with juvenile catch rates recorded in Scottish Ground Fish Surveys (Ellis *et al.,* 2010a).

8.4.2.83 Herring spawning grounds as defined by Coull *et al.* (1998) are located approximately 1.4 km from the Moray West Offshore Wind Farm. Alternative publications however suggest that the Development falls within defined herring spawning grounds (e.g. Payne, 2010). In addition, the Development falls within high intensity nursery grounds as defined by Ellis *et al.* (2010a). It should be noted that given the substrate requirements of spawning herring it is very unlikely that the whole area defined in Coull *et al.* (1998) will be used for spawning.

8.4.2.84 Figure 8.4.9 (Volume 3a) is a heat map of spawning areas in the vicinity of the Development that has been produced using IHLS data on herring larvae abundance between 2007/2008 to 2016/2017. This figure highlights "hotspots" of the areas with the highest combined density of herring larvae and the location of these hotspots for herring larvae can be used a proxy for herring spawning grounds. It is important to note that the sampling locations for the IHLS surveys do not explicitly cover the Development and are determined by a fixed grid determined by ICES. Despite this, and as shown in Volume 3a - Figure 8.4.9, the most important herring spawning grounds for this section of the North Sea is to the east of Orkney extending northwards towards Shetland, and in the vicinity of the Fraserburgh and Peterhead coastline. Volume 3a - Figure 8.4.9 illustrates that there is very limited spawning that occurs within the Moray Firth and in the vicinity of the Development.

8.4.2.85 The method of undertaking heat mapping of IHLS data to identify herring larvae hotspots and therefore determine the main herring spawning grounds is promoted in order to enable a more up to date appraisal of spawning grounds than that presented within the historical Coull *et. al* (1998) fish sensitivity maps. This novel approach fits well when compared with the historical fish sensitivity maps and is an all-encompassing approach using all available evidence base as opposed to a series of older spawning maps.

8.4.2.86 Results from herring larval surveys undertaken at the Beatrice Offshore Wind Farm (located to the north-east of the Moray West Site) in 2014 and 2015 indicated that larvae were first observed in the most northerly stations of the survey area, by the Pentland Firth, before being recorded further south into the survey area in each progressive sampling week, indicating that larvae are transported into the survey area from the north rather than there being any significant spawning activity within the survey area.

8.4.2.87 Herring is a PMF and UKBAP species. It is also listed on the IUCN Red List as a species of least concern.

Sandeels

8.4.2.88 The North Sea sandeel stock has been divided into seven sub populations which are reproductively isolated from each other (ICES, 2013). The sandeel population of the Moray Firth is part of the Central Western North Sea sandeel stock (ICES, 2013).

8.4.2.89 Sandeels spend most of the year buried in the sea bed and only emerge into the water column briefly in winter for spawning and for an extended feeding period in spring and summer (Van der Kooij *et al.*, 2008). Spawning principally takes place in December and January (Gauld & Hutcheon, 1990; Bergstad *et al.*, 2001, Winslade, 1974). Females lay demersal eggs and after several weeks planktonic larvae hatch, usually in February-March (Macer, 1965; Langham, 1971; Wright & Bailey, 1996). After spawning the fish remain buried in sand until April (Winslade 1974).

8.4.2.90 The area in the vicinity of the study area has been identified as a high intensity spawning ground and a low intensity nursery ground for sandeels (Ellis *et al.*, 2010). Sandeel spawning and nursery grounds are shown in Volume 3a - Figure 8.4.2. Sandeels require suitable substrate in which to bury and it is expected that sandeel distribution will occupy discrete patches of the seabed, rather than be continuous throughout the Moray Firth.

8.4.2.91 In relation to sandeel distribution in the vicinity of the Development, results from sandeel surveys undertaken across the Moray Firth Zone in 2012 confirmed an overall patchy distribution of sandeels across the Moray Firth Zone (MORL, 2012). The highest numbers of sandeels were found in dredge samples from the north-eastern section of the Moray West Site and to a lesser extent in the western section of the Moray East Site. In general terms, sandeels were found in highest numbers in areas where sediments containing a high proportion of coarse sands and a low proportion of silt and fine sands were recorded in grab samples. Raitt's sandeel (*Ammodytes marinus*) was the species caught in greatest numbers, accounting for 89.8% of the total sandeel catch, with the majority (78.5%) being caught within the Moray West Site. The relatively low sandeel catches recorded in the survey suggest that there are not extensive areas supporting important sandeel populations in the Moray Firth Zone.

8.4.2.92 Similarly, results from sandeel surveys undertaken at the Beatrice Offshore Wind Farm (located to the north-east of the Moray West Site) in 2014 also indicated an overall patchy distribution and low abundance of sandeels across the Beatrice Offshore Wind Farm site (BOWL, 2014b).

8.4.2.93 Raitt's sandeel is listed as both a PMF and UKBAP species.

Lemon sole

8.4.2.94 The Development lies within lemon sole spawning grounds defined by Coull *et al.*(1998) (Volume 3a - Figure 8.4.3). This species is widely distributed throughout the North Sea and is thought to spawn wherever it is found (Rogers & Stocks, 2001). Spawning occurs from April until September (Coull *et al.*, 1998). In addition to spawning grounds, nursery grounds have also been identified by Coull *et al.* (1998) in the study area (Volume 3a - Figure 8.4.3).

8.4.2.95 Lemon sole is not afforded any protection or assigned any conservation status under International or national legislation.

Sprat

8.4.2.96 The Development falls within sprat spawning and nursery grounds defined by Coull *et al.* (1998) (Volume 3a - Figure 8.4.4). Spawning takes place from May to August (Coull *et al.*, 1998), with peak spawning observed from May to early July (Kraus & Köster, 2001). Spawning occurs in both coastal and offshore waters, up to 100 km from the shore, in deep basins (Whitehead, 1986; FAO, 2011; Nissling *et al.,* 2003).

8.4.2.97 Females spawn repeatedly in batches throughout the spawning season (Milligan, 1986). Eggs and larvae of sprat are pelagic and so subject to larval drift, moving into coastal nursery areas, depending on the wind-driven currents (Hinrichsen *et al.*, 2005; Nissling *et al.*, 2003). Feeding larvae are mainly found in the upper part of the water column (Nissling *et al.,* 2003).

8.4.2.98 Sprat is not afforded any protection or assigned any conservation status under international or national legislation.

<u>Overview of Spawning Times for Key Fish Species</u>

8.4.2.99 As described previously and illustrated in Volume 3a - Figures 8.4.2 to 8.4.8 a number of fish species spawn and / or have nursery ground in the study area (Coull *et al.*, 1998; Ellis *et al.*, 2010). An overview of the spawning timings and intensity of these spawning / nursery areas are presented in Table 8.4.2. Spawning times are given as provided in Coull *et al.* (1998) and spawning / nursery grounds intensity as described in Ellis *et al.,* (2010).

8.4.2.100 It is important to note that spawning and nursery grounds are dynamic features of fish life history and are rarely fixed in one location from year to year. In addition, fish may spawn earlier or later in the season in response to environmental change. Therefore, the information provided in the previous sections and summarise below represent the widest known distribution of spawning and nursery grounds.

Table 8.4.2: Species with Spawning and Nursery Areas within / in Close Proximity to the Moray West Fish and Shellfish Ecology Study Area and Spawning Times and Intensities (Coull *et al.*, 1998, Ellis *et al.*, 2010)

Species	January	February	March	April	May	June	July	August	September	October	November	December	Nursery (Intensity)
Cod		*	*										
Herring													
Lemon sole (*Microstomus kitt*)													
Nephrops				*	*	*							
Plaice	*	*											
Sandeel													
Sprat *(Sprattus sprattus)*					*	*							
Whiting													
Monkfish / Anglerfish	N/A												
Blue whiting (*Micromesistius poutassou*)	N/A												
Haddock	N/A												
Hake (*Merluccius merluccius*)	N/A												
Ling *(Molva molva)*	N/A												
Mackerel	N/A												
Saithe *(Pollachius virens)*	N/A												
Spotted ray *(Raja montagui)*	N/A												
Spurdog *(Squalus acanthias)*	N/A												
Thornback ray *(Raja clavata)*	N/A												

<u>Key:</u>
Dark blue – high intensity spawning/nursery ground.
Grey – low intensity spawning / nursery ground.
Light blue – unknown intensity.
* - Peak spawning.

Diadromous Migratory Species

8.4.2.101 A number of diadromous species could potentially use areas in the vicinity of both the Moray West Site and the Offshore Export Cable Corridor during certain times of their life cycle. Due to specific characteristics of their life cycles, all of these species are also afforded protection and assigned conservation status under international and national legislation. These key diadromous species, together with their conservation status are listed in Table 8.4.3 below.

Table 8.4.3: Conservation Status of Diadromous Migratory Species

Common Name	Scientific Name	OSPAR	IUCN[6] Red List	Bern Convention	Habitats Directive	The Wildlife & Countryside Act 1981	The Conservation (Natural Habitats, &c.) Regulations 1994 The Conservation of Offshore Marine Habitats and Species Regulations 2017	UK BAP[7] Species	Scottish Priority Marine Feature (PMF)
European eel	*Anguilla anguilla*	✔	Critically endangered					✔	✔
Allis shad	*Alosa alosa*	✔	Least concern	✔	✔	✔	✔	✔	
Twaite shad	*Alosa fallax*		Least concern	✔	✔	✔	✔	✔	
Sea lamprey	*Petromyzon marinus*	✔	Least concern	✔	✔			✔	✔
River lamprey	*Lampetra fluviatilis*		Least concern	✔	✔		✔	✔	✔
Smelt	*Osmerus eperlanus*		Least concern					✔	✔ *
Salmon	*Salmo salar*	✔	Lower Risk/ least concern	✔	✔		✔	✔	✔
Sea trout	*Salmo trutta*		Least concern					✔	✔

Notes: OSAR = Convention for the Protection of the Marine Environment of the North-East Atlantic – list of flora and fauna of vital importance; IUCN Red List = list of threatened species in terms of risk to extinction; and Bern Convention = binding international legal instrument to protect Europe's wild plants and animals.

[6] International Union for Conservation of Nature (IUCN)
[7] Biodiversity Action Plan (BAP)

8.4.2.102 Diadromous species listed under Annex II of the Habitats Directive (as transcribed by the Habitats Regulations) are afforded protection through the designation of SACs. For Atlantic salmon, sea lamprey and sea trout, it is the freshwater spawning grounds of these species that are afforded protection (e.g. rivers). All rivers that flow into the Moray Firth and surrounding waters have been identified as spawning grounds for Atlantic salmon, with a number of these rivers also recognised as spawning grounds for sea lamprey. Those rivers that are designated as SACs are listed in Table 8.4.4 and illustrated in Volume 3a - Figure 8.4.1. As indicated within the OfTI Scoping Report (Moray West, 2017), the movement of Atlantic salmon adults and post-smolts is not clearly understood although some initial, recent research is now available for the Moray Firth.

Table 8.4.4: SACs Designated for Migratory Fish Interests with Potential Connectivity with the Development

Site	Qualifying Species	Distance to Closest Point (Km)	
		Moray West Site	Offshore Export Cable Corridor
Berriedale and Langwell Waters SAC	Atlantic salmon	22.7	25.6
River Borgie SAC	Atlantic salmon	79.2	82.0
River Dee SAC	Atlantic salmon	96.1	60.2
River Naver SAC	Atlantic salmon	68.7	70.0
River Thurso SAC	Atlantic salmon	40.2	43.4
River Oykel SAC	Atlantic salmon	68.1	68.1
River Moriston SAC	Atlantic salmon	121.1	114.7
River Spey SAC	Atlantic salmon Sea lamprey	37.0	11.3

8.4.2.103 The distribution and ecology of the diadromous species is described in the following sections.

River and Sea Lamprey

8.4.2.104 River and sea lampreys are parasitic anadromous migratory species and have both been recorded in a number of rivers in the Moray Firth (Kelly & King, 2001; JNCC, 2011).

8.4.2.105 In the wider Moray Firth study area, sea lampreys occur mainly in the River Spey, a designated Special Area of Conservation (SAC) (Volume 3a - Figure 8.4.1), but have also been recorded in the River Conon and Loch Ness (JNCC, 2011; NBN Gateway, 2011). Sea lamprey is a primary reason for the selection of the Spey SAC (JNCC, 2011). River lamprey has only been recorded in the Rivers Conon and Spey (JNCC, 2011).

8.4.2.106 Both species spawn in fresh water in spring or early summer, followed by a larval phase (ammocoetes) spent in suitable silt beds in streams and rivers (Laughton & Burns, 2003). In the Spey, sea lampreys have been recorded returning to the river in early summer, and spawning in rivers in June/July (pers. comm. Bob Laughton, May 2011). All individuals die after spawning (Maitland, 2003). Ammocoetes can spend several years in these silt beds, feeding on organic detritus and eventually transforming into adults from late summer onwards (Laughton & Burns, 2003). The transformation into the adult stage is characterised by the development of functional eyes and the mouth changes into a fully formed sucker (Maitland, 2003).

8.4.2.107 After transformation, river and sea lampreys migrate to sea, where they use their suckers to attach to other fish (Maitland, 2003). In the Spey, this was noted as occurring in late summer (pers. comm. Bob Laughton, May 2011). After several years in the marine environment the adults return to fresh water to spawn (Laughton & Burns, 2003).

8.4.2.108 The distribution of sea lamprey is largely dictated by their host (Waldman *et al.*, 2008). At sea, lamprey feed on a variety of marine mammals and fish, including shad, herring, pollock, salmon, cod, haddock, swordfish and basking sharks (Kelly & King, 2001; Ter Hofstede *et al.*, 2008). Homing behaviour is not apparent in this species (Waldman *et al.*, 2008). Thus, unlike salmonids and shads, lampreys do not have specific river populations (Ter Hofstede *et al.*, 2008). The rarity of capture in coastal and estuarine waters suggests that marine lampreys are solitary hunters and widely dispersed at sea (MSS, 2011). It is quite possible that they often feed in deeper offshore waters as they have been caught at considerable depths (as deep as 4,100 m) (Moore *et al.*, 2003).

8.4.2.109 Unlike sea lamprey, river lampreys are generally found in coastal waters, estuaries and accessible rivers (Maitland, 2003). In estuaries, they feed on a variety of fish, particularly on small fish such as young herring, sprat and flounder (*Platichthys flesus*) (Maitland, 2003). After one to two years in estuaries, river lampreys stop feeding in the autumn and move upstream into medium to large rivers, usually migrating into fresh water between October and December (Maitland, 2003).

European Eel

8.4.2.110 The European eel stock has been assessed as being at a historical minimum and continuing to decline (ICES, 2009). In 2007, an EU Regulation (EU 1100/2007) was established with the objective to protect and sustainably use the stock (ICES, 2009). In the Moray Firth, they are thought to be present in most rivers and streams and are covered by the Scottish River Basin District Eel Management Plan (Defra, 2010).

8.4.2.111 European eel is a catadromous migratory species which is thought to spawn in the Sargasso Sea. The newly hatched larvae use oceanic currents to cross the Atlantic Ocean towards the European continental shelf and once there, metamorphose into glass eels (Malcolm *et al.*, 2010). All juvenile eels found in the shallower waters off Scotland are therefore likely to be glass eels, with larval eels occurring only to the west of the continental shelf (Tesch, 2003). Glass eels generally migrate into fresh water in their first year after arrival, although some may remain in coastal waters until they mature, while others may move back and forth between coastal, estuarine and freshwaters throughout their lives (Daverat *et al.*, 2006). After living and growing in these various environments for up to 60 years, adult eels (yellow eels) turn silver and start their migration back to the Sargasso Sea to spawn and, presumably, die (Malcolm *et al.*, 2010).

8.4.2.112 Glass eels entering coastal waters use selective tidal stream transport to migrate to the coast and into river systems. They are transported by the flood stream in higher water levels and dwell near the bottom during the ebb stream (Creutzberg, 1958). To progress further upstream, though, active migration into the river is required, swimming against the river flow (Bult & Dekker, 2007). The transition from selective tidal stream transport to active swimming has been related to a change in external factors (salinity or temperature: Creutzberg, 1961), but also been described as an internally determined delay, allowing morphological and physiological adaptation (Deelder, 1958; McCleave & Wippelhauser, 1987).

8.4.2.113 Negative phototaxis is pronounced in eels of all stages and they are rarely found within a few meters of the surface during daylight, or even bright moonlight, if deeper water is available (Malcolm *et al.*, 2010).

8.4.2.114 The migratory behaviour of eels in Scottish coastal waters is poorly understood and migration seasons for both adults and juveniles are probably quite protracted. Tesch (2003) notes that eels typically arrive off Shetland and the Western Isles in September, Orkney and Caithness in November, and areas off the rest of eastern mainland Scotland in December. The first eels may, however, arrive as early as August and continuous glass eel arrival is likely to occur for several months after the midwinter peak and perhaps even through the whole year, although in lower numbers.

8.4.2.115 It has been suggested that glass eels destined for Scottish rivers remain in coastal regions until April or May before river temperatures rise sufficiently for them to enter fresh water. The bulk of the return of silver eel migration is thought to extend from September to January (Malcolm *et al.*, 2010).

Allis and Twaite Shad

8.4.2.116 Allis shad and twaite shad are anadromous migratory species occurring mainly in shallow coastal waters and estuaries, with a preference for water 10 to 20 m deep (MSS, 2011). They are relatively scarce in the UK. Allis shad has occasionally been recorded in the River Spey and estuarine and coastal areas of the Moray Firth (JNCC, 2011; NBN Atlas, 2018a). No catches of twaite shad have been recorded in any rivers of the Moray Firth (JNCC, 2011; NBN Gateway, 2018), although this species has been recorded in coastal areas.

8.4.2.117 Migration into fresh water occurs during late spring (April to June) along the coast to watercourses of rivers to spawn from mid-May to mid-July (Maitland & Hatton-Ellis, 2003; Acolas *et al.*, 2004; Patberg *et al.*, 2005). In contrast to twaite shad, the vast majority of allis shad only spawn once and then die (ter Hofstede *et al.*, 2008). There are no known spawning sites for allis shad in Britain, though both sub-adults and sexually mature adults are regularly found around the British coast, including the Solway Firth (Maitland & Lyle, 1995). Spawning populations of twaite shad are still found in a few rivers notably the Severn, Wye and Usk (Aprahamian & Aprahamian, 1990).

European Smelt

8.4.2.118 Smelt are diadromous migratory species. Adults congregate in estuaries during the winter, entering rivers in early spring to spawn during March and April over a period of only a few days. After spawning the adults return to sea whilst the juveniles remain in the estuary for the remainder of the summer. Most adults die after spawning although some fish do return to sea, recover and spawn again in later years.

8.4.2.119 Smelt populations have declined in Great Britain and are no longer present in many rivers. In Scotland, there are only three populations left (in the rivers Cree, Tay and Forth) from the fifteen or more previously recorded (Maitland & Lyle, 1995; Dumfries and Galloway Council, 2011). In 2018, JNCC reports that most of the recorded populations in Scotland are now extinct, as are a third of those from estuaries in England and Wales (http://jncc.defra.gov.uk/page-5667).

Salmon

Lifecycle

8.4.2.120 Atlantic salmon (and sea trout – discussed in following section) are anadromous migratory species which utilise both freshwater and marine habitats during their life cycles. Both are species of the family *Salmonidae* and are referred to as salmonids. Atlantic salmon are widely distributed within the EU, with Scottish rivers being a European stronghold of the species (JNCC 2010).

8.4.2.121 Atlantic salmon spawn in rivers in late autumn / early winter. Eggs are deposited in redds (nests excavated by the females in gravelly substrates) and the eggs hatch the following early spring. Newly hatched salmon, known as 'alevins', remain hidden in the river bed gravels feeding from the attached yolk sac. Once the yolk sac has been depleted the alevins are known as 'fry' and start feeding on small invertebrates. Salmon fry grow quickly during the first year increasing in size to become 'parr'. Parr remain in the river for one to four or five years, but within Scottish river systems, they most commonly stay for two or three years.

8.4.2.122 In spring time, parr will eventually undergo a transformation both externally and internally, which allows them to adapt to salt water. They are then known as 'smolts'. Smolts move down rivers in April to June to start their oceanic migration. Once they enter the sea they are known as post-smolts until spring of the following year (Malcolm *et al.,* 2010).

8.4.2.123 After one or more years feeding at sea, salmon return to their home rivers to spawn. The amount of time spent at sea prior to the spawning migration varies from one winter for 'grilse' to up to four for 'multi-sea-winter' salmon (MSW). Once they have spawned salmon are known as "kelts". The majority of kelts (90-95%) die following their first spawning. Some individuals survive and recover condition, returning to spawn again. Repeat spawners are predominantly females and return to sea to feed between spawning (Mills *et al.,* 2003; Fleming, 1996). The proportion of repeat spawners, whilst generally considered to be low in Scotland, is thought to vary between rivers and change over time.

Migration to Sea

8.4.2.124 A summary of the information currently describing salmon migrations is given below. This is primarily based on the publication 'Review of migratory routes and behaviour of Atlantic salmon, sea trout and European eel in Scotland's coastal environment: implications for the development of marine renewables'(Malcolm *et al.*, 2010) and a number of other relevant research publications.

8.4.2.125 The beginning of the downstream migration of smolts from river to sea is thought to be related to environmental factors such as temperature and water flow (McCormick *et al.*, 1998). The importance of these factors may however be variable and stimulate migration in different ways (Carlsen *et al.*, 2004). Downstream migration within the river is mainly nocturnal and often triggered by increases in flow (Hendry & Cragg-Hine, 2003; Moore *et al.*, 1998). In addition, social factors, such as the presence of other migrants in the river, may also play a role (Hansen & Jonsson 1985; Hvidsten *et al.*, 1995).

8.4.2.126 It is believed that salmon smolts use environmental cues in the rivers related to favourable ocean conditions allowing them to arrive at sea at an appropriate time (Hvidsten *et al.*, 2009). Smolts from upper tributaries generally start migration earlier than those from lower tributaries, resulting in a synchronised sea entry of smolts from the same watershed (Stewart *et al.*, 2006). Timing in the spring migration may therefore play an important role in salmon post-smolt survival at sea (Aas *et al.*, 2011).

8.4.2.127 The main smolt runs within the wider Moray Firth study area have been identified to principally occur from April to June. Malcolm *et al.* (2015) reported a peak period of smolt migration between mid-April to late-May following analysis of pre-existing smolt data leaving Scottish Rivers. A summary of the timing of the smolt runs by district specifically within the Moray Firth, as defined by District Salmon Fisheries Boards (DSFBs) is given in Table 8.4.5 below.

Table 8.4.5: Timing of Smolt Runs as defined by District Salmon Fishery Boards	
District Salmon Fishery Board	**Timing of Smolt Run**
Spey	April to May (sometimes into early June)
Cromarty Firth (Conon and Alness Districts)	May
Ness and Beauly	April to June
Helmsdale	May
Caithness (Berriedale, Dunbeath and Wick Districts)	Mid-April to Mid-May with some earlier running smolts and a good number through June also
Lossie	May, peaking towards the end of the month and finishing in early June
Kyle of Sutherland	Spring (smolt traps operate March to June)

8.4.2.128 The migration of salmon smolts into the marine environment is thought to be a critical stage in the life cycle. During this period they are vulnerable to marine predators, as well as to changes in environmental conditions, which may affect the availability of food (Potter and Dare, 1993).

8.4.2.129 Studies of the movement of Atlantic salmon post-smolts indicate active, directed swimming during migration, rather than passive drifting, with fish generally moving close to the surface (Lacroix *et al.*, 2005; Lacroix *et al.*, 2004). It seems that no period of acclimation is required when the fish move from fresh to saltwater (Moore *et al.*, 1998; Lacroix and McCurdy, 1996), with post-smolts making limited use of the estuarine habitat and moving rapidly to the open ocean (Marschall *et al.*, 1998; Moore *et al.*, 1998; Malcolm *et al.*, 2010). Limited existing data suggest that post-smolts usually swim close to the surface (1-3 m depth) and make irregular dives down to 6.5 m depth (Davidsen *et al.,* 2008).

8.4.2.130 Research undertaken in Norwegian fjords (Thorstad *et al.,* 2004) suggests post-smolts do not use the immediate near-shore areas during migration, the mean reported distance to shore being 370 m. Similarly, tagging experiments carried out by Finstad *et al.* (2005) in the same area, found salmon used the full width of the fjord and travelled rapidly. Further studies undertaken in Canada in the Bay of Fundy (Lacroix and Knox, 2005), showed that fish travelled near the coast at a distance 2.5 - 5 km from shore.

8.4.2.131 It should be noted that the current knowledge on salmon post-smolt migration and behaviour is principally based on the results of experiments and research carried out in Canada and Norway which have been summarised above. A lack of data specific to salmon post-smolts originating from Scottish rivers makes predictions of their behaviour in coastal waters difficult and speculative. Scottish coastal waters, especially in the case of the east coast rivers where there are no substantial bays or sea lochs (fjords), differ substantially from the locations where studies have been carried out in Canada and Norway.

8.4.2.132 Malcolm *et al.*, 2010 noted a gap in the understanding of post-smolt migration routes from natal rivers to distant feeding grounds. It is generally acknowledged that migrating salmon smolts will move in a northerly direction past Orkney and Shetland to feed in the seas around Greenland (Malcolm *et al.,* 2010), however the specific migration pathways remain poorly understood. A number of recent studies have been undertaken to fill this knowledge gap.

8.4.2.133 The Scottish Centre for Ecology and the Natural Environment's (SCENE) recent study, in the River Deveron, which enters the Moray Firth at Banff Bay, found that the trajectory of smolts leaving the river was north-easterly, which is the direction needed for fish to exit to the North Sea. On this swimming trajectory, smolts remained closer to the centre of the bay than to the coast, indicating that they may not follow geographical features, but have a mechanism for navigation that does not include contouring coastal land features (Lothian *et al.,* 2017).

8.4.2.134 As part of their Marine Licence consent conditions, BOWL commissioned an acoustic tracking study of migrating salmon smolts in the River Conon and through the Cromarty Firth during 2016 (BOWL, 2017). The objective of the study was to identify the migration direction and swimming depths of downstream migrating salmon smolts in both estuarine and marine environments. This was a collaborative study between the University of Glasgow and MSS. The findings reported an eastward movement of individuals from the Cromarty Firth and swimming direction did not appear to be aligned with tidal currents. Smolts were predominantly detected within the top metre of the water column, and were detected shallower in the water column at night than during the day.

8.4.2.135 MSS has also undertaken a one year smolt tagging / netting study in the Cromarty Firth during the spring of 2017 (Pers. Comm. Moray West & Ross Gardiner, August 2017). This was a collaborative project with SSE, Glasgow University and Aberdeen University to look at the behaviour and survival of smolts as they migrate to sea through the Cromarty Firth. Salmon smolts were tagged with acoustic tags and a network of listening bouys were deployed in the Cromarty Firth and Inner Moray Firth. The study was informative, showing how smolts move from the River Conon into the Moray Firth. Genetic studies have also been undertaken using surface trawls within the Moray Firth to catch salmon and sea trout. Results of this work appears to show that there are separate genetic signatures for rivers around the Scottish west, north and east coastlines. Salmon smolts would appear to be widespread in the Moray Firth although detailed information on this study has not yet been made available.

8.4.2.136 There has also been a tracking project completed during 2017 in the River Dee. There is no report available at the current time, however results have indicated that smolts travel east and south east upon exit from the river (pers. comm. R Gardiner (MSS) / Moray West, January 2018).

8.4.2.137 Glasgow University has also recently completed some further acoustic tracking of salmon smolts in the Inner Firth on River Conon smolts, however the results of this study are also not currently available.

8.4.2.138 In addition, the migratory behaviour of post-smolts may vary depending on river of origin. A study undertaken by Plantalech Manel-la *et al*. (2011) found differences in early marine migratory behaviour between salmon from two different stocks and it was suggested that the distance that a salmon travels to reach the open coastline may influence its early marine migratory behaviour and performance.

8.4.2.139 The information given above, despite its limitations, provides an indication of the likely behaviour of salmon post-smolts during migration. As identified in Malcolm *et al.* (2010) and the more recent studies within the Cromarty Firth, the common findings across the research carried out to date can be summarised as follows:

- Post-smolts were observed to migrate rapidly and actively towards open marine areas after leaving their home river;
- Post-smolts do not appear to follow nearby shores closely, or follow tidal currents, although this may occur in areas where coastal currents are substantial; and
- Limited information on swimming depths suggests post-smolts generally use shallow depths (generally 1-3 m, but up to 6 m).

Smolt Behaviour at Sea

8.4.2.140 Data and information are also lacking to accurately define the routes followed, the areas used and the behaviour of salmon post-smolts in distant waters. The available information on the distribution and abundance of salmon at sea is principally based on records of tagging experiments from the West Greenland and Faroese fisheries (Shelton *et al*., 1997; Malcolm *et al.*, 2010).

8.4.2.141 Post-smolts are thought to move in schools whilst heading off to feeding areas (Shelton *et al*., 1997, Mills *et al*., 2003). The best-known feeding locations are in the Norwegian Sea and the waters off southwest Greenland, however, there are believed to be many other sub-arctic feeding areas. MSW salmon undertake longer migrations than grilse, which tend not to travel beyond the Faroe Islands and the southern Norwegian Sea (Mills *et al*., 2003).

8.4.2.142 The results of tagging experiments of salmon post-smolts suggest they travel rapidly over long distances. Research in the Faroe-Shetland Channel (Shelton *et al.*, 1997) found minimum progression rates of 7-30 km/day; similarly, data from the North Sea, the Norwegian Sea and the Barents Sea, indicate minimum progression rates of between 6 and 24 km/day (Holm *et al.*, 2003).

8.4.2.143 Historic recapture data from smolts tagged in Scottish rivers (Dee, Tay and North Esk), and data from the Girnock Burn (a tributary of the Dee) recorded between 1968 and 1982, suggest that at least some of the Scottish MSW salmon use the north-western Atlantic Area, around West Greenland (Malcolm et al., 2010).

8.4.2.144 Data recorded from the East Greenland and Irminger Sea fisheries suggest these areas are of less importance to Atlantic salmon in general, and Scottish salmon in particular. This should however be taken in the context of the limited data that are available for these areas (Malcolm *et al*., 2010).

8.4.2.145 Information derived from smolt and adult salmon tagging studies (Jakupsstovu, 1988; Hansen and Jacobsen, 2003) also suggest Scottish salmon make use of sea areas around the Faroes. Hansen and Jacobsen (2003) found Scottish salmon tend to be more prevalent around the Faroes in the autumn rather than in the winter, including fish from the Spey, Brora, Tay, North Esk and Dee. In addition, whilst the Scottish salmon found in West Greenland, East Greenland and Irminger are thought to mainly be MSW fish, studies carried out around the Faroes suggest that both 1SW (grilse) and MSW salmon occur in the area, depending on the zone fished and the time of the year (Malcolm *et al.,* 2010).

Migration to Rivers

8.4.2.146 The timing and duration of the pre-spawning migration of Atlantic salmon varies from river to river. It depends on the distance from the sea to the spawning areas and the degree of interaction between hydrologic regimes, the geomorphology of the river network and stream temperatures (Tetzlaff *et al.,* 2008).

8.4.2.147 The return migration in adult salmon is, as described for post-smolts, an active process with fish generally being found swimming near the surface (1-5 m depth) and occasionally diving to greater depths (Aas *et al.*, 2011). There appears not to be a period of acclimation during the transition from salt to fresh water (Hogåsen, 1998) and provided that river conditions are favourable, river entry seems to take place quickly (Thorstad *et al.*, 1998).

8.4.2.148 Studies carried out in Iceland on the migratory pattern of homing Atlantic salmon in coastal waters (Sturlaugsson and Thorisson, 1997) found that salmon migrated close to the coast, with some individuals entering estuaries (most often for brief periods), and even into rivers (for up to more than one day) on their way to their natal streams. The depth records suggested that in general salmon migrated in the uppermost few metres of the water column. A diurnal rhythm in vertical movements was also noted, with salmon staying deeper at night and closest to the surface at noon.

8.4.2.149 The review paper by Malcolm *et al.* (2010), suggests a range of potential migratory routes for salmon in Scottish coastal waters, primarily using the results of adult fish tagging studies and the spatial distribution of tag returns from adult fish tagged as smolts as they left Scottish rivers. In this exercise the assumption that fish would return to their river of origin is needed. A summary of the findings of Malcolm *et al.* (2010) primarily focused on studies undertaken in the Moray Firth and its vicinity is given below.

8.4.2.150 A number of tagging experiments have been carried out in coastal areas in the Moray Firth. Calderwood tagged fish in the Black Isle in 1913 and 1914 (Calderwood, 1914), and found fish moving, north, east and south, with low numbers recorded in rivers as distant as the Forth. The majority were however recaptured within 50 miles of the tagging site. The following year Calderwood continued his work further north, tagging fish in netting stations on the coast of Sutherland between Brora and Helmsdale (Calderwood, 1915). This work recorded almost twice as many fish heading north as south, although a wide range of movements were observed. Relatively high recaptures were obtained in coastal areas in the vicinity of the Development, between Berriedale and Lybster.

8.4.2.151 Tagging experiments undertaken by Menzies on the west coast of Scotland in 1936 and 1937 (fish were tagged at Loch Inchard and Raffin) found fish were more likely to be recaptured north and east of the tagging locations, rather than to the south. Low numbers of fish were recaptured in the Moray Firth area (Malcolm *et al.*, 2010).

8.4.2.152 Based on the information above, it is difficult to draw any firm conclusions on the movements of adult salmon within the Moray Firth. On the Black Isle and Sutherland fish appear to move in both a northerly and southerly direction whilst on the north and extreme northwest coasts fish seems to move both to the east and west, with easterly movements being more common (Malcolm *et al.*, 2010).

8.4.2.153 The geographic distribution of arrival location and natal rivers suggests variable and random directions of movement in a given location making the interpretation of the results difficult in most coastal areas, including the Moray Firth. An exception to this is the east coast, in areas south of Aberdeenshire, where the dominant direction of movement appears to be northerly (Malcolm *et al.*, 2010).

8.4.2.154 Based on the results of tagging experiments undertaken to date it still remains uncertain whether salmon adults or post-smolts migrate through the area around Orkney and Shetland or if the Pentland Firth is the preferred or only route used (Malcolm *et al.*, 2010). In addition to the uncertainties in relation to migration routes for fish originating in rivers flowing into the Moray Firth, there is the potential for fish from other rivers to use the area during their coastal migration.

8.4.2.155 Limited information is also available in relation to the distance from shore at which salmon migrate. Research carried out by Smith *et al.* (1981) found that six fish tagged in coastal nets near Montrose rarely approached the shore and travelled at distances of up to 17 km offshore. Previous studies however found that fish remained inshore for much of the time (Malcolm *et al.*, 2010). Similarly, information on swimming depths is also limited. Malcolm *et al.* (2010) concluded based on research undertaken to date (Jakupsstovu 1986; Holm *et al.* 2005; Starlaugsson, 1995) that in general terms salmon spend most of the time close to the surface although dives to greater depths of up to 280 m have often been observed. Dives do not appear restricted to offshore areas, persisting late into the migration on the return to home waters. Early studies (Jakupsstovu 1986) suggest an association between diving and feeding. This is in line with research by Fraser (1987) which found grilse feeding in western Scottish coastal waters until early July. More recently, Godfrey *et al.'s* (2014) recent observations, corroborated the conclusion that homing salmon predominately use surface waters. Godfrey *et al.'s* (2015) study, based on telemetry data from salmon tagged off the north coast of Scotland, concluded that although homing salmon may typically follow coastal swimming routes, they are by no means restricted to this zone and may utilise areas further offshore.

8.4.2.156 Salmon of different sea-ages tend to return at different times of the year and often spawn in different parts of a river (Potter and Ó Maoiléidigh, 2006). In most countries, salmon runs tend only to take place at specific times, normally during late summer and autumn. In Scotland, however, salmon enter rivers throughout the year, resulting in the existence of a range of salmon runs. This is of importance to the salmon fisheries as it provides fishing opportunities over extended periods of time (MSS, 2010b).

8.4.2.157 The majority of grilse (1SW salmon) enter the Scottish rivers from early summer until shortly before spawning in autumn and early winter. Many of the MSW salmon also enter rivers over that same period of time, however, for the Scottish MSW salmon class as a whole, river entry occurs over a greater period of time, extending back to the autumn months of the year before spawning (Youngson *et al.*, 2002). Based on the time of the year when the fish enter the river, salmon can be broadly classified as winter, spring, summer and autumn salmon. The timing of MSW salmon and grilse runs is further detailed by district in Table 8.4.5.

8.4.2.158 It should be noted that the perceived importance of salmon to fishermen may vary, depending on the run. Large, spring-running MSW salmon are particularly highly prized by fishermen (Potter and Ó Maoiléidigh, 2006). In the past, spring salmon runs made a major contribution to the Scottish fisheries, especially to those of the east coast and its rivers. Concern on the state of this component of the stock has risen in recent years, as it has declined more significantly than other stock components (Potter and Ó Maoiléidigh, 2006; MSS, 2003; Youngson *et al.* 2002; Smith *et al.*, 1998).

8.4.2.159 The timing of river entry is thought to be highly dependent on flow conditions. Research undertaken in the late 1980s in the Fowey estuary, and more recently in the Avon, indicates that fish wait for suitable river conditions, particularly elevated flows, before they enter freshwater and that, provided there are suitable holding areas, fish may remain in the estuary for long periods (Potter and Dare, 2003; Potter, 1988). Studies carried out in the Dee (Smith & Johnstone, 1996) found that fish enter and ascend the river relatively quickly during elevated river flows and that river entry may be delayed during periods of drought.

Sea Trout

8.4.2.160 Sea trout is the migratory form of the common and widely distributed brown trout. Both forms are recognised as the same species and are present together with Atlantic salmon in many Scottish rivers. The distribution of sea trout in western Europe extends from north Portugal to the White Sea and Cheshkaya Gulf, including Iceland and the Baltic Sea (Elliott, 1994).

8.4.2.161 The life cycle of the sea trout is similar to that of Atlantic salmon. Spawning generally occurs between mid-October and January. Smolting takes place in spring once a threshold size is reached. Most sea trout populations in the UK become smolts after two or three years in the river (Atlantic Salmon Trust (AST), 2018). Sea trout smolts leave the river around the same time as salmon smolts, between April and early June (SNH, 2010). Female individuals are more likely to become smolts and migrate to sea (MSS, 2010a; SNH, 2010).

8.4.2.162 Most sea trout return to the rivers after twelve or more months at sea. These can be seen in the rivers between May and October (SNH, 2010) and are often found together in the same redds as brown trout as spawning time approaches in late autumn (MSS, 2010a).

8.4.2.163 Some immature fish return to the rivers after only a few months at sea, often in July and September (SNH, 2010). These are small fish regionally known as 'finnock', 'herling' or 'whitling' and are found feeding in most Scottish estuaries as they move in and out with the tide (MSS, 2010a). Many gather in larger rivers and lochs, not necessarily in their natal systems, and over-winter in fresh water before returning to the sea in spring.

8.4.2.164 Unlike salmon, a significant proportion of spent sea trout kelts survive and make their way back to sea to recover and grow (SNH, 2010). Once they start to return they are annual spawners. There is however evidence of alternate year spawning as opposed to annual spawning in some stocks with long distance migrations (Solomon, 2007).

8.4.2.165 Some individuals return to the sea soon after spawning (mid-October-December) whilst others remain in the rivers and estuaries, migrating out in the spring (AST, 2018).

8.4.2.166 A summary of the information currently available on sea trout migrations, primarily based on the review paper "Review of Migratory routes and behaviour of Atlantic salmon, sea trout and European eel in Scotland's coastal environment: implications for the development of marine renewables", published by MSS (Malcolm *et al.*, 2010), and a number of other relevant research publications, is given below. The migratory patterns and behaviour of sea trout in the Moray Firth and, where possible, in the vicinity of the Development has been the primary focus.

8.4.2.167 Seaward migration in sea trout, like in salmon, is thought to be an active process (Thorstad *et al.*, 2004, Thorstad *et al.*, 2007). Tagging studies carried out in the River Conwy, North Wales (Moore *et al.*, 1998) found sea trout smolts migrating seawards on ebb tides and swimming close to the surface. In addition, the movements in the lower portion of the estuary were found to be indicative of active directed swimming and it was suggested that there was no apparent period of acclimation when moving from fresh to saltwater.

8.4.2.168 As mentioned above, the majority of sea trout smolts are thought to exit the river between April and early June. Information gathered by Pratten and Shearer (1983) in the River North Esk, found the peak of the sea trout smolt migration to occur usually in May or June.

8.4.2.169 Sea trout differ from Atlantic salmon in that generally they do not venture to distant feeding grounds in the sea, instead, remaining in coastal areas. A range of migratory strategies have however been observed in sea trout stocks, including estuary residence, local coastal movements and extensive open sea migrations (Solomon, 2007).

8.4.2.170 Detailed tracking studies on the migration of sea trout post-smolts have been carried out in sea lochs in the west coast of Scotland (Pemberton, 1976; Middlemas *et al.*, 2009) and in Norwegian fjords (Finstand *et al.*, 2005; Thorstad *et al.*, 2007). The results of these studies suggest a relatively local movement with sea trout remaining within sea lochs and fjords during the first couple of months at sea (Malcolm *et al.*, 2010).

8.4.2.171 On the east coast of Scotland, information on sea trout post-smolts is scarce, being principally derived from tagging studies carried out in the North Esk. Studies by Pratten and Shearer (1983) found that the majority of reported recaptures were from the Montrose area, although numerous examples of tagged sea trout travelling appreciable distances (>100 km) along the coast were also found. Furthermore, a low number of fish were recaptured in excess of 500 km from the North Esk, on the Scandinavian coast and the River Barvas, North West Lewis. Further research by Shearer (1990) in the North Esk, concluded that most sea trout post-smolts were probably staying within a short distance of the Esk rivers, although recaptures as far north as the River Spey and as far south as the River Tweed also occurred (Malcolm *et al.*, 2010).

8.4.2.172 More recent worked carried out by MSS investigating genetic signatures of salmon and sea trout used surface trawls to catch individuals in the Moray Firth as detailed in Paragraph 8.4.2.135. The full results of the study are not yet available however, no sea trout post-smolts were recorded. Fourteen adult sea trout were caught in the surface trawls and all at locations some distance from the shore (Pers. Comm. Moray West & Ross Gardiner, August 2017).

8.4.2.173 As previously discussed for salmon, timing of river entry in sea trout may also be influenced by river condition (e.g. river flow). It was however noted during consultation that river entry in sea trout may be less restricted than in salmon, with sea trout in some rivers not having to wait for “right” river conditions before starting the upstream migration (Moray East Consultation, 2011).

8.4.2.174 Based on information gathered through consultation and the analysis of MSS salmon and sea trout catch statistics, it appears that the main sea trout runs in districts within the wider Moray Firth study area occur in the summer months from May to October, with peak runs varying between rivers.

8.4.2.175 The information available to date does not allow for common patterns, behaviour or routes, either in general or for particular rivers, to be determined. Whilst tagging studies carried out in the east coast suggest that sea trout generally remain in their local area, it appears that sea trout also exhibit a wide range of migratory patterns (Malcolm *et al.*, 2010).

8.4.2.176 Nall (1935) analysed the findings of tagging studies carried out between 1914 and 1935 along the east coast of Scotland. In the majority of cases, recaptures were made within the local estuarine, river or firth areas, with very few distant recaptures being observed (within 40 miles). As previously explained, studies undertaken by Pratten and Shearer (1983) and Shearer (1990) in the Montrose area, found similar patterns, with the majority of fish being found in adjacent rivers, although longer migrations were also observed.

8.4.2.177 Little is known about the behaviour of sea trout during migration around Scottish coastal and distant waters. Research carried out in Norway indicates a preference for swimming at depths below 3 m, however, within the same study, records of sea trout at depths up to 28 m were also observed (Rikardsen *et al.*, 2007).

Freshwater Pearl Mussel

8.4.2.178 Fresh Water Pearl Mussel (FWPM) are found as adult mussels in riverine environments only. They live partly or wholly buried in coarse sand and fine gravel of clean fast-flowing rivers. FWPM rely on migrating anadromous salmonids during the glochidial stage of their lifecycle when the larvae attach to the gills of passing fish as parasites. FWPM are known to be present in a number of river systems that flow into the Moray Firth (NBN Atlas Scotland, 2018b).

8.4.2.179 The Development will not have any direct impacts on FWPM although indirect effects are possible in the event that there are significant impacts on migrating salmonid populations. Therefore, any impacts on salmon migration are considered applicable to FWPM populations.

Sharks & Rays (Elasmobranchs)

8.4.2.180 Sharks and rays have slow growth rates and low reproductive output compared to other species groups (Camhi *et al.*, 1998). This results in slow rates of stock recruitment (Smith *et al.*, 1998) and low resilience to fishing mortality (Holden, 1974). Directed fisheries have caused stock collapse for many species (Musick, 2005), although in more recent years, mortality in mixed-species and by-catch fisheries seems to be a more important threat (Bonfil, 1994).

8.4.2.181 The principal species with conservation status and/or declining stocks, potentially transiting or inhabiting areas relevant to the Development are given in Table 8.4.6.

Table 8.4.6: Shark / Ray Species of Conservation Importance in the Moray Firth

Common Name	Scientific Name	MMO Landings Data	Recorded in Moray Firth (Ellis *et al.*, 2005)	OSPAR	IUCN Red List	The Wildlife & Countryside Act 1981	UK BAP Species	Scottish Priority Marine Feature (PMF)	The Nature Conservation (Scotland) Act 2004
Sharks									
Basking shark	*Cetorhinus maximus*	-	-	✔	Vulnerable	✔	✔	✔	✔
Blue shark	*Prionace glauca*	-	-	-	Near threatened	-	✔	-	-
Gulper shark	*Centrophorus granulosus*	✔	-	✔	Critically endangered	-	✔	-	-
Leafscale gulper shark	*Centrophorus squamosus*	✔	-	✔	Vulnerable	-	✔	-	-
Porbeagle	*Lamna nasus*	-	-	✔	Vulnerable	-	✔	-	-
Portuguese dogfish	*Centroscymnus coelolepis*	✔	-	✔	Near threatened	-	✔	-	-
Sailfin roughshark	*Oxynotus paradoxus*	✔	-	-	Data deficient	-		-	-
Spurdog	*Squalus acanthias*	✔	✔	✔	Vulnerable	-	✔	✔	-
Tope	*Galeorhinus galeus*	✔	-	-	Vulnerable	-	✔		-
Skates and Rays									
Common skate	*Dipturus batis*	✔	✔	✔	Critically endangered	-	✔	✔	-
Long-nosed skate	*Dipturus oxyrinchus*	✔	-	-	Near threatened	-	-	-	-
Sandy ray	*Leucoraja circularis*	-	-	-	Endangered	-	✔	-	-
Spotted ray	*Raja montagui*	-	✔	✔	Least concern	-		-	-
Thornback ray	*Raja clavata*	✔	✔	✔	Near threatened	-		-	-

Table 8.4.6: Shark / Ray Species of Conservation Importance in the Moray Firth									
Common Name	**Scientific Name**	**MMO Landings Data**	**Recorded in Moray Firth (Ellis *et al.*, 2005)**	**OSPAR**	**IUCN Red List**	**The Wildlife & Countryside Act 1981**	**UK BAP Species**	**Scottish Priority Marine Feature (PMF)**	**The Nature Conservation (Scotland) Act 2004**
White skate	*Rostroraja alba*	✔	-	✔	Endangered	-	✔	-	-

Note: No species designated under the Habitats Regulations.

Sharks

8.4.2.182 Spurdog are widely distributed around the British Isles and the Scottish coast (MSS, 2011; Ellis *et al.*, 2005; ICES, 2010c). They are commercially exploited, being principally caught as by-catch in mixed fisheries such as trawl fisheries, especially otter-trawl fisheries, and to a lesser extent gillnet and long line fisheries. The wider Moray Firth area is considered to be a nursery ground for this species (Ellis *et al.*, 2010a) (Volume 3a - Figure 8.4.7).

8.4.2.183 Although formerly abundant, the stock was considered to be depleted and in danger of collapse in 2010, but in recent years this has changed significantly in line with restrictive management measures, which have included more restrictive quota, a maximum landing length and bycatch regulations (ICES 2017). Exploitation has been reduced substantially in recent years as a result of decreasing quota allocations, with the Total Allowable Catch (TAC) reduced by approx. 99.7 % between 2000 and 2009 (Ellis *et al.*, 2010b). In addition, in 2010, the TAC for spurdog was set to zero. Landings are still permitted under a by-catch TAC (equal to 10% of the 2009 quotas), provided certain conditions are met including a maximum landing length and by-catch ratio limits (ICES, 2010c).

8.4.2.184 Other shark species potentially present in the Moray Firth area are Portuguese dogfish, porbeagle, tope and leafscale gulper shark. With the exception of porbeagle, all have been recorded in the landings data from the wider Moray Firth study area. It should be noted that the majority of these species are either rare or tend to be more prevalent in offshore waters and the west and north coast of Scotland, than in the Moray Firth.

8.4.2.185 Portuguese dogfish, for example, are principally found off the far west and north coasts of Scotland. Similarly, tope tend to be rarer in the east coast and leafscale gulper sharks are primarily found off the far west and north-west coast of Scotland. Porbeagles are widely distributed around Scotland, although currently considered to be rare. In 2010, zero EU-wide TAC was introduced for this species (MSS, 2011).

8.4.2.186 The blue shark, whilst not present in the landings data, is also known to make use of Scottish coastal waters as part of their migration. They are more commonly recorded off the west coast of Scotland during the summer months (MSS, 2011).

8.4.2.187 In addition to the species mentioned above, another species of conservation importance which could potentially transit areas relevant to the three proposed Development is the basking shark. Basking sharks migrate from the western English Channel in spring to west Scottish waters, where they spend the summer and early autumn before moving offshore between November and March. Sightings for this species peak in the summer at a number of hot spots on the west coast. Sightings have also been recorded in the Moray Firth, however, to a much lesser extent. Increases in sea water temperatures are thought to be related to sightings being observed further north than in previous decades, with occasional records now around Shetland and Orkney north to the Norwegian coast and in the northern North Sea (Bloomfield & Solandt, 2008; Solandt & Ricks, 2009).

Skates and Rays

8.4.2.188 Thornback ray is considered to be the most important species of ray for commercial fisheries (ICES, 2010c). The stock of this widely distributed species has steadily declined since the start of the 20th century resulting in a decreased distribution area, concentrated now in the southwest North Sea (from the Thames Estuary to the Wash) (ICES, 2010c). The species is mostly found in shelf areas in depths of 10 to 60 m and remain resident within an average of 30 to 50 nautical miles (Walker *et al.,* 1997; Pawson, 1995). They are considered to be one of the most abundant ray species through Scotland, being more common in the western and northern regions. The Moray Firth is considered a low intensity nursery area for this species (Ellis *et al.*, 2010a) (Volume 3a - Figure 8.4.7).

8.4.2.189 Common skate was historically one of the most abundant rays in the North-east Atlantic, being widely distributed around the British Isles. Current data indicates that they have disappeared from the English Channel and the southern and central North Sea, although they are regularly observed off northern and north-western Scotland, the Celtic Sea and along the edge of the continental shelf (Dulvy *et al.*, 2007; Ellis *et al.*, 2005).

8.4.2.190 Both the common skate and thornback ray have been recorded in the landings data in the wider Moray Firth study area together with the long-nosed skate and the white skate.

8.4.2.191 Other species of conservation importance potentially present in the Moray Firth are sandy ray and spotted ray. Sandy ray are typically found on sandy or muddy seabeds of the north-west of Scotland although can occur elsewhere around the coast (MSS, 2011). Spotted ray are widespread around the northern and western coasts of Scotland being rare in the North Sea (MSS, 2011).

8.4.3 Future Baseline

8.4.3.1 Recent research has suggested that there have been substantial changes in the fish communities in the northeast Atlantic over several decades as a result of a number of factors including climate change and fishing activities (DECC, 2016a). These communities consist of species that have complex interactions with one another and the natural environment.

8.4.3.2 Fish and shellfish populations are subject to natural variation in population size and distributions, largely as a result of year to year variation in recruitment success and these population trends will be influenced by broad-scale climatic and hydrological variations, as well as anthropogenic activities such as climate change and overfishing. Fish and shellfish play a pivotal role in the transfer of energy from some of the lowest to the highest trophic levels within the ecosystem and serve to recycle nutrients from higher levels through the consumption of detritus. Consequently, their populations will be determined by both top-down factors, such as ocean climate and plankton abundance, and bottom-up factors, such as predation. Fish and shellfish are important prey items for top marine predators including elasmobranchs, seabirds, cetaceans and humans, and small planktivorous species such as sandeel and herring act as important links between zooplankton and top predators (Frederiksen *et al.*, 2006).

8.4.3.3 Climate change may influence fish distribution and abundance, affecting growth rates, recruitment, behaviour, survival and response to changes of other trophic levels. Within the northern North Sea, increased sea surface temperatures may lead to an increase in the relative abundance of species associated with more southerly areas.

8.4.3.4 One potential effect of increased sea surface temperatures is that some fish species will extend their distribution into deeper, colder waters. In these cases, however, habitat requirements are likely to become important, with some species having specific habitat requirements which are not available in these deep water areas. This may include sandeel, which are less able to adapt to increasing temperatures as a result of its specific habitat requirements for coarse sandy sediment; declining recruitment in sandeel in parts of the UK has been correlated with increasing temperature. Climate change may also affect key life history stages of fish and shellfish species, including the timing of spawning migrations. However, climate change effects on marine fish populations are difficult to predict and the evidence is not easy to interpret and therefore it is difficult to make accurate estimations of the future baseline scenario for the entire lifetime of the Development.

8.4.3.5 In addition to climate change, overfishing subjects many fish species to considerable pressure, reducing biomass of commercially valuable species, and non-target species. Overfishing can reduce the resilience of fish and shellfish populations to other pressures, including climate change and other anthropogenic impacts. A study on cod in an area where trawl fishing has been banned since 1932 indicated that this population was significantly more resilient to environmental change (including climate change) than populations in neighbouring areas (Lindegren *et al.*, 2010). Conversely modelling by Beggs *et al.* (2013) indicated that cod may be more sensitive to climate variability during periods of low spawning stock biomass. There are indications that overfishing in UK waters is reducing to some degree, with declines in fishing mortality estimates in recent years and ICES advice suggesting that some of the stocks are recovering, with increased quotas for several species in 2016. OSPAR's Quality Status Report (OSPAR, 2010) concluded that many fish stocks are still outside safe biological limits, although there have been some improvements in some stocks. Should these improvements continue, this may not result in significant changes in the species assemblage in the study area, although may result in increased abundances of the characterising species present in the area.

8.5 Assessment Methodology

8.5.1 Impacts Identified as Requiring Assessment

8.5.1.1 Table 8.5.1 lists all potential impacts on benthic and intertidal ecology identified as requiring consideration as part of the assessment. This list of impacts is based on expert judgement and reflects responses provided by statutory consultees and other stakeholders in the offshore wind farm and OfTI Scoping Opinions. The assessment also takes into account impact assessment approaches described in the various guidance documents and publications listed in Section 8.2.3 of this chapter.

Table 8.5.1: Impacts on Fish and Shellfish Ecology Requiring Assessment

Potential Impact	Nature of Impact (direct or indirect)	Inter-relationships with other EIA Topics / Receptors
Construction Impacts		
Temporary habitat loss / habitat disturbance	Direct Indirect	Chapter 6: Physical Processes and Water Quality Chapter 7: Benthic and Intertidal Ecology Chapter 11: Commercial Fisheries

Table 8.5.1: Impacts on Fish and Shellfish Ecology Requiring Assessment		
Potential Impact	**Nature of Impact (direct or indirect)**	**Inter-relationships with other EIA Topics / Receptors**
Increased suspended sediment concentrations / sediment deposition	Direct and Indirect	Chapter 6: Physical Processes and Water Quality Chapter 7: Benthic and Intertidal Ecology
Noise and vibration	Direct Indirect	Chapter 7: Benthic and Intertidal Ecology Chapter 9: Marine Mammal Ecology
Accidental release of hydrocarbons and chemicals from infrastructure installation processes or from vessels	Indirect	Chapter 6: Physical Processes and Water Quality Chapter 7: Benthic and Intertidal Ecology
Operation and Maintenance (O&M) Impacts		
Long term habitat loss	Direct Indirect	Chapter 7: Benthic and Intertidal Ecology Chapter 11: Commercial Fisheries
Noise and vibration	Direct Indirect	Chapter 7: Benthic and Intertidal Ecology Chapter 9: Marine Mammal Ecology
Accidental release of hydrocarbons and chemicals from infrastructure installation processes or from vessels	Indirect	Chapter 7: Benthic and Intertidal Ecology
Creation of new substrate and habitat	Direct	Chapter 7: Benthic and Intertidal Ecology
Electromagnetic fields (EMF)	Direct	Chapter 7: Benthic and Intertidal Ecology
Seabed sediment heating from subsea cables	Direct	Chapter 7: Benthic and Intertidal Ecology
Decommissioning Impacts		
Temporary habitat loss / habitat disturbance	Direct Indirect	Chapter 7: Benthic and Intertidal Ecology Chapter 11: Commercial Fisheries
Increased suspended sediment concentrations/sediment deposition	Direct and Indirect	Chapter 6: Physical Processes and Water Quality Chapter 7: Benthic and Intertidal Ecology
Noise and vibration	Direct Indirect	Chapter 7: Benthic and Intertidal Ecology Chapter 9: Marine Mammal Ecology
Removal of structures and hard substrates	Direct and Indirect	Chapter 7: Benthic and Intertidal Ecology
Accidental release of hydrocarbons and chemicals from infrastructure installation processes or from vessels	Indirect	Chapter 7: Benthic and Intertidal Ecology

8.5.2 Scoped Out Impacts

8.5.2.1 In accordance with the Scoping Reports produced in 2016 and 2017 (Moray West, 2016 & Moray West 2017) and in line with the Scoping Opinions received from MS-LOT in August 2016 and August 2017, no potential impacts have been scoped out of the assessment, with the exception of changes to tides and current speeds due to presence of OSP foundations and subsea cabling with scour protection.

8.5.2.2 There are no marine invasive non-native species (MINNS) of fish, although there are shellfish species (crustaceans and molluscs). As MINNS are fully covered within Chapter 7 Benthic and Intertidal Ecology, an assessment of MINNS is not repeated within this chapter.

8.5.3 Assessment Approach and Criteria

8.5.3.1 The general approach to the assessment impact significance is detailed in Chapter 5 EIA Methodology. This is a two stage process involving the application of specific criteria to defining the sensitivity of the receptors and the magnitude of the potential impacts. Specific criteria developed to inform the assessment of impacts on fish and shellfish ecology associated with the construction, operation and maintenance and decommissioning of the Development is described below.

Sensitivity Criteria

8.5.3.2 The sensitivity of fish and shellfish receptors has been defined through an assessment of three factors: the combined vulnerability of the receptor to a given impact; the likely rate of recoverability to pre-impact conditions; and the value of the receptor (Chapter 5: EIA Methodology). Vulnerability is defined as the susceptibility of a species to disturbance, damage or death, from a specific external factor. Recoverability is the ability of the same species to return to a state close to that which existed before the activity or event which caused change. It is dependent on its ability to recover or recruit subject to the extent of disturbance/damage incurred. The value (or importance) is based on conservation status of the receptor (e.g. international, local). The overall sensitivity of a receptor to an impact then identified from a four point scale as presented in Table 8.5.2.

Table 8.5.2: Definition of Terms Relating to the Sensitivity of the Receptor

Sensitivity	Definition
High	Nationally and internationally important receptors e.g. species and habitats listed on the IUCN Red List and / or protected under OSPAR, Habitats Directive and Habitats Regulations 1994 and 2010, Wildlife and Countryside Act 1981; salmonids protected by the Salmon and Freshwater Fish (Consolidation) Scotland Act 2003; PMF or UK BAP species; and / or qualifying interest of Special Areas of Conservation (SACs), Marine Protected Areas (MPAs) or Sites of Special Scientific Interest (SSSI); with high vulnerability and low recoverability.
Moderate	Nationally and internationally important receptors as listed above with medium vulnerability and medium recoverability. Regionally important receptors e.g. species and habitats identified in policy, considered of sufficient value to merit a formal nature conservation designation (e.g. Local Nature Reserve), with medium to high vulnerability and low recoverability. Locally important receptors (see below) with high vulnerability and no ability for recovery.
Low	Nationally and internationally important receptors as listed above with low vulnerability and high recoverability. Regionally important receptors with low vulnerability and medium to high recoverability.

Table 8.5.2: Definition of Terms Relating to the Sensitivity of the Receptor	
Sensitivity	**Definition**
	Locally important receptors e.g. habitats or species lacking policy status, considered important at local or site level, with insufficient value to merit a formal nature conservation designation with medium to high vulnerability and low recoverability.
Negligible	Habitats or species lacking policy status, not considered important at any level. Receptor is not vulnerable to impacts regardless of value/importance. Locally important receptors with low vulnerability and medium to high recoverability. Commonplace feature of little or no species / historical significance. Loss of such a feature would not be seen as detrimental to the marine ecology of the area e.g. introduced or invasive species of fish or waters impacted upon by stocking activity.

Impact Magnitude

8.5.3.3 The criteria for defining magnitude in this chapter follows the approach outlined in Table 8.5.3, which follows Chapter 5 of this EIA Report (EIA Methodology).

Table 8.5.3: Definition of Impact Magnitude	
Magnitude of Impact	**Description**
High	Total loss or major alteration to key elements/features of the baseline conditions Impact occurs over a large scale or spatial extent (define extent) resulting in widespread, long term or permanent changes in site characteristics or affecting a large proportion of receptor population. Impact will occur repeatedly or continuously over a long period of time.
Moderate	Partial loss or alteration to one or more key elements/features of the baseline conditions. Impact occurs over a medium scale or spatial extent (define extent) with short to medium term change to site characteristics or affecting a moderate proportion of the receptor population. Impact will occur repeatedly or continuously over a moderate period of time or at moderate intensity for short periods of time.
Low	Minor shift away from the baseline conditions. Impact is localised and temporary or short term (define extent) with detectable change to site characteristics or noticeable change to small proportion of the receptor population. Low frequency impact occurring occasionally or intermittently and at low intensity
Negligible	Very slight change from baseline conditions. Impact is highly localised and short term resulting in very slight / imperceptible changes to site characteristics / receptors population. Full rapid recovery is expected.

Significance Criteria

8.5.3.4 The significance of the effect upon fish and shellfish ecology is determined by correlating impact magnitude and the sensitivity of the receptor. The particular method employed for this assessment is presented in Table 8.5.4. Where a range of significance of effect is presented in Table 8.5.4, the final assessment for each effect is based upon expert judgement.

8.5.3.5 For the purposes of this assessment, any effects with a significance level of minor or less has been concluded to be not significant in terms of the EIA Regulations.

Table 8.5.4: Effect Significance				
Sensitivity of Receptor	**Impact Magnitude**			
	Negligible	**Low**	**Moderate**	**High**
Negligible	Negligible	Negligible or Minor	Negligible or Minor	Minor
Low	Negligible or Minor	Negligible or Minor	Minor	Minor or moderate
Moderate	Negligible or Minor	Minor	Moderate	Moderate or Major
High	Minor	Minor or moderate	Moderate or Major	Major

8.5.4 Data Limitations

8.5.4.1 The fish and shellfish baseline characterisation described for the Development within the previous sections represents a 'snapshot' of the fish and shellfish assemblages of the study area. Over the short term, fish and shellfish assemblages vary seasonally and annually (through natural population fluctuations caused by spawning success, recruitment and mortality and also through behavioural changes such as migrations to spawning, nursery and feeding grounds). Over the long term, there are also environment changes in general due to factors such as temperature, fishing mortality and climate change). Any changes that may occur during the lifetime of the project (i.e. construction, operation and maintenance and decommissioning) should be considered in the context of the natural variability, anthropogenic effects and other environmental effects.

8.5.4.2 In order to account for these limitations, a wide range of literature has been reviewed for the wider northern North Sea, including commercial fisheries consultation work undertaken as part of the commercial fisheries baseline characterisation. Further information with regards to the commercial fisheries is provided in Chapter 11: Commercial Fisheries and Appendix 11.1: Commercial Fisheries Technical Report.

8.5.4.3 As recognised during Scoping, there is an existing data gap regarding behaviour of Atlantic salmon smolts and adult salmon during their migration to and from the sea. Some recent research undertaken by MSS and other collaborations in 2016 and 2017 within the River Conon, Cromarty Firth and Inner Moray Firth has provided some initial data to address this knowledge gap. The National Research and Monitoring Strategy for Diadromous Fish (NRMSD) has been set up by Marine Scotland in order to prioritise the collection of information to fill this gap in knowledge and this research is ongoing.

8.5.4.4 An additional key data gap relates to the effects of the particle motion element of underwater noise, which is considered to be more important for many fish species, and particularly invertebrates (i.e. including shellfish), than sound pressure which has been the main consideration in noise impact assessments to date. This is currently an area being considered in greater detail and although there are no threshold criteria established yet for particle motion, and there is limited understanding as a whole, this data gap has been addressed through detailed literature review and impact assessment as far as possible in the absence of published thresholds.

8.6 Design Envelope Parameters

8.6.1 Realistic Worst Case Design Scenario

8.6.1.1 As identified in Chapter 4 Development Description, Moray West is considering a range of potential construction methods and design options for the Development. The Design Envelope presented in Chapter 4 presents the range (minimum and maximum) of design parameters for each of the options under consideration e.g. substructure type or turbine model.

8.6.1.2 In order to determine potential impacts of the various options it is necessary to define the 'realistic worst case scenario'. The realistic worst case scenario represents, for any given receptor and potential impact on that receptor, various options in the Design Envelope that would result in the greatest potential for change to the receptor in question.

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

8.6.1.4 Table 8.6.1 presents the realistic worst case scenario for potential impacts on fish and shellfish ecology during construction, operational and maintenance and decommissioning phases of the Development and provides justification as to why the options and design parameters identified are considered to be the realistic worst case scenario.

Table 8.6.1: Design Envelope Parameters Relevant to the Fish and Shellfish Impact Assessment		
Potential Impact	**Realistic Worst Case Scenario**	**Justification**
Construction		
Temporary habitat loss / habitat disturbance	The maximum area of temporary habitat loss and disturbance across the Moray West Site has been quantified based on the following: • Area of seabed preparation (125 m diameter dredge-affected area) required for installation of gravity base structure foundations (based on 55 m diameter gravity base for Model 4 turbines) (see Chapter 4 Description of Development Table 4.4.6). The resulting area of disturbance per foundation is 12,272 m^2. Therefore, for 62 foundations the maximum area of disturbance would be 1,043,120 m^2 (1.043 km^2); • Seabed disturbance within the area of seabed preparation (125m diameter dredge-affected area) required for two small offshore substation platforms (OSPs) using gravity base foundation (55 m diameter). Total area of seabed disturbance amounts to 24,544 m^2; • Jack up vessel seabed footprint for 85 WTG and 2 OSP foundations, based on a max jack up barge footprint of 1,650 m^2 (275 m^2 per spud can and max 6 legs per jack-up), the maximum disturbance would be 143,550 m^2; • Installation of up to 275,000 m inter-array cables (with worst case trench affected width of 15 m) of 4,125,000 m^2 (4.125 km^2); • Installation of up to 15,000 m of OSP interconnector cabling (with worst case trench affected width of 15 m) of 225,000 m^2 (0.225 km^2); and • Seabed disturbance would occur over a 36 month period. The maximum area of temporary habitat loss and disturbance across the Offshore Export Cable Corridor has been quantified based on the following: • Installation of offshore export cable circuits within up to two trenches, each 65,000 m in length and 15 m width. Which would result in a maximum disturbed area of 1,950,000 m^2 (1.95 km^2) and would occur over a six-month period (within the overall 36 month construction period). The overall total footprint of disturbance of the Moray West Site and Offshore Export Cable Corridor combined under a worst-case approach is 7,511,214 m^2 (7.511 km^2).	The worst case scenario is associated with the largest spatial footprint and area of seabed disturbance. This is based on maximum dredged area required for installation of the large diameter GBSs required for the larger Model 4 WTGs (max 62) and installation of two small OSPs, resulting in the installation of up to 64 substructures, in additional to max length of inter-array, OSP interconnector and offshore export cable circuits. With regard to seabed disturbance associated with the jack-up barges this is based on installation of the maximum number of WTGs (85) and two small OSPs on the basis that the footprints associated with the jack-up barges are the same for all WTG models.

Table 8.6.1: Design Envelope Parameters Relevant to the Fish and Shellfish Impact Assessment		
Potential Impact	**Realistic Worst Case Scenario**	**Justification**
Increased suspended sediment concentrations (SSC) / sediment deposition	The worst-case scenario would involve the maximum amount of sediment disturbance which is identified as follows: • The total maximum excavation requirement within the Moray West Site would be 2,411,663 m^3 based on an excavated seabed preparation area of 85 m diameter and 5 m depth for GBSs for 85 Model 1 WTGs; • The total maximum excavation requirements are for one large OSP and would be 90,478 m^3 based on seabed preparation of 120 m diameter and 8 m depth (total excavated area for two small OSPs based on 95 m diameter and 5 m depth is 70,880 m^3); • The total maximum excavation requirement for gravity base foundations within the Moray West Site would be 2,502,141 m^3 (2,411,663 m^3 for 85 WTG foundations and 90,478 m^3 for one large OSP); • Maximum excavated area for the inter-array cables (total length 275,000 m) based on a maximum trench width of 3 m, maximum burial depth of 3 m and assuming a 'V-shaped' trench is 1,237,500 m^3 (275 km x 3 m x 3 m x 0.5); • Maximum excavated area for the OSP interconnector cables (total length up to 15,000 m) based on a maximum trench width of 3, maximum burial depth of 3 m and a 'V-shaped' trench is 67,500 m^3; and • Maximum excavated area for the offshore export cables (total length 130,000 m (130 km) based in two circuits at 65 km each) based on a maximum V-shaped trench width of 3 and maximum burial depth of 3 m is 585,000 m^3. Therefore, the total maximum excavated sediment required for seabed preparation for gravity base foundations (WTGs and OSPs), cable installation within the Moray West Site and cable installation along the offshore export cable route would be up to 4,392,141 m^3 (4.4 km^2). The maximum cable laying rate is likely to be 1,000 m/hr. The installation of cables would be spread across six months for the inter-array cables, three months for the OSP interconnector cables and six months for the offshore export cables.	For single WTGs, the worst case scenario in terms of excavated material for installation of GBS foundations is for the Model 4 WTGs with an excavated seabed volume of 35,441 m^3 based on excavated area of 95 m diameter x 5 m depth. Total excavated area for one Model 1 WTG is 28,373 m^3 based on 85 m diameter x 5 m depth. However, worst case scenario for total volume of excavated material across the site (for WTGs) = 2,411,663 based on 85 Model 1 WTGs. Total for 62 Model 4 WTGs = 2,197,348 m^3). Of the methods proposed for inter-array and offshore export cable installation, jetting results in the greatest volume of sediment dispersed as it is assumed that 100% of the sediment is liquidised, whereas for any other method less sediment would be suspended. Predicted increases in suspended sediment and sediment deposition assumes the greatest number and length of cables and the greatest burial depth.
Noise and vibration	The maximum anticipated hammer energy for monopile installation is 5,000 kJ. Maximum number of monopiles installed in one day is three. This is based on a two vessel piling campaign (concurrent piling).	The maximum adverse scenario for foundation installation is monopile foundation as these may require a

Table 8.6.1: Design Envelope Parameters Relevant to the Fish and Shellfish Impact Assessment		
Potential Impact	**Realistic Worst Case Scenario**	**Justification**
	Maximum duration of piling (based on pin-piles with 3,000 kJ hammer energy) is nine months. The spatial WCS is 85 x monopiles at 5,000kJ hammer energy over five months. The temporal WCS is 85 x 4 pin-piled jacket structures (340 pin-piles) at 3,000 kJ hammer energy over nine months.	hammer energy up to 5,000 kJ, and while the pin-pile jacket foundation would involve more piles and consequently a longer piling time, the maximum hammer energy is lower and therefore the noise and vibration impacts arising from the installation of the monopiles will have more impact and be of greater significance.
Accidental release of hydrocarbons and chemicals from infrastructure installation processes or from vessels	Synthetic compound, heavy metal and hydrocarbon contamination may be released accidentally as a result of offshore infrastructure installation and the presence of various construction vessels during the construction period (up to 25 at any one time, comprising of installation, support, transport and cable lay vessels, tugs, cranes and barges). Water-based drilling muds associated with drilling to install foundations and HDD may also be required. Grout may be required to secure joints between offshore structures. There may also be potential contamination of intertidal habitats resulting from machinery use and vehicle movement.	These parameters are considered to represent the maximum adverse scenario with regards to release of contaminants during construction.
Operation and Maintenance		
Long term habitat loss / habitat disturbance	This is the largest seabed footprint that will be required for the Development and includes scour protection. Under the worst case scenario the size of the maximum footprint is based on the following: • 45 m diameter gravity base foundations and scour protection calculated as 5,675 m^2 per foundation. For 85 foundations the maximum area of disturbance would be 482,333 m^2; • Scour protection for two small OSPs will have a footprint of 14,176 m^2 based on a maximum requirement for scour protection to extend out over a 95 m diameter area (including the 55 m diameter gravity base foundation) (7,088 m^2 per foundation); • A worst-case measure of 10% of the total inter-array cable length is predicted to require cable protection. This would result in 27,500 m of the inter-array cables requiring protection. Assuming 3m wide concrete mattress protection is used this would result in a footprint of up to 82,500 m^2;	The maximum adverse scenario is associated with gravity base foundations for 85 WTGs (each gravity base will have a 45 m diameter and associated 85 m scour protection) and the construction of two OSPs with 55 m diameter gravity base foundations and 95 m scour protection (including foundation). This assumes that scour protection is required for all foundations. The maximum adverse scenario for long-term habitat loss also includes the use of

Table 8.6.1: Design Envelope Parameters Relevant to the Fish and Shellfish Impact Assessment		
Potential Impact	**Realistic Worst Case Scenario**	**Justification**
	• Protection associated with 15 cable crossings for inter-array cables requiring rock protection extending 200 m in length and 6 m in width will result in a footprint of up to 18,000 m^2; and • A worst-case measure of 10% of the total OSP interconnector cabling is predicted to require cable protection. This would result in 1,500 m of the inter-array cable requiring protection, resulting in a footprint of up to 22,500 m^2. Total footprint across the Moray West Site during operation is therefore 545,516 m^2. • A worst- case measure of 20% of the total offshore export cable length is predicted to require cable protection. This would result in 26,000 m of the offshore export cable affording protection, resulting in a footprint of up to 78,000 m^2; and • Protection associated with six cable crossings for offshore export cables resulting in a footprint of up to 7,200 m^2. The total footprint across the Moray West Site which could be subject to permanent habitat loss during operation of the offshore export cables is therefore 85,200m^2. The overall total footprint which could be subject to permanent habitat loss would therefore be 630,716 m^2 (0.3% of the overall Development area). There may be the need to perform maintenance operations on electrical cables during the lifetime of the Development.	cable protection along 10% of the inter-array cables and along 20% of the offshore export cable. The maximum adverse scenario for habitat loss associated with cable crossings comprises 15 crossings of inter-array cables and six crossings of offshore export cables. The maximum maintenance operations presented are considered to represent the maximum adverse scenario with regards to vessel movement during construction.
Noise and vibration	A number of vessel visits to each WTG and OSP would be required each year to allow for scheduled and unscheduled maintenance. If O&M activity is coordinated entirely from an onshore base, this would mean small crew vessels sailing to and from the Moray West Site on a daily basis from shore. If the support vessel option is preferred, the majority of small crew vessels would be operated on a daily basis from a single support vessel, although further support vessels are also still likely to transit to and from shore each day. OSPs would require one visit a week maximum.	Expected numbers of vessels during the operational period.
Accidental release of hydrocarbons and chemicals from infrastructure installation processes or from	Synthetic compound, heavy metal and hydrocarbon contamination resulting from up to 85 turbines and two OSPs. Accidental pollution may also result from O&M vessels (including crew supply vessels and jack-up vessels). A typical turbine is anticipated to require grease, synthetic or hydraulic oil, and other operating	These parameters are considered to represent the maximum adverse scenario with regards to chemicals and vessel presence during the operational period.

Table 8.6.1: Design Envelope Parameters Relevant to the Fish and Shellfish Impact Assessment		
Potential Impact	**Realistic Worst Case Scenario**	**Justification**
vessels	compounds or materials such as liquid nitrogen, silicone oil and gas. The OSP is expected to require chemicals and other operating compounds such as diesel, water, coolants, oil, batteries and fire suppressant material. A number of vessels (currently undetermined) will be required during O&M activities (Section 4.8.2 of the EIA Report).	
Creation of new substrate and habitat	The introduction of new hard structures with a maximum surface area of 605,781 m^2 provided by the following Development infrastructure: • Gravity base foundations for 85 WTGs and scour protection (482,333 m^2); • Gravity base foundations for two OSPs and scour protection (14,176 m^2); • Inter-array cable protection 10% (82,500 m^2); • OSP interconnector cable protection 10% (4,500 m^2); • Offshore export cable protection 20% (19,500 m^2); and • Crossings (2,772 m^2).	Maximum scenario for introduced hard substrate is the greatest number of GBS and scour / cable protection.
EMF	To inform the assessment of impacts associated with EMF the following worst case scenario parameters are considered: • The maximum length of inter-array (up to 72.5 kV of alternating current) cables would be up to 275,000 m; • The maximum length of OSP interconnector cables (up to 400 kV) would be 15,000 m; and • The maximum length of offshore export cable circuits (up to 400 kV) would be 130,000 m (based on two circuits of 65,000 m).	The maximum adverse scenario is associated with the use of 85 turbines as this results in the greatest length of inter-array cable and two offshore export cable circuits as this results in the longest total length of offshore export cable.
Seabed sediment heating from subsea cables	Refer to EMF impact above.	Refer to EMF impact above.
Decommissioning		
Temporary habitat loss / habitat disturbance	The maximum area of disturbance during decommissioning is based on: • Removal of 85 turbines with 45m diameter gravity base foundations and scour protection calculated at 5,675 m^2 per foundation with a combined footprint of 482,333 m^2; • Removal of two OSPs and scour protection (14,176 m^2); • The footprint of the jack-up barge removing 87 foundations (85 WTGs and 2 OSPs), max	Maximum adverse scenario assumes the removal of all WTG (85) and one large OSP foundation, inter-array, OSP interconnector and offshore export cables.

Table 8.6.1: Design Envelope Parameters Relevant to the Fish and Shellfish Impact Assessment		
Potential Impact	**Realistic Worst Case Scenario**	**Justification**
	jack up barge footprint of 1,650 m^2 (275 m^2 per spudcan and max 6 legs per jack-up). The maximum disturbance would be 143,550 m^2; • Removal of 275,000 m of inter-array cables, would result in 4,125,000 m^2 disturbance; • Removal of 15,000 m of OSP interconnector cabling, would result in 225,000 m^2 disturbance; and • Removal of 130,000 m of offshore export cables, would result in 1,950,000 m^2 disturbance. Total decommissioning footprint of disturbance within the Moray West Site and Offshore Export Cable Corridor during decommissioning would be approximately 6,940,059 m^2 (6.940 km^2).	The removal of cables is considered to be the worst-case, however, the necessity to remove cables will be reviewed at the time, after consideration of the environmental impact of the removal operation and the safety of the cables left *in situ*.
Increased suspended sediment concentrations (SSC) / sediment deposition	As per details in construction impact (above) for increased suspended sediment concentration and sediment deposition (although predicted to be much less in reality due to lower impact of decommissioning activities involved e.g. no dredging of seabed, trenching or jetting).	Maximum adverse scenario as per the construction phase and assumes the removal of all WTG and OSP foundations and associated inter-array, OSP interconnector and offshore export cables.
Noise and vibration	Noise created by the removal of foundations using cutting machinery.	Based on application of cutting equipment to remove foundations.
Removal of structures and hard substrates	The introduction of new hard structures with a maximum surface area of 605,781 m^2 provided by the following Development infrastructure: • Gravity base foundations for 85 WTGs and scour protection (482,333 m^2); • Gravity base foundations for two OSPs and scour protection (14,176 m^2); • Inter-array cable protection 10% (82,500 m^2); • OSP interconnector cable protection 10% (4,500 m^2); • Offshore export cable protection 20% (19,500 m^2); and • Crossings (2,772 m^2).	Based upon removal of all structures at / above seabed level. Maximum scenario for is the greatest number of GBS and scour / cable protection
Accidental release of chemicals from infrastructure installation processes or from vessels	Synthetic compound, heavy metal and hydrocarbon contamination resulting from a maximum of 85 turbines and two offshore substations. Various decommissioning vessels (number currently undetermined) will also be active over the decommissioning period. Potential contamination in the intertidal area resulting from machinery use and vehicle movement.	Maximum adverse scenario as per construction phase.

8.6.2 Embedded Measures

8.6.2.1 As part of the project design process, a number of embedded mitigation measures have been included to reduce the potential for impacts on fish and shellfish ecology. These measures are recognised as standard industry practice for this type of development and have therefore been considered in the assessment presented in Section 8.7 below. Assessment of sensitivity, magnitude and therefore effect significance includes implementation of these measures.

8.6.2.2 The embedded mitigation relating to fish and shellfish ecology is summarised below:

- Through completion of site-specific surveys and review of previous Moray East and Beatrice Offshore Wind Farm survey data, careful site selection of the Moray West Site and Offshore Export Cable Corridor has been undertaken to avoid key commercial fisheries and protected fish species and habitats (e.g. PMFs, spawning areas and sites designated for fish and shellfish interests such as rivers designated as SACs for diadromous fish) as far as possible;
- An appropriate Environmental Management Plan (EMP) will be produced and followed to cover the construction, operation and maintenance phase of the Development. A Decommissioning Programme will also be developed to cover the decommissioning phase;
- Best-practice techniques including appropriate vessel maintenance will be used at all times to minimise the potential for contamination as outlined in the Marine Pollution Contingency Plan (MPCP) and International Convention for the Prevention of Pollution from Ships (MARPOL);
- The measures outlined in these documents will be adopted to ensure that the potential for release of contaminants from construction, operation and maintenance, and decommissioning equipment and activities is minimised. In this manner, accidental release of potential contaminants from drilling rigs and other construction / O&M vessels will be strictly controlled, thus providing protection for marine life across all phases of the development;
- The cable design incorporates burial of the cables to a minimum target depth of 1 m as far as possible in order to reduce the potential effects of EMF, reducing the need for cable protection and the amount of introduced hard substrate (albeit that artificial substrate can be beneficial in term of benthic habitat creation). A Cable Burial Risk Assessment (CBRA) will inform cable burial depth which will depend on ground conditions, with this CBRA to be undertaken post consent. Burial of cables will increase the distance between cables and fish and shellfish receptors, thereby potentially reducing the effect on those receptors. Where burial is not possible, cables will be protected by rock dumping or an alternative suitable approach (e.g. mattress protection);
- Cable specifications will be used that reduce EMF emissions as per industry standards and best practice such as the relevant IEC (International Electrotechnical Commission) specifications;
- To minimise the extent of any unnecessary habitat disturbance, material displaced as a result of cable burial activities will be back filled, where possible, in order to promote recovery;
- A Piling Strategy will be submitted to MS-LOT for approval prior to the commencement of piling outlining any mitigation and management measures that will be implemented during pile installation; and
- During piling, soft starts will be used, with lower hammer energies used at the beginning of the piling sequence before increasing energies to the higher levels. This measure will reduce the risk of injury to fish species in the immediate vicinity of piling operations.

8.7 Assessment of Potential Effects

8.7.1 Potential Construction Effects

Temporary Habitat Loss / Habitat Disturbance

Magnitude of Impact

8.7.1.1 Temporary habitat loss / habitat disturbance will occur during construction activities and is likely to include sediment compaction and disturbance during foundation installation (e.g. jack up operations and anchor placements), sediment and substrate removal during seabed preparation prior to gravity base installation and cable burial operations (potentially including boulder clearance for cable/foundation installation).

8.7.1.2 All fish and shellfish receptors have the potential to be affected by this impact, through loss of spawning, nursery or feeding habitats, however demersal fish and shellfish species have the greatest potential to be affected. Pelagic fish such as herring that use specific habitat as spawning beds may be impacted upon through loss or disturbance to pockets of suitable spawning habitats. Similarly, habitats used by shellfish, such as soft burrowing muds for *Nephrops* may be lost through the creation of foundations.

8.7.1.3 The total maximum area of temporary habitat loss due to construction activities described in Table 8.6.1 is predicted to be approximately 7,488,397 m^2 (7.4 km^2). This equates to 3.3 % of the total seabed area within the Moray West Site. Activities resulting in temporary habitat loss will occur intermittently throughout the construction period (potentially through phased development) and will be highly localised to the vicinity of the construction activities (i.e. limited to the immediate footprints). The construction works will not result in a significant loss of habitat as the seabed will recover over a short timeframe and become re-established in and around the foundations and cables to reflect its previous condition and biotopes. The only long term alteration will result from the footprints of the foundations and scour protection.

8.7.1.4 The impact is predicted to be of local spatial extent (i.e. within the Development), short term duration, intermittent and reversible. The magnitude of the impact is therefore, considered to be **low**.

Sensitivity of Receptor

8.7.1.5 In general, the more mobile fish species (such as cod and flatfish) are able to avoid temporary disturbance (EMU, 2004). The most vulnerable species are likely to be shellfish (such as crabs, lobsters, scallops and other molluscs) which are much less mobile than fish and often inhabit the seafloor (e.g. within burrows or crevices or within beds). Fish species which spawn on or near the seabed sediment (e.g. elasmobranchs, sandeel and herring) are also most vulnerable, although elasmobranchs occur within the study area at very low abundances.

8.7.1.6 Species of greater conservation value or commercial value will also be more sensitive. Demersal fish, seabed spawning pelagic fish and shellfish PMF species include European spiny lobster, herring, cod and whiting. All of these mobile species, with the exception of European spiny lobster will be able to avoid habitat loss and disturbance. European spiny lobster has not been recorded as present within any of the site-specific surveys so is unlikely to be impacted upon.

8.7.1.7 All of the habitats recorded within the Moray West Site and the Offshore Export Cable Corridor are common place features and are wide spread within the study area and the wider Moray Firth. No Annex I, Annex II or PMF habitats have been recorded within the Development or immediately surrounding area.

8.7.1.8 The Development is likely to coincide with nursery and spawning grounds for *Nephrops,* though the proportion of this habitat affected through construction works is small in the context of the availability of similar habitat in the Moray Firth. It is also important to note that given the specific substrate requirements of this species, it is unlikely that spawning occur throughout the spawning area defined by Coull *et al.* (1998), but that it is focused within specific spawning grounds. No other key shellfish nursery and spawning grounds are recorded as present, but as noted above, the proportion of shellfish habitat affected through construction works will be small in the context of the wider Moray Firth and the presence of this commonplace habitat throughout the area.

8.7.1.9 Indirect effects on fish and shellfish species include loss of feeding habitat and prey items. However, since this impact is predicted to affect only a small proportion of benthic habitats in the study area, with similar habitats (and prey species) occurring throughout the area (see Chapter 7.1: Benthic and Intertidal Ecology), these effects are likely to be limited.

8.7.1.10 The recoverability and rate of recovery of an area after large-scale sea bed disturbance (e.g. dredging or trawling activities) is linked to the substrate type (Newell *et al.*, 1998; Desprez, 2000). Mud or sand habitats, similar to those found in the study area, have been shown to return to baseline species abundance after approximately one to two years (Newell *et al.*, 1998; Desprez, 2000; Chapter 7.1: Benthic and Intertidal Ecology). Harder gravely and rocky substrate takes proportionally longer to re-establish: up to ten years for boulder coastlines (Newell *et al.*, 1998).

8.7.1.11 Larger crustacea (e.g. *Nephrops*, brown crab, European lobster) are classed as equilibrium species (Newell *et al.*, 1998), only capable of recolonising an area once the original substrate type has returned. The sensitivity of these receptors is therefore higher than for smaller benthic organisms which move in and colonise new substrate immediately after the effect. Therefore, although recovery of benthic assemblages may occur over relatively fast timescales (e.g. within one to two years; see Chapter 7.1: Benthic and Intertidal Ecology), recovery of the equilibrium species may take up to ten years in some areas of coarse sediments (Phua *et al.*, 2002). Larval settlement will also increase the rate of recovery in an area (Phua *et al.*, 2002), with shellfish spawning and nursery habitats in the vicinity of the Development potentially increasing the rate of recovery into disturbed areas.

8.7.1.12 Sandeel are known to have high intensity spawning habitats within the Moray Firth, although surveys undertaken by Moray East (MORL, 2012) suggested that there are not extensive areas supporting important sandeel populations within the Moray Firth Zone (which includes the Moray West Site). Temporary habitat loss is predicted to affect only a small proportion of potential sandeel habitat within the Development area (i.e. 1.5 % of the Development area). It should also be noted that although temporary habitat loss could occur over a period of up to 36 months throughout the construction period (2022 to 2024), only a small proportion of the total habitat would be affected at any one time.

8.7.1.13 Physical disturbance to sandeel habitats may also lead to indirect effects on adult and juvenile sandeel (e.g. increased mortality), where individuals are not able to colonise viable sandy habitats in the immediate vicinity, or where habitats may be at carrying capacity. Sandeel may also be particularly vulnerable during their winter hibernation period when these animals are less mobile. Recovery of sandeel populations would be expected following construction operations. Effects of offshore wind farm construction (Jensen *et al.*, 2004) and operation (i.e. post-construction: van Deurs *et al.*, 2012) on sandeel populations have been examined through short term and long term monitoring studies at the Horns Rev offshore wind farm. These monitoring studies have shown that offshore wind farm construction and operation has not led to significant negative effects on sandeel populations.

8.7.1.14 Further information on recovery potential of sandeel can also be inferred from a study by Jensen *et al.* (2010), which examined mixing of adult sandeel populations at different fishing grounds within the entire North Sea. This study showed evidence of mixing of sandeel populations between different fishing grounds located up to 5 km apart and mixing within fishing grounds to distances of up to 28 km. This suggests that some recovery of adult populations would be predicted following construction operations, with adults recolonising suitable sandy substrates from adjacent unimpacted habitats. Recovery may also occur through larval recolonisation of suitable sandy sediments (which was not investigated in the Jensen *et al.*, 2010 study) with sandeel larvae likely to be distributed throughout the study area.

8.7.1.15 The main spawning grounds for herring in the vicinity of the Development are to the east of Orkney extending northwards towards Shetland, and in the vicinity of the Fraserburgh and Peterhead coastline. These herring spawning grounds are outside the Development area, although limited spawning may occur within the Moray Firth and in the vicinity of the Development. The proportion of potential herring spawning habitat (coarse gravelly sediments) affected during construction of the Development is expected to be limited as indicated in Volume 3a - Figure 8.4.9.

8.7.1.16 With the exception of the shellfish and demersal species / spawning adults identified below, all fish and shellfish receptors in the study area are deemed to be of low vulnerability, high recoverability and of local to international importance within the study area. The sensitivity of these receptors is therefore considered to be **low**.

8.7.1.17 Brown crab, European lobster, scallops and *Nephrops* are deemed to be of high vulnerability, medium to high recoverability and of regional importance within the study area. The sensitivity of these receptors is therefore considered to be **moderate**.

8.7.1.18 Sandeel and herring are deemed to be of high vulnerability, medium recoverability and of regional importance within the study area. The sensitivity of these receptors is therefore considered to be **moderate**.

Significance of Effect

8.7.1.19 Given that the magnitude of the impact is **low**, for fish and shellfish of low sensitivity, the overall effect is considered to be **negligible to low** and **not significant** in terms of EIA. For fish and shellfish receptors with **moderate** sensitivity, the overall effect is considered to be **minor** and **not significant** in terms of EIA.

<u>Increased Suspended Sediment Concentrations (SSC) and Sediment Re-Deposition</u>

Magnitude of Impact

8.7.1.20 In terms of increased SSC levels, the main source of increased SSC levels is from dredging required as part of the seabed preparation work for installation of the GBS foundations. SSC levels generated from all other construction activities will be within the range of natural variability and will have negligible impacts on any benthic habitats and species including scallop. Table 8.6.1 presents the maximum worst case design scenario for increases in SSC and sediment deposition that are associated with dredging for foundation installation of 62 WTG (Model 4), one large OSP and cable laying. Chapter 6 (Physical Processes and Water Quality) should be referred to for a more detailed identification of specific worst case scenarios (Table 6.6.1). It is assumed that dredging will take place through the use of a hopper suction dredger (Section 6.7.2 of Chapter 6: Physical Processes).

8.7.1.21 Across much of the Moray West Site, the seabed sediment comprises coarse sand and gravel, with varying low quantities of fines present (Figure 6.7.1 (Volume 3a - Chapter 6: Physical Processes and Water Quality)). Dredging of coarse sediment (sands and gravels) would not create persistent plumes as the coarse material would quickly settle to the seabed. However, the disturbance of the finer grained sediments (silts, clays and muds) has the potential to give rise to more persistent plumes that settle out of suspension over a wider area than for coarse grained sediments. Dredging causes two situations of increased SSC; spoil disposal from the release of material from the dredger; and overspill during dredging. Overspill deposits of coarser material would deposit on the seabed in close proximity to the dredged area, while overspill deposits of finer material would characteristically be deposited within 100 m to 500 m of the dredged area. The worst releases would occur during dredging itself, via spoil disposal. Again, most coarse material would settle relatively quickly and within relative close proximity to the dredged area. Sufficiently fine sediment may persist in suspension for hours to days or longer, but will become diluted to very low concentrations (indistinguishable from natural background levels and variability) within timescales of around one day. The distribution pattern of depositions would vary depending on the tidal state and would occur either upstream, downstream, or both from the dredged area.

8.7.1.22 As the potential for increased SSC and deposition from seabed preparation for foundations is determined to be short-term (lasting a day at the longest) and localised (with a worst case of one tidal excursion extent), the magnitude of impact is considered to be **low**.

8.7.1.23 The maximum design scenario for increases in SSC associated with inter-array, OSP interconnector and offshore export cable installation are predicted to occur as a result of open cut trench installation, by jetting (Chapter 6.1: Physical Processes). Disturbance of medium to coarse sand and gravels during cable installation are likely to result in a temporally and spatially limited plume affecting SSC levels (and settling out of suspension) in close proximity to the point of release. Only a small proportion of the material disturbed is expected to be fines, with a corresponding reduction in the expected levels of SSC.

8.7.1.24 The impact of increased SSC ad deposition from cable laying operations is predicted to be of local spatial extent, short term duration, intermittent and reversible. The magnitude is therefore, considered to be **low**.

Sensitivity of Receptor

8.7.1.25 The potential impacts upon fish and shellfish are related to the to increased SSC levels causing smothering of species present on the seabed, or affecting the water quality through sediment plumes and the species present within these areas.

8.7.1.26 For pelagic and demersal adult fish, their mobility will allow avoidance behaviour within areas affected by increased SSC (ABP Research, 2007; EMU, 2004), making them less susceptible to physiological effects from this type of impact. Juvenile fish will generally have lower mobility and therefore are more likely to be affected by increased SSC than adult fish as they are less able to avoid impacts. Juveniles fish are likely to occur throughout the Development area, with nursery grounds being present for herring, haddock, whiting, saithe, plaice (landfall coastal area only), lemon sole and sprat. Sandeel also use the inner Moray Firth and coastal area included within the Offshore Export Cable Corridor / landfall. Due to the temporary increases in SSC associated with winter storm events and the occurrence of juveniles in offshore and inshore areas (where SSCs are typically higher), it can be expected that most fish juveniles will be largely unaffected by the low level temporary increases in SSC, as these species are likely to be within the range of natural variability.

8.7.1.27 Migratory fish species such as Atlantic salmon, sea trout and European eel are also likely to occur in the Development (both the Moray West Site and the Offshore Export Cable Corridor) but are also expected to be able to tolerance naturally high SSC, given their migration routes pass through estuarine habitats which have background SSC considerably higher than those expected in the Moray Firth.

8.7.1.28 The sensitivity of adult fish is therefore considered to be **low**.

8.7.1.29 For fish spawning grounds, the sensitivity is slightly higher, particularly for PMF species such as herring. There is potential for increased SSC and sediment deposits to smother eggs and larvae and cause increased mortality levels or reduced growth rates. Spawning grounds within the Development comprise cod, plaice, lemon sole and sprat. Herring spawn to the north of the Moray West Site, while whiting spawn further to the east. Sandeel (*Ammodytes marinus* and *Ammodytes tobianus*) are mapped as spawning within the inner Moray Firth, including the area within the Offshore Export Cable Corridor.

8.7.1.30 Sandeel eggs are likely to be tolerant to sediment deposition due to the nature of re-suspension and deposition within their natural high energy environment. Sandeel populations are also sensitive to sediment type within their habitat, preferring coarse to medium sands and showing reduced selection or avoidance of gravel and fine sediments (Holland *et al.*, 2005). Therefore, any increase in the fine sediment fraction of their habitat may cause avoidance behaviour until such time that the current removes fine sediments in suspension or on the seabed. Again, it is unlikely that these effects will have any impact on sandeel receptors within study area as sediment deposition levels here are expected to be low.

8.7.1.31 With respect to the effects of sediment deposition on herring spawning activity, it has been shown that herring eggs are tolerant of very high levels of SSC (Mesieh *et al.*, 1981; Kiorbe *et al.*, 1981). Detrimental effects may be seen if smothering occurs and the deposited sediment is not removed by the currents (Birklund and Wijsmam, 2005), however this would be expected to occur quickly with such a small amount of sediment deposition being forecast.

8.7.1.32 The spawning grounds for all of these species listed above are deemed to be of medium vulnerability, high recoverability and of regional importance in the study area, and therefore the sensitivity of these receptors is considered to be **moderate**.

8.7.1.33 Many shellfish species, such as brown crab, have a high tolerance to SSC and are reported to be insensitive to increases in turbidity; however, they are likely to avoid areas of increased suspended sediment concentration as they rely on visual acuity during predation (Neal and Wilson, 2008). Berried crustaceans (e.g. brown crab, European lobster and *Nephrops*) are likely to be more vulnerable to increased SSC as the eggs carried by these species require regular aeration. Both *Nephrops* nursery and spawning grounds are present within the Development. *Nephrops* are not considered to be sensitive to increases in SSC or subsequent sediment deposition, since this is a burrowing species with the ability to excavate any sediment deposited within their burrows (Sabatini and Hill, 2008).

8.7.1.34 With the exception of scallops, these shellfish species are deemed to be of medium vulnerability, high recoverability and regional importance in the study area. The sensitivity of these receptors is considered to be **low**.

8.7.1.35 For adult scallops, sensitivity is slightly higher due to their feeding sensitivity to increased SSC / sediment deposits and their inability to apply avoidance behaviour quickly due to their limited mobility. The MarLIN sensitivity assessment reports that the growth of king scallop is adversely affected by increases in SSC levels (Bricelj & Shumway, 1991) and that excessive particle bombardment may threaten the viability of the feeding apparatus (Gibson, 1956), thereby potentially decreasing ingestion rates. However, although king scallop have limited mobility, they are still expected to be able to move away from areas with highest SSC levels and therefore is considered to be tolerant to increases in suspended sediment levels (Marshall & Wilson, 2008). Scallops are deemed to be of **moderate** sensitivity.

Significance of Effect

8.7.1.36 Increases in SSC and associated sediment deposition will represent a temporary and short term, intermittent impact, affecting a relatively small proportion of the fish and shellfish habitats in the study area. Most fish and shellfish receptors are predicted to have some tolerance to this impact and it is expected that much of this deposited material will be naturally dispersed by the local wave and tidal current regime within the site (Chapter 6: Physical Processes and Water Quality). For the majority of adult fish and shellfish, avoidance behaviour and tolerance to increased SSC and sediment deposition means that with a **low** magnitude of impact and **low** sensitivity, the overall effect is **negligible or minor** and **not significant** in EIA terms.

8.7.1.37 For spawning grounds of the fish species listed above and for *Nephrops*, the overall effects will be **minor** and not significant in EIA terms.

8.7.1.38 For scallops, the potential for smothering and reduced growth rates / increased mortality rates leads to a sensitivity of **moderate.** With a **low** impact magnitude, this results in a **minor** and **not significant** effect in terms of EIA.

<u>Noise and Vibration</u>

Background and Approach to Noise Modelling

8.7.1.39 Underwater noise (both sound pressure and particle motion) generated during the installation of WTG and OSP foundations (pile driving) can potentially cause changes to fish species in terms of physical injury (temporary or permanent), mortality or behavioural effects (such as avoidance or displacement).

8.7.1.40 In general, biological damage as a result of sound pressure is either related to a large pressure change (barotrauma) or to the total quantity of sound energy received by a receptor. Barotrauma injury can result from exposure to a high intensity sound even if the sound is of short duration, such as an explosion. However, when considering injury due to the energy of an exposure, the time of the exposure becomes important. For example, a continuous source operating at a given sound pressure level has a higher total energy and is therefore more damaging (Southall *et al.*, 2007) than an intermittent source reaching the same sound pressure level (SPL)).

8.7.1.41 Behavioural effects vary depending on how different fish and shellfish species perceive sound pressure and particle motion in the environment. Behavioural effects in response to construction related underwater noise include a wide variety of responses including startle responses (also known as C-turn responses), strong avoidance behaviour, changes in swimming or schooling behaviour or changes of position in the water column. Depending on the strength of the response and the duration of the impact, there is potential for some of these responses to lead to significant effects at an individual level (e.g. reduced fitness, increased susceptibility to predation) or at a population level (e.g. avoidance or delayed migration to key spawning grounds), although these may also result in short term, intermittent changes in behaviour that have no wider effect, particularly once acclimatisation to the noise source is taken into account.

8.7.1.42 Predictive subsea noise modelling has been carried out as part of this EIA to determine potential effects of noise from the Development on fish and shellfish within the study area. This modelling focuses specifically on noise from pile driving and considers the following two worst case scenarios as set out in Table 8.6.1:

- Spatial maximum design scenario – installation of 85 monopiles (with 15 m diameter) using a maximum hammer energy of 5,000 kJ over a maximum of five months (one vessel); and
- Temporal maximum design scenario - installation of up to 340 pin-piles for 85 four legged jacket foundations with maximum hammer energy of 3,000 kJ, installed over a maximum of nine months.

8.7.1.43 It should be noted that these maximum hammer energies are considered highly conservative. Although the absolute maximum hammer energy identified within the design envelope is 5,000 kJ for the monopiles, hammer energies will be significantly lower than this for the majority of the time and the driving energy will be raised to 5,000 kJ only when absolutely necessary. To minimise fatigue loading on the piles, hammer energies are continuous, set at the minimum required, which also reduces likelihood of breakdown of the equipment. Hammer energies will therefore typically start at low levels (soft start of a maximum of 500 kJ) and gradually increase to the maximum required installation energy during the piling of the final metres, which is typically significantly less than the maximum consented hammer energy.

8.7.1.44 The temporal maximum design scenario represents the longest duration of effects from subsea noise and assumes a scenario whereby piled jacket foundations are used for all offshore structures. The temporal scenario includes maximum hammer energy of 3,000 kJ for pin-pile installation, which is also considered conservative with many of the assumptions discussed in paragraph 8.7.1.42 also expected to be relevant to this maximum hammer energy.

8.7.1.45 In order to quantify the spatial extent of any potential noise impacts on fish populations, predictive subsea modelling was undertaken, with modelling undertaken using the two maximum design hammer energies (i.e. 5,000 kJ for monopoles and 3,000 kJ for pin-piles) at three representative locations around the boundary of the Moray West Site (Technical Appendix 9.2). For the purposes of the current assessment, the underwater noise modelling has modelled the criteria given for Group 4 Fish, i.e. those where the swim bladder is involved in hearing, as the most precautionary threshold. All modelling scenarios were based upon a stationary animal model (as precaution) and repeated for the following parameters:

- Each modelling location;
- Both types of foundations (GBS and monopile); and
- Both single piling vessel and two piling vessels.

8.7.1.46 Noise modelling was undertaken for both SPL_{peak} and SEL_{cum}. For SPL_{peak}, the relevant thresholds for fish are 213dB and 207dB: the corresponding distances are 50 m and 85 m (for 3,000 kJ, pin-pile case) and 67 m and 124 m (for 5,000 kJ, monopile case). Note that these short-range predictions below 250 m are subject to increased uncertainty due to the short distance that they cover. Results are presented in Noise Modelling Report in Technical Appendix 9.2

Threshold Assessment Criteria

8.7.1.47 Recent papers on the effects of underwater noise on fish and shellfish species have highlighted the lack of clear evidence to support setting thresholds for impacts on fish and shellfish receptors (Hawkins and Popper, 2016; Popper *et al.*, 2014). These have highlighted some of the shortcomings of impact assessments, including the use of broad criteria for injury and behavioural effects based on limited studies. As acknowledged in Section 8.5.4, the effects of particle motion are not well understood but are considered to be more important for many fish species, and particularly invertebrates (i.e. including shellfish), than sound pressure which has been the main consideration in noise impact assessments to date.

Hearing capabilities of fish

8.7.1.48 Recent peer reviewed guidelines have been published by the Acoustical Society of America (ASA) and provide directions and recommendations for setting criteria (including injury and behavioural criteria) for fish. For the purposes of this assessment, the Sound Exposure Guidelines for Fishes and Sea Turtles (Popper *et al.*, 2014) were considered to be most relevant. The Popper *et al.* (2014) guidelines broadly group fish into the following categories based on their anatomy and the available information on hearing of other fish species with comparable anatomies:

- Group 1: Fishes lacking swim bladders that are sensitive only to sound particle motion and show sensitivity to a narrow band of frequencies (includes flatfishes and elasmobranchs);
- Group 2: Fishes with a swim bladder where the organ does not appear to play a role in hearing. These fish are sensitive only to particle motion and show sensitivity to a narrow band of frequencies (includes salmonids and some tuna);
- Group 3: Fishes with swim bladders that are close, but not intimately connected to the ear. These fishes are sensitive to both particle motion and sound pressure and show a more extended frequency range than groups 1 and 2, extending to about 500 Hz (includes gadoids and eels); and
- Group 4: Fishes that have special structures mechanically linking the swim bladder to the ear. These fishes are sensitive primarily to sound pressure, although they also detect particle motion. These species have a wider frequency range, extending to several kHz and generally show higher sensitivity to sound pressure than fishes in Groups 1, 2 and 3 (includes clupeids such as herring, sprat and shads).

8.7.1.49 There have been a few studies on the ability of aquatic invertebrates (including shellfish) to respond to noise (e.g. Wale *et al.*, 2013; Roberts *et al.*, 2016), although these are insufficient to make firm conclusions about sensitivity. It is highly likely, however, that aquatic invertebrates do detect particle motion, including seabed vibration and existing evidence indicates these species are primarily sensitive to particle motion at frequencies well below 1 kHz (Hawkins and Popper, 2016).

Injury criteria

8.7.1.50 There is a lack of accepted injury criteria for fish species and recent reviews on the effects of anthropogenic sound on fishes (e.g. Popper and Hastings, 2009; Popper *et al.*, 2014; Hawkins *et al.*, 2014b) concluded that there are substantial gaps in the knowledge that need to be filled before meaningful noise exposure criteria can be developed. The recent ASA guidelines (Popper *et al.*, 2014) have provided recommendations for setting injury criteria for fish from a range of noise sources, with Table 8.7.1 summarising the fish injury criteria recommended for pile driving.

Table 8.7.1: Criteria for Onset of Injury in Fish due to Piling Operations (Popper *et al.*, 2014). All criteria are presented as sound pressure even for fish without swim bladders since no data for particle motion exist

Type of Fish	Mortality and Potential Fatal Injury		Recoverable Injury		TTS [b] (SELcum Weighted dB re 1 µPa2.s)
	SPLpeak Unweighted (dB re 1 µPa)	SELcum Weighted (dB re 1 µPa2.s)	SPLpeak Unweighted (dB re 1 µPa)	SELcum Weighted (dB re 1 µPa2.s)	
Group 1 Fish: no swim bladder (particle motion detection)	>213	>219	>213	>216	>186
Group 2 Fish: swim bladder is not involved in hearing (particle motion detection)	>207	210	>207	>203	>186
Group 3 and 4 Fish: swim bladder involved in hearing (pressure and particle motion detection)	>207	207	>207	203	186
Eggs and larvae	>207	>210	N: Moderate risk[a] I: Low risk F: Low risk		N: Moderate risk[a] I: Low risk F: Low risk

a: Relative risk (high, moderate, low) is given for animals at three distances from the source defined in relative terms as near field (N; i.e. 10s of metres), intermediate (I; i.e. 100s of metres), and far field (F; i.e. 1,000s of metres); Popper *et al.* (2014).

b: Temporary Threshold Shift.

<u>Behavioural criteria</u>

8.7.1.51 The recent ASA guidelines (Popper *et al.*, 2014) provide qualitative behavioural criteria for fish from a range of noise sources. These categorise the risks of effects in relative terms as "high", "moderate" or "low" at three distances from the source: "near" (i.e. tens of metres), "intermediate" (i.e. hundreds of metres) or "far" (i.e. thousands of metres). These behavioural criteria for piling operations are summarised in Table 8.7.2 for the four fish groupings considered in paragraph 8.7.1.48.

Table 8.7.2: Criteria for Onset of Behavioural Effects in Fish from Piling Operations (Popper *et al.*, 2014)		
Type of Fish	**Masking**	**Behaviour**
Group 1 Fish: no swim bladder (particle motion detection)	N: Moderate risk I: Low risk F: Low risk	N: High risk I: Moderate risk F: Low risk
Group 2 Fish: swim bladder is not involved in hearing (particle motion detection)	N: Moderate risk I: Low risk F: Low risk	N: High risk I: Moderate risk F: Low risk
Group 3 and 4 Fish: swim bladder involved in hearing (pressure and particle motion detection)	N: High risk I: High risk F: Moderate risk	N: High risk I: High risk F: Moderate risk
Eggs and larvae	N: Moderate risk I: Low risk F: Low risk	N: Moderate risk I: Low risk F: Low risk
Relative risk (high, moderate, low) is given for animals at three distances from the source defined in relative terms as near field (N; i.e. 10s of metres), intermediate (I; i.e. 100s of metres), and far field (F; i.e. 1,000s of metres); Popper *et al.* (2014).		

Assessment of Noise Modelling Results

Injury effects – noise

8.7.1.52 The full results of the modelling of injury ranges for fish species are presented in Technical Appendix 9.2. Noise Modelling. These show that for the 5,000 kJ hammer energy (monopiles) within the Moray West Site, recoverable injury effects may be expected within a mean range of approximately 124 m from the noise source (pile driving) for all fish groups based on SPL_{peak}, and a mean range of up to 989 m based on SEL_{cum}, assuming a stationary animal. For the 3,000kJ hammer energy (pin piling) within the Moray West Site, recoverable injury effects may be expected within a more restricted area, with a mean range of up to 85 m from the noise source (pile driving) for all fish groups based on SPL_{peak}, and a mean range of approximately 818 m, based on SEL_{cum}, assuming a stationary animal.

8.7.1.53 These injury ranges are for recoverable injury, with full recovery occurring after exposure, although decreased fitness during this recovery period may result in increased susceptibility to predation or disease (Popper *et al.*, 2014). Potential for mortality or lethal injury may occur in extreme proximity to the pile, although the risk of this occurring will be reduced by use of soft start techniques at the start of the piling sequence (i.e. starting at lower hammer energies and building up to the maximum hammer energy). This means that fish in close proximity to piling operations will move away from the impact range, before noise levels reach a level likely to cause lethal injury.

8.7.1.54 Although there is currently limited understanding of the effects of piling noise on fish eggs and larvae, a study by the Institute for Marine Resources and Ecosystem Studies (IMARES) (Bolle *et al.*, 2011; 2012) which exposed common sole larvae to piling noise, observed no statistically significant effect on their survival rates for a piling sequence which resulted in a SEL dose of 206 dB re 1 µPa2 s. For fish larvae, the risk of mortality due to prolonged noise exposure would be significantly reduced by any drift of larvae due to water currents and would substantially reduce the risk of mortality to an insignificant level based on recent work by Bolle *et al.,* (2011; 2012). Effects on fish larvae may therefore occur within ranges smaller than those summarised in

Section 8.7.1.50 above, noting that the ranges these are based on are the most precautionary criteria for fish injury. It is however, not possible to establish if mortality might occur or indeed at what range from the pile, as the work by Bolle *et al.,* (2011; 2012) was unable to induce a statistically significant change in survival rates of fish larvae, following a prolonged exposure with a substantial cumulative SEL dose.

8.7.1.55 Group 1 fish (e.g. flatfish and elasmobranchs), Group 2 fish (e.g. salmonids) and shellfish are less sensitive to sound pressure, with these species detecting sound in the environment through particle motion (Section 8.7.1.48) whereas Group 3 (including gadoids such as cod and whiting) and Group 4 fish (including herring and sprat) are more sensitive to the sound pressure component of underwater noise (Section 8.7.1.48). The baseline shows that there is limited evidence of cod and herring spawning in the Development area. Any cod, herring and other noise sensitive species that are present are likely to be juveniles or adults and can move out of the lethal injury impact zone. For herring, the sensitivity is adult spawning fish and not eggs or larvae, while surveys and assessment of ICES IHLS data shows that the Development area is not a key spawning area for herring, with spawning taking place to the north.

Behavioural effects – noise

8.7.1.56 Group 3 (including gadoids such as cod and whiting) and Group 4 fish (including herring and sprat) are more sensitive to the sound pressure component of underwater noise (Section 8.7.1.48) and, as indicated in Table 8.7.2, the risk of behavioural effects in the intermediate and far fields are therefore greater for these species. A number of studies have examined the behavioural effects of the sound pressure component of impulsive noise (including piling operations and seismic airgun surveys) on fish species, including gadoids. Mueller-Blenkle *et al.,* (2010) measured behavioural responses of cod (and sole) to sounds representative of those produced during marine piling, with considerable variation across subjects (i.e. depending on the age, sex, condition etc. of the fish, as well as the possible effects of confinement in cages on the overall stress levels in the fish). This study concluded that it was not possible to find an obvious relationship between the level of exposure and the extent of the behavioural response.

8.7.1.57 Fish and shellfish behavioural responses to underwater noise are also highly dependent on a number of factors such as the type of fish/shellfish, its sex, age and condition, as well as other stressors to which the fish is or has been exposed. For example, it would be expected that due to their size, smaller fish might show behavioural responses at slightly lower mobility levels than larger fish. In addition to this, the response of the fish will depend on the reasons and drivers for the fish being in the area. Foraging or spawning, for example, may increase the desire for the fish to remain in the area despite the elevated noise level (see Peña *et al.*, 2013).

8.7.1.58 Key species within the Development will comprise Group 3 and 4 fish (e.g. cod, whiting, sprat and herring). Spawning and nursery habitats for these species coincide with the Development area (Volume 3a - Figures 8.4.2 – 8.4.8) and extend across the wider study area and effects on these habitats would be expected to occur. Baseline characterisation would indicate that, although present within Coull *et. al* (1998) spawning areas, the Development is not within key spawning grounds for cod, herring or sandeel and that these spawning grounds are located in more suitable areas out with the Development area. For example, due to the distance between known herring spawning grounds and the Development, spawning adults would not be affected by construction related underwater noise at the Development. Non-spawning herring, sprat, cod and whiting would at worse show displacement behaviour as they alter their movements to avoid noise. Research has shown that spawning adults are unlikely to show displacement as their spawning activity takes precedence over any other behaviour due to the amount of energy put into the spawning process and its importance in successful recruitment. The overall proportion of these habitats that are likely to be affected by underwater noise from piling operations within the Development would be expected to be small in the context of the widespread nature of these habitats in the southern North Sea.

Particle motion

8.7.1.59 Particle motion is the displacement or movement of fluid particles within a sound field. Particle motion is detected by the lateral line of fishes (a visible line along the side of a fish that contains hundreds of flow sensors and neuromasts (hair cell sensors) which detect pressure and vibration) and the otolithic organs (small oval calcareous structures in the inner ear of vertebrates which contain sensory epithelium and sensory hair cells which cause otoliths to vibrate). It is the otolithic organs of fish that respond to particle motion of the surrounding fluid. The receptors of the lateral line system in fish also respond to the particle motion but over a very short range (one or two body lengths away from the source) (Popper *et al.*, 2014). Directional hearing in fishes is based on the detection of particle motion.

8.7.1.60 Different species of fish respond differently to the particle motion and pressure components of noise. Fish species lacking a gas-filled cavity (Group 1) primarily detect particle motion and do not detect sound pressure. Fish that have a functional connection between the swim bladder and the inner ear (Group 4) are likely to predominately detect sound pressure. However, they are still likely to have a capacity of the detection of particle motion similar to non-hearing specialists. Herring are considered more sensitive to sound pressure; cod and eel sensitive to both components of sound and the species such as dab, plaice and Atlantic salmon are predominately sensitive to particle motion (Popper *et al.*, 2014).

8.7.1.61 Particle motion attenuation is known to deviate significantly from the attenuation of sound pressure (except under very specific conditions) and will also be highly site specific, especially in shallow coastal areas (Nedelec *et al.*, 2016) (so that it cannot be assumed that the measurement or modelling of sound pressure levels provides a proxy for particle motion). Popper *et al.,* (2014) note that the three-dimensional particle motion field is quite complex near boundaries that include the air/water interface and the seabed, as well as in shallow water. In these instances, the particle motion may be unpredictable. For example, there can also be instances where transient sound waves in the sediment are transmitted from the sediment into the water column resulting in localised areas of high and low particle motion. In this way it has been postulated that it would be possible for higher measurements of particle motion to be detected at distance from the sound source (Caltrans, 2001; Hawkins, 2009).

8.7.1.62 The development of modelling techniques for particle motion has been inhibited by the limited availability of any field measurements of particle motion at varying distance from a noise source (Farcas *et al.*, 2016; Hawkins and Popper, 2016). This absence of field measurements during, for example, pile driving means that few studies have been able to model predicted impact ranges in respect of particle motion that could be applied in the EIA process to predict a range of effects on any given species and at any given level of noise.

8.7.1.63 However, Miller *et al.,* (2016) used a novel modelling technique to estimate impact ranges on two species and compared the model outputs with measured data for the driving of a 1.2 m pile in up to 30 m of water. Extant information on species sensitivity was then used to estimate impact ranges for flounder and American lobster. Miller *et al.,* (2016) concluded that flounder and American Lobster may be able to detect particle motion at a distance of 250 m and 500 m from the sound source, respectively.

8.7.1.64 Bass and Clark (2003) report that the particle motion component of sound is likely to decrease more rapidly than the sound pressure component.

8.7.1.65 Although there is general acknowledgment that fish and shellfish species will detect the particle motion component of anthropogenic noise, there has been little progress in identifying hearing or response thresholds that could be used to determine the response of any given species to a given level of impact (i.e. a pile driving event). Studies that have observed responses to sound have generally failed to distinguish whether observed responses are as a result of sound pressure or particle motion (Mueller-Blenke *et al.*, 2010; Harding *et al*., 2016). Radford *et al.* (2012) isolated the particle motion component of sound and exposed three species of teleost fish with different sound pressure hearing capabilities. It was observed that the three species exhibited a similar capacity to detect particle motion despite large difference in their ability to detect sound pressure, although the author notes that further investigations into other species are required to draw any firm conclusions. However, more general classifications of 'particle motion sensitivity' have been attempted. Popper *et al.* (2014) report that, where species of fish have a mechanical connection between the swim bladder and the inner ear, such as those present in clupeids, they are more likely to respond to the sound pressure component of a stimuli (although these species are likely to also detect particle motion). Species without specialised connections between the inner ear and swim bladder, or with no swim bladder at all, are more likely to respond to the particle motion component of sound. Demersal fish that live on or in the Moray West Site are also likely to be more sensitive to sediment-borne vibrations resulting from pile driving. A range of behavioural responses have been reported in response to pile driving noise exposure. Cod and sole were observed to change swimming behaviour, although again the study did not distinguish between sound pressure and particle motion (Mueller-Blenkle *et al.*, 2010).

8.7.1.66 Invertebrates are considered unlikely to detect sound pressure levels but are known to detect particle motion via other anatomical adaptions such as superficial surface receptors, internal statocyst receptors and the chordotonal organs (Thomsen *et al.*, 2015; Roberts and Elliot, 2017). Particle motion detection has been demonstrated in bivalves with responses including closing their siphon, burrowing deeper and increased clearance rate (Roberts *et al.*, 2015; Solan *et al.*, 2016; Spiga *et al.*, 2016; Robert *et al.*, 2017). A number of crustacean species have been reported to respond to anthropogenic noise including hermit crab (*Pagurus bernhardus*; (Roberts *et al.*, 2016), *Nephrops* (Goodall *et al.*, 1990), American lobster (*Homarus americanus*) (Payne *et al.*, 2007) the shore crab *Carcinus maenus* (Ware *et al.*, 2013) and the two shrimp species *Crangon crangon* and *Pandulus borealis* (Roberts *et al.*, 2017). Roberts *et al.,* (2015) and Roberts *et al.,* (2016) concluded that both the mussel (*Mytilus edulis*) and hermit crab responded to noise from blasting within 300 m of the source.

8.7.1.67 The sensitivity of the receptor systems in crustaceans appears to be much less compared to fish - up to 105 times lower in terms of particle velocity (Fay and Simmons, 1998). This suggests that any impacts resulting from particle motion would only be detectable at relatively close range to the sound source.

8.7.1.68 It is important to note that, to date, there is no evidence demonstrating that the particle motion component of noise can cause tissue damage, although research into this area is limited (Popper *et al.*, 2014). There is, currently, therefore an assumption that sensitivity to particle motion in fish (and invertebrates) is most likely to result in behavioural responses rather than injury (Hawkins, 2009; Mueller-Blenkle *et al.*, 2010; Hawkins *et al.*, 2014a).

8.7.1.69 Effects on migratory species may also occur as a result of construction related underwater noise from the Development. Shad would be expected to have similar sensitivities as herring and sprat (all are members of the clupeid family; Group 4, see paragraph 8.7.1.48), with potential behavioural responses to the far field (i.e. kilometres to tens of kilometres). European eel would be expected to have some sensitivity to both particle motion and sound pressure components of piling noise (Group 3 Fish, see paragraph 8.7.1.48) and therefore may show some behavioural responses in the far field, although as discussed above, these may not necessarily include strong avoidance responses. Salmonids (including salmon and trout) are included in Group 2 Fish (see paragraph 8.7.1.48) and would therefore be sensitive to the particle motion component of piling noise, with a low risk of behavioural effects in the far field. Atlantic salmon and sea trout are likely to pass through the Moray West Site and surroundings both as smolts, leaving their natal rivers and entering the marine environment heading, and as adults returning to natal rivers to spawn (and in the case of some sea trout as residents of coastal waters). Sea lamprey would similarly be expected to be more sensitive to the particle motion component of piling noise (Group 2 Fish, see paragraph 8.7.1.48), again with a low risk of behavioural effects in the far field. The migratory species use of the site is considered to be transitory in nature with individuals passing through the Development on migrations to remote feeding grounds or on return migrations to natal rivers.

8.7.1.70 Even though the movements of migratory fish are not clearly known within a local or regional context, recent research by Harding *et al.,* (2016) has demonstrated that the hearing threshold of salmonids is not as sensitive as other fish species and that the noise produced from piling activities from offshore wind farm construction does not appear to have significant effects upon the movement behaviour or physiological behaviour of Atlantic salmon and individuals do not show a startle response or stress to this source of underwater noise.

8.7.1.71 Research reports that Atlantic salmon are known to detect low frequency acoustic stimuli below 380 Hz, coinciding with the dominant frequencies produced during impact piling operations (100 Hz to 2 kHz; Hawkins & Johnstone, 1978). More recent research has been undertaken on the hearing capabilities of Atlantic salmon (Harding *et al.*, 2016), whereby a series of hearing sensitivity tests were undertaken on wild and captive post-smolts and adult Atlantic salmon. The research reported similar findings to the previous research in terms of hearing thresholds, but also found evidence of a response to sounds at higher frequencies (400-800 Hz). Slightly less sensitive hearing was noted at 100 Hz than reported in Hawkins & Johnstone, 1978, but found more sensitive hearing than the earlier study at frequencies >200 Hz. Atlantic salmon are not as sensitive to noise as some other species (such as clupeids) due to a lack of secondary hearing modifications linking the swim bladder to the auditory system. The recent research went on to test individual salmon of both migratory phases to exposure of piling noise. In terms of behavioural effects, the findings reported no startle response was shown to individual hammer strikes and the noise of piling did not drive any differences in behaviour. Physiologically, there was no change in the active metabolism rate when exposure to pile driving noise took place. No evidence of avoidance behaviour was recorded. It was considered that Atlantic salmon are sound insensitive as they lack specialist hearing mechanisms. They therefore have a poorer ability to distinguish specific acoustic cues.

8.7.1.72 Mitigation measures that will be adopted during construction of the WTG and OSP foundations, such as the application of 'soft start' procedures, will provide measures to ensure that underwater noise is introduced slowly to migratory fish and other species) so as to seek to avoid any harm or injury. By operating 'soft start' procedures, it is assumed that most fish will be able to react to the noise source and will likely move away from it. It is noted that the noise propagation modelling undertaken to inform the assessment assumes that fish do not flee from the noise source; this precautionary assumption results from there being no standard, agreed fleeing speed that can be applied.

Magnitude of Impact

8.7.1.73 Based upon the detailed noise modelling results and the information presented above regarding injury and behavioural criteria, given that soft start piling will take place and fish will be able to change their behaviour to avoid the sound pressure and particle motion, the magnitude is considered to be **low**. This is based on there being minor changes to the baseline as fish are displaced but fish are able to recover quickly and effects are short-term (linked to a specific piling duration).

Sensitivity of Receptors

8.7.1.74 Sea lamprey have a similar hearing range underwater as Atlantic salmon, with research indicating that sea lamprey respond to sound at frequencies of between 20 Hz and 100 Hz (Lenhardt & Sismour, 1995), they do not possess a swim bladder and are less sensitive to sound than fish that do possess a swim bladder (Maes *et al.*, 2004). The sensitivity of this species is considered to be **low**.

8.7.1.75 Herring, sprat, cod, whiting, and salmonids are considered to be of medium vulnerability, high recoverability and of regional to international importance. The sensitivity of these receptors is therefore considered to be **moderate**.

8.7.1.76 All other fish and shellfish species within the study area are deemed to be of low vulnerability, high recoverability and of local to international importance. The sensitivity of these receptors is therefore considered to be **low**.

Significance of Effect

8.7.1.77 Construction related underwater noise will represent a temporary, short to medium term duration (i.e. piling occurring over nine months) and intermittent impact, affecting all fish and shellfish species, but in a way that will allow individuals to recover after noise exposure (sound pressure and particle motion). Overall, with **low** impact magnitude and sensitivity of the receptor ranging from **low to moderate** it is predicted that the effect will be of **minor** adverse significance and **not significant** in EIA terms.

Accidental release of Hydrocarbons and Chemicals

8.7.1.78 During construction, in addition to the controlled discharge of substances / chemicals required for certain activities e.g. discharge of water based muds during pile driving / HDD at landfall and leachates from cements and / or grouts used in construction, there is also the potential for accidental release of hydrocarbons (e.g. diesel fuels) from construction vessels.

Magnitude of Impact

8.7.1.79 The number of vessels expected to be present within the Development as a result of construction activities is up to 25 at any one time over the construction period (i.e., up to three years). Vehicle and machinery movements are also anticipated within the intertidal area of the Offshore Export Cable Corridor, in addition to a barge which may anchor in the intertidal zone.

8.7.1.80 Without any embedded mitigation, any pollution caused by the release of hydrocarbons or other pollutants from vessels could potentially be highly detrimental to fish and shellfish as the presence of hydrocarbons and other chemicals or toxic substances can result in mortality of all species. However, with the implementation of the embedded mitigation identified within Section 8.6.2, including the application of a project specific EMP, a MPCP, MARPOL requirements and good vessel maintenance, the risk of, and impacts from pollution events can be managed and minimised. The magnitude of impact from an accidental release is considered to be highly unlikely, and if a release does occur, this will be managed through the application of contingency plans / management systems to ensure any resulting impact is highly localised and only has a restricted effect upon the baseline populations of fish and shellfish.

8.7.1.81 For HDD activities, the drilling muds that are used are required to be environmentally friendly and only certain types such as bentonite are approved for use in intertidal / subtidal areas. As such the magnitude is identified as **low**.

Sensitivity of Receptor

8.7.1.82 Pelagic / mid water fish species that are present within the study area, or passing through the study area, are likely to be most affected by accidental spills of hydrocarbons and other oil or fuel based substances given that these will be concentrated in the upper water column. Shellfish and demersal fish may however be more sensitive to chemical spillages or drilling muds that could potentially rest on the sea floor and cause contamination of the seabed or smothering. The sensitivity of all fish and shellfish receptors is considered to be **moderate**, irrespective of whether they are PMFs or other receptors with higher conservation protection. All fish and shellfish would potentially suffer the same fate with limited capacity to recover.

Significance of effect

8.7.1.83 All fish and shellfish species, irrespective of their conservation value are considered to be of **moderate** sensitivity to accidental hydrocarbon and chemical release. With a **low** impact magnitude, the overall effect is considered to be **minor** and **not significant** in terms of EIA.

8.7.2 Potential Operational Effects

Long Term Habitat Loss

8.7.2.1 The presence of WTG and OSP foundations, associated scour protection and cable protection for offshore cables (including cable crossings) all have the potential to impact on fish and shellfish by the long term removal of essential habitats (e.g. spawning, nursery and feeding habitats). As detailed in Section 8.7.1, shellfish species (e.g. brown crab, lobster and *Nephrops*) and demersal spawning fish species (e.g. sandeel and herring) with spawning grounds coinciding with the study area are likely to be most vulnerable to long term habitat loss as these species have specific seabed habitat requirements.

Magnitude of Impact

8.7.2.2 The long-term habitat loss due to the presence of foundations, scour protection and cable protection is estimated to be up to 7,488,397 m^2 (Table 8.6.1) which represents 0.12 % of the Development area. No long-term habitat loss is expected due to maintenance activity.

8.7.2.3 Due to the limited area of habitat loss in comparison to the wider area, along with the habitat being widespread and commonplace, the magnitude of the impact is considered to be **low**. The magnitude of the impact is predicted to be of a local spatial extent (i.e. within the Development area only), long-term duration, continuous and irreversible during the lifetime of the project (but reversible through decommissioning). It is predicted that the impact will affect all fish and shellfish receptors directly.

Sensitivity of Receptor

8.7.2.4 Fish and shellfish species that are reliant upon the presence of suitable sediment/habitat for their survival are considered to be more vulnerable to change depending on the availability of habitat within the wider geographical region. The study area coincides with fish spawning and nursery habitats including sandeel, herring, *Nephrops*, lemon sole, plaice, lemon sole, cod, sprat, plaice, whiting, haddock and elasmobranchs (Coull *et al.*, 1998, Ellis *et al.*, 2012).

8.7.2.5 The fish species most vulnerable to habitat loss include herring and sandeel which are demersal spawning species (i.e. eggs are laid on the seabed), as these have specific habitat requirements for spawning (i.e. gravelly sediments for herring and sandy sediments for sandeel). The main herring spawning grounds in the northern North Sea are located to the east of Orkney extending northwards towards Shetland, and in the vicinity of the Fraserburgh and Peterhead coastline and therefore will not be affected by long term habitat loss. Also, surveys completed by BOWL, as described in the baseline section (Section 8.4.2.67) concluded that there is little evidence of herring spawning in the vicinity of the Moray West Site. As well as laying demersal eggs, sandeel also have specific habitat requirements throughout their juvenile and adult life history and loss of this specific type of habitat could represent further impact on this species. However, as detailed in paragraph 8.7.1.13, monitoring at other offshore wind farm sites has indicated that the presence of operational wind farm structures has not led to significant negative effects on sandeel populations in the long term.

8.7.2.6 The study area also coincides with low intensity sandeel spawning habitat and long term habitat loss (loss of soft substrate) will result in direct impacts on this habitat. Detailed studies have been completed to ascertain whether the habitats present within the Development are important for sandeel populations and this work has shown that the Development area does not support important populations of sandeel.

8.7.2.7 Sandeel and herring are deemed to be of high vulnerability and of regional importance within the study area. Due to the specific habitat requirement of these species, the sensitivity of these receptors is considered to be **moderate**.

8.7.2.8 The Development area also coincides with known *Nephrops* spawning habitat. Although there is predicted to be long term habitat loss, this will only affect a small proportion of this habitat in the context of the wider available habitat for this species in this part of the northern North Sea. The sensitivity for *Nephrops* is considered to be **moderate**.

8.7.2.9 Brown crab, scallop and European lobster are deemed to be of high vulnerability and of regional importance within the study area. The sensitivity of these receptors is therefore considered to be **moderate**.

8.7.2.10 All other fish and shellfish receptors in the study area are deemed to be of low vulnerability and, although some species are considered to be of international importance (recoverability is not applicable for this impact due to the impact occurring over the lifetime of the project), given the widespread nature of spawning and nursery habitat in the wider northern North Sea, the overall sensitivity of these receptors is considered to be **low**.

Significance of Effect

8.7.2.11 Long term habitat loss will represent a long term and continuous impact throughout the lifetime of the Development. However, only a relatively small proportion of the fish and shellfish habitats in the study area are likely to be affected. Overall, it is predicted that the sensitivity of fish and shellfish is considered to be **low to moderate** and the magnitude is deemed to be **low**. The overall effect for sandeel, herring, *Nephrops*, brown crab, scallop and European lobster will be of **minor** adverse significance, which is **not significant** in EIA terms. For all other fish and shellfish the overall effect will be **negligible** to **minor** and **not significant** in EIA terms.

<u>Underwater Noise and Vibration</u>

8.7.2.12 Underwater noise and vibration levels during the operational phase are predicted to be considerably lower than those of the construction phase, being limited to noise from operational turbines and maintenance vessel traffic.

Magnitude of Impact

8.7.2.13 As detailed in Table 8.6.1, during the operational phase, there is potential for underwater noise and vibration to occur as a result of the operation of up to 85 turbines within the Moray West Site and vessels associated with the operation and maintenance phase.

8.7.2.14 Underwater noise from operational WTGs mainly originates from the mechanically generated vibration from the turbines which is transmitted into the sea through the structure of the support pile and foundations (Madsen *et al.*, 2005; Tougaard *et al.*, 2009). The radiated levels are low and the spatial extent of the potential impact of the operational wind farm noise on marine receptors is generally estimated to be small and thus unlikely to result in any injury to fish (Wahlberg and Westerberg, 2005). Besides the sound source level, the potential for impact will also depend on the propagation environment, the receptor's hearing ability and the ambient sound levels.

8.7.2.15 Marine animals may perceive the radiated tonal components where these exist above the ambient noise levels, which may result in a behavioural response of the receptor or lead to a reduced detection of other sounds due to masking. Previous studies show that behavioural responses of fish are only likely at close ranges from the turbine (i.e. a few metres; Wahlberg and Westerberg, 2005). Although effects on fish are difficult to establish given the lack of information available in the scientific literature, there is indicative evidence that fish would be unlikely to show significant avoidance to the noise levels radiating from the turbine.

8.7.2.16 Studies of very low frequency sound have indicated that consistent deterrence from the source is only likely to occur at particle accelerations equivalent to a free-field SPL of 160 dB re 1 µPa (RMS) (Sand *et al.*, 2001). Particle acceleration resulting from an operational wind turbine has also been measured by Sigray *et al.* (2011) with the resultant levels being considered too low to be of concern for behavioural reactions from fish. Furthermore, the particle acceleration levels measured at 10 m from the turbine were comparable with hearing thresholds. Whilst limited, the available data provides an indicator that operational wind turbines are unlikely to result in disturbance of fish except within very close proximity of the turbine structure, as postulated by Wahlberg and Westerberg (2004). Any potential avoidance reactions (should they occur) would, however, be limited to a short distance from the operational turbine with the potential for acclimatisation occurring over the lifetime of the Development.

8.7.2.17 As detailed in Table 8.6.1, noise would also result from surface vessels servicing the offshore wind farm, with various vessel movements occurring per year during operation (exact number currently unknown). However, noise levels reported by Malme *et al.* (1989) and Richardson *et al.* (1995) for large surface vessels indicate that physiological damage to fish and shellfish is unlikely, although the levels could be sufficient to cause local disturbance of sensitive marine fauna (e.g. clupeids such as herring and sprat) in the immediate vicinity of the vessel, depending on ambient noise levels.

8.7.2.18 Considering the operational turbine noise of the offshore wind farm and any associated service vessels, the ambient noise levels within the Moray West Site would be expected to be lower than those present in the vicinity of nearby shipping routes. Details of the location of these shipping routes, and the types of vessels using these routes is provided within Chapter 12: Shipping and Navigation.

8.7.2.19 The impact is predicted to be of a highly localised spatial extent (i.e. in the immediate vicinity of operational turbines and service vessels), long term duration, continuous and reversible (once decommissioning takes place). It is predicted that the impact will affect the fish and shellfish receptors directly. However, due to the extremely localised spatial extent of the potential impact and low noise levels, the magnitude is therefore considered to be **negligible**.

Sensitivity of Receptor

8.7.2.20 Given the low noise levels associated with WTGs, any risk of significant behavioural disturbance for fish and shellfish would be limited to the area immediately surrounding the turbine, which represents a very small proportion of the total Development area. A major contributor to the ambient noise is sea-state, which would be expected to increase as the turbine rotational speed increases with wind speed. Increased ambient noise may exceed the WTGs noise, as has been observed by Tougaard *et al.* (2009) at three offshore wind farms; Middelgrunden and Vindeby in Denmark and Bockstigen-Valar in Sweden. Investigations at all three offshore wind farms resulted in no response by fish and shellfish receptors. Sensitivities of fish and shellfish receptors to underwater noise are discussed in detail within Section 8.7.1.

8.7.2.21 In terms of vessel operation noise, fish and shellfish are very much accustomed to shipping traffic within their natural environment and are generally present within environments with such activity present. It is unlikely that the vessel movements and operations associated with O&M activities will be of any more significance than the regularly occurring shipping traffic that occurs and vulnerability will not increase. The sensitivity of all fish and shellfish to vessel noise is considered to be **negligible**.

8.7.2.22 Herring, sprat, cod, whiting, and salmonids are considered to be of medium vulnerability, high recoverability and of regional to international importance. The sensitivity of these receptors to turbine noise is considered to be **moderate**.

8.7.2.23 All other fish and shellfish species within the study area are deemed to be of low vulnerability, high recoverability and of local to international importance in terms of turbine noise. The sensitivity of these receptors is therefore considered to be **low**.

Significance of Effect

8.7.2.24 Subsea noise resulting from WTG operation will represent a long term and continuous impact throughout the lifetime of the Development until decommissioning. The risk of significant behavioural disturbance for fish and shellfish would be very limited to the area around the WTGs. Taking the above identified **moderate** sensitivities for herring, sprat, cod, whiting and migratory fish and the **negligible** impact magnitude into consideration, the overall effect from WTG operation is considered to be **negligible to minor** and **not significant** in terms of EIA. For all other fish and shellfish species (**low** sensitivity), the overall effect is also considered to be **negligible to minor** effect and **not significant** in terms of EIA.

8.7.2.25 Vessel noise will be long-term but irregular and the extent of the noise will depend upon the size of the vessel, the work being completed by the vessel and the distances that the vessel is travelling. Taking the above identified sensitivity of **negligible** and magnitude of **negligible**, the overall effect is considered to be **negligible** and **not significant** in EIA terms.

Accidental Release of Hydrocarbons and Chemicals

8.7.2.26 The source of potential impacts arising during operation and maintenance will be slightly different to those during the construction works due to certain construction activities not taking place (such as pile driving or cable laying) and the main source of potential impact being related to the various types of support vessels that will be required to support with any maintenance activities. These will include planned and unplanned maintenance, for example in the event that a turbine needs to be replaced this will require a jack-up or heavy lift vessel. In the case of cable failure / damage (highly unlikely as cable will be buried / protected) any repairs could involve a cable lay (or cable recovery vessel) and support / guard vessels.

8.7.2.27 Operational and maintenance activities will continue to require an element of construction works such as cable repairs, reburial and this will be undertaken by various types of construction vessels (at a reduced number to those participating during the construction phase). Given that various vessels will still be present and some construction work will be required, the risk of an accidental release or spillage will remain the same and the embedded mitigation identified in Section 8.6.2 will remain relevant.

Magnitude of Impact

8.7.2.28 The magnitude of impact will be **low**, as identified in Section 8.7.1.79 – 8.7.1.81.

Sensitivity of Receptors

8.7.2.29 The sensitivity of receptors will be **moderate**, as identified in Section 8.7.1.82.

Significance of Effect

8.7.2.30 The overall sensitivity will be **minor** and **not significant** in terms of EIA, as identified in Section 8.7.1.83.

Creation of New Substrate and Habitat

8.7.2.31 Foundation and scour protection components of offshore wind farms can be viewed as artificial reefs, as these add hard substrate to areas typically characterised by soft, sedimentary environments, or additional surface area within harder substrate habitats. Man-made structures placed on the seabed attract many marine organisms including benthic species normally associated with hard substrates (see Chapter 7.1: Benthic and Intertidal Ecology) and therefore, may have indirect effects on fish and shellfish populations through their potential to act as artificial reefs and to bring about beneficial changes to food resources (Inger *et al.*, 2009). Additionally, man-made structures may also have positive direct effects on fish or shellfish through their potential to act as fish aggregation devices or provide additional crevices for habitat; significant increases in abundances of fish species such as sprat have been observed following installation of these structures (Petersen and Malm, 2006). There is also potential for adverse effects in terms of displacement of soft-bottom dwelling species due to a change to hard substrate.

Magnitude of Impact

8.7.2.32 As detailed in Table 8.6.1 up to 605,781 m^2 of new hard substrate habitat will be created in the development area as a result of the presence of up to 85 GBS foundations, two OSPs, associated scour protection and cable protection for inter-array, OSP interconnector and offshore export cables, including cable crossings.

8.7.2.33 Hard substrate habitat created by the introduction of WTG and OSP foundations, associated scour protection and cable protection (e.g. concrete mattresses or rock dumping) are likely to be primarily colonised within hours or days after construction by demersal and semi-pelagic fish species (Andersson, 2011). Continued colonisation occurs over a number of years after construction, until a stratified recolonised population is formed (Krone *et al.*, 2013). Fish aggregate from the surrounding areas, attracted by feeding opportunities or the prospect of encountering other individuals which may be beneficial by increasing the carrying capacity of the area (Andersson and Öhman, 2010; Bohnsack, 1989).

8.7.2.34 The existing, natural substrate type (e.g. soft sediment or hard rocky seabed) present within an area to be constructed upon (e.g. foundation or cable footprint) will, to some extent, determine the species taxa and diversity that will colonise the newly introduced vertical hard surface and associated scour protection. When placed on an area of seabed which is already characterised by rocky substrates, few species will be added to the area, but the increase in total hard substrate could sustain higher abundance (Andersson and Öhman, 2010). Conversely, when placed on a soft seabed, most of the colonising fish will be normally associated with rocky (or other hard bottom) habitats, thus the overall diversity of the area may increase (Andersson *et al.*, 2009).

8.7.2.35 There is, however, potential for the original soft-bottom population to be negatively displaced as a result of recolonization by a new species assemblage (Desprez, 2000). Studies by Leonhard *et al.* (Danish Energy Agency, 2012) at the Horns Rev offshore wind farm, and Bergström *et al.* (2013) at the Lillgrund offshore wind farm, showed an increase in fish species associated with reefs but decrease in the original sandy-bottom fish population. Consequently, while there may be a change in species assemblage, and or potential increase in species diversity, this does not necessarily equate to an increase in fish or shellfish numbers.

8.7.2.36 A monitoring programme at the Lillgrund offshore wind farm showed no overall increase in fish numbers, although more species were recorded after construction than before, which is consistent with the hypothesis that localised beneficial increases in biodiversity may occur following the introduction of hard substrates in a soft sediment environment. However, there is uncertainty as to whether artificial reefs facilitate recruitment in the local population, or whether the effects are simply a result of concentrating biomass from surrounding areas (Inger *et al.*, 2009).

8.7.2.37 There is, however, evidence to suggest that increased abundances of small demersal fish occur in the vicinity of structures due to increased abundance of epifaunal communities (such as mussels and barnacles). Although changes in species assemblage and diversity might not lead to an increase in total fish numbers, there could also be potential benefits on larger commercially important finfish e.g. cod where there is an increase in abundance of certain prey species such as small demersal fish.

8.7.2.38 The aggregation of larger finfish species, including cod, around vertical structures in the North Sea was observed by Wilhelmsson *et al.* (2006a). This was thought to be related to localised increases in species richness and diversity around the structures. Monitoring of fish populations in the vicinity of an offshore wind farm off the coast of the Netherlands also indicated that the offshore wind farm acted as a refuge for at least part of the cod population (Lindeboom *et al.,* 2011; Winter *et al*., 2010).

8.7.2.39 In contrast, post construction fisheries surveys conducted in line with the FEPA licence requirements for the Barrow and North Hoyle offshore wind farms, found no evidence of fish abundance across these sites being affected, either positively or negatively, by the presence of the offshore wind farms (Cefas, 2009; BOWind, 2008) therefore suggesting that any effects, if seen, are likely to be highly localised.

8.7.2.40 The magnitude of this impact is considered to be beneficial and **low**. This is on the basis that, as discussed above, the impact is predicted to be of local spatial extent (i.e. within the Development area), long term duration, continuous and irreversible during the lifetime of the project (but potentially reversible through decommissioning phase). It is predicted that the impact has the potential to affect fish and shellfish receptors both directly and indirectly, but only in terms of a noticeable change to small proportion of the receptor population.

Sensitivity of Receptor

8.7.2.41 Fish and shellfish species will show a different sensitivity with regards to new habitat creation due to differing ecology and habitat requirements. Additionally, pelagic and demersal fish will also show different sensitivity levels.

8.7.2.42 It is likely that the least vulnerability and sensitivity exists for crustacean species, such as crab and lobster, that naturally inhabit hard substrate and crevices created by such habitat. This is due to expansion of their natural habitats (Linley *et al.*, 2007) and the creation of additional refuge areas through the Development. In addition, where foundations and scour protection are placed within areas of sandy and coarse sediments, this can introduce new habitat and potential sources of food in these areas for some other shellfish species and could potentially extend the habitat range available to them.

8.7.2.43 Post-construction monitoring surveys at the Horns Rev offshore wind farm noted that the hard substrates were used as a hatchery or nursery grounds for several species, and was particularly successful for brown crab. As both crab and lobster are commercially exploited within the study area, there is potential for benefits to these fisheries, depending on the materials used in construction of the offshore wind farm. The sensitivity of crustaceans is therefore considered to be **low**.

8.7.2.44 For scallop, both the king scallop and queen scallop prefer rocky outcrops or boulders on silty / sandy mixed habitat. It is likely that after initial habitat disturbance / loss resulting from construction, that scallops will slowly start to colonise the artificial habitat and establish populations within these areas. Squid are similar in that they seem to prefer the harder substrate but do move into sandier / muddier areas over the fishing season. The sensitivity for both these species is considered also to be **low**.

8.7.2.45 For other shellfish species that are present within the softer substrates at risk of being replaced by hard substrate, the vulnerability is higher and these species are more sensitive to change. Species of shellfish such as *Nephrops* that require soft sediment to burrow may become displaced and this is also true for species of fish such as sandeel sp., and flatfish (plaice, lemon sole) that prefer the soft sediments. Although a pelagic fish, herring spawn on very specific habitat which can include softer gravel material. However, as the Development is not located in key herring spawning grounds, their sensitivity is not any higher than other species. As such all other shellfish, along with these specific fish receptors are considered to be of **moderate** sensitivity.

8.7.2.46 All other fish receptors in the study area are generally deemed to be of low vulnerability as they can react to changes in habitat type and adapt their behaviour, moving to more suitable habitats. Fish are therefore of local vulnerability and the sensitivity of the receptors is therefore considered to be **low**. Some fish species, such as cod will potentially be attracted to the Development infrastructure through increased feeding opportunity and others passing through the Development (e.g. migratory fish) will not be vulnerable at all to habitat changes. These fish will also have a sensitivity of **low**.

8.7.2.47 The colonisation of new habitats may potentially lead to the introduction MINNS. The sensitivities associated with MINNS is assessed within Chapter 7.1: Benthic and Intertidal Ecology.

Significance of Effect

8.7.2.48 There is some uncertainty associated with the likely effects of introduction of hard substrates into the marine environment on fish and shellfish receptors. From research and studies to date, it is considered that fish populations are unlikely to show noticeable changes (either beneficial or adverse) as a result of this impact, though there is evidence that shellfish populations (particularly crustaceans) would benefit from the introduction of hard substrates. Overall, although only of **low** magnitude, the effect is considered to be beneficial. Given species sensitivity ranges from low to moderate, the significance of the effect is **negligible to minor** and **not significant** (especially for crustaceans and demersal fish species). The exception to this is the significance of the effect on species that prefer softer sediment habitat which is considered to be **minor adverse** and **not significant** in EIA terms.

Electromagnetic Fields (EMF)

8.7.2.49 EMF will result from the installation of inter-array, OSP interconnector and offshore export cables. The transport of electricity through subsea power cables has the potential to emit a localised EMF which could potentially affect the sensory mechanisms of some species of fish and shellfish, particularly electrosensitive species (including elasmobranchs) and migratory fish species (CMACS, 2003).

Magnitude of Impact

8.7.2.50 A comprehensive study was undertaken as part of the Moray East ES 2012 (for the Telford, Stevenson and MacColl Wind Farms) looking at electromagnetic field (EMF) emissions from the inter-array cables.

8.7.2.51 EMF emissions are generated from the transmission of electricity through subsea cables, such as the AC inter-array, OSP interconnector and offshore export cables proposed for this development. The cables produce EMFs which have both electric (E) measured in volts per metre (V m-1) and magnetic components (B) measured in micro tesla (µT). While the direct electric (E) field is mostly blocked with the use of conductive sheathing, the magnetic (B) field can penetrate most materials and therefore are emitted into the marine environment with the resultant induced electric (iE) field.

8.7.2.52 In an underwater environment, vision is limited by both light availability and turbidity, therefore fish species have adapted to rely on other senses such as hearing, chemoreception and electro-sensitivity for orientation or navigation, predators/prey detection and for social or reproductive behaviours. The introduction of anthropogenic EMFs from inter-array cables therefore has the potential to interfere with these natural behaviours.

8.7.2.53 Modelling undertaken by Normandeau *et al*. (2011) found that the intensity of EMF emissions was roughly a direct function of cable voltage (ranging from 33 kV to 345 kV). The predicted magnetic (B) fields were found to be strongest directly above the cables and dissipated rapidly on the vertical and horizontal axis. Results from the EMF Modelling Report (Appendix 8.1) found that where subsea cables (33, 66 and 220 kV) are buried to 1 m depth, the predicted magnetic (B) field strength at the seabed is expected to be well below the earth's magnetic field (assumed to be 50 µT).

8.7.2.54 Although cable burial is the most effective way to reduce exposure of electromagnetic sensitive species to EMF emissions, it is not always possible due to seabed characteristics. Where burial is not an option, embedded mitigation measures such as mattresses or rock placement will be used increase the distance between the cables and electromagnetic sensitive species.

8.7.2.55 Assuming the installation of 72.5 kV inter-array cables and 400 kV OSP interconnector and offshore export cables (WCS), the EMF modelling (Appendix 8.1) concluded that a significant reduction in the magnetic (B) field is expected to occur within 5 m (vertical within the water column) from the seabed (assuming 1 m burial depth) and up to a few m either side of the cable (horizontal within the seabed). Given the localised nature of potential EMF emissions, the magnitude of any potential impacts is expected to be **low**. The significance of potential impacts on fish and shellfish depends on their sensitivity to EMF emissions and their position within the water column as discussed below.

Sensitivity of Receptor

8.7.2.56 Shellfish (particularly molluscs and crustaceans) and fish (particularly elasmobranchs) are able to detect applied or modified magnetic fields (Orpwood *et al.,* 2015, Normandeau *et al*. 2011 and Gill *et al.* 2005).

8.7.2.57 There has also been a significant amount of research on migratory species such as Atlantic salmon and European eel (Armstrong *et al.*, 2015; Orpwood *et al*., 2015). Species for which there is evidence of a response to E and B fields include elasmobranchs (sharks, skates and rays), river lamprey, sea lamprey, cod (E field only), European eel, plaice and Atlantic salmon (Gill *et al.*, 2005). It is considered that the life functions supported by an electric sense may include detection of prey, predators or conspecifics to assist with feeding, predator avoidance, and social or reproductive behaviours. Life functions supported by a magnetic sense may include orientation, homing, and navigation to assist with long or short-range migrations or movements (Gill *et al.*, 2005; Normandeau *et al.*, 2011). Therefore, the EMF emitted by subsea cables may interfere with these functions in areas where the cable EMF levels are detectable by the organism, causing expenditure of energy moving to areas which may not be suitable for finding either prey species or members of the same species, or expenditure of energy to moving away from areas where predators are mistakenly located.

8.7.2.58 Shellfish have been shown to demonstrate a response to B fields, with the Caribbean spiny lobster *Panulirus argus* shown to use a magnetic map for navigation (Boles and Lohmann, 2003). However, it is uncertain if crustaceans, including brown crab and European lobster are able to respond to magnetic fields in this way. Limited research undertaken with the European lobster found no neurological response to magnetic field strengths considerably higher than those expected directly over an average buried power cable (Normandeau *et al.*, 2011; Ueno *et al.*, 1986). Indirect evidence from post construction monitoring programmes undertaken in operational offshore wind farms do not suggest that the distribution of potentially magnetically sensitive species of crustaceans or molluscs have been affected by the presence of submarine power cables and associated magnetic fields. However, it should be noted that there have been no shellfish specific EMF monitoring programmes. Shellfish receptors are deemed to be of low vulnerability and are of local to regional importance in the study area. The sensitivity of these receptors is therefore, considered to be **low.**

8.7.2.59 Elasmobranchs (i.e. sharks, skates and rays) are known to be the most electro-receptive of all fish. These species possess specialised electro-receptors which enable them to detect very weak voltage gradients (down to 0.5 µV m-1) in the environment naturally emitted from their prey (Gill *et al.*, 2005). Both attraction and repulsion reactions to E-fields have been observed in elasmobranch species. Spurdog, one of the elasmobranch species known to occur within the study area, though at low abundances, avoided electrical fields at 10 µV cm-1 (Gill and Taylor, 2001). Gill and Taylor (2001) found limited laboratory based evidence that the lesser spotted dogfish avoids DC E-fields at emission intensities similar to those predicted from offshore wind farm AC cables (i.e. 10 µV cm-1), but was attracted to DC emissions at levels similar to those emanating from their prey (i.e. 0.1 µVcm-1 at 10 cm from the source). A COWRIE-sponsored mesocosm study demonstrated that the lesser spotted dogfish and thornback ray were able to respond to EMF of the type and intensity associated with subsea cables; the responses of some ray individuals suggested a greater searching effort when the cables were switched on. However, the responses were not predictable and did not always occur (Gill *et al.*, 2009). Elasmobranch species are deemed to be of medium vulnerability and local importance in the study area and therefore are considered to have **low** sensitivity.

8.7.2.60 EMF is often associated with migratory fish (Atlantic salmon, European eel, sea trout and lamprey species). The main impact is considered to be potential interference with navigation of sensitive migratory species. Lampreys possess specialised ampullary electroreceptors that are sensitive to weak, low frequency electric fields (Bodznick and Northcutt, 1981; Bodznick and Preston, 1983), but information regarding what use they make of the electric sense is limited. Chung-Davidson *et al.,* (2008) found that weak electric fields may play a role in the reproduction of sea lamprey and it was suggested that electrical stimuli mediate different behaviours in feeding-stage and spawning-stage individuals. This study (Chung-Davidson *et al.*, 2008) showed that migration behaviour of sea lamprey was affected (i.e. adults did not move) when stimulated with electrical fields of intensities of between 2.5 and 100 mV/m, with normal behaviour observed at electrical field intensities higher and lower than this range. These levels were considerably higher than modelled induced electrical fields expected from DC or AC subsea cables (i.e. 0.194 and 0.765 mV/m, respectively).

8.7.2.61 Atlantic salmon and European eel have both been found to possess magnetic material of a size suitable for magnetoreception, and these species can use the earth's magnetic field for orientation and direction finding during migration (Gill and Bartlett, 2010). Mark and recapture experiments undertaken at the operational offshore wind farm of Nysted showed that eel did cross the offshore export cable (Hvidt *et al.*, 2003) but studies on European eel in the Baltic Sea have highlighted some limited effects of subsea cables. The swimming speed during migration was shown to change in the short term (tens of minutes) with exposure to AC electric subsea cables, even though the overall direction remained unaffected (Westerberg and Langenfelt, 2008). The authors concluded that any delaying effect (i.e. on average 40 minutes) would not be likely to influence fitness in a 7,000 km migration.

8.7.2.62 Studies investigating the mechanism for navigation of Atlantic salmon when returning to natal rivers was conducted using historical datasets for sockeye salmon on the west coast of Canada. Putman *et al.* (2013) concluded that homing to natal rivers is achieved at least partially by geomagnetic navigation, and then by olfactory senses once in close proximity. Further study concluded that smolts inherit a 'magnetic map' which allows smolts to navigate to remote feeding grounds and return to natal rivers (Putman *et al.,* 2014). Putman (2015) noted that salmon species likely respond to spatial gradients in components of the geomagnetic field, such as the inclination angle of field lines, and the total field intensity, to navigate to and from natal rivers. Therefore, it may not be as simple as identifying magnetic field strength in the context of background magnetic field strength in identifying potential effects in salmon species.

8.7.2.63 Recent studies show that AC cables, as proposed at Moray West, do not emit EMF strong enough to influence salmonids and other species sensitive to EMF (Armstrong *et al.*, 2015). Armstrong *et al.* (2015) reported that the effects of EMF at 50 Hz (like those emitted from AC cables) result in no unusual behaviour being observed in Atlantic salmon (both adult and smolt stages). Research (Godfrey *et al.*, 2014; Malcolm *et al.*, 2010, Malcolm *et. al.* 2015), demonstrates that Atlantic salmon are known to migrate using coastal routes and generally only congregate at the mouths of their natal rivers prior to ascending them, so the Development is unlikely to affect migrations.

8.7.2.64 The review by Gill and Bartlett (2010) highlights the mixed results from the few studies that have been reported and that there is no clear evidence as to what, if any, the overall effect of EMFs on migration and movement behaviour of these species is likely to be. It concludes that EMFs from subsea cables and cabling orientation may interact with migratory eel (and perhaps salmonids) if their migration route takes them over the cables, particularly in shallow waters (less than 20 m) where there is a greater probability of encounter with the high voltage cables coming ashore. Current understanding suggests that where a migration route is parallel to the EMF source there is likely to be no influence on the direction of migration (Öhman *et al.*, 2007), whereas there may be a limited effect (i.e. reduced swimming speed in immediate vicinity of cables) on eel migratory routes for cables that are either at right or oblique angles to the migration route (Westerberg and Langenfelt, 2008). Effects on fish migration may therefore be expected in the inshore section of the Offshore Export Cable Corridor, should this coastal route be used by migratory species, although as discussed above any such effects are likely to be short lived and affecting only a small area of habitat within metres of the buried cable.

8.7.2.65 Migratory fish species are deemed to be of medium vulnerability and regional to international importance in the study area and therefore are considered to have **moderate** sensitivity, although effects will be largely limited to coastal areas close to the Landfall Area.

8.7.2.66 All other fish receptors are deemed to be of low vulnerability and are of local to regional importance in the study area. The sensitivity of these receptors is therefore, considered to be **low**.

Significance of Effect

8.7.2.67 EMF from the inter-array, OSP interconnector and offshore export cables will represent a long term and continuous impact throughout the lifetime of the project (until decommissioning). Effects will, however, be highly localised, affecting a relatively small proportion of the surrounding area , within metres of the cables and the predicted magnetic (B) field strength at the seabed is expected to be well below the earth's magnetic field (assumed to be 50 µT).

8.7.2.68 For shellfish, it is considered that, with a sensitivity of **low** and magnitude of **low**, the overall effect will be of **negligible or minor** significance and **not significant** in EIA terms.

8.7.2.69 For elasmobranchs, with a sensitivity of **low** and **magnitude** of low, the overall effect is considered to be of **negligible or minor** significance and **not significant** in EIA terms.

8.7.2.70 For migratory fish species, the effects are potentially higher as these species are more sensitive (**moderate**). With a magnitude of **low**, the overall effect is considered to be of **minor significance**, which is **not significant** in EIA terms.

8.7.2.71 For all other fish, it is considered that, with a sensitivity of **low** and magnitude of **low**, the overall effect will be of **negligible or minor** significance and **not significant** in EIA terms.

Seabed Sediment Heating from Subsea Cables

Magnitude of Impact

8.7.2.72 A certain amount of energy gets lost as heat when electricity is transported through subsea cables. This heat loss has the potential to cause an increase in temperature on the cable surface, potentially warming the surrounding ambient environment. Subsea cables installed on the sea floor do not heat up their surroundings due to the constant flow of water dissipating the thermal energy (Worzyk, 2009). However, buried subsea cables may result in sediment that is slightly warmer in the immediate vicinity (Worzyk, 2009).

8.7.2.73 Field studies are very limited and experiments carried out until now are not exhaustive; so it is not clear to what extent an increase in temperature could affect benthic communities (Boehlert and Gill, 2010) and life stages of fish populations.

8.7.2.74 The current suggestion is that the thermal effect is a small increase in temperature within a few centimetres of the cable (Boehlert and Gill, 2010). A study for the BritNed interconnector indicated that during the summer the immediate sediment temperature may increase between 0.5°C and 5.5°C through localised heating when the cable is buried at a depth of 1 m. At a burial depth of 3 m the increase in temperature was calculated to be between less than 0.5°C to 1.8°C. A field experiment on subsea power cables from Nysted offshore windfarm found the maximum temperature difference between control sites and cable sites was 2.5°C and the mean difference was 0.8°C (Meißber *et al.*, 2006).

8.7.2.75 There is a significant lack of field data on the effect of thermal radiation on fish and shellfish receptors. However, it is clear from research to date that localised heating may occur which could potentially cause a minor shift in baseline conditions, through the attraction of species to the heat source, or through species displacement of species from the heat source. This is therefore considered to be of **low** magnitude of impact.

Sensitivity of Receptor

8.7.2.76 The key receptors that would potentially be susceptible to seabed heating would be benthic species living and foraging on the seabed floor and its sediments. This would focus on softer sediment species being more susceptible where burial behaviour can take place and species may be present within sediments in close proximity to buried cables. Cables buried within (or laid on top of) harder substrates would be less sensitive due to reduced heating.

8.7.2.77 Species of shellfish (such as Nephrops, crabs and molluscs) will be of higher sensitivity to mobile, demersal fish species and pelagic fish species. Considering that most fish species are mobile and capable of relocating from affected areas, the sensitivity of fish is considered to be negligible since fish species are not vulnerable, can recover and adapt their behaviour to move away from areas that may not have tolerable temperatures. For shellfish species, sensitivity is considered to be **low**, as these species (particularly those species that show burial behaviour) can also adapt and move to more suitable locations, albeit over a slightly longer period due to slower mobility e.g. scallops.

8.7.2.78 Fish spawning activity may be sensitive to higher temperature and any spawning that may take place in areas of increased seabed temperatures, may be exposed to higher mortality rates / reduced recruitment success. This sensitivity is given a level of **moderate** as potentially populations of shellfish and fish could be impacted upon.

Significance of Effect

8.7.2.79 The potential for effects as a result of seabed heating are considered to be low due to the highly localised area over which heating from cables would occur and due to most shellfish and fish species being able to adapt their behaviour to avoid seabed heating if it became intolerable to them. Seabed heating can also, however, attract some species to an area (both predators and prey species) and could also introduce displacement to and from the heat source. Although shellfish may inhabit the sediments or surface of the seafloor close to the cables, they are considered to have low sensitivity to seabed heating. With a **low** impact magnitude, the overall effect is considered to be **negligible or minor** and not significant in terms of EIA. For fish species (**negligible** sensitivity), the overall effect is also considered to be **negligible or minor** and **not significant** in terms of EIA. For spawning activity and eggs and larvae (**moderate** sensitivity) the overall effect is considered to be **minor** and **not significant** in EIA terms.

8.7.3 Potential Decommissioning Effects

Temporary Habitat Loss / Habitat Disturbance

8.7.3.1 Taking a worst case scenario, the nature and extent of temporary habitat loss/disturbance during decommissioning (i.e. from removal of WTG and OSP structures, piles, foundations and cables) is likely to be similar to that described for installation of these during the construction phase in Section 8.7.1. This worst case approach is, however, precautionary as much of the subsea structures present at or below seabed level are likely to be left in-situ to minimise environmental effects. For instance, there is no statutory requirement for decommissioned cables to be removed and it is highly possible that subsea cables will be left in place, along with other infrastructure such as foundations below seabed and cable protection. Alternatively, partially removal by pulling the cables back out of the ducts may take place (Chapter 4: Description of Development). Such details will be determined and included within the Decommissioning Plan which will be developed to minimise environmental disturbance and will be updated throughout the lifetime of the Development to account for changing best practice.

Magnitude of Impact

8.7.3.2 As detailed in Table 8.6.1, the magnitude of temporary habitat loss / disturbance is predicted to be the same as or (more realistically) less than that described for the construction phase (Sections 8.7.1.1 - 8.7.1.4), as seabed preparation works for GBS foundations will not be required.

8.7.3.3 The magnitude is therefore, considered to be **low**. This is on the basis that, as with the construction phase, the impact will be of local spatial extent (i.e. within the Development area), short term duration and reversible. It is most likely that decommissioning will be undertaken within as short a timeframe as possible in order to minimise the decommissioning programme.

Sensitivity of Receptor

8.7.3.4 The sensitivity of fish and shellfish to temporary habitat loss / disturbance is fully discussed in Sections 8.7.1.5 – 8.7.1.17, with those species with the greatest sensitivity to this impact being the species with lower levels of mobility (such as crabs, lobsters, scallops and other molluscs) and those with specific habitat requirements (such as spawning herring, sandeels and *Nephrops*).

8.7.3.5 With the exception of the shellfish and demersal species / spawning adults identified below, all fish and shellfish receptors in the study area are deemed to be of low vulnerability, high recoverability and of local to international importance within the study area. The sensitivity of these receptors is therefore considered to be **low**.

8.7.3.6 Brown crab, European lobster, scallops and *Nephrops* are deemed to be of high vulnerability, medium to high recoverability and of regional importance within the study area. The sensitivity of these receptors is therefore considered to be **moderate**.

8.7.3.7 Sandeel and herring are deemed to be of high vulnerability, medium recoverability and of regional importance within the study area. The sensitivity of these receptors is therefore considered to be **moderate**.

Significance of Effect

8.7.3.8 As set out within Section 8.7.1.18, for fish and shellfish of **low** sensitivity, with an impact of low magnitude, the overall significance of the effect is considered to be **negligible to minor** and **not significant** in terms of EIA. For fish and shellfish receptors with **moderate** sensitivity, the overall effect is considered to be **minor** and **not significant** in terms of EIA.

Increased SSC / Sediment Deposition

8.7.3.9 Potential impacts and effects of increased SSC and sediment deposition during decommissioning will, as a worst case scenario, be similar to those associated with construction (Section 8.7.1.20 to 8.7.1.38). However, it is likely that the magnitude of these impacts and resulting effect significance will be less than those predicted to occur during construction on the basis that there will be no requirement for any seabed preparation works for the GBS foundations or trenching of cables. The impact of increased SSC and deposition from decommissioning operations is predicted to be of local spatial extent, short term duration, intermittent and reversible. The magnitude is therefore, considered to be **low**. The sensitivity for adult fish is **low**, for spawning grounds and scallop this is **moderate**, and for all other shellfish this is **low**. The overall effect is therefore considered to be **negligible or minor** and **not significant** for adult fish, **minor** and **not significant** for spawning grounds, **negligible or minor** and **not significant** for all shellfish except scallop, and **minor** and **not significant** for scallop. The magnitude of impact, sensitivity of receptors and significance of effect are provided in more detail within Sections 8.7.1.20 to 8.7.1.38.

Underwater Noise and Vibration

Magnitude of Impact

8.7.3.10 Decommissioning of offshore infrastructure for the Development may result in temporarily elevated underwater noise (sound pressure and particle motion) levels which could have physiological and behavioural effects on fish species, which could result in temporary injury or subsequent displacement and effects on spawning and nursery habitats. These elevated noise levels may be due to increased vessel movements as well as removal of the WTG subsea structures or foundations. The resulting noise levels will be dependent on the decommissioning methods used for removal of the foundation and indeed the extent of decommissioning works required. If substructures at or below seabed level are left then noise emissions are likely to be less.

8.7.3.11 As detailed in Technical Appendix 9.2. Noise Modelling, the decommissioning methods may include high powered water jetting / cutting apparatus and grinding of drilling techniques. The exact methods will be set out within a Decommissioning Plan and will be agreed in advance with consenting authorities. Abrasive cutting, often anticipated for wind turbine removal, would not be expected to be significantly higher than general surface vessel noise.

8.7.3.12 Studies of underwater construction noise (decommissioning) reported source levels which are similar to those reported for medium sized surface vessels and ferries (Malme *et al.*, 1989; Richardson *et al.*, 1995). Fish are generally exposed to , and acclimatised to vessel activity within their natural environment due to shipping traffic and other maintenance activities such as dredging and so are unlikely to be affected The noise resulting from abrasive cutting associated with wind turbine decommissioning is unlikely to result in any injury, avoidance or significant disturbance of local marine animals since noise emissions from these activities are far less than those created during wind farm construction (e.g. pile driving). Some temporary minor disturbance might be experienced in the immediate vicinity of the decommissioning activity, for example, from dynamically positioned (DP) vessels.

8.7.3.13 The impact is predicted to be of highly local spatial extent, short term duration, intermittent and reversible. Based on the information available at the time of writing, and due to the extremely localised spatial extent, the expected magnitude is considered to be **negligible**.

Sensitivity of Receptor

8.7.3.14 Given the low noise levels associated with offshore wind farm decommissioning, any risk of significant behavioural disturbance (i.e. avoidance) for fish and shellfish would be limited to the area immediately surrounding the decommissioning activities. These noise levels are highly unlikely to result in injury or mortality of fish and shellfish species. Sensitivities of fish and shellfish receptors to underwater noise are discussed fully in Section 8.7.1.39 onwards.

8.7.3.15 Sea lamprey have a similar hearing range underwater as Atlantic salmon, with research indicating that sea lamprey respond to sound at frequencies of between 20 Hz and 100 Hz (Lenhardt & Sismour, 1995), they do not possess a swim bladder and are less sensitive to sound than fish that do possess a swim bladder (Maes *et al.*, 2004). The sensitivity of this species is considered to be **low**.

8.7.3.16 Herring, sprat, cod, whiting, and salmonids are considered to be of medium vulnerability, high recoverability and of regional to international importance. The sensitivity of these receptors is therefore considered to be **moderate**.

8.7.3.17 All other fish and shellfish species within the study area are deemed to be of low vulnerability, high recoverability and of local to international importance. The sensitivity of these receptors is therefore considered to be **low**.

Significance of Effect

8.7.3.18 Overall, it is predicted that the sensitivity of fish and shellfish receptors is considered to be **low to moderate** and the magnitude is deemed to be **negligible**. The effect will, therefore, be of **negligible** significance, which is **not significant** in EIA terms.

Removal of Structures and Hard Substrates

Magnitude of Impact

8.7.3.19 As detailed in Table 8.6.1, the removal of foundations during the decommissioning phase of the Development (assuming all scour and cable protection is left in situ) is predicted result in the temporary habitat loss / disturbance of 6,797,256 m^2.[2] This has the potential to impact upon fish populations that may have colonised the Moray West Site during the operational phase (see Section 8.7.2.31). In those areas where hard substrate will be removed, the baseline species assemblage may revert back to pre- development baseline conditions (e.g. being dominated by soft-bottom species) as opposed to the opportunistic reef inhabitants which may have colonised this area during the design life with the increased amount of hard substrate available.

8.7.3.20 The impact is predicted to be of local (i.e. within the Development area), long term duration, intermittent and irreversible. It is predicted that the impact will affect the receptor directly and indirectly. The magnitude is therefore, considered to be **low**.

Sensitivity of Receptor

8.7.3.21 Information on sensitivity of fish and shellfish species to either the increase or decrease of hard substrate are outlined in Section 8.7.2.45. The loss of reef habitats due to removal of GBSs is likely to impact these same species however the previous species assemblage may benefit from the seabed returning to the baseline state present before construction of the Moray West Site and Offshore Export Cable Corridor. In this case, the impacts of reef removal may balance the losses experienced throughout the construction of the Development and the habitat may return to previous conditions.

8.7.3.22 As discussed in Section 8.7.2.45, shellfish receptors in the study area are deemed to be of medium vulnerability and of local to regional value in the study area (recoverability is not relevant to this impact). The sensitivity of the receptor is therefore considered to be **moderate**.

8.7.3.23 Fish receptors in the study area are deemed to be of low vulnerability and local to international value in the study area (recoverability is not relevant to this impact). The sensitivity of the receptors is therefore considered to be **low**.

Significance of Effect

8.7.3.24 Overall, it is predicted that the sensitivity of fish and shellfish receptors is **low and moderate** respectively, and the magnitude is predicted to be **low**. The effect will therefore be of **minor** adverse significance, which is **not significant** in EIA terms.

Accidental Release of Hydrocarbons and Chemicals

8.7.3.25 The potential impacts arising during decommissioning will be the same as during construction, albeit at a reduced level due to the majority of substantial construction works not taking place (such as seabed preparation for GBS foundations, pile driving or cable laying). Decommissioning activities will require an element of construction works undertaken by various types of vessels (although on a reduced level of trips than those for construction). The risk of an accidental release or spillage will remain the same, and the embedded mitigation identified in Section 8.6.2 will remain relevant.

Magnitude of Impact

8.7.3.26 The magnitude of impact will be **low**, as identified in Section 8.7.1.79 – 8.7.1.81.

Sensitivity of Receptors

8.7.3.27 The sensitivity of receptors will be **moderate**, as identified in Section 8.7.1.82.

Significance of Effect

8.7.3.28 With **low** impact magnitude and **moderate** receptor sensitivity, the significance of the effect will be **minor** and **not significant** in terms of EIA, as identified in Section 8.7.1.83.

8.7.4 Additional Mitigation

8.7.4.1 The impact assessment set out above, has determined that with the incorporation of embedded mitigation measures, there are no significant environmental effects identified in relation to fish and shellfish. As such, there is no requirement for additional mitigation or monitoring plans to be identified as part of the EIA process. No further additional mitigation is therefore proposed.

8.7.5 Summary of Development Specific Effects

8.7.5.1 Table 8.7.3 summarises the conclusions from the assessment of impacts during construction, operation and maintenance and decommissioning phases of the Development on fish and shellfish ecology. The results presented in the table take into account both embedded, and where relevant, any additional mitigation that has been identified to mitigate potentially significant effects and identifies the resulting residual effects.

Table 8.7.3: Summary of Development Specific Effects

Likely Effect	Receptor	Impact Magnitude	Sensitivity of Receptor	Effect Significance	Mitigation (in additional to embedded mitigatoin)	Residual Significance
Construction						
Temporary habitat loss / disturbance	Brown crab, European lobster, scallops, Nephrops	Low	Moderate	Minor	N/A	N/A
	Sandeel	Low	Moderate	Minor		
	Herring, cod and other spawning adults	Low	Moderate	Minor		
	All other fish and shellfish	Low	Low	Negligible to minor		
Increased SSC / sediment deposition	Scallops	Low	Moderate	Minor	N/A	N/A
	Spawning grounds	Low	Moderate	Minor		
	Fish	Low	Low	Negligible to minor		
	Shellfish	Low	Low	Negligible to minor		
Noise and vibration	Sea lamprey	Low	Low	Minor	N/A	N/A
	Herring, sprat, cod, whiting, salmonids	Low	Moderate	Minor		
	Other fish and shellfish	Low	Low	Minor		
Accidental release of hydrocarbons and chemicals	All fish and shellfish	Low	Moderate	Minor	N/A	N/A

Table 8.7.3: Summary of Development Specific Effects						
Likely Effect	**Receptor**	**Impact Magnitude**	**Sensitivity of Receptor**	**Effect Significance**	**Mitigation (in additional to embedded mitigatoin)**	**Residual Significance**
Operation and Maintenance						
Long term habitat loss	Herring	Low	Moderate	Minor	N/A	N/A
	Sandeel	Low	Moderate	Minor		
	Nephrops	Low	Moderate	Minor		
	Brown crab	Low	Moderate	Minor		
	European lobster	Low	Moderate	Minor		
	All other fish and shellfish	Low	Low	Negligible to minor		
Noise and vibration	Herring, sprat, cod, whiting, migratory fish (turbine noise only)	Negligible	Moderate	Negligible to minor	N/A	N/A
	All other fish and shellfish (turbine noise only)	Negligible	Low	Negligible to minor		
	All fish and shellfish (vessel noise)	Negligible	Negligible	Negligible		
Accidental release of hydrocarbons and chemicals	All fish and shellfish	Low	Moderate	Minor	N/A	N/A
Creation of new substrate and habitat	Scallop and other shellfish Fish	Low	Low	Negligible to minor	N/A	N/A

Table 8.7.3: Summary of Development Specific Effects						
Likely Effect	**Receptor**	**Impact Magnitude**	**Sensitivity of Receptor**	**Effect Significance**	**Mitigation (in additional to embedded mitigatoin)**	**Residual Significance**
	Soft substrate species (e.g. *Nephrops*, sandeel, flatfish)	Low	Moderate	Minor		
	Fish	Low	Low	Negligible to minor, not significant		
EMF	Shellfish	Low	Low	Negligible to minor	N/A	N/A
	Elasmobranchs	Low	Low	Negligible to minor		
	Migratory fish	Low	Moderate	Minor		
	All other fish	Low	Low	Negligible to minor		
Seabed sediment heating	Fish	Low	Negligible	Negligible to minor	N/A	N/A
	Shellfish	Low	Low	Negligible to minor		
	Spawning activity	Low	Moderate	Minor		
Decommissioning						
Temporary habitat loss/ habitat disturbance	Demersal / spawning adults (sandeel, herring, cod)	Low	Moderate	Minor	N/A	N/A
	Brown crab, European lobster, scallop, *Nephrops*	Low	Moderate	Minor		
	All other fish and shellfish	Low	Low	Negligible to minor		

Table 8.7.3: Summary of Development Specific Effects						
Likely Effect	**Receptor**	**Impact Magnitude**	**Sensitivity of Receptor**	**Effect Significance**	**Mitigation (in additional to embedded mitigatoin)**	**Residual Significance**
Increased SSC / sediment deposition	Scallops	Low	Moderate	Minor	N/A	N/A
	Spawning grounds	Low	Moderate	Minor		
	Fish	Low	Low	Negligible to minor		
	Shellfish	Low	Low	Negligible to minor		
Noise and vibration	Sea lamprey	Negligible	Low	Negligible	N/A	N/A
	Herring, sprat, cod, whiting, salmonids	Negligible	Moderate	Negligible to minor		
	All other fish and shellfish	Negligible	Low	Negligible to minor		
Removal of structures and hard substrates	Shellfish	Low	Moderate	Minor	N/A	N/A
	Fish	Low	Low	Negligible or minor		
Accidental release of hydrocarbons and chemicals	All fish and shellfish	Low	Moderate	Minor	N/A	N/A

8.8 Assessment of Cumulative Effects

8.8.1 Introduction

8.8.1.1 The approach to the Cumulative Impact Assessment (CIA) upon fish and shellfish receptors for the Development takes into account the standard guidance listed in Section 8.2. The cumulative study area for fish and shellfish covers the Moray Firth area.

8.8.2 Projects Considered for Cumulative Assessment

8.8.2.1 The projects and activities considered within the cumulative impact assessment are set out in Table 8.8.1. These include the Moray East Offshore Wind Farm and the consented Beatrice Offshore Wind Farm. In addition, the decommissioning of the Beatrice Demonstrator Site and Oil Field has been considered.

8.8.2.2 Based on information presented in the Beatrice Oil Field Decommissioning Scoping Report (Repsol Sinopec, 2017) it is understood that decommissioning of the Beatrice Oil Field and Beatrice Demonstrator Turbines will take place between 2024 to 2027. Therefore, there is potential for decommissioning activities to overlap with initial operational period for the Moray West Development. Both the Moray East Site and the Beatrice Offshore Wind Farm border the Moray West Site and have the potential to have direct cumulative effects due to this proximity and potential effects being located next to each other e.g. areas of permanent habitat loss adjoining each other.

8.8.2.3 There may be an element of uncertainty associated with the design envelope of proposed projects; therefore, a judgement is made on the confidence associated with the latest available design envelope.

Table 8.8.1: Projects for Cumulative Assessment

Development Type	Project	Status	Location	Status / Details
Offshore Wind Farm	Moray East Offshore Wind Farm (Formerly Telford, Stevenson and MacColl Offshore Wind Farms)	Consented	0 km from the Moray West Site (boundary shared)	High - Third party project details published in the public domain and confirmed as being ‘accurate’.
Offshore Wind Farm	Beatrice Offshore Wind Farm	Under construction	0 km from the Moray West Site (boundary shared)	High - Third party project details published in the public domain and confirmed as being ‘accurate’.
Beatrice Oil Field and Demonstrator Turbines	Repsol Sinopec	Operational	22 km from the Scottish coastline.	High - Third party project details published in the public domain and confirmed as being ‘accurate’.

8.8.3 Cumulative Effects Requiring Assessment

8.8.3.1 The main cumulative effects on the fish and shellfish are likely to be:

- Permanent habitat loss and disturbance in relation to fish and shellfish populations during construction, operation, maintenance and decommissioning;
- Temporary increases in suspended sediment concentrations and sediment deposition where there is potential for simultaneous seabed disturbance during construction, operation, maintenance and decommissioning;
- EMF during operation; and
- Introduction of subtidal hard substrates within other project sites (i.e., other offshore wind farm substructures) and associated colonisation which may affect benthic ecology and biodiversity during operation.

8.8.4 Cumulative Construction Effects

8.8.4.1 The Moray East (Telford, Stevenson and MacColl) Offshore Wind Farm is to be installed between 2019 and 2021 and expected to be operational by 2022. The Beatrice Offshore Wind Farm began construction in 2017 and the wind farm is expected to become fully operational in 2019. Given that the construction of the Moray West offshore wind farm and the offshore export cables is not planned to commence until 2022, spanning 36 months and ending in 2024, there will be no temporal overlap of the construction phases of these projects. Therefore, there is no requirement to consider potential cumulative impacts associated with construction activities for any of these two projects.

8.8.4.2 The decommissioning of the Beatrice Oil Fields and Demonstrator wind turbines are due to occur between 2024 and 2027, and so there is potential for the later stages of the construction works at the Moray West Site to overlap with the decommissioning. As the decommissioning is likely to result in infrastructure below the sea bed remaining in-situ and with infrastructure above seabed being cut / removed for dismantling onshore, the potential for suspended sediment is likely to be very localised to the Oil Field and Demonstrator turbines, with any materials settling quickly in a similar manner to that determined for the Moray West Site. Noise levels will also likely be limited to cutting and vessel movements which have previously been likened to underwater noise created by medium sized vessels and of negligible effect. The overall cumulative effect with this Development is determined to be **minor** and **not significant**.

8.8.5 Cumulative Operational Effects

<u>Permanent Habitat Loss / Habitat Disturbance</u>

8.8.5.1 The maximum area of habitat that will be permanently lost due to the construction of Moray East is calculated to be 3.76 km^2 (based upon a worst case scenario of the originally consented project), which accounts for 1.27% of the total area of the three proposed wind farm sites. The effect will be permanent and last for the duration of the project until decommissioning takes place. The effect is assessed as being of 'minor significance' (MORL, 2012) and not significant.

8.8.5.2 At Beatrice Offshore Wind Farm the maximum area of habitat loss is predicted to be 3.79 km^2, which equates to 2.9% of the total consent area. This impact will be permanent and last for the duration of the project until decommissioning takes place. The effect is assessed as being 'negligible and probable'.

8.8.5.3 Combined with the Moray West Site and Offshore Export Cable Corridor habitat loss (Table 8.6.1: 7.5 km^2), the total area of habitat loss that would occur if all three projects are consented would be 15.05 km^2. This takes into account all of the offshore wind farm arrays plus the Moray West Site. This represents a very small area in comparison to the area of similar habitat that exists within the Moray Firth and the wider North Sea, which covers the east coast offshore waters. The magnitude of the impact is therefore likely to be **negligible**. Based on the evidence presented within the environmental assessments for these projects and the understanding of the fish and shellfish populations that characterise each development area, the sensitivity of the fish and shellfish receptors is considered to be **low**. Consequently, the cumulative effect of habitat loss caused by the offshore wind farm developments is considered to be **negligible or minor** and **not significant** in EIA terms.

Accidental and Controlled Discharges

8.8.5.4 There is potential for the accidental release of pollutants from vessels involved in maintenance activities for both BOWL and Moray East offshore wind farms, and vessels involved in the decommissioning of the Beatrice Oil Field. There is also potential for localised leakages of fluids and lubricants used in the WTGS and OSPs and accidental spills or chemical releases associated with decommissioning activities at the Beatrice Oil Field. However, these projects will all have appropriate measures in place (such as Marine Pollution Contingency Plans) to manage the use of chemicals and other potentially polluting substances and mitigate the risk of an accidental pollution release. The adjacent wind farms will also utilise bunding within offshore installations and so risk of accidental release is likely to be a result of operational and maintenance vessels only. It is extremely unlikely that there would be multiple spills resulting from operation and maintenance activities from Moray West and adjacent projects that would result in cumulative effects given the proposed control measures that will be implemented.

8.8.5.5 Provided published guidelines and best working practices are adhered to, the likelihood of accidental spills are extremely low and, in the event of a spill, the volumes of potential contaminants released would be small and rapidly dispersed thus minimising the likelihood of cumulative effects on fish and shellfish. The magnitude of any impact is considered to be **negligible**.

8.8.5.6 As described within paragraph 8.7.1.82 all fish and shellfish receptors are considered to have moderate sensitivity to accidental contamination / pollution incidents. The cumulative effect of accidental release of pollutants on fish and shellfish receptors will therefore be of **minor** significance and **not significant** in EIA terms.

Introduction of Subtidal Hard Substrates

8.8.5.7 An area (605,781 m^2) of approximately the size of the area of permanent habitat loss during operation will be created through construction of WTG, OSP and cable protection during operation of the Moray West Offshore Wind Farm. For the Moray East and Beatrice Offshore Wind Farm projects the situation will be similar, where similar areas of new hard substrate will replace permanent habitat loss. The presence of introduced hard substrate does not result in long term habitat loss in the localised area affected, but rather it results in a beneficial change in the fish and shellfish numbers and diversity that may colonise (e.g. from soft sediment species to hard substrate species) or in an increase in species numbers if in an area of existing hard substrate. Often, this is considered to be a beneficial effect of offshore wind, with the creation of ‘reef’ type habitat. A negative, displacement of fish to or from an area due to the introduction of new hard substrate has been determined to not show adverse effects of significance (Section 8.7.2).

8.8.5.8 While the sensitivity of all fish species is considered to be **low** to **moderat**e, the magnitude is considered to be **low** (due to localised changes and recoverability). The overall effect is therefore considered as **negligible** to **mino**r and **not significant** in EIA terms.

EMF

8.8.5.9 None of the projects considered within Table 8.8.1 have inter-array or OSP interconnector cables that overlap or are positioned within close proximity of one another (< 100 m in distance). However, there will be a requirement for inter-array and OSP interconnector cables within the Moray West Site to cross the Beatrice export cables which will run south through the centre of the Moray West Site linking the Beatrice offshore wind farm site to landfall on the south coast of the Moray Firth. There is also likely to be a requirement for the Moray West offshore export cables to have to cross the Beatrice export cables. Where cable crossings occur, there is potential for an increase in the levels of EMF emitted at those crossing points. However, it is expected that the materials required to construct the crossing and ensure long term protection of both cables, will help to quickly dissipate any increased emissions at these locations. Given, therefore that any cumulative EMF emissions will be highly localised (limited to crossing points only) and are expected to be rapidly dissipated as they pass through cable protection materials, the potential for cumulative EMF to affect fish and shellfish is **low**. With a sensitivity of fish and shellfish species of **low** to **moderate** and a magnitude of **low**, the overall cumulative effect is considered to be **negligible** to **minor** and **not significant** in terms of EIA.

Seabed Sediment Heating from Cables

8.8.5.10 As detailed above in Sections 8.7.2.72 to 8.7.2.75, heating of cables is highly localised and detectable within a few centimetres of the cable only where it is buried within sediments. Where cables are surface laid water flow over the cable results in loss of thermal energy. As with cumulative impacts in relation to EMF there is potential for cumulative interactions where the Moray West inter-array, OSP interconnector or offshore export cables cross the Beatrice offshore export cable. However, where there are cable crossings the installation of the materials required to construct the crossing and ensure long term protection of both cables will increase the distance between any benthic receptors and the cable surface to a distance where an increase in temperature is unlikely to be detectable. The magnitude of cumulative impacts from seabed sediment heating from cables will be **negligible**. The sensitivity of fish and shellfish receptors to increased seabed temperatures is considered to be **negligible**. Therefore, the significance of the cumulative effect of seabed sediment heating from subsea cables on fish and shellfish receptors will be **minor** and not significant in EIA terms.

8.8.6 Cumulative Decommissioning Effects

8.8.6.1 Moray West is applying for consent for the Development for a period of 50 years, with the Development expected to be operational for approximately 35 years based depending on the design life of the various components. The operational phase of Moray East Offshore Wind Farm is consented for a period of 25 years, which will result in decommissioning starting in 2047. Beatrice Offshore Wind Farm also has an expected operational period identified within their draft Decommissioning Plan of 25 years, bring the start of decommissioning works to 2044. No overlap in decommissioning activities is therefore identified and as such there will be no cumulative effects resulting from decommissioning.

8.9 References

Aas, Ø., Einum, S., Klemetsen, A., and Skurdal, J. (2011) Atlantic Salmon Ecology. Wiley-Blackwell, 467.

ABP Research (2007) MEPF 04/04: Predictive Modelling- Coupling Physical and Ecological Models: Final Report, MEPF 04/04, R/3482/1, Defra.

Acolas, M. L., Be´gout Anras, M. L., Ve´ron, V., Jourdan, H., Sabatie´, M. R., and Baglinie`re, J. L. (2004) An assessment of the upstream migration and reproductive behaviour of allis shad (Alosa alosa L.) using acoustic tracking. e ICES Journal of Marine Science, 61: 1291e1304.

Agnalt, A.L., Kristiansen, T.S. and Jorstad, K.E. (2007) Growth, Reproductive Cycle and Movement of Berried European Lobsters (Homarus gammarus) in a Local Stock off Southwestern Norway. ICES Journal of Marine Sciences 64:288-297.

Aires, C., González-Irusta, J.M., and Watret, R. (2014) Scottish Marine and Freshwater Science Volume 5, Number 10. Updating Fisheries Sensitivity Maps in British Waters.

Andersson, M. and Öhman, M. (2010) Fish and sessile assemblages associated with wind-turbine constructions in the Baltic Sea. Marine and Freshwater Research 61, 642-650.

Andersson, M. H., Berggren, B., Wilhelmsson, D., and Öhman, M. C. (2009) Epibenthic Colonization of Concrete and Steel Pilings in a Cold-Temperate Embayment: A Field Experiment. Helgoland Marine Research, 63, pp. 249–260.

Aprahamian, M. W. & C. D. Aprahamian. (1990) Status of the Genus Alosa in the British Isles: past and present. Journal of. Fish Biology 37A: 257–258. Status of the genus Alosa in the British Isles. Cited in Maitland & Lyle (1995).

Armstrong, M. J., Connolly, P., Nash, R. D. M., Pawson, M. G., Alesworth, E., Coulahan, P. J., Dickey-Collas, M., Milligan, S. P., O'Neill, M. F., Witthames, P. R., and Woolner, L. (2001) An application of the annual egg production method to estimate the spawning biomass of cod (Gadus morhua L.), plaice (Pleuronectes platessa L.) and sole (Solea solea L.) in the Irish Sea. ICES Journal of Marine Science, 58: 183–203.

Armstrong, D., Hunter, D.C., Fryer, R.J., Rycroft, P. and Orpwood, J.E. (2015). Scottish Marine and Freshwater Science. Volume 6 Number 9. Behavioural Responses of Atlantic Salmon to Mains Frequency Magnetic Fields.

Atlantic Salmon Trust (2018) Sea Trout Facts. Atlantic Salmon Trust. Available online at: http://www.atlanticsalmontrust.org/salmon-and-sea-trout-facts/

Bass A.H., Clark C.W. (2003) The Physical Acoustics of Underwater Sound Communication. In: Simmons AM, Popper AN, Fay RR (eds) Acoustic Communication. Springer Verlag New York, p 404.

BOWL (2014a) Herring Larval Survey Results – Technical Report. BOWL reference number: LF000005-REP-345.

BOWL (2014b) Sandeel Survey Results – Technical Report. BOWL reference number: LF000005-REP-095

BOWL (2015) Cod Survey Results Technical Report. BOWL reference number: LF000005-REP-094

BOWL (2016a) Herring Larval Survey Results – Technical Report. BOWL reference number: LF000005-REP-786.

BOWL (2016b) Pre-construction Baseline Herring Larval Survey Report. BOWL reference number: LF000005-REP-813.

BOWL (2017) Atlantic Salmon *Salmo Salar* smolt movements in the Cromarty and Moray Firths, Scotland. BOWL reference number: LF000005-REP-1854. March 2017.

Beggs S.E., Cardinale M, Gowen R.J. & Bartolino V. (2013). Linking cod (Gadus morhua) and climate: investigating variability in Irish Sea cod recruitment. Fisheries Oceanography 23: 54-64.

Bergstad, O. A., Hoines, A. S., and Kruger-Johnsen, E. M. (2001) Spawning time, age and size at maturity, and fecundity of sandeel, Ammodytes marinus, in the north-eastern North Sea and in unfished coastal waters off Norway. Aquatic Living Resources, 14: 293e301.Winslade, 1974b.

Bergström, L., Sundqvist, F., Bergström, U. (2013) Effects of an offshore wind farm on temporal and spatial patterns in the demersal fish community. Marine Ecology Progress Series 485, 11pp.

Birklund, J. and Wijsman, J. W. M. (2005) Aggregate Extraction: A Review on the Effects on Ecological Functions. Report Z3297/10 SAWDPIT Fith Framework Project no EVK3-CT-2001-00056. [online] Available at: <http://www.fws.gov/filedownloads/ftp_gis/R4/Louisiana_ES/Walther/Dredge%20holes/sandpitecology.pdf>

Blaxter, J.H.S. (1985) The herring: A successful species? Can.J.Fish.Aquat.Sci.42 (Suppl.1):21-30.

Bloomfield, A. and Solandt, J.L. (2008) The Marine Conservation Society Basking Shark Watch 20- year report (1987-2006).

Bodznick, D. and Northcutt, R.G. (1981) Electroreception in Lampreys: Evidence that the Earliest Vertebrates were Electroreceptive. Science, 212, 465-467.

Bodznick, D. and Preston, D.G. (1983) Physiological Characterization of Electroreceptors in the Lampreys. Ichthyomyzon uniscuspis and Petromyzon marinus. Journal of Comparative Physiology 152, 209-217.

Boehlert G.W. and Gill A. B. (2010) Environmental and Ecological effects of ocean renewable energy development: a current synthesis. Oceanography, 23(2): pp 68-81

Boehlert, G. W. and Gill, A. B. (2010) Environmental and Ecological effects of Ocean renewable energy development: A current synthesis. Oceanography, 23 (2), 68-81.

Bohnsack, J. A. (1989) Are High Densities of Fishes at Artificial Reefs the Result of Habitat Limitation or Behavioural Preference? B. Mar. Sci., 44(2), pp. 631-645.

Boles, L.C. and Lohmann, K.J. (2003) True Navigation and Magnetic Maps in Spiny Lobsters. Nature 421: 60-63

Bolle, L. J., de Jong, C. A. F., Bierman, S., de Hann, D., Huijer, T., Kaptein, D., Lohman, M., Tribuhl, S., van Beek, P., van Damme, C. J. G., van den Berg, F., van der Heul, J., van Keeken, O., Wessels, P. and Winter, E. (2011) Effect of Piling Noise on the Survival of Fish Larvae (Pilot Study). IMARES Report number CO92/11.

Bolle, L. J., de Jong, C. A. F., Bierman, S., van Beek, P., van Keeken, O., Wessels, P., van Damme, C. J. G., Winter, E., de Hann, D. and Dekeling, R. P. A. (2012) Common Sole Larvae Survive High Levels of Pile-Driving Sound in Controlled Exposure Experiments. PLoS ONE, 7(3), pp.e33052 doi:10.1371/journal.pone.0033052.

Bonfil, R. (1994) Overview of world elasmobranch fisheries. FAO Fisheries Technical Paper No 341: 119pp.

BOWind (2008) Barrow Offshore Wind Farm Post Construction Monitoring Report. First annual report. 15 January 2008, 60pp.

Boyle P.R., Pierce G.J., Hastie, L.C. (1995) Flexible reproductive strategies in the squid Loligo forbesi. Marine Biology 121: 501-508.

Brand, A. R. (2006) Scallop ecology: distribution and behaviour In: "Scallops: biology ecology and aquaculture". S.E. Shumway and G. J. Parsons (eds), Elsevier Press, 651-744. Accessible at http://books.google.co.uk.

Brawn, V. M. (1961) Sound production by the cod (Gadus callarias L.). Behaviour, 18: 239–245. Cited in Nordeile & Kjellsby 1999.

BSI (2015). PD 6900:2015. Environmental impact assessment for offshore renewable energy projects – Guide.

Bult, T. P., and Dekker, W. (2007) Experimental field study on the migratory behaviour of glass eels (Anguilla anguilla) at the interface of fresh and salt water. – ICES Journal of Marine Science, 64: 1396–1401.

Byrne Ó Cléirigh Ltd, Ecological Consultancy Services Ltd (EcoServe) and School of Ocean and Earth Sciences, University of Southampton (2000) Assessment of Impact of Offshore Wind Energy Structures on the Marine Environment. Prepared for the Marine Institute.

Calderwood, W. L. (1914) Salmon Research in 1914- sea netting results. Fisheries Scotland, Salmon, Fish. 1914. No. III. In- Malcolm, I.A., Godfrey, J. and Youngson, A.F. 2010. Review of migratory routes and behaviour of Atlantic salmon, sea trout and European eel in Scotland's coastal environment: Implications for the development of marine renewable. Environmental Research Institute, Thurso. Published by Marine Scotland Science. ISSN: 2043-7722.

Calderwood, W.L. (1915) Salmon Research in 1915- sea netting results. Fisheries Scotland, Salmon, Fish. 1915. No. I. In- Malcolm, I.A., Godfrey, J. and Youngson, A.F. 2010. Review of migratory routes and behaviour of Atlantic salmon, sea trout and European eel in Scotland's coastal environment: Implications for the development of marine renewable. Environmental Research Institute, Thurso. Published by Marine Scotland Science. ISSN: 2043-7722.Carlsen *et al*., 2004.

Camhi, M., Fowler, S., Musick, J., Brautigam A. And Fordham S. (1998) Sharks and their relatives: Ecology and Conservation. Occasional Paper of the IUCN Species Survival Commission Occas. Pap. No. 20.

Campbell, A., and Stasko, A. B. (1985) Movements of tagged American lobster, Homarus americanus, off southwestern Nova Scotia. Canadian Journal of Fisheries and Aquatic Sciences, 42: 229–238.

Campbell, R. and McLay, A. (2007) The Moray Firth Squid Fishery 2006. Fisheries Research Services Internal Report No 15/07. RSE 2004. The Royal society of Edinburgh. Inquiry into the future of the Scottish Fishing Industry.

Centre for Environment, Fisheries and Aquaculture Science (Cefas) (2004) Offshore Wind Farms: Guidance Note for Environmental Impact Assessment in Respect of Food and Environmental Protection Act (FEPA) and Coast Protection Act (CPA) Requirements: Version 2.

Cefas (2009) Strategic Review of Offshore Wind Farm Monitoring Data Associated with FEPA Licence Conditions. Project ME1117. July 2009.

Cefas (2011) ANGLERFISH in the South West of the British Isles (ICES Division VIIb-k and VIIIa,b) – 2009. Available online at http://www.cefas.co.uk/media/311369/anglerfish.pdf.

Cefas (2009) Strategic Review of Offshore Wind Farm Monitoring Data Associated with FEPA Licence Conditions. Benthic Ecology Contract. ME1117. (Bioconsult, 2006).

Chung-Davidson., Y., Bryan, M.B., Teeter, J., Bedore, C.N., and Li, W. (2008) Neuroendocrine and Behavioural Responses to Weak Electric Fields in Adult Sea Lampreys (Petromyzon marinus). Hormones and Behaviour, 54(1), 34-40.

CIEEM (2010) Guidelines for Ecological Impact Assessment in Britain and Ireland. Marine and Coastal. Final Document.

CIEEM (2016) Guidelines for Ecological Impact Assessment in the UK and Ireland. Terrestrial, Freshwater and Coastal. Chartered Institute of Ecology and Environmental Management. Second Edition. January 2016.

Centre for Marine and Coastal Studies (CMACS) (2003) A Baseline Assessment of Electromagnetic fields Generated by Offshore Wind farm Cables. Report No. COWRIE EMF-01-2002, 66. Centre for Marine and Coastal Studies, Birkenhead, UK.

Collins, M. A., Pierce, G. J., and Boyle, P. R. (1997) Population indices of reproduction and recruitment in *Loligo forbesi* (Cephalopoda: Loliginidae) in Scottish and Irish waters. Journal of Applied Ecology, 34: 778 – 786.

Comeau, M., and Savoie, F. (2002) Movement of American lobster (*Homarus americanus*) in the southwestern Gulf of St Lawrence. Fishery Bulletin US, 100: 181–192.

Coull, K. A., Johnstone, R and Rogers, S. I. (1998) Fishery Sensitivity Maps in British Waters. Published and distributed by UKOOA Ltd.

Creutzberg, F., (1958) Use of tidal streams by migrating elvers (*Anguilla vulgaris* Turt.). Nature, 181: 357– 358. Cited in Bult & Dekker 2007.

Creutzberg, F. (1961) On the orientation of migrating elvers (*Anguilla vulgaris* Turt.) in a tidal area. Netherlands Journal of Sea Research, 1: 257– 338. Cited in Bult & Dekker 2007.

Danish Energy Agency (2013) Danish Offshore Wind. Key Environmental Issues - a Follow-up. The Environmental Group: The Danish Energy Agency, The Danish Nature Agency, DONG Energy and Vattenfall.

Daverat, F., Limburg, K.E., Thibault, I., Shiao, J.-C., Dodson, J.J., Caron, F., Tzeng, W.-N., Iizuka, Y. & Wickström, H. (2006) Phenotypic plasticity of habitat use by three temperate eel species, *Anguilla anguilla*, *A. japonica* and *A. rostrata*. Marine Ecology Progress Series, 308, 231-241. Cited in Malcolm *et al* 2010.

Davidsen, J.G., Plantalech Manel-la, N., Økland, F., Diserud, O.H., Thorstad, E.B., Finstad, B. Sivertsgård, R., McKinley, R.S., Rikardsen, A.H. (2008) Changes in swimming depths of Atlantic salmon *Salmo salar* post-smolts relative to light intensity. Journal of Fish Biology, 73 (4), 1065-1074.

De Groot, S. J., (1980) The consequences of marine gravel extraction on the spawning of herring, *Clupea harengus* Linné. Journal of Fish Biology, 16: 605 – 611.

DECC (2016a) UK Offshore Energy Strategic Environmental Assessment 3 (OESEA3). Appendix 1a.4 Fish and Shellfish.

Deelder, C. L. (1958) On the behaviour of elvers (*Anguilla vulgaris* Turt.) migrating from the sea into fresh water. Journal du Conseil Permanent International pour l'Exploration de la Mer, 24: 135– 146. Cited in Bult & Dekker 2007.

Defra (2010) Eel Management plans for the United Kingdom Scotland River Basin District. March 2010.

Desprez, M. (2000) Physical and biological impact of marine aggregate extraction along the French coast of the eastern English Channel: short and long-term post-dredging restoration. ICES Journal of Marine Science 57, 1428-1438.

Dulvy, N.K., Notobartolo di Sciara, G., Serena, F., Tinti, F., Ungaro, N., Mancusi, C. & Ellis, J. (2006) Dipturus batis. In: IUCN 2007. IUCN Red List of Threatened Species.

Elliott, J.M. (1994) Quantitative Ecology and the Brown Trout. Oxford Series in Ecology and Evolution, Oxford. University Press, Oxford.

Ellis, J.R., Cruz-Martínez, A., Rackham, B.D., and Rogers, S.I. (2005) The Distribution of Chondrichthyan Fishes Around the British Isles and Implications for Conservation. J. Northw. Atl. Fish. Sci., 35: 195-213. doi:10.2960/J.v35.m485

Ellis, J.R., Doran, S., Dunlin, G., Hetherington, S., Keable, J. and Skea, N. (2010b) Programme 9: Spurdog in the Irish Sea. Final Report.

Ellis, J.R., Milligan, S., Readdy, L., South, A., Taylor, N., and Brown, M. (2010a) Mapping spawning and nursery areas of species to be considered in Marine Protected Areas (Marine Conservation Zones).

Ellis, J.R., Milligan, S.P., Readdy, L., Taylor, N. and Brown, M.J. (2012) Spawning and Nursery Grounds of Selected Fish Species in UK Waters. Sci. Ser. Tech. Rep., Cefas Lowestoft, 147: 56 pp. ICES, (2009) Report of the ICES Advisory Committee 2009. ICES Advice, 2009. Book 6, 236 pp.

EMU (2004) Subsea Cable Decommissioning – A Limited Environmental Appraisal. Report commissioned by British Telecommunications plc, Cable and Wireless and AT&T, Report no. 04/J/01/06/0648/0415, available from UKCPC.

EMU (2008a) Barrow Offshore Wind Farm Monopile Ecological Survey. Report No 08/J/1/03/1321/0825. Report prepared on behalf of Narrow Offshore Wind Ltd. December 2008.

EMU (2008b) Kentish Flats Offshore Wind Farm Turbine Foundation Faunal Colonisation Diving Survey. Report No 08/J/1/03/1034/0839. Prepared on behalf of Kentish Flats Ltd. November 2008.

Enger, P.S. (1967) Hearing in herring. Comp. Biochem. Physiol. 22, 527-538. Cited in de Groot (1980).

European Commission (1999). Guidelines for the Assessment of Indirect and Cumulative Impacts as well as Impact Interactions.

FAO (2011) Available online http://www.fao.org.

Farcas, A., Thompson, P. M., & Merchant, N. D. (2016) Underwater noise modelling for environmental impact assessment. Environmental Impact Assessment Review, 57, 114-122.

Filina, E.A., Khlivnoy, V.N., and Vinnichenko, V.I. (2009) The reproductive biology of haddock (*Mellanogrammus aeglefinus*) at the Rockall Bank. J. Northw. Atl. Fish. Sci., 40: 59–73. doi:10.2960/J. v40.m639.

Finstad, B., Økland, F., Throstad, E.B., BjØrn, A.B. and McKinley, R.S. (2005) Migration of hatchery reared Atlantic salmon and wild anadromous brown trout post-smolts in a Norwegian fjord system. Journal of Fish Biology. 66 (1) 86-96.

Fleming, I.A. (1996) Reproductive strategies of Atlantic salmon: Ecology and evolution. Reviews in Fish Biology and Fisheries 6:379–416.

Fox, C.J., Taylor, M., Dickey-Collas, M., Fossum, P., Kraus, G., Rohlf, N., Munk, P., van Damme, C.J., Bolle, L.J., Maxwell, D.L. and Wright, P.J. (2008) Mapping the spawning grounds of North Sea cod (*Gadus morhua*) by direct and indirect means. Proc Biol Sci. 2008 Jul 7; 275(1642):1543-8.

Franklin A., Pickett G. D., Connor P. M. (1980) The Scallop and its fishery in England and Wales. Laboratory leaflet No. 51.

Fraser, P.J. (1987) *Salmo salar* L. Feed in Scottish coastal waters. Aquaculture Research. 18 (3): 243- 247.

Frederiksen M, Edwards M, Richardson AJ, Halliday NC & Wanless S. (2006). From plankton to top predators: bottom-up control of a marine food web across four trophic levels. Journal of Animal Ecology 75: 1259-1268.

Fudge, S. B., and Rose, G. A. (2009) Passive- and active-acoustic properties of a spawning Atlantic cod (*Gadus morhua*) aggregation. – ICES Journal of Marine Science, 66: 1259–1263.

Gauld, J.A., and Hutcheon, J.R. (1990) Spawning and fecundity in the lesser sandeel, *Ammodytes marinus Raitt*, in the northwestern North Sea. Journal of Fish Biology, 36: 611e613.

Gibb, F.M, Gibb, I.M and Wright, P.J. (2007) Isolation of Atlantic cod (*Gadus morhua*) nursery areas. Marine Biology: 1185-1194. Cited in Gibb *et al* (2008).

Gibb, F.M, Wright, P.J., Gibb, I.M. and O'Sullivar, M. (2004) Haddock and whiting spawning areas in the North Sea and Scottish West coast. Fisheries Research Services Internal Report No 11/04.

Gibb, I.M., Wright, P.J., and Campbell, R. (2008) Identifying Critical Spawning and Nursery Areas for North Sea Cod; Improving The Basis for Cod Management. Scottish Industry/Science Partnership (SISP) Report No 03/08.

Gill, A. B. and Bartlett, M. (2010) Literature Review on the Potential Effects of Electromagnetic Fields and Subsea Noise from Marine Renewable Energy Developments on Atlantic Salmon, Sea Trout and European Eel. Scottish Natural Heritage, Commissioned Report No. 401. (Sutton and Boyd, 2009).

Gill, A. B., Gloyne-Phillips, I., Neal, K. J. and Kimber, J. A. (2005) The Potential Effects of Electromagnetic Fields Generated by Sub-Sea Power Cables Associated with Offshore Wind Farm Developments on Electrically and Magnetically Sensitive Marine Organisms – A Review. COWRIE 1.5 Electromagnetic Fields Review.

Gill, A.B. and Taylor. H. (2001) The Potential of Electromagnetic Fields Generated by Cabling between Offshore Wind Turbines upon Elasmobranch Fishes. Report for the Countryside Council for Wales (CCW Science report No. 488) 60pp.

Gill, A.B., Huang, Y., Gloyne-Philips, I., Metcalfe, J., Quayle, V., Spencer, J. and Wearmouth, V. (2009) COWRIE 2.0 Electromagnetic Fields (EMF) Phase 2: EMF-Sensitive Fish Response to EM Emissions from Sub-Sea Electricity Cables of the Type used by the Offshore Renewable Energy Industry. COWRIE-EMF-1-06.

Godfrey, J.D., Stewart, D.C., Middlemas, S.J. & Armstrong, J.D. (2014). Depth use and movements of homing Atlantic salmon (*Salmo salar*) in Scottish coastal waters in relation to marine renewable energy development. Scottish Marine and Freshwater Science Vol 05, No 18.

Godfrey, JD Stewart, DC Middlemas, SJ and Armstrong, JD (2015) Depth use and migratory behaviour of homing Atlantic salmon (Salmo salar) in Scottish coastal waters. ICES Journal of Marine Science, 72: 568–575

González-Irusta, J. M., & Wright, P. J. (2015) Spawning grounds of Atlantic cod (*Gadus morhua*) in the North Sea. ICES Journal of Marine Science, 73(2), 304-315.

González-Irusta, J. M., & Wright, P. J. (2016) Spawning grounds of haddock (*Melanogrammus aeglefinus*) in the North Sea and West of Scotland. Fisheries Research, 183, 180-191.

González-Irusta, J. M., & Wright, P. J. (2017) Spawning grounds of whiting (*Merlangius merlangus*). Fisheries Research, 195, 141-151.

Hall, S.J. (1993) Pit-digging by the crab *Cancer pagurus*: a test for long-term, large scale effects on infaunal community structure. Journal of Animal Ecology 62, 59-66. Cited in Mill *et al* 2009.

Hansen, L.P. and Jacobsen J.A. (2003) Origin and migration of wild and escaped farmed Atlantic salmon, *Salmo salar* L., in oceanic areas north of the Faroe Islands. ICES Journal of Marine Science. 60: 110-118.

Hansen, L.P. and Jonsson, B. (1985) Downstream migration of hatchery reared smolts of Atlantic salmon (*Salmo salar* L.) in the River Imsa, Norway, Aquaculture 45 (1985), pp. 237–248.

Harding, D., Nichols, J.H., and Tungarte, D.S. (1978) The spawning of plaice (*Pleuronectes platessa* L.) in the southern North Sea and North Sea plaice SSB using the annual egg production method 2009 Conseil International pour l'Exploration de la Mer, 172: 102–113. Cited in van Damme *et al* 2009.

Harding, H., Bruintjes, R., Radford A.N. and Simpson S.D. (2016) Measurement of Hearing in the Atlantic salmon (Salmo salar) using Auditory Evoked Potentials, and effects of Pile Driving Playback on salmon Behaviour and Physiology Scottish Marine and Freshwater Science Report Vol 7 No 11.

Hart, P.J.B., Blyth, R.E., Kaiser, M.J. and Jones, G.E. (2004) Sustainable Exploitation with Minimal Conflict: Is It Possible? In: Who owns the sea? (Who owns the sea workshop proceedings, Tjarno, Sweden, 24 - 27 June 2002), M. Johnson and C. Wheatley eds.

Hawkins, A. (2006) Effects on fish of pile driving, wind turbines, and other sources. J. Acoust. Soc. Am., 119, pp. 3283.

Hawkins, A. (2009) The impact of pile driving upon fish. Proc. Inst. Acoustics, vol.31. pt.1, pp. 72-79.

Hawkins, A. D. and Popper, A. N. (2016) A sound approach to assessing the impact of underwater noise on marine fishes and invertebrates. ICES Journal of Marine Science, 74 (3): 635-651.

Hawkins, A. D., and Amorim, M.C.P. (2000) Spawning sounds of the male haddock, *Melanogrammus aeglefinus*. Environmental biology of fishes. Volume 1 / 1976 - Volume 91 / 2011.

Hawkins, A. D., Pembroke, A. E., and Popper A., N. (2014b) Information gaps in understanding the effects of noise on fishes and invertebrates, Rev. Fish Biol. Fisheries, http://dx.doi.org/10.1007/s11160-014-9369-3, Springer International Publishing.

Hawkins A.D. & Johnstone A.D.F. (1978). The hearing of the Atlantic salmon, *Salmo salar*. Journal of Fish Biology, 13, 655-673.

Hawkins, A. D., Roberts L., and S. Cheesman (2014a) Responses of free-living coastal pelagic fish to impulsive sounds, J. Acoust. Soc. Am., 135, PP3101-3116.

Heath, M. and Gallego, A. (1997) From the biology of the individual to the dynamics of the population: bridging the gap in fish early life stages. J Fish Biol (Suppl. A):1–29. Cited in Gibb *et al* (2007).

Heath, M., Leaver, M., Matthews, A., and Nicoll, N. (1989) Dispersion and feeding of larval herring (*Clupea harengus* L.) in the Moray Firth during September 1985. Estuar. Coast. Shelf Sci. Vol. 28. 549-566.

Hedger, R., McKenzie, E., Heath, M., Wright, P., Scott, B., Gallego, A., and Andrews, J. (2004) Analysis of the spatial distributions of mature cod (*Gadus morhua*) and haddock *Melanogrammus aeglefinus*) abundance in the North Sea (1980-1999) using generalised additive models. Fisheries Research 70(1): 17-25.

Hendry, K. and Cragg-Hine, D. (2003) Ecology of the Atlantic Salmon. Conserving Natura 2000 Rivers Ecology Series no.7. English Nature. Peterborough.

Hinrichsen, H.H., Kraus, G., Voss, R., Stepputtis, D., and Baumann, H. (2005) The general distribution pattern and mixing probability of Baltic sprat juvenile populations. Journal of Marine Systems, 58: 52–66.

Hodgson, W.C. (1957) The herring and its fishery. London, Routledge and Kegan Paul.

Høgåsen, H.R. (1998) Physiological Changes Associated with the Diadromous Migration of Salmonids. Canadian Special Publication of Fisheries and Aquatic Science 127. ISSN 0706-6481: no. 127.

Holden, M.J. (1974) Problems in the rational exploitation of elasmobranch populations and some suggested solutions. Sea Fisheries Research (F. R. Harden Jones, ed). Elek: London 117-137.

Holland, G. J., Greenstreet, S. P. R., Gibb, I. M., Fraser, H. M. and Robertson, M. R. (2005) Identifying Sandeel *Ammodytes marinus* Sediment Habitat Preferences in the Marine Environment. Mar. Ecol. Prog. Ser., 303, pp. 269-282.

Holland, G. J., Greenstreet, S. P. R., Gibb, I. M., Fraser, H. M. and Robertson, M. R. (2005) Identifying Sandeel *Ammodytes marinus* Sediment Habitat Preferences in the Marine Environment. Mar. Ecol. Prog. Ser., 303, pp. 269-282.

Holm, M., Holst, J.C., Hansen, L.P., Jacobsen, J.A., Ó Maoiléidigh N. and Moore, A. (2003). Migration and distribution of Atlantic salmon post-smolts in the North Sea and North East Atlantic. In: Mills, D. Salmon at the Edge. Oxford: Blackwell Science; 2003. p. 7-23. 307 pp.

Holm, M., Jacobsen, J.A., Sturlaugsson, J. and Holst, J.C. (2005) Preliminary results from DST tagging of salmon in the Norwegian Sea ICES, WGNAS 2005: Working paper 13.

Howard, A. E. and Nunny, R. S. (1983) Effects of near-bed current speeds on the distribution and behaviour of the lobster, Homarus gammarus (L.). J. Cons. Int. Explor. Mer. 71, 27 - 42.

Howard, F.G. (1989) The Norway Lobster. Scottish Fisheries Information Pamphlet Number 7 1989 (Second Edition) ISSN 03099105.

Howell, T.R.W., Davis, S.E.B., Donald, J., Dobby, H., Tuck, I. And Bailey, N. (2006) Report of marine laboratory scallop stock assessments. Fisheries Research Services Internal Report No 08/06.

http://www.atlanticsalmontrust.org/salmon-and-sea-trout-facts/. Accessed on 15/01/18.

Huang, Y. (2005) Electromagnetic Simulations of 135-kV Three phase Submarine Power Cables. Centre for Marine and Coastal Studies, Ltd. Prepared for Sweden Offshore.

Hunter, E., Metcalfe, J.D. and Reynolds, J.D. (2003) Migration route and spawning area fidelity by North Sea plaice. Proceedings of the Royal Society of London B, 270. pp. 2097-2103.

Hvidsten, N.A., Jensen, A.J., Rikardsen, A.H., Finstad, B., Aure, J., Stefansson, S., Fiske, P., Johnsen, B. O. (2009) Influence of sea temperature and initial marine feeding on survival of Atlantic salmon Salmo salar post-smolts from the Rivers Orkla and Hals, Norway. Journal of Fish Biology 74, 1532–1.

Hvidsten, N.A., Jensen, A.J., Viva¨s H., Bakke, Ø., and Heggberget, T.G. (1995) Downstream migration of Atlantic salmon smolts in relation to water flow, water temperature, moon phase and social interaction. Nordic Journal of Freshwater Research 70:38–48.

Hvidt, C. B., Bech, M., & Klaustrup, M. (2003). Monitoring programme-status report 2003. Fish at the cable trace. Nysted offshore wind farm at Rødsand. Bioconsult.

ICES (2005a) Spawning and life history information for North Atlantic cod stocks. ICES Cooperative Research Report, No. 274. 152 pp.

ICES (2005b) Report of the Planning Group on North Sea Cod and Plaice Egg Surveys in the North Sea (PGEGGS), 10–12 May 2005, Lowestoft, UK. ICES CM 2005/G:11. 85 pp.

ICES. 2013. Report of the ICES Advisory Committee 2013. ICES Advice, 2013. Book 6, 421 pp.ICES (2017) Report of the Working Group on Elasmobranch Fishes (WGEF), 31 May– 7 June 2017, Lisbon, Portugal. ICES CM 2017/ACOM:16.

Inger, R., Attril, M.J., Bearhop, S., Broderick, A.C., Grecian, W.J., Hodgson, D.J., Mills, C., Sheehan, E., Votier, S.C., Witt, M.J., and Godley, B.J. (2009) Marine Renewable Energy: Potential Benefits to Biodiversity? An Urgent Call for Research. Journal of Applied Ecology, 46, 1145-1153.

Jakpsstovu, S.H. (1986) In- Malcolm, I.A., Godfrey, J. and Youngson, A.F. 2010. Review of migratory routes and behaviour of Atlantic salmon, sea trout and European eel in Scotland's coastal environment: Implications for the development of marine renewable. Environmental Research Institute, Thurso. Published by Marine Scotland Science. ISSN: 2043-7722.

Jakupsstovu, S.H. (1988) Exploitation and migration of salmon in Faroese waters. In- Hansen L.P., Friedland K.D., Holm M., Holst J.C and Jacobsen J.A. 2002. Temporal and Spatial Migration and Distribution of Atlantic Salmon, *Salmo salar* L., in the Northeast Atlantic Ocean. NPAFC technical Report No.4.

Jensen, H., Kristensen, P.S., Hoffmann, E. (2004) Sandeels in the wind farm area at Horns Reef. Report to ELSAM, August 2004. Danish Institute for Fisheries Research, Charlottenlund.

Jensen, H., Rindorf, A., Wright, P.J. and Mosegaard, H. (2010) Inferring the location and scale of mixing between habitat areas of lesser sandeel through information from the fishery. ICES Journal of Marine Science, 68 (1), p42.

Jessop, R.W., Woo, J.R. and Torrice, L. (2007) Research report. Eastern Sea Fisheries Joint Committee.

JNCC. (2010) Atlantic salmon. Available online at: http://www.jncc.gov.uk/ProtectedSites/SACselection/species.asp?FeatureIntCode=S1106. Accessed on 15/01/18.

Jones, G., Gibson, P., Dobby, H. and McLay, A. (2010) Brown Crab (*Cancer pagurus*) Migrations off the Northern Scottish Coast. Scottish Industry Science Partnership Report 02/10.

Judd, A. (2012) Guidelines for data acquisition to support marine environmental assessments of offshore renewable energy projects. Cefas contract report: ME5403 – Module 15 submitted to Defra and the MMO.

Kelly, F.L. and King, J.J. (2001) A review of the ecology and distribution of three lamprey species, *Lampetra fluviatilis* (L), *Lampetra planeri* (L.), and Petromyzon marinus (L.): a context for conservation and biodiversity considerations in Ireland. Biology and Environment: Proceedings of the Royal Irish Academy. 101B(3):165-185.

Keltz, S., Bailey N. (2010) Fish and Shellfish stocks 2010. Marine Scotland, the Scottish Government. ISSN 2044-0359.

Kinnear, J.A.M. and Mason, J. (1987) A preliminary study of an unfished population of the velvet swimming crab Liocarcinus puber (L.). International Council for the Exploration of the Sea (CM Papers and Reports), (Shellfish and Benthos Committee), CM 1987/K:6, 10pp (Cited in in Jessop *et al* 2007).

Kraus, G. and Köster, F. W. (2001) Duration, frequency and timing of sprat spawning in the Central Baltic: An analysis based on gonadal maturity. ICES CM 2001/J:25.

Krone, R. Gutowa, L. Joschko, TJ. Schröder, A. (2013) Epifauna dynamics at an offshore foundation Implications of future wind power farming in the North Sea. Marine Environmental Research, 85, 1-12.

Lacroix, G. L. and McCurdy, P. (1996) Migratory behaviour of post-smolt Atlantic salmon during initial stages of seaward migration. Journal of Fish Biology 49(6): 1086-1101.

Lacroix, G. L., McCurdy, P., Knox, D. (2004) Migration of Atlantic Salmon Postsmolts in Relation to Habitat Use in a Coastal System. Transactions of the American Fisheries Society 133(6): 1455-1471.

Lacroix, G.L. and Knox, D. (2005) Distribution of Atlantic salmon (*Salmo salar*) postsmolts of different origins in the Bay of Fundy and Gulf of Maine and evaluation of factors affecting migration, growth and survival. Canadian Journal of Fisheries and Aquatic Sciences. 62(6):1363-1376.

Lacroix, G.L., Knox, D. and Stokesbury, M.J.W. (2005) Survival and behaviour of post-smolt Atlantic salmon in coastal habitat with extreme tides. Journal of Fish Biology 66.485-498.

Lambert, T.C. (1987) Duration and intensity of spawning in herring *Clupea harengus* as related to the age structure of the mature population. Mar. Ecol. Prog. Ser. Vol. 39: 209-220. 1.

Langham, N. P. E. (1971) The distribution and abundance of larval sand-eels (Ammodytidae) in Scottish waters. Journal of the Marine Biological Association of the United Kingdom, 51: 697e707. Cited in Jensen *et al* 2003.

Laughton, R., and Burns, S. (2003) Assessment of sea lamprey distribution and abundance in the River Spey: Phase III. Scottish Natural Heritage Commissioned Report No. 043 (ROAME No. F02AC604).

Lenhardt M.L. & Sismour, E. (1995). Hearing in the sea lamprey (*Petromyzon marinus*) and the long nose gar (Lepisosteus spatula). 1995, 259, Session I3, Poster Abstract.

Lindeboom, H.J., Kouwenhoven, H.J., Bergman, M.J.N., Bouma, S., Brasseur, S., Daan, R., Fijn, R.C. de Haan, D., Dirksen, S., van Hal, R., Hille Ris Lambers, R., ter Hofstede, R., Krijgsveld, K.L., Leopold, M. and Scheidat, M. (2011) Short-term ecological effects of an offshore wind farm in the Dutch coastal zone; a compilation. Environmental Research Letters, Volume 6, Number 3.

Lindegren M, Diekmann R & Möllmann C (2010). Regime shifts, resilience and recovery of a cod stock. Marine Ecology Progress Series 402: 239-253.

Linley, E.A.S., Wilding, T.A., Black, K., Hawkins, A.J.S. and Mangi S. (2007) Review of the Reef Effects of Offshore Wind Farm Structures and their Potential for Enhancement and Mitigation. Report from PML Applications Ltd and the Scottish Association for Marine Science to the Department for Business, Enterprise and Regulatory Reform (BERR), Contract No: RFCA/005/0029P.

Lothian AJ, Newton M, Barry, J, Walters M, Miller RC and Adams CE (2017) Migration pathways, speed and mortality of Atlantic salmon (Salmo salar) smolts in a Scottish river and the near-shore coastal marine environment. Ecology of Freshwater Fish.

Lum-Kong, A., Pierce, G. J., and Yau, C. (1992) Timing of spawning and recruitment in *Loligo forbesi* Steenstrup (Cephalopoda: Loliginidae) in Scottish waters. Journal of the Marine Biological Association of the UK, 72: 301 – 311.

Macer, C.T. (1965) The distribution of larval sand eels (Ammodytidae) in the southern North Sea. Journal of the Marine Biological Association of the United Kingdom, 45: 187e207. Cited in Jensen *et al* 2003.

Madsen, P. T. (2005) Marine Mammals and Noise: Problems with Root Mean Square Sound Pressure for Transients", J. Acoust. Soc. Am., 117, pp. 3952-3956.

Maes, J. Turnpenny, A. W. H. Lambert D. R. Nedwell J. R. Parmentier A. and Ollevier F. (2004). Field evaluation of a sound system to reduce estuarine fish intake rates at a power plant cooling water inlet. Journal of Fish Biology Volume 64 Issue 4,938–946.

Maitland, P.S, and Lyle, A.A. (1995) Shad and smelt in the Cree Estuary, SW Scotland. Report to Scottish Natural Heritage, Edinburgh.

Maitland, P.S. (2003) Ecology of the River, Brook and Sea Lamprey. Conserving Natura 2000 Rivers Ecology Series No. 5. English Nature, Peterborough.

Maitland, P.S. (2003) The status of smelt *Osmerus eperlanus* in England. English nature research reports. Report number 516. ISSN 0967-876X.

Maitland, P.S., and Hatton-Ellis T.W. (2003) Ecology of the Allis and Twaite Shad. Conserving Natura 2000 Rivers Ecology Series No. 3. English Nature, Peterborough.

Malcolm, I.A., Godfrey, J. And Youngson, A.F. (2010) Review of migratory routes and behaviour of Atlantic salmon, sea trout and European eel in Scotland's coastal environment: implications for the development of marine renewable. Scottish Marine and Freshwater Science Vol 1 No 14.

Malcolm, I, A., Millar, C. P. and Millidine, K. J. (2015) Spatio-temporal variability in Scottish smolt emigration times and sizes. Scottish Marine and Freshwater Science. Volume 6 Number 2 http://www.gov.scot/Resource/0047/00472202.pdf.

Malme, C. I., Miles, P. R., Miller, G. W., Richardson, W. J., Reseneau, D. G., Thomson, D. H., Greene, C. R. (1989) Analysis and Ranking of the Acoustic Disturbance Potential of Petroleum Industry Activities and Other Sources of Noise in the Environment of Marine Mammals in Alaska, C. R., BBN Report No. 6945 OCS Study MMS 89-0005. Reb. From BBN Labs Inc., Cambridge, MA, for U.S. Minerals Managements Service, Anchorage, AK. NTIS PB90-188673.

Marine Management Organisation (2017) UK Sea Fisheries Statistics 2016. September 2017.

Marine Scotland (2010) Strategic Environmental Assessment (SEA) of Draft Plan for Offshore Wind Energy in Scottish Territorial Waters: Volume 1. Environmental Report

Marine Scotland (2017a). The Marine Works (Environmental Impact Assessment) (Scotland) Regulations 2017 (as amended). The Marine Works (Environmental Impact Assessment) Regulations 2007 (as amended). Scoping Opinion for the Proposed Marine Licence Application for Moray West Offshore Transmission Infrastructure. August 2017.

Marine Scotland (2017b). The Conservation (Natural Habitats, & c.) Regulations 1994. The Offshore Marine Conservation (Natural Habitats, &c.) Regulations, 2007. Offshore Habitats Regulations Appraisal Screening Opinion on the Moray West Offshore Wind Farm to be Located in the Outer Moray Firth Approximately 22 km South of the Caithness Coastline. October 2017.

Marschall, E., Quinn, T. Roff, D., Hutchings, J., Metcalfe, N., Bakke, T., Saunders, R. & Poff, N. (1998) A framework for understanding Atlantic salmon (*Salmo salar*) life history. Can.J.Fish.Aquat.Sci.55 (S1):48-58.

Maucorps, A. (1969) Biologie et peche du hareng en Mer du Nord, son exploitation rationelle. Science et Pêche, Bull. Insf. Pêches marif., no 186, novembre 1969.

McCauley, R. D., Fewtrell, J., Duncan, A. J., Jenner, C., Jenner, M-N., Penrose, J. D., Prince, R. I. T., Adhitya, A., Murdoch, J. and McCabe, K. (2000) Marine Seismic Surveys – A Study of Environmental Implications. Appea Journal, pp. 692-707.

McCleave, J. D., and Wippelhauser, G. S. (1987) Behavioral aspects on selective tidal stream transport in juvenile American eels. Transactions of the American Fisheries Society, 1: 138– 150. Cited in Bult & Dekker 2007.

McCormick S., Hansen L., Quinn T. and Saunders R. (1998). Movement, migration, and smolting of Atlantic salmon (*Salmo salar*). Can.J.Fish.Aquat.Sci. 55 (S1):77-92.

Meißner K, Schabelon H, Bellebaum J, and Sordyl H. (2006) Impacts of submarine cables on the marine environment: a literature review. Federal Agency of Nature Conservation/ Institute of Applied Ecology Ltd

Middlemas, S.J., Stewart, D.C., Mackay, S. and Armstrong, J.D. (2009) Use and dispersal of post-smolt sea trout Salmo trutta in a Scottish sea loch system. Journal of Fish Biology. 74(3):693-651.

Mill, A., Dobby, H., McLay, A. and Mesquita, C. (2009) Crab and lobster fisheries in Scotland: an overview and results of stock assessments, 2002-2005. Marine Scotland Science Internal Report 16/09.

Miller, J.H., Potty, G.R., Hui-Kwan, K. (2016). Pile-driving pressure and particle velocity at the seabed: quantifying effects on crustaceans and groundfish. In: Popper, A.N., Hawkins, A.D. (Eds.), The Effects of Noise on AQUATIC Life II. Springer, New York, NY, pp. 705–712.

Milligan, S. P. (1986) Recent studies on the spawning of sprat (*Sprattus sprattus* L.) in the English Channel. Fisheries Research Technical Report no. 83.

Mills D.H., Hadoke G.D.F., Shelton R.G.J and Read J.B.D. (2003) Atlantic Salmon Facts. Atlantic Salmon Trust Booklet. Prepared in 1986. Revised in 2003.

Moore A., Ives M., Scott M. and Bamber A. (1998b) The migratory behaviour of wild sea trout (*Salmo trutta* L.) smolts in the estuary of the River Conwy, North Wales. Aquaculture. 168 (1-4): 57-68.

Moore A., Ives S., Mead T.A. and Talks L. (1998a)The migratory behaviour of wild Atlantic salmon (*Salmo salar* L.) smolts in the River Test and Southampton Water, southern England. Hydrobiologia. 371-372: 295-304

Moore, J.A., Hartel, K.E. Craddock, J.E. and Galbraith, J.K. (2003) An annotated list of deepwater fishes from off the New England region, with new area records. Northeastern Naturalist 10(2):159–248.

Moray Offshore Renewables Ltd. (2010) Environmental Impact Assessment Scoping Report, Eastern Development Area: Offshore Wind Farm Infrastructure: Offshore Wind Turbines, Substations & Interarray Cables.

Moray Offshore Renewables Ltd. (2012) Environmental Statement: Telford, Stevenson, MacColl Wind Farms and Associated Transmission Infrastructure.

Moray West (2017). Moray West Offshore Habitats Regulations Appraisal. HRA Screening Report. September 2017.Moray Offshore Windfarm (West) Ltd.

MSS. (2003) The Changing Abundance of Spring Salmon. FWO 2/02/2003. Available online at: http://www.scotland.gov.uk/Uploads/Documents/FW02SpringSalmon.pdf. Accessed: 15/01/18.

MSS. (2010a) Sea trout. Marine Scotland Science online publications. Available online at: http://www.scotland.gov.uk/Topics/marine/marine-environment/species/fish/freshwater/seatrout. Accessed: 15/01/18.

MSS. (2010b) Marine Mortality rate in Atlantic salmon. Marine Scotland Topic Sheet no. 40.

Munro, J., Gauthier, D. and Gagné, J. A. (1998) Description d'une frayère de hareng (Clupea harengus L.) à l'île aux Lièvres dans l'estuaire moyen du Saint-Laurent. Rapp. tech. can. sci. I halieut. aquat. 2239 : vi + 34 p.

Murua H. nd Saborido-Rey F. (2003) Female Reproductive Strategies of Marine Fish Species of the North Atlantic.

Musick, J.A. (2005) Management Techniques for elasmobranch fisheries. FAO Fisheries Technical paper 474.

Nall, G.H. (1935) Sea-trout of the Montrose District. Part III – The migrations of Sea-Trout. Fisheries, Scotland, Salmon, Fish., 1935, No.III. In- Malcolm, I.A., Godfrey, J. and Youngson, A.F. 2010. Review of migratory routes and behaviour of Atlantic salmon, sea trout and European eel in Scotland’s coastal environment: Implications for the development of marine renewable. Environmental Research Institute, Thurso. Published by Marine Scotland Science. ISSN:2043-7722.

NBN Atlas. (2018a) Alosa alosa (Linnaeus, 1758) Allis shad. . Available online at: https://species.nbnatlas.org/species/NBNSYS0000188601 [Accessed on 15/01/2018]

NBN Atlas (2018b) *Margaritifera margaritifera* (Linnaeus, 1758) FREFreshwater pearl mussel. https://scotland-species.nbnatlas.org/species/NHMSYS0001702090 [Accessed on 26/04/2018].

Neal, K.J. & Wilson, E. (2008) Cancer pagurus Edible crab. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. Available from: http://www.marlin.ac.uk/species/detail/1179.

Nedwell, J. R., Parvin, S. J., Edwards, B., Workman, R., Brooker, A. G. and Kynoch, J. E. (2007) Measurement and Interpretation of Underwater Noise During Construction and Operation of Wind farms in UK waters, Subacoustech Report No. 544R0738 to COWRIE Ltd. ISBN: 978-0-9554279-5-4.

Newell, RC. Seiderer, LJ. Hitchcock, DR. (1998) The impact of dredging works in coastal waters: A review of the sensitivity to disturbance and subsequent recovery of biological resources on the sea bed. Oceanography and Marine Biology, 36, 127-178.

Nissling, A., Muller, A., Hinrichsen, H.H. (2003) Specific gravity and vertical distribution of sprat (Sprattus sprattus) eggs in the Baltic Sea. Fish Biol. 63, 280–299.

Nordeide, J. T. and Kjellsby, E. (1999) Sound from spawning cod at their spawning grounds. – ICES Journal of Marine Science, 56: 326–332.

Norman, C. P. and Jones, M. B. (1992) Influence of depth, season and moult stage on the diet of the velvet swimming crab Necora puber (Brachyura, Portunidae). Estuarine, Coastal and Shelf Science 34, 71-83.

Norman, C.P. and Jones, M.B. (1993) Reproductive ecology of the velvet swimming crab, Necora puber (Brachyura: Portunidae), at Plymouth. Journal of the Marine Biological Association of the United Kingdom, 73, 379-389. Cited in Jessop, RW, Lowry, M, Graves KM, 2007. Eastern Sea Fisheries District Research Report 2004. Kings Lynn. Eastern Sea Fisheries Joint Committee.

Normandeau (Normandeau Associates, Inc.), Exponent Inc., T. Tricas, T. and Gill, A. (2011) Effects of EMFs from Undersea Power Cables on Elasmobranchs and Other Marine Species. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Regulation, and Enforcement, Pacific OCS Region, Camarillo, CA.OCS Study BOEMRE 2011-09. [online] Available at: <http://www.gomr.boemre.gov/PI/PDFImages/ESPIS/4/5115.pdf.>

Öhman, M.C., Sigray, P. and Westerberg, H. (2007) Offshore Windmills and the Effects of Electromagnetic Fields on Fish. Ambio, 36: 630-633.

Orpwood, J.E., Fryer, R.J., Rycroft, P. & Armstrong, J.D (2015). Scottish Marine and Freshwater Science Vol 6 No 8. Effects of AC Magnetic Fields (MFs) on Swimming Activity in European Eels Anguilla.

OSPAR (2011) OSPAR's List of Threatened and/or Declining Species and Habitats. Available online at http://www.snh.gov.uk/docs/B469310.pdf.

Page, F. H. and Frank, K. T. (1989) Spawning time and egg stage duration in northwest Atlantic haddock (Melanogrammus aeglefinus) stocks with emphasis on Georges and Browns Bank. Can. 1. Fish. Aquat. Sci. 46(Suppl, I): 68-81.

Parrish, B.B., Saville, A., Craig, R.E., Baxter, I.G. and Priestley, R. (1959) Observations on herring spawning and larval distribution in the Firth of Clyth in 1958. J.mar.biol. Ass. U.K. (1959) 38,445-453.

Patberg, W., de Leeuw, J.J., Winter, H.V. (2005) Verspreiding van rivierprik, zeeprik, fint en elft in Nederland na 1970. Nederlands Instituut voor Visserij Onderzoek (RIVO) BV. Rapport Nummer: C004/05.

Pawson, M.G. (1995) Biogeographical identification of English Channel fish and shellfish stocks. Fisheries Research technical report No 99.

Payne, M. R. (2010) Mind the gaps: a state-space model for analysing the dynamics of North Sea herring spawning components. – ICES Journal of Marine Science, 67: 1939–1947.

Pearson, W. H., Skalski, J. R. and Malme, C. I. (1992) Effects of Sounds from a Geophysical Survey Device on Behaviour of Captive Rockfish (Sebastes spp.). Can. J. Fish. Aquat. Sci., 49, pp. 1343-1355.

Pemberton, R. (1976a). Sea trout in North Argyll Sea lochs, population, distribution and movements. Journal of Fish Biology. 9(2): 157-179

Pena, H., Handegard, N. O., and Ona, E. (2013) Feeding herring schools do not react to seismic air gun surveys. ICES Journal of Marine Science, 70: 1174–1180.

Petersen, JK. Malm, T. (2006) Offshore Windmill Farms: Threats to or possibilities for the marine environment. AMBIO, 35, 75-80.

Phua, C. van den Akker, S. Baretta, M. van Dalfsen, J. (2002) Ecological Effects of Sand Extraction in the North Sea. The North Sea Foundation.

Pierce G. J., Boyle P.R., Hastie L.C. and Kye, L. (1994) The life history of *Loligo forbesi* (Cephalopoda: Loliginidae) in Scottish waters. Fisheries Research 21 (1994) 17-41.

Plantalech manel-la, N., Chittenden, C. M., ØKland, F., Thorstad, E. B., Davidsen, J. G., Sivertsgård, R., McKinley, R. S. and Finstad, B. 2011. Does river of origin influence the early marine migratory performance of *Salmo salar*?. Journal of Fish Biology, no. doi: 10.1111/j.1095-8649.2010.02882.x

Popper, A. N. and Hastings, M. C. (2009). The Effects of Anthropogenic Sources of Sound on Fishes. Journal of Fish Biology, 75, pp. 455-489.

Popper, A. N., Hawkins, A. D., Fay, R. R., Mann, D., Bartol, S., Carlson, Th., Coombs, S., Ellison, W. T., Gentry, R., Hal vorsen, M. B., Lokkeborg, S., Rogers, P., Southall, B. L., Zeddies, D. G. and Tavolga, W. N. (2014) ASA S3/SC1.4 TR-2014 Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI. Springer and ASA Press, Cham, Switzerland.

Popper, A. N., Salmon, M. and Horch, K. W. (2001) Acoustic detection and communication by decapod crustaceans. Journal of Comparative Physiology A, 187 (2): 83-89.

Potter, E.C. (1988). Movements of Atlantic salmon, *Salmo salar* L., in an estuary in south-west England. Journal of Fish Biology. 33 (Supplement A): 153-1 59.

Potter, E.C., and Dare, P.J. (2003). Research on migratory salmonids, eel and freshwater fish stocks and fisheries. Sci. Ser. Tech Rep., CEFAS, 119: 64pp.

Potter, E.C., and Ó Maoiléidigh, N. (2006). Review of Mixed Stock Fisheries for Atlantic Salmon in European Community Waters, excluding the Baltic Sea.

Pratten, D. J., and Shearer, W. M. (1983) The Migrations of North Esk Sea Trout. Aquaculture Research, 14: 99–113.

Putman, N.F. , Lohmann, KJ, Putman, EM, Quinn,TP, Klimley, AP and Noakes, DLG (2013) Evidence for Geomagnetic Imprinting as a Homing Mechanism in Pacific Salmon. Current Biology 23, 312–316

Putman, N.F.,Scanlan, M.M., Billman, E.J., O'Neil, J.P., Couture, R.B., Quinn, T.P., Lohmann, K.J. and Noakes, D. L. G. (2014) An Inherited Magnetic Map Guides Ocean Navigation in Juvenile Pacific Salmon. Current Biology 24, 446–450

Putman, N. F., 2015. Inherited Magnetic Maps in Salmon and the Role of Geomagnetic Change Integrative and Comparative Biology, volume 55, number 3, pp. 396–405

Radford, CA, Montgomery, JC, Caiger P and Higgs DM (2012) Pressure and particle motion detection thresholds in fish: a re-examination of salient auditory cues in teleosts. The Journal of Experimental Biology 215, 3429-3435

Rijnsdorp, A. D. (1989) Maturation of male and female North Sea plaice (*Pleuronectes platessa* L). - J. Cons. int. Explor. Mer, 46: 35-51.

Rikardsen, A.H., Diserud, O.H., Elliott, J.M., Dempson, J.B., Sturlaugsson, J. and Jensen, A.J. (2007) The marine temperature and depth preferences of Artic charr (*Salvelinus alpines*) and sea trout (*Salmo trutta*), as recorded by data storage tags. Fisheries Oceanography. 16(5):436-447.

Roberts L and Elliott M (2017) Good or bad vibrations? Impacts of anthropogenic vibration on the marine epibenthos. Science of the Total Environment 595:255-268.

Roberts, L. (2015) Behavioural responses by marine fishes and macroinvertebrates to underwater noise (Doctoral dissertation, University of Hull).

Roberts, L., Cheesman, S., Elliott, M., and Breithaupt, T. (2016) Sensitivity of *Pagurus bernhardus* (L.) to substrate-borne vibration and anthropogenic noise. Journal of Experimental Marine Biology and Ecology, 474: 185–194.

Rocha F., Guerra A., González A.F. (2001) A review of reproductive strategies in cephalopods. Biol Rev. 76, 291-304.

Rodmell, D.P. and Johnson, M.L. (2003) The Development of Marine Based Wind Energy Generation and Inshore Fisheries in UK Waters: Are They Compatible? In: Who owns the sea?, (Who owns the sea workshop proceedings, Tjarno, Sweden, 24 - 27 June 2002), M. Johnson and C. Wheatley eds.

Rogers, S. and Stocks, R. (2001) North Sea Fish and Fisheries Technical Report TR_003 Strategic Environmental Assessment – SEA2 Cefas and FRS.

Russel, F.D. (1976) The eggs and planktonic stages of British marine fishes. Academic Press, London. 524 pp. In ICES, 2011b: ICES-Fishmap. Available online at http://www.ices.dk/marineworld/fishmap/ices/.

Sabatini, M. & Hill, J.M. (2008) *Nephrops norvegicus* Norway lobster. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. Available from: http://www.marlin.ac.uk/species/detail/1672.

Sand, O., Enger P. S., Karlsen H. E. and Knudesen, F. R. (2001) Detection of Infrasound in Fish and Behavioural Responses to Intense Infrasound in Juvenile Salmonids and European Silver Eels: A Mini Review, Am. Fish Soc. Symp. 26, pp. 183 - 193.

Scottish Natural Heritage (SNH)(2005). Cumulative Effects of Wind Farms. Version 2 Revised 13.04.05.

Shearer, W. M. (1990) North Esk Sea Trout. In Malcolm, I.A., Godfrey, J. and Youngson, A.F. 2010. Review of migratory routes and behaviour of Atlantic salmon, sea trout and European eel in Scotland's coastal environment: Implications for the development of marine renewable. Environmental Research Institute, Thurso. Published by Marine Scotland Science. ISSN:2043-7722.

Shelton, R.G.J, Holst, W.R., Turrel, W.R., MacLean, J.C., McLaren, I.S. and Nicoll, N.T. (1997). Records of post-smolt Atlantic salmon, *Salmo salar* L., in the Faroe-Shetland Channel in June 1996. Fisheries Research 31:159-162.

Sigray, P. and Andersson, M.H. (2011) Particle Motion Measured at an Operational Wind Turbine in Relation to Hearing Sensitivity in Fish. J. Acoustic Soc. Am., 130(1) pp.200-207.

Simpson, A. C. (1959) The spawning of the plaice (*Pleuronectes platessa*) in the North Sea. Fishery Investigations, London, Series II, 22(7). 111 pp. Cited in Van Damme *et al* (2009).

Smith, G.W., Hawkins, A.D., Urquhart G.G., and Shearer, W.M. (1981) Orientation and energetic efficiency in the offshore movements of returning Atlantic salmon (*Salmo salar* L.). Scottish Fisheries Research Report 21. 22pp.

Smith, G.W., Nelson, K., Youngston A. and Carss, D. (1998) The movements and estimated spawning positions of late-running adult Atlantic salmon (*Salmo salar* L.) returning to the Aberdeenshire Dee. Fisheries Research Services Report No 3/98.

Smith, I.P. and Johnstone, A.D.F. (1996) Migration of adult Atlantic Salmon (Salmo salar L.) in the Aberdeenshire Dee, 1995. Fisheries Research Services Report No 5/96.

Smith, I.P., Jensen, A.C., Collins, K.J. and Mattey, E.L. (2001) Movement of wild European lobsters *Homarus gammarus* in natural habitat. Marine Ecology Pregress Series. 222:177-186.

Smith, S.E., Au. D.W., Show, C. (1998) Intrinsic rebound potentials of 26 species of Pacific sharks. Mar. Freshwater. Res., 41:663-678.

SNH (2010) Scottish Natural Heritage. Freshwater Fish. Trout. Available online at: http://www.snh.gov.uk/about-scotlands-nature/species/fish/freshwater-fish/trout/. Accessed on: 15/01/18.

Solan, M., Hauton, C., Godbold, J.A., Wood, C.L., Leighton, T.G., White, P. (2016) Anthropogenic sources of underwater sound can modify how sediment-dwelling invertebrates mediate ecosystem properties. Sci. Rep. 6, 1–9.

Solandt, J.L. and Ricks, N. (2009) The Marine Conservation Society Basking Shark Watch 2009 annual report.

Solomon, D. (2007) Migration as a Life-History Strategy for the Sea Trout, in Sea Trout: Biology, Conservation and Management (eds G. Harris and N. Milner), Blackwell Publishing Ltd, Oxford, UK. doi: 10.1002/9780470996027.ch15

Southall, T.D. and Hambrey, J. (2005) Assessment of the Feasibility of Implementing the Moray Firth Fisheries Action Plan. For the Moray Firth Partnership, on behalf of the Moray Firth Fisheries Action Group

Spiga I, Caldwell GS and Bruintjes R. (2016) Influence of Pile Driving on the Clearance Rate of the Blue Mussel, *Mytilus edulis* (L.). In: Fourth International Conference on the Effects of Noise on Aquatic Life. 2016, Dublin, Ireland: Acoustical Society of America.

Stewart, D. C., Middlemas, S. J. and Youngson, A. F. (2006) Population structuring in Atlantic salmon (*Salmo salar*): evidence of genetic influence on the timing of smolt migration in sub-catchment stocks. Ecology of Freshwater Fish, 15: 552–558. doi: 10.1111/j.1600-0633.2006.00197.x

Sturlaugsson, J. (1995) Migration Study of homing of Atlantic salmon (*Salmo salar* L.) in coastal waters w-Iceland- Depth movements and sea temperatures recorded at migration routes by data storage tags. International Council for the Exploration of the Sea. C.M.1995/M:17. 13p.

Sturlaugsson, J. and Thorisson, K. (1997) Migratory pattern of homing Atlantic salmon (*Salmo salar* L.) in coastal water W-Iceland, recorded by data storage tags. ICES. C.M. 1997/CC:09. 23pp.

Tasker, M. L., Amundin, M., Andre, M., Hawkins, A., Lang, W., and Merck, T. (2010) Marine Strategy Framework Task Group 11 Report and Other Forms of Energy. Underwater noise. Group. doi:10.2788/87079.

Teal, L.R., van Hal, R., van Damme, C.J.G., Bolle, L.J. and ter Hofstede, R. (2009) Review of the spatial and temporal distribution by life stage for 19 North Sea fish species. IMARES Wageningen UR. C126/09.

Tesch, F.W. (2003) The Eel (3rd edition, Thorpe, J.E. ed), Blackwell Science, Oxford, pp408. Cited in Malcolm *et al* 2010.

Tetzlaff, D., Gibbins, C., Bacon, P.J., Youngson, A.F. and Soulsby, C. (2008) Influence of hydrological regimes on the pre-spawning entry of Atlantic Salmon (*Salmo salar* L.) into an upland river. River.Res.Applic. 24:528-542

Thomas, H.J. (1955) Observations on the recaptures of tagged lobsters in Scotland. Marine Research. S.H. Department. Edinburgh. In- Mill, A., Dobby, H., Mclay, A. and Mesquita, C., (2009) Crab and Lobster Fisheries in Scotland: An overview and results of stock assessment, 2002-2005. Marine Scotland Science Internal Report 16/09.

Thomsen, F., Gill, A., Kosecka, M., Andersson, M. H., Andre, M., Degraer, S., and Norro, A. (2015) MaRVEN–Environmental Impacts of Noise, Vibrations and Electromagnetic Emissions from Marine Renewable Energy. Final study report., Brussels, Belgium.

Thorstad, E.B., Heggberget, T.H. and ØKland, F. (1998) Migratory behaviour of adult wild and escaped farmed Atlantic salmon, *Salmo salar* L., before, during and after spawning in a Norwegian river. Aquaculture Research. 29(6):419-428.

Thorstad, E.B., ØKland, F., Finstad, B., Sivertsgård, R., Bjorn, P.A. and McKinley, R.S. (2004) Migration speeds and orientation of Atlantic salmon and sea trout post-smolts in a Norwegian fjord system. Environmental Biology of fishes 71:305-311.

Thorstad, E.B., ØKland, F., Finstand, B., Sivertsgård, R., Plantalech, N, Bjorn P.A. and Mckinley, R.S. (2007) Fjord migration and survival of wild and hatchery-reared Atlantic salmon and wild brown trout post-smolts. Hydrobiologia. 582 (1): 99-107.

Tougaard, J. and Henriksen, O. D. (2009) Underwater Noise Form Three Types of Offshore Wind Turbines: Estimation of Impact Zones for Harbor Porpoises and Harbor Seals. J. Acoust. Soc. Am., 125, pp. 3766-3773.

Tyler-Walters, H., James, B., Carruthers, M. (eds.), Wilding, C., Durkin, O., Lacey, C., Philpott, E., Adams, L., Chaniotis, P.D., Wilkes, P.T.V., Seeley, R., Neilly, M., Dargie, J. & Crawford-Avis, O.T. (2016) Descriptions of Scottish Priority Marine Features (PMFs). Scottish Natural Heritage Commissioned Report No. 406

Ueno, S.P., Lovsund, P. and Ober, P.A. (1986) Effect of Time-Varying Magnetic Fields on the Action Potential in Lobster Giant Axon. Medical and Biological Engineering and Computing 24.

Ungfors, A., Hallback, H. And Nilson, Per G. (2007) Movement of adult edible crab (*Cancer pagurus* L.) at the Swedish West Coast by mark-recapture and acoustic tracking. Fisheries Research 84 (2007) 345–357.

Van der Kooij, J., Scott, B.E., Mackinson S. (2008) The effects of environmental factors on daytime sandeel distribution and abundance on the Dogger Bank. Journal of Sea Research 60 (2008) 201– 209.

van Deurs, M. Grome, T. M. Kaspersen, M. Jensen, H. Stenberg, C. Sørensen, T. K. Støttrup, J. Warnar, T. Mosegaar, H. (2012) Short and Long Term Effects of an Offshore Wind Farm on Three Species of Sandeel and their Sand Habitat. Marine Ecology Progress Series, 458: 169-180.

van Deurs, M. Grome, T. M. Kaspersen, M. Jensen, H. Stenberg, C. Sørensen, T. K. Støttrup, J. Warnar, T. Mosegaar, H. (2012) Short and Long Term Effects of an Offshore Wind Farm on Three Species of Sandeel and their Sand Habitat. Marine Ecology Progress Series, 458: 169-180.

Viana, M., Pierce, G.J., Illian, J., MacLeod, C.D., Bailey, N., Wang, J. and Hastie L.C. (2009) Seasonal movements of veined squid *Loligo forbesi* in Scottish (UK) waters.

Wahlberg, M. and Westerberg, H. (2005) Hearing in Fish and their Reactions to Sounds from Offshore Wind Farms. Mar.Ecol. Prog. Ser., 288, pp. 295 – 309.

Wahlberg, M., & Westerberg, H. (2004). Sovjetiske ubåde eller pruttende sild?. Fisk og Hav, 57, 12-21.

Wahlberg, M., and Westerberg, H. (2005) Hearing in fish and their reactions to sounds from offshore wind farms. Mar Ecol Prog Ser. Vol. 288: 295–309, 2005.

Waldman, J., Grunwald, C. and Wirgin, I. (2008) Sea lamprey *Petromyzon marinus*: an exception to the rule of homing in anadromous fishes. Biol. Lett. (2008) 4, 659-662. doi:10.1098/rsbl.2008.0341.

Wale, M. A., Simpson, S. D., and Radford, A. N. (2013) Size-dependent physiological responses of shore crabs to single and repeated playback of ship noise. Biology Letters, 9: 20121194.

Walker, P. A., Howlett, G., and Millner, R. (1997) Distribution, movement and stock structure of three ray species in the North Sea and eastern English Channel. – ICES Journal of Marine Science, 54: 797–808.

Westerberg, H. and Langenfelt, I. (2008) Sub-Sea Power Cables and the Migration Behaviour of the European eel. Fisheries Management and Ecology, 15, 369-375.

Westerberg, H., Langenfelt, I., Andersson, I., Wahlberg, M., and Sparrevik, E. (2007) Inverkan på fisk och fiske av SwePol Link - Fiskundersökningar 1999-2006 (in Swedish). Swedish Fisheries Agency.

Whitehead, P.J.P., Bauchot, M.-L., Hureau, J.-C., Neilsen, J., and Tortonese, E. (1986) Clupeidae. In Fishes of the North-eastern Atlantic and the Mediterranean Volume I. UNESCO, Paris, 268-281.

Wilhelmsson, D., Malm, T. and Ohman, M.C. (2006a) The Influence of Offshore Wind Power on Demersal Fish. ICES Journal of Marine Science 63, 775-784.

Wilhelmsson, D., Malm, T., Thompson, R., Tchou, J., Sarantakos, G., McCormick, N., Luitjens, S., Gullström, M., Patterson Edwards, J.K., Amir, O. and Dubi, A. (2010) Greening Blue Energy: Identifying and Managing the Biodiversity Risks and Opportunities of Offshore Renewable Energy. Edited by Gland, Switzerland: IUCN. 102 pp.

Wilhelmsson, D., Yahya, S.A.S. and Ohman, M.C. (2006b) Effects of high-relief structures on cold temperate fish assemblages: A field experiment. Marine Biology Research, 2006; 2: 136-147.

Winslade, P., (1974b) Behavioural studies on the lesser sandeel *Ammodytes marinus* (Raitt) III. The effect of temperature on activity and the environmental control of the annual cycle of activity. Journal of Fish Biology, 6: 587–599. doi: 10.1111/j.1095-8649.1974.tb05102.x

Winter H.V., Aarts G. and Van Keeken O.A. (2010) Residence time and behaviour of sole and cod in the Offshore Wind Farm Egmond aan Zee (OWEZ) IMARES, Wageningen YR Report number: C038/10, p 50.

Woodruff, DL. Ward, JA. Schultz, IR. Cullinan, VI. Marshall, KE. (2012) Effects of Electromagnetic Fields on Fish and Invertebrates Task 2.1.3: Effects on Aquatic Organisms Fiscal Year 2011 Progress Report. US Department of Energy.

Worzyk T (2009) Submarine Power Cables: Design, Installation, Repair, Environmental Aspects. Springer Science & Business Media, 11 Aug 2009 Technology & Engineering. 313 pp

Wright, P.J., and Bailey, M. C. (1996) Timing of hatching in *Ammodytes marinus* from Shetland waters and its significance to early growth and survivorship. Marine Biology, 126: 143e152. Cited in Jensen *et al* (2003).

Wright, P.J., Neat, F.C., Gibb, F.M., Gibb, I.M. and Gallego, A. (2007) Cod movements in relation to sub-stock structure in the North Sea and west of Scotland. Fisheries Research Services Internal.

Young, I.A.G., Pierce, G.J., Stowasser, G., Santos, M.B., Wang, J., Boyle, P.R., Shaw, P.W., Bailey, N., Tuck, I. And Collins, M.A. (2006) The Moray Firth directed squid fishery. Fisheries Research 78 (2006) 39–43.

Youngson, A.F. and MacLean, J.C. (2002) Rod catch trends for early-running MSW salmon in Scottish rivers (1952-1997): divergence among stock components. ICES Journal of Marine Science, 59: 836- 849.

Offshore EIA Report

Moray Offshore Windfarm (West) Limited

Chapter 9 Marine Mammal Ecology

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Acronyms	
Acronym	**Expanded Term**
ADD	Acoustic Deterrent device
AHEP	Aberdeen Harbour Expansion Project
ASCOBANS	Agreement on the Conservation of Small Cetaceans in the Baltic, North-East Atlantic, Irish and North Seas
BOWL	Beatrice Offshore Wind Ltd.
CI	Confidence Intervals
CIA	Cumulative Impact Assessment
CODA	Cetacean Offshore Distribution and Abundance in the European Atlantic
CPOD	Cetacean Porpoise Detector
CRRU	Cetacean Research and Rescue Unit
cSAC	Candidate Special Area of Conservation
DBEIS	Department for Business, Energy and Industrial Strategy
DEPONS	Disturbance Effects on the harbor Porpoise population in the North Sea
DECC	Department of Energy & Climate Change (former name for the DBEIS)
EARs	Ecological Acoustic Recorders
ECOMMAS	East Coast Marine Mammal Acoustic Study
EEZ	Exclusive Economic Zone
EIA	Environmental Impact assessment
EMP	Environmental Management Plan
EPS	European Protected Species
ES	Environmental Statement
FCS	Favourable Conservation Status
GAMM	Generalised Additive Mixed Model
HF	High Frequency
HLV	Heavy Lift Vessel
HPDI	Highest Posterior Density Intervals
HRA	Habitats Regulations Assessment
IAMMWG	Inter-Agency Marine Mammal Working Group
ICES	International Council for the Exploration of the Sea
iPCoD	interim Population Consequences of Disturbance
JCP	Joint Cetacean Protocol
JNCC	Joint Nature Conservation Committee
JUV	Jack-Up Vessel
LF	Low Frequency

Acronyms	
Acronym	**Expanded Term**
MF	Mid-Frequency
ML	Most Likely
MMMP	Marine Mammal Monitoring Plan
MP	Monopile
MPA	Marine Protected Area
MPCP	Marine Pollution and Contingency Plan
MS-Lot	Marine Scotland Licensing Operations Team
MSS	Marine Scotland Science
MU	Management Unit
NERC	Natural Environment Research Council
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
O&M	Operation & Maintenance
OfTI	Offshore Transmission Infrastructure
OSP	Offshore Substation Platform
OWF	Offshore Wind Farm
PAM	Passive Acoustic Monitoring
PP	Pin Pile
PTS	Permanent Threshold Shift
PW	Phocids in Water
SAC	Special Area of Conservation
SCANS	Small Cetacean Abundance and density in the North Sea
SCOS	Special Committee on Seals
SEERAD	Scottish Executive Environment and Rural Affairs Department
SEL	Sound Exposure Level
SEL_{cum}	Cumulative Sound Exposure Level
SEL_{ss}	Sound Exposure Level (Single Strike)
SMRU	Sea Mammal Research Unit
SNCB	Statutory Nature Conservation Bodies
SNH	Scottish Natural Heritage
SOV	Service Operations Vessel
SPL	Sound Pressure Level
SPL_{zp}	Sound Pressure Level (Zero-Peak)
TPOD	Timing Porpoise Detector

Acronyms	
Acronym	**Expanded Term**
TTS	Temporary Threshold Shift
UK BAP	UK Biodiversity Action Plan
UOA	University of Aberdeen
VMP	Vessel Management Plan
WC	Worst Case
WDA	Western Development Area
WDT	Whale and Dolphin Trust
WTG	Wind Turbine Generator

Glossary of Terms	
Term	**Definition**
Cetacean	The order Cetacea includes whales, dolphins and porpoises, collectively known as cetaceans.
dBht	A frequency weighted scale. The dBht(Species) provides a measurement of sound that accounts for inter-species differences in hearing ability.
Fecundity	The reproductive rate of an animal or population, measured by the number of offspring. In this sense, fecundity may include both birth rates and survival of young to a particular time step.
Management Unit (MU)	The management unit is a term given to the scale defined for the management of a specific marine mammal population, based on understanding of population movements and dynamics. Management Units for cetaceans were defined by the UK SNCB Interagency Marine Mammal Working Group in 2015 and seal management units (or areas) are defined by the Special Committee on Seals published annually by the Sea Mammal Research Unit.
Maximum design scenario piling parameters	The definition of the hammer energy profile (how the hammer energy ramps up over time) and the maximum hammer energy based on the absolute maximum expected hammer energy to be required across all locations for the installation of each foundation type.
Mean	The average of a range of values (the sum of the values added together, divided by the number of values)
Median	The middle number in a range of values.
Most likely piling parameters	The definition of the hammer energy profile and the maximum hammer energy likely to be reached on the majority of pile installations.
Odontocete	Odontocetes (toothed-whales) form a suborder of the order Cetacea (cetaceans). This suborder is characterised by the presence of teeth, rather than the baleen of other whales and includes sperm whales, beaked whales and dolphins.
Pinniped	A fin-footed group of marine mammals which are semi-aquatic. Pinnipeds comprise of the following families: Odobenidae (walrus); Otariidae (eared seals,

Glossary of Terms	
Term	**Definition**
	sea lions, and fur seals); and Phocidae (earless seals). Pinnipeds are more broadly known as "seals".
Permanent Threshold Shift (PTS)	Following a marine mammal's exposure to high noise levels, if a Threshold shift occurs and does not return to normal after several weeks then a Permanent Threshold Shift (PTS) has occurred. This results in a permanent auditory injury to the marine mammal.
Sound Exposure Level	Sound exposure level (SEL) is a measure of energy that takes into account both received level and duration of exposure. SEL can be calculated for a single pulse or signal (SELss) or SEL can be calculated accounting for the accumulated exposure over the duration of an activity within a 24-hour period (SEL_{cum}).
Sound Pressure Level	Sound pressure level (SPL) is a means of characterizing the amplitude of a sound.
Soft-start	The term 'soft-start' is applied to the gradual, or incremental, increase in hammer blow energy from the initiation of piling activity until required blow energy is reached for installation of each pile, usually over a period of 30 minutes (not less than 20 minutes). Maximum hammer blow energy may not be required to complete pile installation.

9 Marine Mammals

9.1 Introduction

9.1.1.1 This chapter considers the likely significant effects of the construction, operation and decommissioning of the Moray West Offshore Wind Farm and associated Offshore Transmission Infrastructure (OfTI) ("the Development") on marine mammals. The specific objectives of the chapter are to:

- Identify the relevant planning legislation and policy relevant to marine mammals;
- Detail the consultation relevant to marine mammals that has informed this assessment;
- Describe the marine mammal baseline;
- Describe the assessment methodology and significance criteria used in completing the impact assessment;
- Describe the potential effects, including direct, indirect and cumulative effects;
- Describe the mitigation measures proposed to address likely significant effects; and
- Assess the residual effects remaining following the implementation of mitigation.

9.1.1.2 The assessment has been carried out by SMRU Consulting. SMRU Consulting is the world's leading marine mammal consultancy with an unrivalled reputation for providing innovative, robust, and environmentally sound solutions for clients active in the marine environment. SMRU Consulting have extensive experience in undertaking offshore wind farm impact assessments for marine mammals.

9.1.1.3 This chapter is supported by:

- Volume 4 - Technical Appendix 9.1: Marine Mammal Baseline;
- Volume 4 - Technical Appendix 9.2: Underwater noise modelling; and
- Volume 4 - Technical Appendix 9.3: Report to Inform European Protected Species Licence Application.

9.2 Legislation, Policy and Guidance

9.2.1.1 The legislation, policy and guidance that is relevant to the assessment of the potential impacts on marine mammals associated with the construction, operation and decommissioning of the Project is listed below. In addition, other national, regional and local policies are considered within this assessment where they are judged to be relevant. Full details of the legislation, policies and guidance considered can be found in the Marine Mammal Baseline Technical Appendix 9.1.

9.2.1.2 The following are the legislation and policy applicable to marine mammals:

- Council Directive (92/43/EEC) on the conservation of natural habitats and of wild fauna and flora (Habitats Directive);
- The Conservation (Natural Habitats, &c.) Regulations 1994 and The Conservation of Offshore Marine Habitats and Species Regulations 2017 (The Habitats Regulations);
- European Protected Species;
- Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention);
- ASCOBANS;

- Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention);
- UK Biodiversity Action Plan and the UK Post-2010 Biodiversity Framework (2012);
- Scottish Priority Marine Features;
- Scottish Biodiversity List;
- Scottish National Marine Plan; and
- Marine (Scotland) Act 2010.

9.2.1.3 The impact assessment has been conducted in accordance with the following guidance:

- National Marine Fisheries Service (2016) Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing: Underwater Acoustic Thresholds for Onset of Permanent and Temporary Threshold Shifts (referred to as NOAA Guidance, 2016);
- There is no equivalent guidance for the assessment of the impact of disturbance related behavioural impacts so the assessment here is informed by the development of current best practice in a number of other recent and current assessments and largely follows the approach presented and developed in (Thompson et al., 2012); and
- CIEEM 2016: Guidelines for Ecological Impact Assessment in the UK and Ireland.

9.3 Consultation

9.3.1.1 Moray West has framed its assessment of potential effects on marine mammals through consultation with key stakeholders including: Marine Scotland Licensing Operations Team (MS-LOT), Marine Scotland Science (MSS), Scottish Natural Heritage (SNH), University of Aberdeen (UOA) and Whale and Dolphin Trust (WDT).

9.3.1.2 Table 9.3.1 provides a summary of the key issues raised in relation to marine mammals in the Moray West Offshore Wind Farm Scoping Opinion (August 2016) and the OfTI Scoping Opinion (August 2017) and summarises other issues / concerns that have been raised during additional consultation activities undertaken as part of the EIA process and how these have been addressed in the preparation of this EIA Report.

Table 9.3.1: Summary of Consultation Relating to Marine Mammals

Consultee and Date	Issue Raised	Moray West Approach
Scottish Ministers - Scoping Opinion (Moray West Offshore Wind Farm) August 2016	It should be noted that any application should incorporate a full HRA and applications for other relevant licensing requirements, such as European Protected Species ("EPS") and basking shark, should they be required.	An EPS license application will be submitted and will be informed by the assessment presented in this chapter. A full Report to Inform Appropriate Assessment will also accompany the ES submission.
	Recommendation that the potential impacts on marine mammals from noise are carefully assessed in the ES and mitigation and measures to reduce the effects of noise should also be set out in the ES.	The potential impacts from noise have been assessed in detail in this chapter, using site specific underwater noise modelling and appropriate thresholds and assessment methodology that have been agreed during subsequent post-scoping consultation (meeting minutes 24/08/2017). A piling strategy will be developed and agreed with consultees at the appropriate point that will include detailed consideration of

Table 9.3.1: Summary of Consultation Relating to Marine Mammals		
Consultee and Date	**Issue Raised**	**Moray West Approach**
		optimised piling parameters to minimise impacts below those assessed in this chapter. The piling strategy will also include details of embedded mitigation such as piling soft starts and associated mitigation protocols which will be based on current best practice at the time.
JNCC and SNH scoping advice to Scottish Ministers (Moray West Offshore Wind Farm) August 2016	Our key concern remains the potential disturbance of marine mammals due to construction noise (particularly from pile-driving the turbine foundations).	Detailed post-scoping discussions were held regarding the methodology for noise modelling and assessment, including population modelling (see below). (meeting minutes 24/08/2017, 20/11/2017 and 25/01/2018).
	The focus of cumulative impact assessment (CIA) for HRA species will relate to potential impacts from the WDA in combination with other wind farms. Consultation required to define scope of CIA.	The scope of the CIA was discussed at a number of post-scoping consultation meetings (meeting minutes 20/11/2017 and 25/01/2018). The CIA includes consideration of potential impacts from other projects in the Moray Firth and Scottish East coast region quantitatively and elsewhere within the relevant Management Units qualitatively (as outlined in Moray West's Approach to Cumulative Impact Assessment Position Paper).
	Advice given on the reference populations and baseline data sources to be incorporated in the assessment for each species.	The assessment has adopted the recommended reference populations. All populations and baseline data sources have been agreed in post scoping consultation meetings (24/08/2017 and 20/11/2017). Agreed reference populations are presented in Section 9.4.2.
	Underwater noise modelling is carried out for the five key species of concern: harbour seal, bottlenose dolphin, harbour porpoise, minke whale and grey seal, in order to ascertain the number of individuals which could be disturbed by pile-driving activity.	Noise modelling has been carried out by Cefas for these five key species and detailed results are presented in Appendix 9.2 Underwater Noise Modelling. The number of individuals that could be affected has been quantified using the outputs from this modelling and the results are presented in Section 9.7.1.
	Injury should be assessed using sound pressure levels and cumulative sound exposure levels. Models investigating disturbance are currently based on sound levels, however, the extent and duration of disturbance should also be considered is influenced by several factors, not just the sound level can influence disturbance.	Agreement has been reached with MSS and SNH through post-scoping consultation discussions to focus the assessment on estimates of auditory injury using the NOAA thresholds. The assessment of disturbance is based on dose response curves but other factors are also considered. REF meeting minutes.
	Any requirements for population modelling will be determined by the outputs from underwater	The adoption of the iPCoD approach for all population modelling was subsequently

Table 9.3.1: Summary of Consultation Relating to Marine Mammals		
Consultee and Date	**Issue Raised**	**Moray West Approach**
	noise modelling, and will only apply to key species. Requirements for population modelling should be agreed with SNH and Marine Scotland and to agree the approach to cumulative impact assessment for marine mammal interests for HRA, EIA and EPS licensing requirements.	agreed during post-scoping consultation meetings. Population modeling was carried out for bottlenose dolphin and harbour seals and is presented in Section 9.7.1.
MSS scoping advice to Scottish Ministers (Moray West Offshore Wind Farm) August 2016	MSS would encourage the most recently available data to be used to inform the ES, including work undertaken as part of the MMMP for the currently consented development, which Marine Scotland has contributed to funding. Depending upon the respective timelines, this may also include data from the SCANS-III surveys.	These data sources have been reviewed and incorporated into the baseline and assessment as appropriate.
	MSS welcome the stated intention to discuss the SACs that require HRA with us and the SNCBs. We would add auditory injury (PTS) to the list of assessment criteria. Mitigation options are likely to mean that this does not occur, but at this stage in the assessment process we would like to ensure that this is considered.	PTS has been fully assessed within this chapter (Section 9.7.1) and is included within the RIAA and EPS assessments.
	If gravity bases, or other bases that require substantial seabed preparation works, are scoped into the project, then we would consider that loss of foraging habitat for marine mammals will require assessment, and that this should be coordinated with the assessments for fish ecology.	The effect of the loss of foraging habitat on marine mammals has been assessed using the assessment outcomes for fish ecology and benthic habitats for the worst case design parameters for these receptors. This is covered in Sections 9.7.2, 9.7.3 and 9.7.4 for the construction, operation and decommissioning phases of the Development respectively.
	Further discussion of the scope of the CIA is required and MS-LOT will be able to provide lists of projects that are currently in the planning process.	The scope of the cumulative effects assessment has been discussed and agreed with MSS and SNH through the Moray West CIA position paper and discussion at post-scoping consultation meetings (28/11/2017 and 25/01/2018).
Scottish Wildlife Trust scoping response (Moray West Offshore Wind Farm) August 2016	When the options for turbine structure are discussed, we would like to see what implications their design has for decommissioning – for example, which has the least environmental impact, which is easiest to remove, which can be recycled and reused?	The Project Description Chapter provides detail of decommissioning plans. Decommissioning activities are assessed in Section 9.7.4.
	We would like to see construction/decommissioning activities to occur outside of breeding periods for local	This assumption is not necessarily correct for marine mammals – e.g. seals less likely to be disturbed by offshore noise during the breeding season when they are more likely to

Table 9.3.1: Summary of Consultation Relating to Marine Mammals		
Consultee and Date	**Issue Raised**	**Moray West Approach**
	marine mammals, when animals are more vulnerable to disturbance.	be ashore. Decommissioning plans will minimise disturbance in light of best available data on species and population vulnerabilities.
	We would like to see a strategic and detailed plan for surveying and monitoring the site prior to construction, during operation, and post decommissioning of the wind farm. This will provide a valuable overview of the total environmental impact throughout the entire life of the wind farm.	It is expected that an environmental monitoring plan covering these details will be required as a condition of consent. This will be developed and agreed in consultation with MSS, SNH and relevant technical experts.
	There has been no consideration to the use of floating wind turbines in the report. Although the use of floating wind is still only at the test stage, it would be of interest to see how floating structures would compare to the other designs discussed, particularly with respect to environmental impacts during construction. There is still considerable scientific uncertainty surrounding the impacts of pile driving during construction on all species, and in this region. As a result, our preference is that pile driving is not used at all during construction.	A number of feasible options have been included in the scoping report for installation of turbine foundations. These include piled foundations, gravity base structures and monopiles. Until detailed site investigations have taken place on site MORL is unable to select a preferred method. Many factors including stakeholder feedback will feed into the final selection decision. The assessment of the impact of piling noise is presented in Section 9.7.1. The uncertainties inherent in this assessment are presented and discussed.
Whale and Dolphin Conservation scoping response (Moray West Offshore Wind Farm) August 2016	Alternatives to pile driving should be considered. Use of noise-reducing techniques could considerably reduce the radius of impacts of this development and those in the region, would reduce cumulative impacts and could mean that there is less dependence on mitigation and less risk to developers. Should pile driving be conducted, further information on the pile driving method and mitigation techniques to reduce the impact of underwater noise generated during pile driving needs to be covered significantly. Considerable uncertainty remains about the efficacy of active acoustic deterrent devices, and the impacts resulting from their use and we do not consider their use to be a suitable or adequate mitigation.	A piling strategy will be developed and agreed with statutory consultees prior to any construction works taking place. Monitoring being carried out as part of the Beatrice Offshore Wind Farm construction will inform the development of the piling strategy, including the use of appropriate mitigation measures. Noise-reducing techniques at the water depths on site are as yet unproven. MORL will engage with any supplier that can offer a viable option to noise reduction and investigate all available options.
	Recently, connectivity between harbour seals in the Moray Firth and Orkney has been shown from tagged data. Due to the significantly declining population in Orkney, harbour seals in the Moray Firth should be given the same level of protection from disturbance and displacement as harbour seals in Orkney. See http://synergy.st-andrews.ac.uk/harbourseals/	Although there is some demonstrated connectivity between the Moray Firth and Orkney, advice has been received from SNH and Marine Scotland that the appropriate scale to assess and manage impacts is the Moray Firth Seal Management Area for both species of seal.

Table 9.3.1: Summary of Consultation Relating to Marine Mammals		
Consultee and Date	**Issue Raised**	**Moray West Approach**
	blog post on 3rd June 2016 for more information on the connectivity.	
Marine Scotland OfTI Scoping response August 2017	Cumulative impacts on marine mammals are specifically referenced by SNH in their consultation response. Careful consideration will be required of the developments noted and the comprehensive list of plans, projects and activities reference in Section 3.5 of the Scoping Report should be agreed prior to undertaking the EIA Report.	As noted above, the scope of the CIA was presented in the Moray West CIA Position Paper and discussed and agreed at pre-application meetings with SNH, MSS and MS-LOT on (28/11/2017 and 25/01/2018.
	Moray West's proposed noise assessment is required to cover all of the species noted in SNH's consultation response and appropriate cross referencing between the benthic ecology and fish and shellfish sections of the EIA report will ensure that indirect effects are considered.	All five species have been considered in the assessment. The findings of the benthic ecology and fish and shellfish sections have been used to inform an assessment of indirect effects.
SNH OfTI Scoping Response August 2017	Each of the cetaceans listed in Table 6.3.2 is a European Protected Species (EPS). The risk of disturbance particularly in the coastal waters of the southern Moray Firth where bottlenose dolphin and minke whale are most frequent suggests an EPS licence may be required. Information should be provided to help inform considerations of any subsequent EPS licence application.	Information to inform an EPS licence application is provided alongside this EIA Report. The risk of disturbance to bottlenose dolphins, minke whale and harbour porpoise is assessed quantitatively in this chapter and the outcome of this assessment is summarised in the EPS risk assessment.
	We agree that the probable risk to marine mammals from operational noise or electromagnetic fields is low and are content that these effects are scoped out at this stage.	Noted. Operational noise and EMF effects have been scoped out of the assessment.
	Disturbance / displacement as a result of construction / operational noise: particularly relevant for the installation of the offshore substation platform(s), depending on foundation type, and the placement of scour protection if needed for the OSP(s) or along the cable route.	The days of piling required for installation of the offshore substation platforms have been included in the construction underwater noise assessment detailed in Section 9.7.1.
	The southern Moray coast is important for marine mammals, so particular care will be needed for working in these coastal waters. We welcome the inclusion of the marine mammals in the subsea noise assessment as proposed in 6.2.7 and recommend this cover all of the five species listed above. We recommend that directional drilling (HDD) is considered for the cable landfall and connection to the offshore export cables.	The impact assessment takes full account of the spatial distribution of all five species of marine mammal in relation to the location of the specific activities assessed. The majority of the route will be constructed using traditional open cut trenching methods, with open cut trenching or horizontal directional drilling used to reach the transition bay on landfall.

Table 9.3.1: Summary of Consultation Relating to Marine Mammals		
Consultee and Date	**Issue Raised**	**Moray West Approach**
	We also highlight the likelihood that cumulative impacts on marine mammals will need to be addressed for these proposed transmission works. There is a range of development consented, or proposed, that may impact on marine mammals in the Moray Firth including the Beatrice and Moray East offshore wind farms, their associated transmission works, the Caithness / Moray subsea cable link and a range of harbour developments – as well as other development proposals further afield.	As noted above, the scope of the CIA was presented in the Moray West CIA Position Paper and discussed and agreed at pre-application meetings with SNH, MSS and MS-LOT on (28/11/2017 and 25/01/2018).
Whale and Dolphin Conservation OfTI Scoping Response, August 2017	The Scottish Ministers agree that the cetacean and pinnipeds species noted in the Scoping Report require consideration and note SNH's direction, to which of these species requires assessment also for a Special Area of Conservation ("SAC"). SNH also highlight minke whale in relation to the Southern Trench area which is being looked at as a potential MPA.	Assessment in relation to SACs is provided in the RIAA accompanying this EIA Report. Impacts on minke whales in the Southern Trench Area are fully assessed as part of the impact assessment presented in this chapter.

9.4 Baseline Conditions

9.4.1 Baseline Characterisation Approach

9.4.1.1 The following section describes the approach to characterisation of the baseline environment to understand the spatial and temporal diversity, abundance and density of marine mammals that could potentially be affected by the Development. Information for the marine mammal baseline characterisation is taken largely from the Environmental Statement (ES) prepared for the Moray East Offshore Wind Farm (Moray East ES, 2012), complemented with additional data that has been collected since then which was compiled through a combination of a literature reviews and further site-specific survey and monitoring work. This section of the chapter summarises the key data sources examined to establish the baseline.

Study Area

9.4.1.2 The study area considered for marine mammals is the entire Moray Firth.

Desk Study / Field Survey

9.4.1.3 The key data sources analysed to inform the baseline characteristics for marine mammals in the study area are summarised below. A detailed description of these data sources is provided in the Marine Mammal Baseline Technical Appendix 9.1.

Small Cetaceans in the European Atlantic and North Sea (SCANS) Surveys

9.4.1.4 The Moray West Site is located in SCANS III survey block S (Image 9.4.1) which was surveyed by aircraft covering a total surface area of 40,383 km^2. While the SCANS surveys provide sightings, density and abundance estimates at a wide spatial scale, the surveys are conducted during a single month, every 11 years and therefore do not provide any fine scale temporal or spatial information on species abundance and distribution. It should be noted that SCANS III survey block S extends considerably further than the Moray Firth, and therefore the uniform density across the entire block may not be representative of densities in the Moray Firth when considered alone.

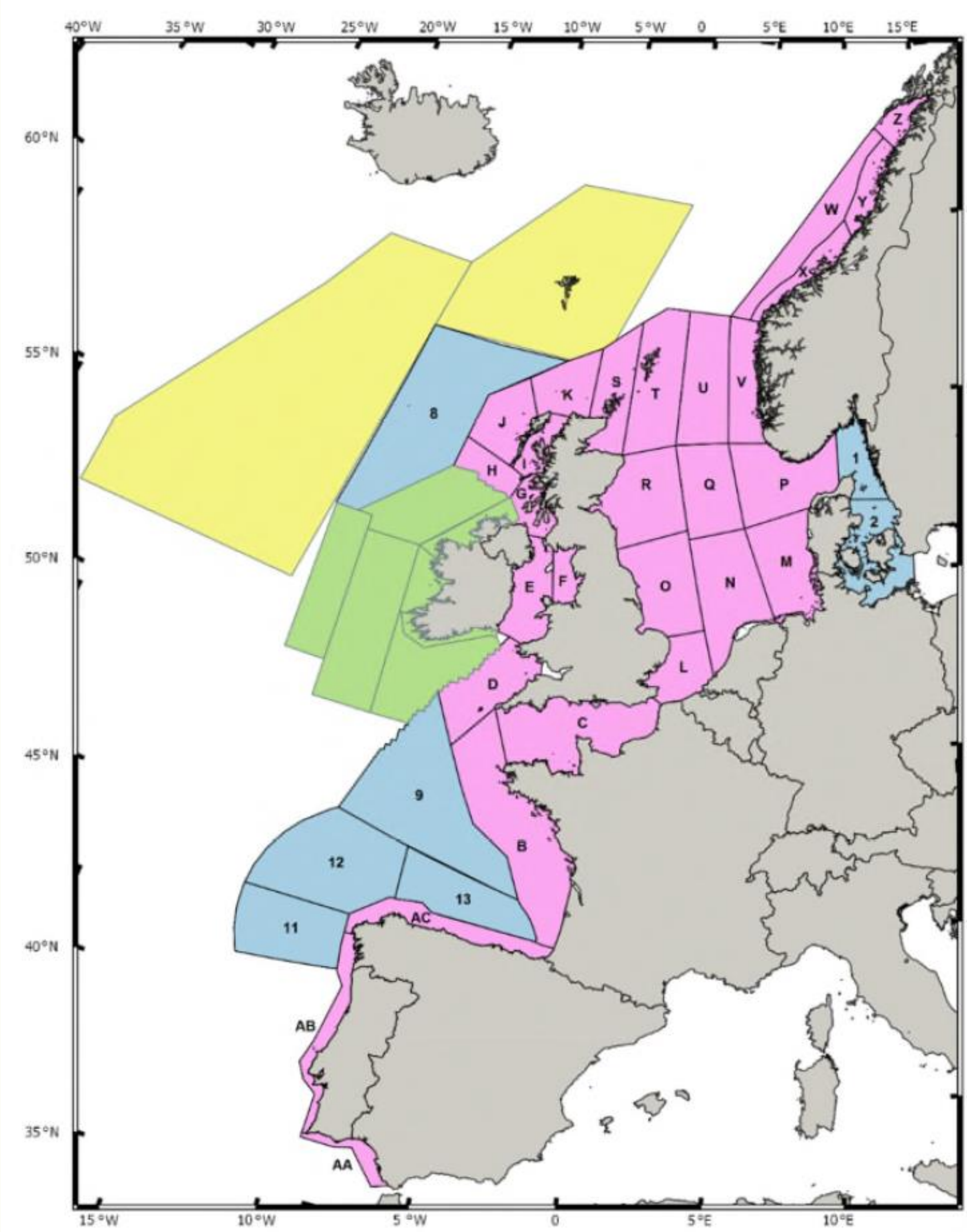


Image 9.4.1: Area covered by SCANS-III and other adjacent surveys. Pink blocks were surveyed by air, blue blocks by ship. Green blocks were surveyed by the Irish ObSERVE project and yellow blocks were surveyed by the Faroe Islands as part of the North Atlantic Sigh

Joint Cetacean Protocol (JCP) Phase III Analysis

9.4.1.5 The JCP Phase III analysis included datasets from 38 sources, totaling over 1.05 million km of survey effort between 1994 and 2010 from a variety of platforms (Paxton *et al.,* 2016). The JCP Phase III analysis was conducted to combine these data sources to estimate spatial and temporal patterns of abundance for seven species of cetaceans (harbour porpoise, minke whales, bottlenose dolphins, common dolphins, Risso's dolphins, white-beaked dolphins and white-sided dolphins). Density surface models were used to predict species density over a fine scale grid of 25 km^2 resolution for one day in each season in each survey year. R code[1] has been provided to extract abundance estimates averaged for summer 2007-2010 and scaled to the SCANS III estimates.

JNCC Report 544: Harbour Porpoise Density

9.4.1.6 Heinänen and Skov (2015) conducted a detailed analysis of 18 years of survey data on harbour porpoise around the UK between 1994 and 2011 held in the JCP database. The goal of this analysis was to try to identify "*discrete and persistent areas of high density*" that might be considered important for harbour porpoise with the ultimate goal of determining Special Areas of Conservation (SACs) for the species. The analysis grouped data into three subsets: 1994-1999, 2000-2005 and 2006-2011 to account for patchy survey effort and analysed summer (April-September) and winter (October- March) data separately to explore whether distribution patterns were different between seasons and to examine the degree of persistence between the subsets. The survey effort on which the analysis is based was particularly patchy in the south-east Moray Firth which may limit the degree of confidence for the modelled predictions in this area.

Special Committee on Seals (SCOS)

9.4.1.7 Under the Conservation of Seals Act 1970 (in England) and the Marine (Scotland) Act 2010, the Natural Environment Research Council (NERC) (now part of UK Research and Innovation) provides scientific advice to government on matters related to the management of UK seal populations through the advice provided by the SCOS. The SMRU provides this advice to SCOS on an annual basis through meetings and an annual report. The report includes advice on matters related to the management of seal populations, including general information on British seals, information on their current status and addresses specific questions raised by regulators and stakeholders. The most recent publicly available SCOS report is SCOS (2017) which presents the data collected up to 2016.

Designated Haul-Out Sites

9.4.1.8 Under Section 117 of the Marine (Scotland) Act 2010, specific seal haul-out sites have been designated to provide protection for seals from intentional or reckless harassment. There are seven harbour seal designated haul-out sites in the Moray Firth Management Unit (MU) that were designated in 2014 based on the SMRU annual August survey counts in preceding years. These haul-outs range from 29 to 78 km from the Moray West Site. There are also three grey seal designated haul-out sites in the Moray Firth MU that were designated based on the presence of grey seal breeding colonies, which range from 21 to 46 km from the Moray West Site. The designated haul-outs and the seal MU are shown in Volume 3a - Figure 9.4.1.

[1] R is a free software environment for statistical computing and graphics (https://www.r-project.org/).

Seal Haul-out Surveys

Harbour Seals

9.4.1.9 Surveys of harbour seals are carried out during the summer months. The main population surveys are carried out when harbour seals are moulting, during the first three weeks of August, as this is the time of year when the largest numbers of seals are ashore. The counts obtained represent the number of seals that were onshore at the time of the survey and are an estimate of the minimum size of the population. They do not represent the total size of the local population since a number of seals would have been at sea at the time of the survey. However, telemetry data from tagged seals are used to scale this estimate to take account of the proportion of animals at sea at the time of survey. It is noted that these data refer to the numbers of seals found within the surveyed areas only at the time of the survey; numbers and distribution may differ at other times of the year.

Grey Seals

9.4.1.10 Grey seals are also counted on all harbour seal surveys, although these data do not necessarily provide a reliable index of population size. Grey seals aggregate in the autumn to breed at traditional colonies. Their distribution during the breeding season can be very different to their distribution at other times of the year. SMRU's main surveys of grey seals are designed to estimate the numbers of pups born at the main breeding colonies around Scotland. Breeding grey seals are surveyed biennially between mid-September and late November using large-format vertical photography from a fixed-wing aircraft.

University of Aberdeen Harbour Seal Pupping Surveys

9.4.1.11 The University of Aberdeen have been conducting surveys of harbour seals at the Loch Fleet National Nature Reserve since 1988. As part of the strategic Moray Firth Marine Mammal Monitoring Plan (MMMP), the University of Aberdeen have conducted harbour seal pupping and moult count surveys at four additional sites (Graham *et al.,* 2016). During the pupping season and the moult a minimum of four counts were conducted at each site, and monthly counts were made in the winter months.

Seal Telemetry

9.4.1.12 SMRU has deployed telemetry tags on grey seals and harbour seals in the UK since 1988 and 2001, respectively. In addition to this, the University of Aberdeen have been tagging harbour seals at the Dornoch Firth and Loch Fleet for various studies between 1989 and 2009 (Thompson *et al.,* 1996, Thompson *et al.,* 1997, Thompson *et al.,* 1998, Sharples *et al.,* 2008, Cordes *et al.,* 2011). As part of the Moray Firth strategic MMMP, the University of Aberdeen have conducted additional harbour seal telemetry studies in the Moray Firth. During the pre-construction phase of the Moray Firth projects, SMRU GPS-GSM tags[2] were deployed on 12 harbour seals in September 2014, on 13 harbour seals in February 2015 and on 31 seals in March 2017 in order to obtain data over multiple seasons.

[2] The GPS Phone tag combines GPS quality locations with efficient data transfer using the international GSM (Global System for Mobile communication) mobile phone network (http://www.smru.st-and.ac.uk/Instrumentation/GPSPhoneTag/)

State-space Modelling of Activity

9.4.1.13 The location and activity data obtained from telemetry tags were used in a state-space model to identify travelling and foraging locations (Graham *et al.,* 2016). The state-space model was based on that described in Russell *et al. (*2015) where foraging is defined as area-restricted searching behaviour and travelling is defined as faster movement with lower turning angles. In order for a location to be assigned as either a travelling or a foraging location, the probability of that activity state had to be above 0.9 and the state-space model excluded all locations within 1 km of a haul-out site. This state-space modelling was conducted for harbour seals only.

Grey Seal Usage Maps

9.4.1.14 Russell *et al. (*2017) have produced revised estimated at-sea distribution usage maps for grey seals. The revised maps contain telemetry data from 270 grey seals tagged within the UK and incorporate count data between 1996 and 2015. The at-sea usage maps represent the average number of grey seals estimated to be in the water in each grid cell at any given time.

Photo-ID – Bottlenose Dolphin

9.4.1.15 The University of Aberdeen have been conducting photo-ID surveys of bottlenose dolphins in the Moray Firth SAC since 1989 in order to estimate population size, fecundity rates and sex specific survival rates. The photos collected during these surveys are quality graded and individual dolphins are identified based on distinct marking on their dorsal fins. These data are then analysed in the program MARK[3] to estimate the population size, fecundity and survival rates.

Visual Boat and Aerial Surveys

9.4.1.16 There have been several visual surveys conducted in the Moray Firth since 2004. These surveys are listed in Table 9.4.1 the survey effort is shown in Image 9.4.2. Further survey information including methods and maps of survey areas can be found in Appendix 9.1: Marine Mammal Baseline.

Table 9.4.1: Summary of the Visual Surveys for Marine Mammals Conducted in the Moray Firth

Survey	Dates	Method	Area
Beatrice Demonstrator baseline surveys	2004 (Aug, Sep & Oct) and 2005 (Apr, May, Jun & July)	Boat based visual	Moray Firth SAC
DECC Outer Moray Firth	2009 (Jun, Aug, Sep & Oct)	Boat based visual	Outer Moray Firth
DECC aerial surveys	2010 (Aug & Sep)	Aerial visual	BOWL & Moray East Development area, central Moray Firth, coastal Moray Firth
Moray East pre-application surveys	April 2010 to March 2012	Boast based visual	Moray East Offshore Wind Farm and a 4 km buffer
BOWL pre-application surveys	April to September 2010	Boast based visual	Beatrice Offshore Wind Farm site and buffer
Cetacean Research and Rescue Unit (CRRU) minke whale surveys	Summers since 2010	Boast based visual	Between Lossiemouth and Fraserburgh

[3] Program MARK is a Windows-based software application for the analysis of data from marked individuals (http://www.phidot.org/software/mark/index.html).

Table 9.4.1: Summary of the Visual Surveys for Marine Mammals Conducted in the Moray Firth			
Survey	**Dates**	**Method**	**Area**
HiDef Moray West pre-construction surveys	April 2016 to March 2017 monthly	Aerial digital video	Moray West Site plus a 4 km buffer

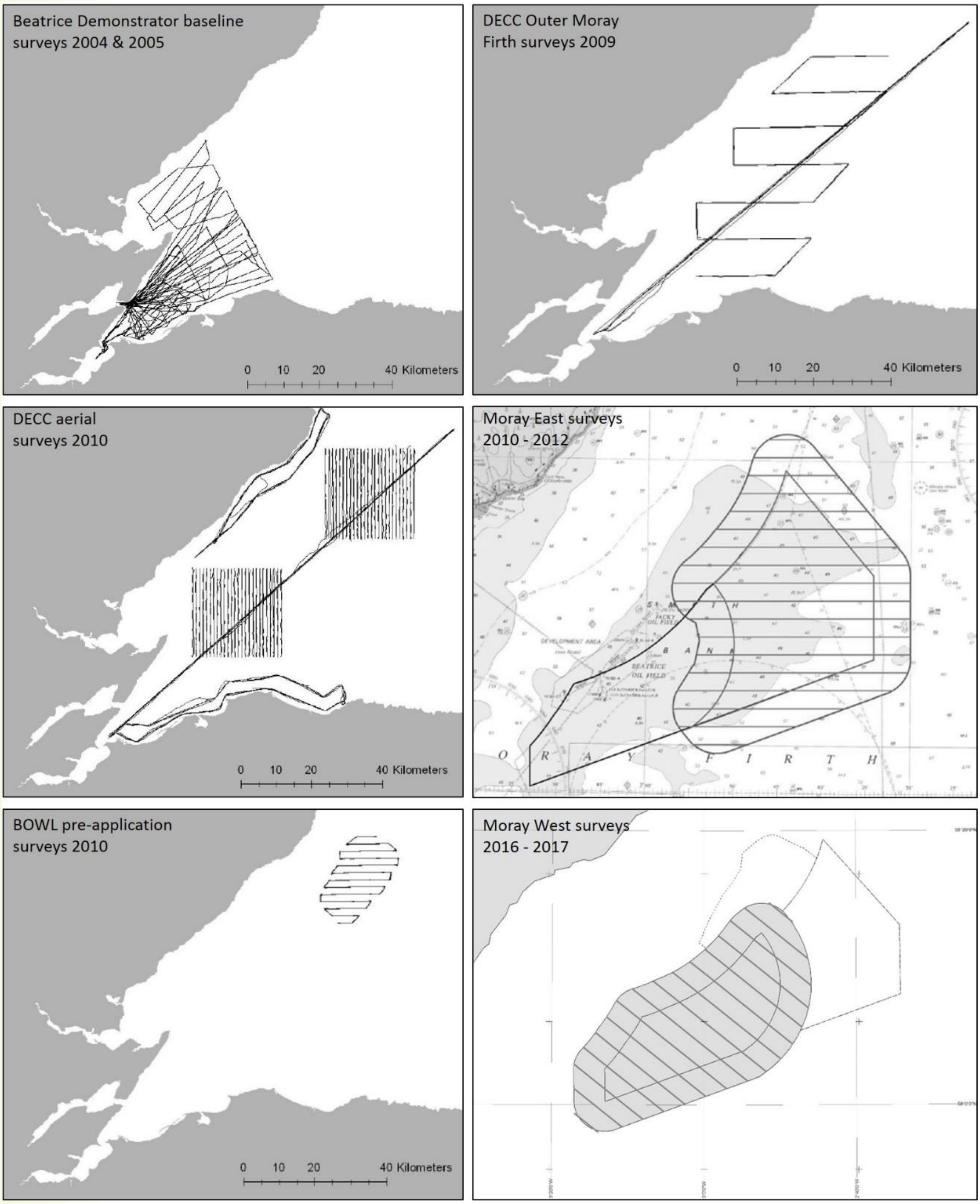


Image 9.4.2:Locations and effort covered by the visual surveys conducted in the Moray Firth.

Acoustic Surveys

9.4.1.17 There have been several acoustic surveys conducted in the Moray Firth since 2001 using click detector devices (CPODS and their predecessor TPODS[4]) and sound recorders (EARs[5] and SM2Ms[6]) to determine the presence/absence of vocalizing marine mammals. This type of data collection is called Passive Acoustic Monitoring (PAM) and the resulting data can be used to indicate spatial and temporal patterns in use of an area. Click detectors such as CPODs detect and log the clicks produced by toothed whales, dolphins and porpoise while EARs and SM2Ms record underwater sound which is then run through detection algorithms to extract detections of clicks, whistles and underwater noise. These surveys are listed in Table 9.4.2 and locations of devices for each survey are presented in Image 9.4.3. Further survey information including methods and maps of survey areas can be found in Appendix 9.1: Marine Mammal Baseline.

Table 9.4.2: Summary of the Acoustic Surveys for Marine Mammals Conducted in the Moray Firth

Survey	Dates	Method	Area
Beatrice Demonstrator	Between August and October in 2005, 2006 and 2007	TPODs	Sutors of Cromarty, Beatrice, Lossiemouth.
SNH & SEERAD[7] surveys	2006 to 2009	-	14 sites within the inner Moray Firth.
DECC surveys	2009 and 2010	CPODs + EARs	Throughout the Moray Firth.
BOWL MMMP	Since 2001 year round	CPODs	Main sites: Sutors of Cromarty, Chanonry, Lossiemouth and Spey Bay. Additional sites summer 2014-15: around Lossiemouth and Spey Bay.
East Coast Marine Mammal Acoustic Study (ECOMMAS)	Since 2013	CPODs and SM2Ms	Within the Moray Firth: Cromarty, Helmsdale, Latheron, Spey Bay and Fraserburgh.

[4] Cetacean Porpoise Detector (CPOD) and Timing Porpoise detector (TPOD) developed by Chelonia Ltd http://www.chelonia.co.uk
[5] Ecological Acoustic Recorders (EARs) developed by the University of Hawaii and NOAA Fisheries
[6] Song Meter SM2M developed by Wildlife Acoustics www.wildlifeacoustics.com
[7] Scottish Executive Environment and Rural Affairs Department

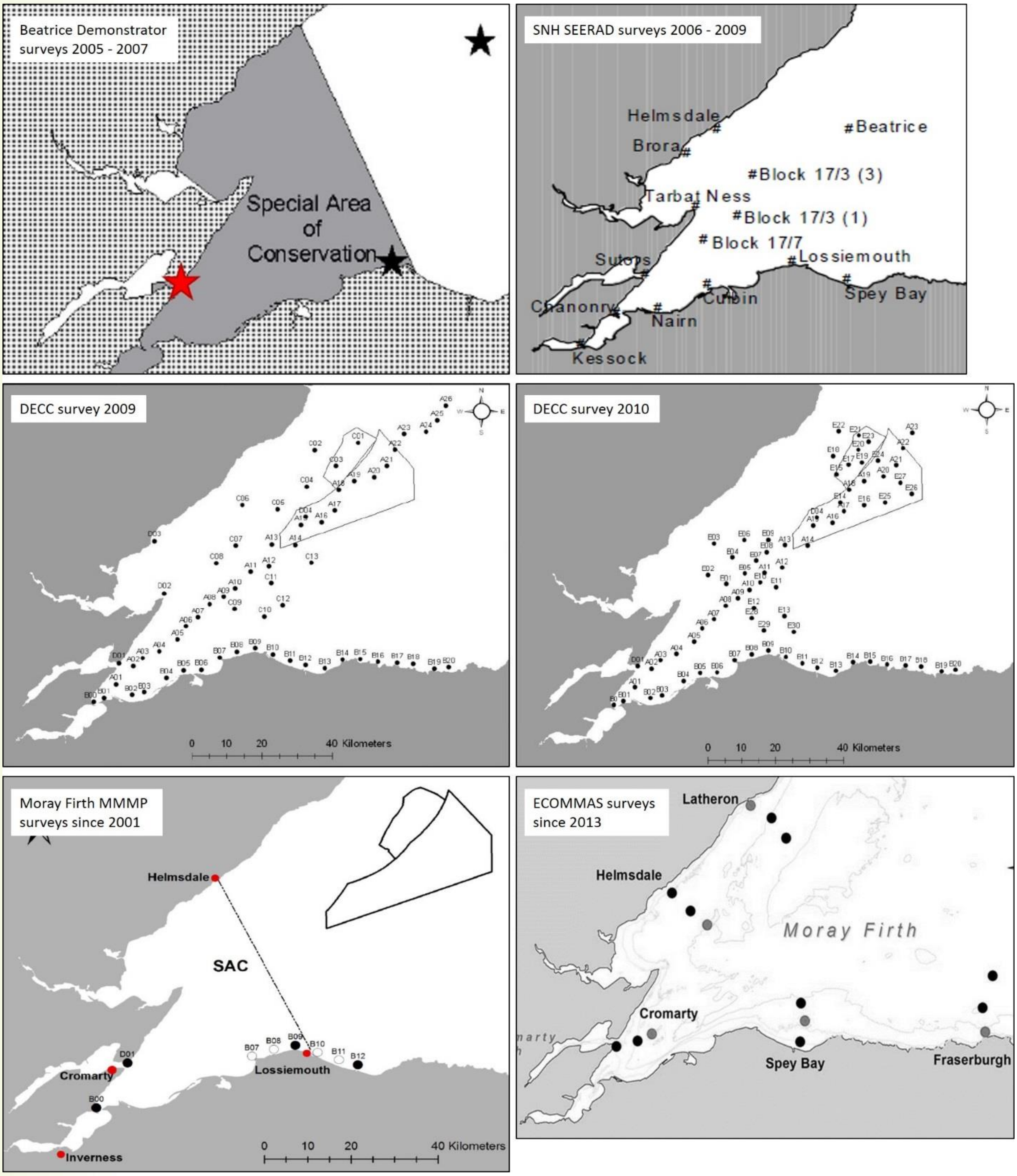


Image 9.4.3: Locations of the acoustic surveys conducted in the Moray Firth

Habitat Modelling to Provide Spatially Explicit Density Estimates

Harbour seal

9.4.1.18 Habitat modelling for harbour seals was conducted in 2011 for the BOWL and Moray East ES (2012) which produced spatially explicit estimates of density. Since this work was carried out, additional telemetry data from 56 harbour seals has been collected by the University of Aberdeen from 2014 to 31st March 2017 when piling for the Beatrice Offshore Wind Farm commenced (see Section 9.4.1.12). This data has been used to update and refine the model and resulting density map. The data were modelled using a case-control approach and the generated control points were combined with environmental data and modelled. The resulting model predictions were scaled to the population abundance estimate of 1,304 to estimate the number of seals within each grid cell (Bailey 2017).

Bottlenose dolphin

9.4.1.19 The acoustic and visual datasets presented in Tables 9.4.1 and 9.4.2 were used to identify dolphin detection rates and predict the dolphin species most likely to be detected within a 4×4 km grid, based on the habitat available within each grid cell. A classification tree demonstrated that dolphins encountered along the coastal areas were most likely to be bottlenose dolphins, while those encountered in offshore areas were more likely to be other species such as common, Risso's or white-beaked dolphins. The results were used to predict the likelihood that detected dolphins in the 4x4 km grid cells were bottlenose dolphins as opposed to other dolphin species. This was then scaled to the population estimate to provide an estimate of the number of bottlenose dolphins in each grid cell (Thompson *et al.,* 2014).

Harbour porpoise

9.4.1.20 The harbour porpoise sightings data obtained from the surveys in Table 9.4.1 were modelled to predict the spatial variation in the relative abundance of porpoise across the Moray Firth. The predicted number of porpoise in each 4x4 km grid cell was modelled against the environmental covariates of depth and substrate type and standardised for a constant unit of effort. The values for the predicted relative abundance were scaled to absolute abundance using the density estimates obtained from the 2010 aerial line transect survey (Brookes *et al.,* 2013) .

9.4.2 Current Baseline

9.4.2.1 A summary of the characteristics of the marine mammal baseline is provided below. Information for the marine mammal baseline characterisation is taken largely from the Moray East ES (2012), complemented with additional data that has been collected since then which was compiled through a combination of a literature reviews and further site-specific surveys. Only five marine mammal species (harbour porpoise, bottlenose dolphin, minke whale, harbour seal and grey seal) were considered in this baseline characterisation as they are the only marine mammal species categorised as commonly occurring in the Moray Firth (Moray East ES 2012). A detailed description of these baseline characteristics is provided in Technical Appendix 9.1: Marine Mammal Baseline.

Harbour Porpoise Baseline

9.4.2.2 Harbour porpoise are the smallest and most abundant cetacean species in UK waters (Reid *et al.,* 2003). They are typically sighted in small groups between one and three individuals. Animals are frequently sighted throughout coastal habitats with studies suggesting they are highly mobile and cover large distances (Nabe-Nielsen *et al.,* 2011). Harbour porpoise in the UK are considered to have a "Favourable Conservation Status" (JNCC 2013). The Moray West Site is located within the North Sea MU for harbour porpoise, as defined by the Inter Agency Marine

Mammal Working Group (IAMMWG 2015), however, the abundance data for this MU has not yet been updated by the IAMMWG since the publication of the UK Cetacean MUs in 2015. The most recent abundance estimate for harbour porpoise in the North Sea is for harbour porpoise, is from the SCANS III surveys, which is estimated to have an abundance of 345,373 porpoise (95% CI: 246,526 to 495,752) (Hammond *et al.,* 2017). The nearest European protected sites for harbour porpoises are the Inner Hebrides and Minches cSAC which is ~210 km from the Moray West Site and the Southern North Sea cSAC which is ~370 km from the site.

SCANS III

9.4.2.3 The SCANS III estimated abundance for block S was 6,147 porpoise (95% CI: 3,401 to 10,065) with an estimated density of 0.152 porpoise/km^2 (Hammond *et al.,* 2017). As noted above and on Image 9.4.1, the SCANS III survey block S extends considerably further than just the Moray Firth, and therefore the uniform density across the entire block may not be representative of densities in the Moray Firth when considered alone.

JNCC Report 544: Harbour Porpoise Density

9.4.2.4 The Heinänen and Skov (2015) analysis of the 18 years of JCP data (between 1994 and 2011), concluded that in the summer months, harbour porpoise presence in the North Sea was best predicted by season, water depth, surface salinity and eddy potential, while the density was best predicted by season, the water depth and the vertical temperature gradient. For the summer months the modelling showed a peak in densities at the inner shelf waters (30-50 m depth) and that animals seemed to avoid well mixed areas and waters with high current speeds as well as avoiding areas with muddy or hard bottom substrates.

9.4.2.5 The modelling predicted high densities of harbour porpoise in the Moray Firth in the summer months. However, as mentioned previously, survey effort within the Moray Firth was not evenly distributed and that there was a lack of effort data in the south-east of the Moray Firth. While the data predict high porpoise densities in the summer of 2009, this was when effort significantly increased due to potential offshore developments in the area. Based on a review of the advice given by MSS, the Scottish Ministers determined that the evidence was not robust enough to put forward the Moray Firth as an SAC for harbour porpoise.

CPOD Surveys

9.4.2.6 The CPOD studies in 2009 and 2010 showed that porpoise were detected on almost every sampling day at most locations throughout the Moray Firth, including at CPOD sites within the Moray East and Moray West, with lower detections at some coastal sites compared to the more offshore sites (Thompson *et al.,* 2010, Thompson *et al.,* 2011, Moray East ES 2012). These survey data have also been analysed to investigate habitat-specific differences in patterns of detection over the 24 hour daily cycle. This analysis found that the proportion of detection positive hours and the proportion of hours in which foraging buzzes were detected increased significantly during the night compared to the day, with different diurnal patterns between muddy and sandy habitats (Williamson *et al.,* 2017). The authors state that these data could indicate a shift in distribution or behaviour between night and day. This highlights the importance of not relying on visual methods alone to understand the distribution and abundance of echolocating cetaceans.

ECOMMAS

9.4.2.7 Porpoise were detected on almost all survey days (porpoise detection days >80%) between 2013 and 2016 at all ECOMMAS CPOD sites apart from Cromarty 05 and Spey Bay 05 where porpoise detection positive days were much lower (6-52%) (Table 9.4.3 and Volume 3a - Figure 9.4.2).

Table 9.4.3: Proportion of Survey Days in which Harbour Porpoise were Detected (porpoise positive days) and Median Porpoise Positive Hours at Each of the 15 ECOMMAS CPOD Sites in the Moray Firth Between 2013 and 2016. '-' denotes that there is no available data for that site and year

Site	Proportion Porpoise Positive Days				Median Porpoise Positive Hours			
	2013	2014	2015	2016	2013	2014	2015	2016
Cromarty 05	0.52	-	0.62	0.52	1.00	-	1.00	1.00
Cromarty 10	0.92	0.92	1.00	0.98	6.00	4.00	11.50	7.00
Cromarty 15	0.71	0.75	0.94	0.89	1.00	1.00	3.00	2.00
Fraserburgh 05	0.99	1.00	1.00	1.00	19.00	19.00	18.00	15.00
Fraserburgh 10	-	-	1.00	1.00	-	-	18.00	11.00
Fraserburgh 15	-	1.00	1.00	1.00	-	16.00	15.00	16.00
Helmsdale 05	1.00	0.96	0.99	1.00	8.00	6.00	8.50	9.00
Helmsdale 10	1.00	-	0.99	0.99	9.00	-	9.00	9.00
Helmsdale 15	1.00	1.00	1.00	0.98	8.00	7.00	12.00	10.00
Latheron 05	1.00	1.00	1.00	0.98	10.00	6.00	11.00	9.00
Latheron 10	1.00	-	1.00	1.00	10.00	-	9.00	10.00
Latheron 15	1.00	-	1.00	1.00	8.00	-	9.00	7.00
Spey Bay 05	0.14	0.06	0.16	0.13	0.00	0.00	0.00	0.00
Spey Bay 10	0.82	-	0.92	0.98	2.00	-	4.50	4.00
Spey Bay 15	-	1.00	1.00	1.00	-	14.00	15.00	15.00

Visual Surveys

9.4.2.8 The five visual survey studies conducted within the Moray Firth have shown that harbour porpoise are present throughout the Moray Firth, including the inner Moray Firth, the outer Firth and the Moray East, Moray West and Beatrice development sites (Moray East ES 2012). These studies showed that estimated harbour porpoise density and abundance was highest in the Beatrice and Moray East/West area compared to the central Moray Firth survey area, with the lowest estimates for the coastal survey areas. The density estimate for the Moray East Site was 0.72 porpoise/km^2 which is comparable to the density estimate from the aerial surveys of the BOWL and Moray East/West area survey block of 0.812 porpoise/km^2.

HiDef Aerial Surveys

9.4.2.9 During the 12 months of aerial surveys a total of 189 harbour porpoise have been identified from survey photographs. Harbour porpoise made up 84% of the total number of marine mammal sightings. Of these 189 porpoise, 66 were categorised as "Definite" porpoise, 113 were categorised as "Probable" porpoise and 10 were categorised as "Possible" porpoise. There was also one sighting of a "cetacean species" and six sightings of "seal/small cetacean species" which could not be identified to species level. Harbour porpoise were predominantly sighted between June and October with a maximum of 49 sightings in the June 2016 survey (sightings rate 0.23 porpoise/km). Harbour porpoise were sighted throughout the survey area, with no apparent spatial pattern to the sightings (Volume 3a - Figure 9.4.3).

9.4.2.10 Uncorrected relative density estimates from these surveys ranged from 0 to 0.45 porpoises per $km^{2,}$ with an average across all surveys of 0.15 km^2. However, these will be underestimates of true porpoise density due to a proportion of porpoises being underwater and therefore not visible at the time of surveys ('availability bias').

9.4.2.11 It is possible to apply a basic correction for availability bias in aerial surveys, by accounting for the proportion of animals that are in the surveyed area but not available to be detected by observers. One approach is to assume that the top two meters of water are visible in the digital images and use animal-borne telemetry data from Teilmann *et al. (*2007) and Teilmann *et al. (*2013) on the proportion of time that harbour porpoise spend in the top two meters of the water column. Using this approach, the resulting density estimate for harbour porpoise ranges between 0 and 1.07 porpoise/km^2 across the Moray West Site + 4 km buffer, with an average density across all survey months of 0.35 porpoise/km^2 (Table 9.4.4). This density estimate is similar to the average density estimate for the entire Moray Firth obtained from the habitat model (0.31 porpoise/km^2, see below).

9.4.2.12 Another approach is to apply a correction factor derived by Williamson *et al. (*2016). Comparison of digital aerial surveys with visual aerial surveys suggested that digital video detected 0.61 of all porpoises. Applying this factor to the data provides an average harbour porpoise density estimate of 0.24 porpoises per km^2.

Table 9.4.4: Corrected Harbour Porpoise Sightings used to Estimate Porpoise Density (#/km^2) at the Moray West Site + 4 km Buffer, Based on a Correction from Telemetry Data

Survey Month	Porpoise Sightings	Corrected Sightings	Effort (km^2)	Corrected Density (#/km^2)
Apr-16	0	0.0	105.1	0.00
May-16	9	21.2	105.6	0.20
Jun-16	48	112.9	105.8	1.07
Jul-16	28	65.9	105.8	0.62
Aug-16	22	51.8	106.0	0.49
Sep-16	31	72.9	105.6	0.69
Oct-16	29	68.2	104.6	0.65
Nov-16	0	0.0	105.6	0.00
Dec-16	0	0.0	104.2	0.00
Jan-17	6	14.1	104.7	0.13
Feb-17	15	35.3	105.8	0.33
Mar-17	1	2.4	106.0	0.02
Total	**189**	**444.7**	**1264.8**	**0.35**

Habitat Modelling

9.4.2.13 The modelled harbour porpoise density grid predicts a total of 6,815 porpoise within the Moray Firth. The average density across the entire grid was 4.89 porpoise/cell (0.31 porpoise/km^2) with a maximum of 337.27 porpoise/cell (21.08 porpoise/km^2) (Volume 3a - Figure 9.4.4). The average density across the grid was higher than the SCANS III block S estimated density of 0.152 porpoise/km^2 (Hammond *et al.,* 2017). Harbour porpoise are not predicted to be evenly distributed throughout the Moray Firth and there is a higher density area at the north east corner of the Moray West Site where densities reach a maximum of 23.53 porpoise/grid cell (1.47 porpoise/km^2).

JCP Phase III

9.4.2.14 The JCP Phase III analysis provides estimated abundances for harbour porpoise in the Moray Firth in 2010 by season, and estimates highest abundance in the winter months (13,500 animals), similar estimates in spring and summer (8,100 and 9,000 animals) and lowest estimates in autumn (5,300 animals) (Paxton *et al.,* 2016). The abundance averaged across summer 2007-2010 resulted in an estimated density across the Moray Firth of 0.544 porpoise/km^2 (0.190 – 1.034). This is higher than the density estimate from SCANS III (0.152 porpoise/km^2) and the average density from the habitat modelling (0.31 porpoise/km^2).

Harbour Porpoise Baseline Conclusion

9.4.2.15 Harbour porpoise in the UK are considered to have a "Favourable Conservation Status". They are the most abundant marine mammal species in the Moray Firth, which has been confirmed by both visual and acoustic surveys and habitat modelling. Acoustic surveys have detected harbour porpoise on almost every sampling day at most locations throughout the Moray Firth, with high detection rates within the Moray West Site and with lower detections at some coastal sites compared to the more offshore sites. The site specific aerial surveys of the Moray West Site have confirmed that harbour porpoise are present throughout the site and throughout the year, with higher sightings rates between June and October. The result of the habitat modelling shows a high predicted density of harbour porpoise at the north east corner of the Moray West Site.

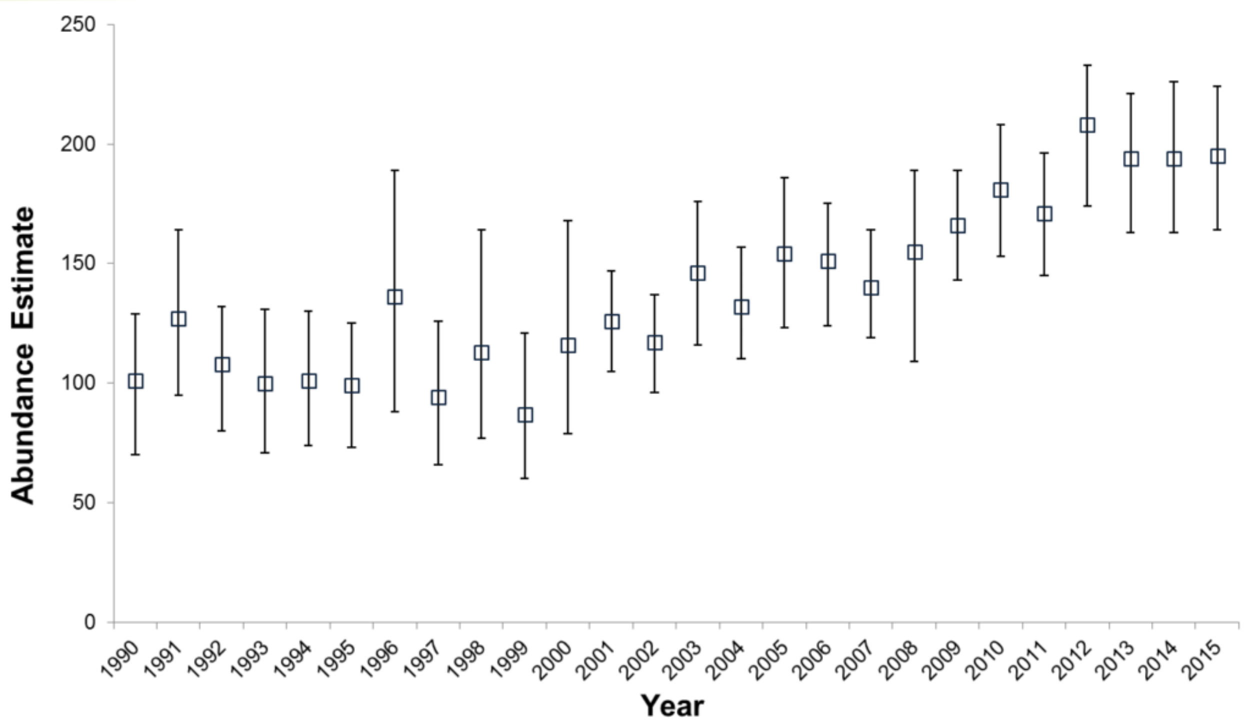
9.4.2.16 Due to the high spatial resolution and the temporal coverage represented by the habitat modelling carried out to predict the spatially explicit density surface for harbour porpoise, the resulting grid cell specific density estimates from this habitat modelling is what has been taken forward into the quantitative impact assessment to predict the numbers of individuals that may be disturbed as a result of underwater noise from pile-driving.

<u>Bottlenose Dolphin Baseline</u>

9.4.2.17 In the UK, bottlenose dolphins are considered to have a "Favourable Conservation Status" (JNCC 2013). The Moray Firth population of bottlenose dolphins is the only known remaining resident population in the North Sea and it was for this reason that the Moray Firth SAC was established in order to protect this population. The conservation objectives of the Moray Firth SAC are to avoid the deterioration of the bottlenose dolphin habitat, to achieve a favourable conservation status and to ensure the population size and distribution of the bottlenose dolphins is maintained in the long-term.

Photo-ID

9.4.2.18 The current population estimate of bottlenose dolphin abundance for the Coastal East Scotland MU population is 195 individuals (95% Highest Posterior Density Intervals (HPDI): 162 to 253) based on photo-ID counts between 2006 and 2007 (Cheney *et al.,* 2013). This resulted in a population growth rate estimate of 1.018 (Cheney *et al.,* 2013). The results of further surveys suggests that the east coast Scotland population has continued to increase in size since 2007, therefore the current population size is likely to be larger than this (Graham *et al.,* 2016). Between 1990 and 2015 the number of individuals using the SAC has remained stable at 98 individuals (95% CI: 83 to 116). Whilst the population size has increased, the relative proportion of the population that uses the SAC has declined (Graham *et al.,* 2016). Though the Moray Firth is clearly an important area for this population, they are not restricted to the either the Moray Firth SAC or the wider Moray Firth. Instead, these animals are highly mobile, and have a large range that extends from within the Moray Firth SAC, east along the outer Moray Firth coastline and south to the Firth of Forth (Cheney *et al.,* 2013).



Graph 9.4.1: Annual estimates of the east coast of Scotland bottlenose dolphin population from 1990 to 2015 with 95% highest posterior density intervals (HPDI) (Graham *et al.,* 2016)

Visual Surveys in the Moray Firth

9.4.2.19 The five visual survey studies conducted in the Moray Firth between 2004 and 2012 have shown that bottlenose dolphins are primarily located in the Moray Firth SAC and in coastal waters and are rare offshore. The boat based transect surveys of the Moray East and the Moray West Sites between 2010 and 2012 show that bottlenose dolphin sightings were extremely rare (only a single sighting in 28 surveys) compared to other dolphin species such as common dolphins (64 sightings) or white-beaked dolphins (188 sightings) (Table 9.4.5). In addition, the confidence level in the identification of this single sighting to species was low.

Table 9.4.5: Sightings of Dolphin Species during the Five Visual Survey Studies of the Moray Firth (Moray East ES 2012)

Species	Aerial			Boat-Based			
	BOWL/Moray East/Moray West	Central	Coast	SAC	Outer Moray Firth	Moray East/West	BOWL
Bottlenose dolphin	0	0	26	56	1	1	4
Unidentified dolphin	1	1	1	0	1	66	6
Common dolphin	1	2	3	0	0	64	1
White-beaked dolphin	1	0	1	0	0	188	0
Risso’s dolphin	1	0	0	0	0	1	0

Acoustic Surveys

9.4.2.20 The CPOD studies in 2009, 2010 and 2011 showed that dolphins were detected regularly in the inner Moray Firth and along the southern Moray Firth coast; with detections also recorded in the more offshore locations within the Moray Firth, including at CPOD sites within the Moray East and Moray West Sites (Thompson *et al.,* 2010, Thompson *et al.,* 2011, Moray East ES 2012, Thompson *et al.,* 2014). Using sightings data and a classification tree it was concluded that the dolphin detections at CPOD locations within the Moray West Site were more likely to be other dolphin species such as common or white-beaked dolphins and not bottlenose dolphins. This was further confirmed with the acoustic data collected by the EARs in 2010 which demonstrated that the detections across the Moray East and Moray West Sites were either other dolphin species or false detections.

9.4.2.21 The results of the classification tree analysis and the habitat modelling provided the probability of bottlenose dolphins occurring in grid cells across the Moray Firth. This habitat model showed that the probability of detecting a bottlenose dolphin in any given hour was up to 0.117 (11.7%) in any one grid cell, and that bottlenose dolphins were more likely to be detected in coastal waters, especially along the southern coast of the Moray Firth, compared to offshore waters (Thompson *et al.,* 2014).

Long Term CPOD Sites and the BOWL MMMP

9.4.2.22 The results from the PAM data collected at the four long-term monitoring sites in the Moray Firth have shown that the percentage of dolphin positive days and the median detection positive hours was highest at all sites between May and August (Table 9.4.6). Both the percentage dolphin positive days and the median dolphin positive hours showed that the sites located in the inner Moray Firth SAC (Sutors of Cromarty and Chanonry) had higher dolphin detection rates than the sites located along the outer southern coast of the Moray Firth (Lossiemouth and Spey Bay).

Table 9.4.6: Percentage of Dolphin Positive Days and Median Dolphin Positive Hours by Month Across the Four Long-Term CPOD Monitoring Sites in the Moray Firth

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
% Dolphin Positive Days												
Chanonry	53.8	47	43	89	92.1	98.7	98.7	99	96	79.7	80.2	68.4
Lossiemouth	46	55	64	77	81.2	85.2	75.8	81	71	42.9	61.6	59.4
Spey Bay	19.4	27	40	72	90.9	94.6	89.9	84	83	62.3	55.1	52.4
Sutors	79.6	80	65	92	100	100	99.3	99	93	95.9	99.1	93.3
Median Dolphin Positive Hours												
Chanonry	1	0	0	3	4	5	7	7	5	3	3	2
Lossiemouth	0	1	1	2	2	2	2	2	1	0	1	1
Spey Bay	0	0	0	2	4	4	3.5	3	2	1	1	1
Sutors	2	1	1	5	11	10	9	8	4	7	6	5

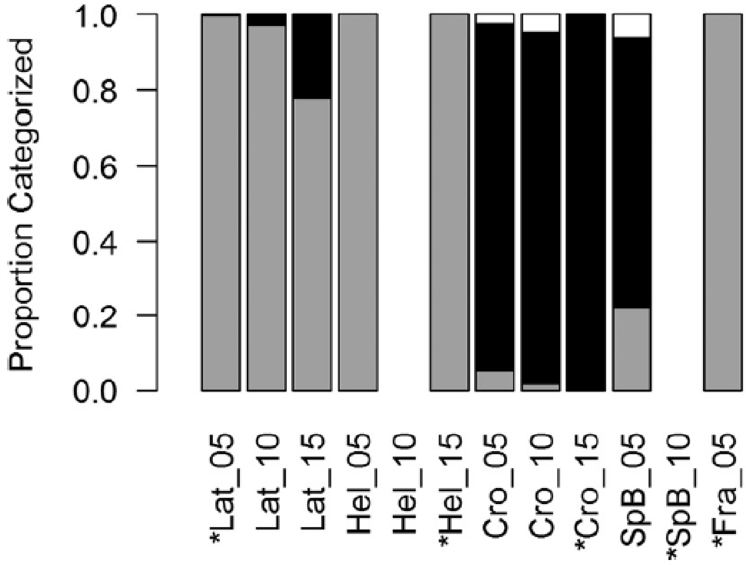
ECOMMAS Surveys

9.4.2.23 Of the five ECOMMAS PAM site groups in the Moray Firth, Cromarty had the highest proportion of dolphin positive days with site Cromarty 05 having between 89 and 96% of the survey days with dolphin detections (Table 9.4.7 and Volume 3a - Figure 9.4.5). There was also a consistent pattern of declines in the proportion of dolphin positive days with increasing distance from the coast at all site groups except Fraserburgh and Spey Bay.

Table 9.4.7: Proportion of Survey Days in Which Dolphins Were Detected (Dolphin Positive Days) at Each of the 15 ECOMMAS CPOD Sites in the Moray Firth Between 2013 and 2016. No data is denoted by '-'

Site	2013	2014	2015	2016
Cromarty 05	0.89	-	0.95	0.96
Cromarty 10	0.32	0.43	0.37	0.36
Cromarty 15	0.02	0.00	0.04	0.01
Fraserburgh 05	0.13	0.30	0.11	0.06
Fraserburgh 10	-	-	0.00	0.00
Fraserburgh 15	-	0.04	0.08	0.10
Helmsdale 05	0.05	0.12	0.14	0.15
Helmsdale 10	0.00	-	0.02	0.04
Helmsdale 15	0.01	0.01	0.00	0.03
Latheron 05	0.19	0.02	0.20	0.27
Latheron 10	0.03	-	0.04	0.14
Latheron 15	0.04	-	0.01	0.05
Spey Bay 05	0.22	0.21	0.14	0.11
Spey Bay 10	0.00	-	0.00	0.00
Spey Bay 15	-	0.01	0.03	0.02

9.4.2.24 These data have been further analysed to separate the CPOD "dolphin" detection data into two groups: broad-band echolocation clicks (made by bottlenose and common dolphins) and frequency banded echolocation clicks (made by Risso's and white-beaked dolphins) (Palmer *et al.,* 2017). The analysis of the CPOD data from the ECOMMAS surveys have shown that at the northern Moray Firth sites at Helmsdale and Latheron, the detections have mostly been frequency banded echolocation clicks (Graph 9.4.2) and so are likely to be either Risso's or white-beaked dolphins. At Cromarty, the detections were identified as predominantly broad-band echolocation clicks (Graph 9.4.2) and are most likely to be bottlenose dolphins. Along the southern coast of the Moray Firth, the Spey Bay detections were mainly broad-band (Graph 9.4.2:) and so are attributed to either bottlenose or common dolphins and at Fraserburgh the detections were all frequency banded (Graph 9.4.2) and so were attributed to Risso's or white-beaked dolphins.



Graph 9.4.2: The proportion of click trains recorded at ECOMMAS PAM sites within the Moray Firth classified as broadband (black), frequency banded (grey) or unknown (white) by the combination of the Generalised Additive model (GAM) click-train classification and the encounter likelihood ratio (Palmer *et al.,* 2017). Asterisks indicate joint C-POD/SM2M deployment locations from which training data were derived and where CPODs were displaced no data are presented

9.4.2.25 The analysis of the ECOMMAS CPOD data by Palmer *et al. (*2017) highlights that the predicted probability of dolphin occurrence presented in Thompson *et al. (*2014) was likely to have overestimated the probability of bottlenose dolphin occurrence along the northern coast of the Moray Firth. In order to provide a more realistic density surface for bottlenose dolphins in the Moray Firth, the dolphins in the grid cells located along the coast north of, and surrounding, Helmsdale and Latheron were re-distributed to other grid cells within the Moray Firth, based on the proportion of the total each cell contained (Volume 3a - Figure 9.4.6). In addition to this, the number of dolphins present in each grid cell has been adjusted in order to reflect the fact that only approximately half the population is likely to be present in the Moray Firth at any one time (and available to be impacted), with the remaining population distributed further south along the east coast as far as the Firth of Forth (Cheney *et al.,* 2013, Graham *et al.,* 2016).

SCANS III

9.4.2.26 The SCANS III estimated abundance for block S was 151 bottlenose dolphins (95% CI: 0 to 527) with an estimated density of 0.004 dolphins/km^2 (Hammond *et al.,* 2017). This is slightly lower than the abundance estimate for the Coastal East Scotland population derived from the dedicated photo-ID surveys of 195, however the SCANS III survey block S does not cover the full range of this population and so it was expected that the abundance estimate would be lower as it covers only the portion of the Coastal East Scotland population in the Moray Firth.

Bottlenose Dolphin Baseline Conclusion

9.4.2.27 The Coastal East Scotland MU population of bottlenose dolphins has been increasing since 1990 and the current population estimate is 195 animals. This population extends between the Moray Firth and south along the east coast of Scotland to the Firth of Forth. The use of the Moray Firth SAC by this population varies from year to year, and in 2015 approximately half of the population used the SAC (Graham *et al.,* 2016). The population has a "Favourable Conservation Status". The analysis from the ECOMMAS acoustic surveys detailed in (Palmer *et al.,* 2017) have determined that the click detections along the northern coast of the Moray Firth are more likely to be species other than bottlenose dolphins, and that bottlenose dolphins are found mainly along the southern coast of the Moray Firth. The impact assessment will be based on the revised grid cell specific density estimates presented in Volume 3a - Figure 9.4.6. Due to the proximity of the Moray West Site to the Moray Firth SAC for bottlenose dolphins, an HRA is also required for bottlenose dolphins.

Minke Whale Baseline

9.4.2.28 Minke whales are widely distributed around the UK, with higher densities recorded on the West coast of Scotland and the western North Sea (Reid *et al.,* 2003). They occur mainly on the continental shelf in water depths less than 200 m and are sighted more frequently in the summer months between May and September. Minke whales in the UK are considered to have a "Favourable Conservation Status" (JNCC 2013) and all minke whales in UK waters are considered to be part of the Celtic and Greater North Seas MU (IAMMWG 2015). There is an abundance estimate for this MU of 23,528 animals (95% CI: 13,989 to 39,572), of which 12,295 (95% CI: 7,176 to 21,066) are estimated within the UK Exclusive Economic Zone (EEZ). However, these abundance estimates are based on data from SCANS II (Hammond *et al.,* 2013) and the Cetacean Offshore Distribution and Abundance in the European Atlantic (CODA) surveys (Macleod *et al.,* 2009) and are therefore likely to be underestimates due to the SCANS II aerial survey estimate not being corrected for perception bias and the CODA estimate not being corrected for either perception or availability bias.

SCANS III

9.4.2.29 The SCANS III estimated abundance for block S was 383 minke whales (95% CI: 0 to 1,364) with an estimated density of 0.01 whales/km^2 (Hammond *et al.,* 2017).

Identification of MPAs for Minke Whales

9.4.2.30 The estimated densities for minke whales are generally low throughout the Moray Firth (<0.1 whales/km^2, Volume 3a - Figure 9.4.7) but higher densities are estimated at the Southern Trench area in the south east of the Moray Firth where densities reach in excess of 10 whales/km^2 in one grid cell. From this, the Southern Trench has been identified as a potential MPA (pMPA) by SNH (see below). When only the data within the Moray Firth are assessed (within the Moray Firth Boundary line in Volume 3a - Figure 9.4.7) the average density across the Moray Firth is 0.006 whales/km^2 (53.67 whales in an area of 8,421.81 km^2) which is similar to the density estimate for the SCANS III block S (0.01 whales/km^2). These data are therefore considered generally comparable, with the density surface from Paxton *et al. (*2014) providing a finer scale density surface than the SCANS III block-wide uniform density estimate. The use of a density surface map will allow assessments of impact to take into consideration the spatial distribution of minke whales within the Moray Firth.

Southern Trench pMPA

9.4.2.31 The Southern Trench pMPA was proposed based on data from the JCP which included survey data between 2000 and 2012 from 23 datasets including the latest data (2010 to 2012) from the CRRU. Adjusted observed densities suggest that minke whales are observed at high relative densities within the proposed area of the pMPA (up to 5-10 whales/km^2 within the pMPA and >10 whales/km^2 in waters just north of the pMPA (Image 9.4.4)) compared to wider Scottish territorial waters and modelled data show that the pMPA area is persistently predicted to support above average densities of minke whales during summer months (Paxton *et al.,* 2014). As identified in the pMPA proposal, these high density areas are highly seasonal with high densities recorded in the summer, when minke whales move into the area for foraging (SNH 2014).

(ii)

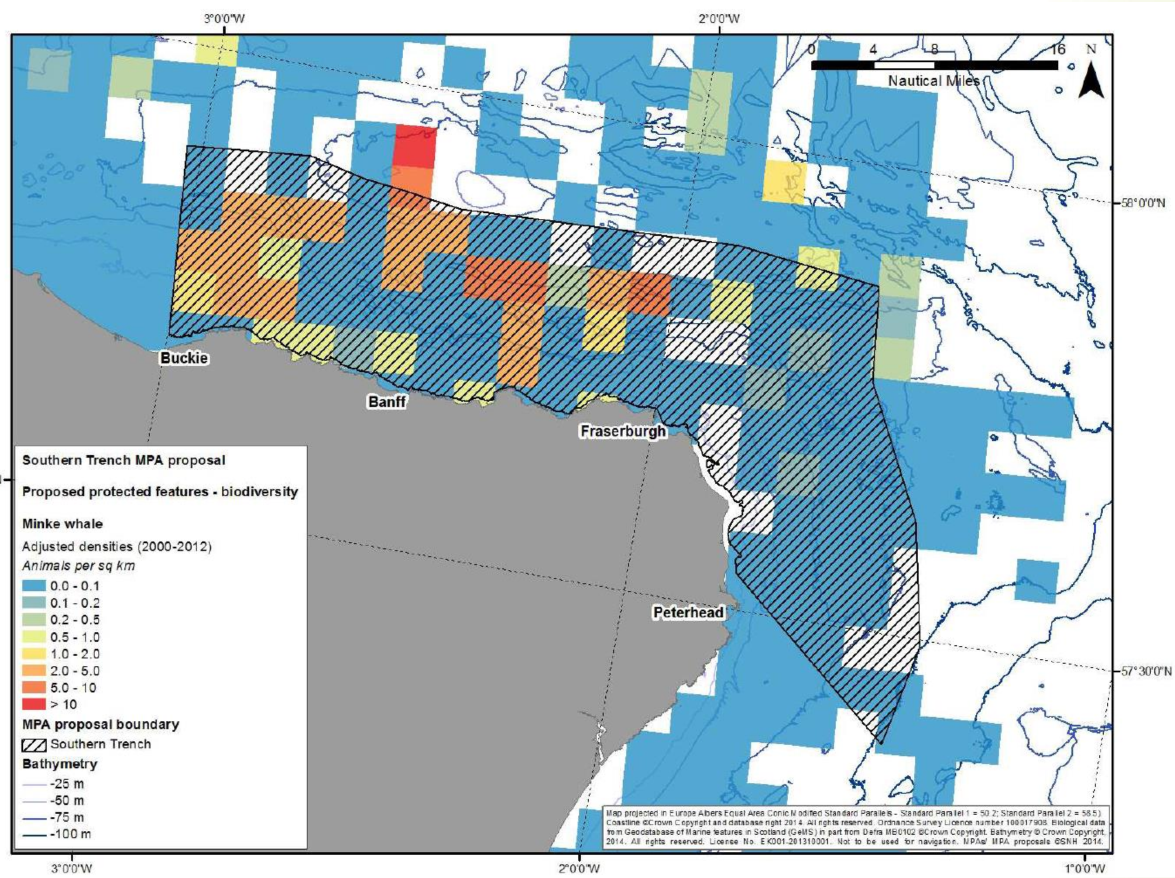


Image 9.4.4: Adjusted densities of minke whales in the Southern Trench pMPA (2000-2012) (SNH 2014).

Visual Surveys in the Moray Firth

9.4.2.32 All five visual surveys conducted within the Moray Firth and presented in the Moray East ES (2012) have confirmed that minke whales are present in both the inner and outer Moray Firth, and within both the Moray East Site and the BOWL site (Table 9.4.8). The only survey for which there was a sufficient number of sightings to conduct Distance analysis was the Moray East Site boat based surveys between April 2010 and March 2012. The analysis assumed a g(0)<1 and estimated a density of 0.01 whales/km^2 in the Moray East Site doing the months April to September (95% CI: 0.007 to 0.02) and a density of 0.008 whales/km^2 within the 4 km buffer zone (0.004 to 0.015).

Table 9.4.8: Number of Recorded Sightings for Each of the Five Visual Surveys Conducted in the Moray Firth (Moray East ES 2012)

	Aerial	Moray East	SAC	Outer MF	BOWL
# Sightings	13	40	10	49	43

CRRU Survey Data

9.4.2.33 A total of 305 minke whale encounters were recorded during the CRRU dedicated boat surveys between May and October 2001 and 2006, with minke whales being sighted in all months between May and October inclusive but with higher encounters in the months of July and August where the number of encounters reached >0.03 encounters/km (Robinson *et al.,* 2009). Analysis of these data showed that minke whales were more likely to be encountered in areas with water depths between 20-50 m, steep slopes and sandy-gravel sediment (Robinson *et al.,* 2009) (Image 9.4.5).

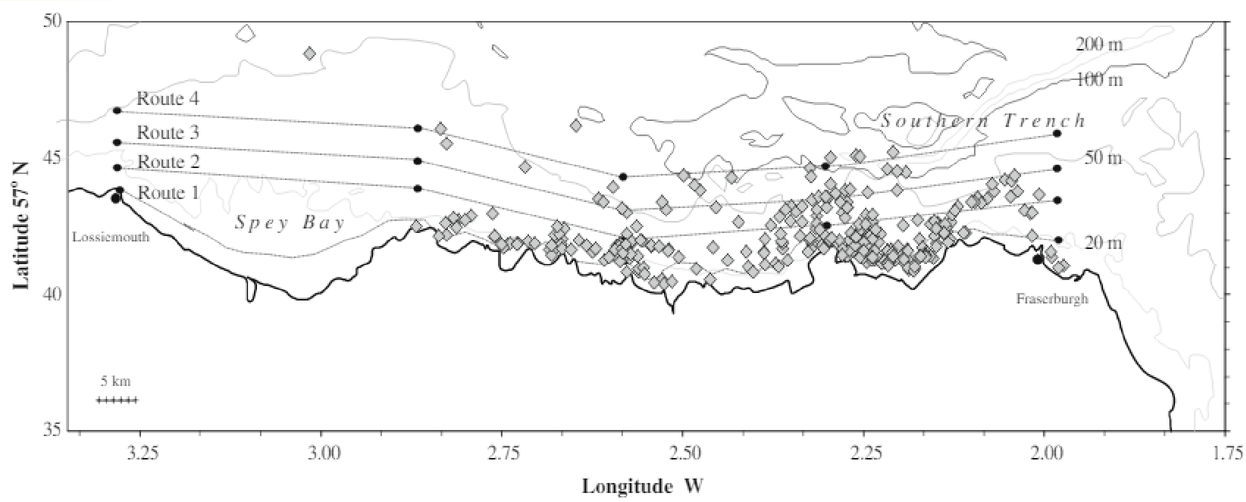


Image 9.4.5: Spatial distribution of minke whale encounters in the southern outer Moray Firth between May and October 2001 to 2006 inclusive (n=305) (Robinson *et al.*, 2009)

JCP Phase III

9.4.2.34 The JCP Phase III analysis provides estimated abundances for minke whales in 2010 by season, and estimates highest abundance in the summer months (210 animals), with similar low estimates in all other seasons (20 to 30 animals).

Hi-Def Aerial surveys

9.4.2.35 During the 12 months of aerial surveys for the Moray West Site a total of five minke whales have been identified from survey photographs which made up 2% of the total number of marine mammal sightings. All five minke whale sightings were made during June 2016 and all were sighted in the northeast of the survey area.

Minke Whale Baseline Conclusion

9.4.2.36 Minke whales are considered to have a "Favourable Conservation Status" in the UK. The estimated densities for minke whales is generally low throughout the Moray Firth but with higher densities at the Southern Trench pMPA in the South East of the Moray Firth during the summer when minke whales move into the area for foraging. Surveys have shown that minke whales are present throughout the summer, with higher encounter rates between July and August. Minke whales were sighted in June 2016 during the site specific aerial surveys of the Moray West Site. While minke whale presence in the Moray Firth during the winter months cannot be ruled out (the JCP III data estimates 20 animals in the Moray Firth during winter months), surveys have shown that densities are considerably lower outside of the summer months.

Harbour Seal Baseline

9.4.2.37 Harbour seals are the smaller of the two species of seal resident in UK waters. They forage at sea and haul-out on land to rest, moult and breed. Harbour seals normally feed within 40 to 50 km around their haul-out sites and take a wide variety of prey including sandeels, gadoids, herring and sprat, flatfish, octopus and squid (SCOS 2017).

9.4.2.38 Harbour seals come ashore in sheltered waters, typically on sandbanks and in estuaries, but also in rocky areas. They give birth to their pups in June and July and moult in August. At these, as well as other times of the year, harbour seals haul-out on land regularly in a pattern that is often related to the tidal cycle.

9.4.2.39 Harbour seals are widespread around the west coast of Scotland and throughout the Hebrides and Northern Isles. On the east coast of the UK, their distribution is more restricted with concentrations in the major estuaries of the Thames, The Wash, Firth of Tay and the Moray Firth.

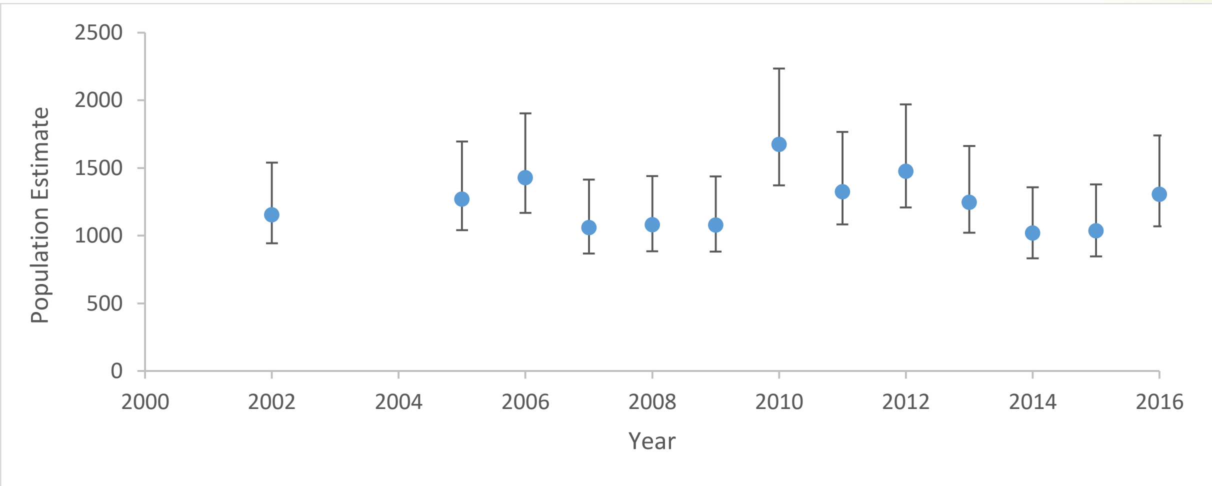
9.4.2.40 In the UK, harbour seals are considered to have an "Unfavourable Inadequate Conservation Status" (JNCC 2013) which means that "*a change in management or policy is required to return the habitat type or species to favourable status but there is no danger of extinction in the foreseeable future*" (ETC/BD 2014).

9.4.2.41 The most recent UK wide harbour seal count presented in SCOS (2017) combines data collected between 2011 and 2016. This produced a total count for the UK of 31,300 seals which, scaled to account for the proportion of animals at sea at the time of the count, gives an estimated UK population size of 43,500 (95% CI: 35,600 to 58,000), of which 85% are located in Scotland (SCOS 2017).

Haul-out Counts

9.4.2.42 The Moray West Site is located within the Moray Firth seal management area where the most recent harbour seal August moult count was 940 in 2016 (SCOS 2017). This scales to a population estimate of 1,306 harbour seals (95% CI: 1,068 to 1741) which accounts for approximately 3.1% of the total population in Great Britain.

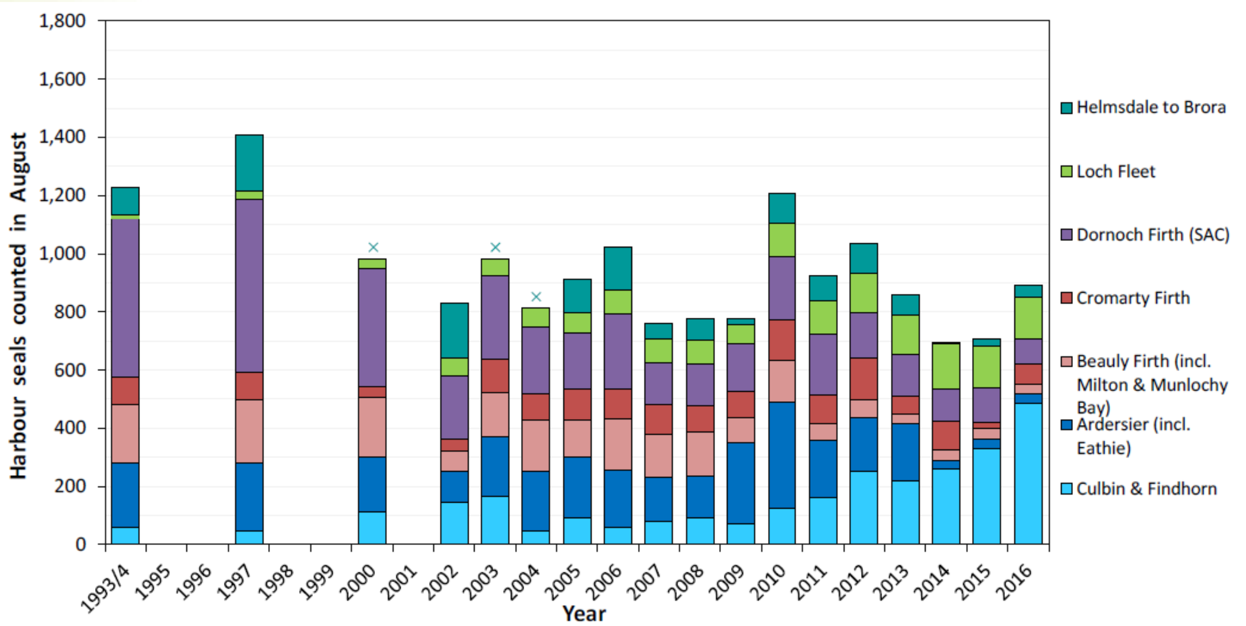
9.4.2.43 Overall, across the time series of data between 2002 and 2016, it appears that the population in the Moray Firth MU is reasonably stable, though with inter-annual variation (Graph 9.4.3). The population appeared to be declining between 2012 and 2015 (from 1,476 in 2012 to 1,018 in 2014 and 1,035 in 2015); however, the 2016 estimate of 1,306 animals was higher than that obtained in 2014 and 2015 and is more in line with the previous estimate in 2012.



Graph 9.4.3: Moray Firth MU harbour seal population estimates (raw counts scaled to account for the proportion at sea) between 2002 and 2016. Error bars show the 95% CIs. Data obtained from SCOS (2017)

9.4.2.44 A breakdown of the counts in the different areas surveyed within the Moray Firth are available up to 2016, as presented in Graph 9.4.4 and Volume 3a - Figure 9.4.8. The haul-out data for the annually surveyed sites show that the Loch Fleet counts have increased from 59 animals in 2002 to 145 animals in 2016 (average p.a. increase of 8.35%). If the 2016 count of 145 is scaled to include the proportion of seals in the water at the time of the count, the abundance of harbour seals in Loch Fleet during the 2016 August moult is estimated as 201 animals (95% CI 165 to 269). Unlike the Loch Fleet site, the annual moult count at the Dornoch Firth and Morrich More SAC has fluctuated annually from 220 in 2002 to a maximum of 290 in 2003 and a minimum of 85 in 2016. Over the period between 2002 and 2016 the counts show an average per annum 0.48% decline in counts. If the 2016 count of 85 is scaled to include the proportion of seals in the water at the time of the count, the abundance of harbour seals in the Dornoch Firth and Morrich More SAC during the 2016 August moult is estimated as 118 animals (95% CI 97 to 157).

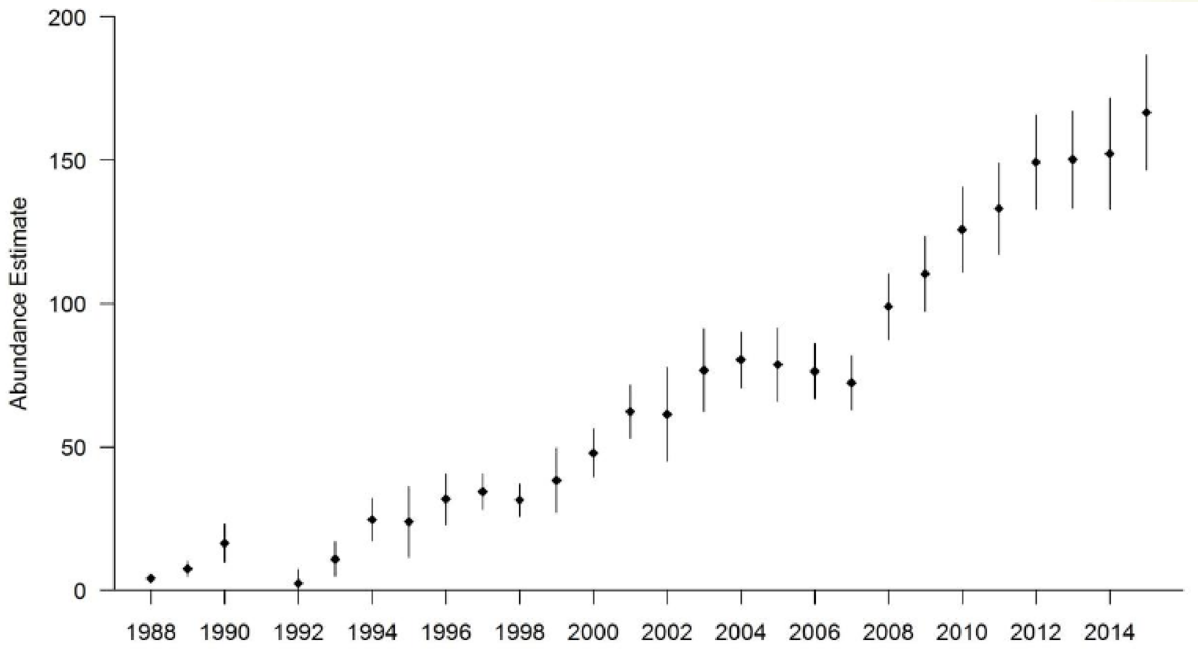
9.4.2.45 Other haul-out sites in the Moray Firth that are surveyed annually during the moult count include Culbin & Findhorn which has shown a large increase in counts from 49 in 2004 to 484 in 2016. All other annually monitored sites (Helmsdale to Brora, Cromarty Firth, Beauly Firth and Ardersier) have shown large fluctuations in annual moult counts (Graph 9.4.4). The distribution of counts and the variation over time indicate that there has been a change in usage within the Moray Firth over time, from most counts being located within the Dornoch Firth and Morrich Moore SAC in the 1990s to most seals being counted in Culbin and Findhorn in more recent years (Graph 9.4.4).



Graph 9.4.4: Harbour seal counts from SMRU surveys at haul-out sites in the Moray Firth between 1993 and 2016 (SCOS 2017) (Helmsdale to Brora not surveyed in 2000, 2003 or 2004)

University of Aberdeen harbour seal haul-out surveys

9.4.2.46 The Loch Fleet National Nature Reserve is the nearest major harbour seal breeding site to the Moray West Site. The estimated abundance of harbour seals at the Loch Fleet National Nature Reserve has increased since the mid 1990's, count data from the University of Aberdeen surveys was available up to 2015 and at this point the count was at its highest of 167 seals (95% CI: 146 to 187; estimated by adjusting counts made during the pupping season) (Graham *et al.,* 2016) (Graph 9.4.5).



Graph 9.4.5: Estimated number of seals using Loch Fleet from 1988 to 2015 with 95% confidence intervals (Graham *et al.,* 2016)

9.4.2.47 Other haul-out sites along the coast north of the Dornoch Firth and Morrich More SAC have been monitored monthly as part of the BOWL strategic pre-construction MMMP in 2014 and 2015, including Lothmore, Lothbeg, Sputie Burn and Dunrobin (in addition to the Loch Fleet surveys). These data show that Loch Fleet supports considerably more seals than the other surveyed sites (mean count of 123 in 2014 and 129 in 2015), however there are also a number of harbour seals that haul-out at Sputie Burn year round (mean count of 39 in 2014, 38 in 2015) (Graham *et al.,* 2016).

Telemetry Data – Seal Movements and Distribution

9.4.2.48 A total of 37 adult harbour seals were tagged in the Moray Firth between 2004 and 2015, with tag durations lasting between 20 and 185 days (mean 115 days). Of these, 12 seals recorded tag locations within the Moray West Site, however, these only comprised a low proportion of their total tag locations (maximum 4.14%) (Volume 3a - Figure 9.4.9). The more recent telemetry data (2014 and 2015 deployments) show much less usage of the Moray West, Moray East and BOWL wind farm development sites than previous tag deployments (Volume 3a - Figure 9.4.9). While this may simply be due to individual variations in range and movement patterns, there is the potential that these data could reflect a change in harbour seal usage of this area in recent years.

At-Sea Usage

9.4.2.49 Both the previous (2004-2007) and the most recent telemetry data (2014-2015, which showed much less usage of the Moray West, Moray East and BOWL wind farm development sites than previous tag deployments) were modelled using a Generalised Additive Mixed Model (GAMM) to predict harbour seal at-sea usage in the Moray Firth. The resulting harbour seal at-sea usage map (Bailey 2017) shows that harbour seals are not predicted to be evenly distributed within the Moray Firth (Volume 3a - Figure 9.4.10). There are hotspots of higher predicted densities in the inner Moray Firth, with highest densities around the Dornoch Firth and Morrich More SAC. The grid cell with the maximum density within the Moray West Site has an estimated at-sea density of 3.97 seals/cell which, assuming uniform distribution within a grid cell, equates to 0.16 seals/km^2.

State Space Modelling

9.4.2.50 A state space model (described in Russell *et al.,* 2015) was used to classify travelling and foraging locations from the telemetry data of 19 of the 25 harbour seals tagged in 2014 and 2015. These data show that there is an important foraging area off the headland near the haul-out sites in the Dornoch Firth and Loch Fleet (Image 9.4.6). A previous study on harbour seal locations in the Moray Firth (Bailey *et al.,* 2014), using data obtained from tags deployed between 1989 and 2009 also identified this area as an area of persistently high usage which had been previously identified as a harbour seal foraging habitat (Thompson *et al.,* 1996, Tollit *et al.,* 1998). This area is known to have high currents and a sandy seabed, which is the preferred habitat of sandeels on which the harbour seals forage. The data also show that the Moray West Site was not an area used for foraging by any of the 19 tagged harbour seals, nor was it an important area where travelling behaviour was observed (Image 9.4.6).

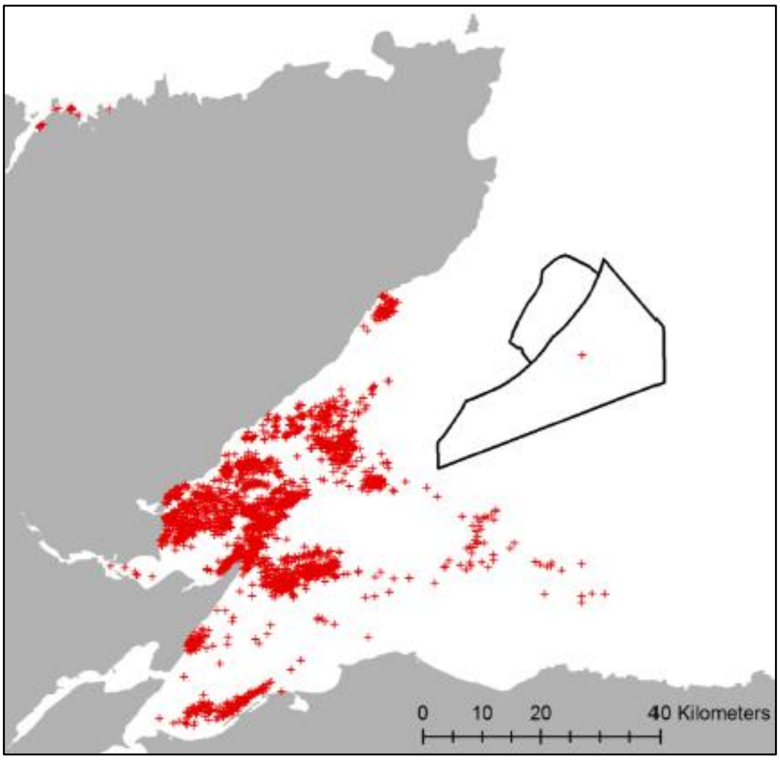


Image 9.4.6: Foraging locations identified by state space modelling of location data from 19 of the harbour seals tagged in the Moray Firth in 2014 and 2015 (Graham *et al.,* 2016)

Harbour Seal Baseline Conclusion

9.4.2.51 In the UK, harbour seals are considered to have an "Unfavourable Inadequate Conservation Status". However, the harbour seal population in the Moray Firth has remained relatively stable since 2002, though there is inter-annual variation in population estimates. The current Moray Firth population size estimate is 1,304 harbour seals which accounts for approximately 3% of the total UK population. The main haul-out sites for harbour seals in the Moray Firth are located at Culbin and Findhorn and no haul-out sites are located within the Offshore Export Cable Corridor and proposed landfall area. The nearest breeding site to the Moray West Site is Loch Fleet, which supported an estimated 167 harbour seals in 2015. The most recent telemetry data show less usage of the Moray West, Moray East and BOWL wind farm development sites than previous tag deployments. The at-sea usage map confirms that harbour seals are not evenly distributed throughout the Moray Firth, and that they occur at highest densities around the Dornoch Firth and Morrich More SAC. Due to the proximity of the Moray West Site to the Dornoch Firth and Morrich More SAC, a Habitats Regulations Appraisal (HRA) will be required for harbour seals. This will be presented in a Report to Inform Appropriate Assessment which accompanies this Environmental Impact Assessment Report.

Grey Seal Baseline

9.4.2.52 Grey seals are the larger of the two species of seal resident in UK waters. They haul-out on land to rest, moult and breed and forage at sea where they range widely, frequently travelling for up to 30 days with over 100 km between haul-out sites (SCOS 2016). Approximately 38% of the World's grey seal population breeds in the UK with 86% of these breeding in Scotland. Grey seal population data are assessed using pup counts during the autumn breeding season when females haul-out to give birth. The number of pups throughout Britain has grown steadily since the 1960s but there is clear evidence that the population growth is levelling off in all areas except the central and southern North Sea where growth rates remain high.

9.4.2.53 In the UK, grey seals typically breed on remote uninhabited islands or coasts and in small numbers in caves. Preferred breeding locations allow females with young pups to move inland away from busy beaches and storm surges. Seals breeding on exposed, cliff-backed beaches and in caves may have limited opportunity to avoid storm surges and may experience higher levels of pup mortality as a result. UK grey seals breed in the autumn, but there is a clockwise cline in the mean birth date around the UK. The majority of pups in south west Britain are born between August and September, in north and west Scotland pupping occurs mainly between September and late November and eastern England pupping occurs mainly between early November to mid-December.

9.4.2.54 The grey seal is considered to have a "Favourable Conservation Status" in the UK (JNCC 2013). The most recent UK wide grey seal pup production count was in 2014, which produced a total UK pup production estimate of 60,500 (95% CI: 53,900 to 66,900), which, modelled to estimate the non-pup portion of the population, gives an estimate of 139,800 aged 1+ grey seals in the UK (95% CI: 116,500 to 167,100) (SCOS 2017).

Haul-out Counts

9.4.2.55 The number of grey seals counted during the August haul-out surveys has varied considerably between years within the Moray Firth Seal Management Area, with lowest counts of 392 in 2002 and highest in 2015 with 1917. Most of the grey seals counted during the August surveys are located in the inner Moray Firth, between Loch Fleet and Findhorn, with concentrations of counts in the Dornoch Firth, Ardersier, Culbin, Lothbeg and Findhorn (Volume 3a - Figure 9.4.11). It is important to note that since the timing of the surveys are conducted to coincide with the harbour seal moult, these surveys are not conducted during a key haul-out period for grey seals. Counts of greys seals during these surveys can be highly variable and although these counts are not used as a population index, they provide useful information on the distribution of grey seals in August.

SMRU Breeding Counts

9.4.2.56 Grey seal pup production at surveyed breeding sites in the Moray Firth has remained stable over the last 10 years, while the Orkney MU has increased by an average of 3.84% per year (Table 9.4.9). The closest grey seal breeding site to the Moray West Site is approximately 21 km away. These data demonstrate that there is a stable population of breeding grey seals in the Moray Firth MU and an increasing breeding population in the Orkney MU.

Table 9.4.9: Grey Seal Pup Production Counts Between 2005 and 2014 for the Moray Firth and the Orkney Management Units								
Year	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2012**	**2014**
Moray Firth MU	**1,174**	**1,284**	**1,201**	**1,201**	**1,098**	**1,043**	**1,602**	**1,658**
Helmsdale to Dunbeath	1,174	1,284	1,201	1,201	1,098	1,043	1,003	1,032
Dunbeath to Wick	-	-	-	-	-	-	163	231
Duncansby Head	-	-	-	-	-	-	436	395
Orkney MU	**17,643**	**18,966**	**18,805**	**18,415**	**18,715**	**19,850**	**22,470**	**22,783**
Faray & Holm of Faray SAC	2,833	3,148	3,315	2,788	2,709	3,192	3,152	3,074

Telemetry Data

9.4.2.57 Grey seals are known to travel further than harbour seals, and they can travel over 100 km from haul-out sites (SCOS 2016). For this reason, a 100 km buffer was placed around the Moray West Site and the grey seal telemetry data within this area is presented here (this replicates the approach taken in the Moray East ES (2012)). Since 1993, 69 tagged grey seals have recorded telemetry tracks that are within a 100 km buffer of the Moray West Site (Volume 3a - Figure 9.4.12). Of these, 30 were tagged in the Orkney and the North Coast MU and 28 were tagged in the East England MU.

9.4.2.58 These data show that there is connectivity between the Moray Firth and the following four SACs where grey seals were the primary qualifying feature for site selection: Berwickshire and North Northumberland Coast, Isle of May, Faray and Holm of Faray and North Rona. They also show connectivity with the Humber Estuary SAC which lists grey seals as a qualifying feature but not the primary reason for selection of the site.

9.4.2.59 Within the 100 km buffer around the Moray West Site, most of the telemetry tracks are located around the Orkney Islands and the Aberdeenshire coastline, with very little telemetry data in the inner Moray Firth or overlapping with the Moray West Site. It should, however, be highlighted that there have been no grey seals tagged at Loch Fleet or the Dornoch Firth and so the usage of these areas are likely to be underestimated by the telemetry data.

At-sea Usage

9.4.2.60 The grey seal at-sea usage maps show that grey seals are not predicted to be evenly distributed within the Moray Firth (Volume 3a - Figure 9.4.13). There are hotspots of higher predicted densities at the very north of the Moray Firth and around the Orkney Islands, and in the waters to the north of, and around the entrance to, the Dornoch Firth and Morrich More SAC. The grid cell with the maximum density within the 25 km buffer around the Moray West Site has an estimated mean at-sea density of 150.3 seals/cell which, assuming uniform distribution within a grid cell equates to 6.0 seals/km^2. This high density cell is located adjacent to the south west corner of the Moray West Site.

Visual Surveys in the Moray Firth

9.4.2.61 Grey seals were sighted regularly during the boat based surveys of the Moray East Site between April 2010 and March 2012. During the 28 surveys conducted in this study, there were a total of 178 grey seal sightings and 121 unidentified seal species sightings recorded within the Moray East Site and the 4 km buffer round the site. Grey seal sightings occurred year round but with a peak in sightings in spring (April) and late summer (August). These data were analysed with

Distance to produce a density estimate of 0.05 grey seals/km^2 within the Moray East Site (95% CI: 0.03 to 0.07) and 0.04 grey seals/km^2 within the 4 km buffer zone around the Moray East Site (95% CI: 0.03 to 0.06). No such estimates are available for the Moray West Site for comparison.

Hi-Def Aerial Surveys

9.4.2.62 During the 12 months of aerial surveys a total of seven grey seals have been identified from survey photographs which made up 3% of the total number of marine mammal sightings. Additionally, there were four sightings of unknown seal species and six sightings of unknown seal/small cetaceans.

Grey Seal Baseline Conclusion

9.4.2.63 The grey seal is considered to have a “Favourable Conservation Status” in the UK. Grey seals haul-out within the Moray Firth, though August haul-out counts vary considerably between years. The most recent grey seal population estimate for the Moray Firth MU based on the 2016 August count is 3,534 grey seals, which are located mainly Loch Fleet and Findhorn, with concentrations of counts in the Dornoch Firth, Ardersier, Culbin, Lothbeg and Findhorn. There is a small (6-10 animals) grey seal haul-out at the edge of the Offshore Export Cable Corridor at Logie Head (approximately 3 km from Sandend Bay) (Volume 3a - Figure 9.4.11). However, this haul-out site is not considered to be important breeding or moulting haul-out sites for grey seals. Telemetry data show that grey seals that have tracks within the Moray Firth also show a degree of connectivity with the Berwickshire and North Northumberland Coast SAC, the Isle of May SAC, the Faray and Holm of Faray and North Rona SAC and the Humber Estuary SAC. Most of the telemetry tracks show grey seal movement located around the Orkney Islands and the Aberdeenshire coastline, with very little telemetry data in the inner Moray Firth or overlapping with the Moray West Site.

Baseline Conclusions

9.4.2.64 Based on the data obtained from the baseline characterisation desk based study and the site-specific surveys conducted for Moray West, the abundance and density values for each marine mammal species presented in Table 9.4.10 have been identified as the most robust values to take forward for the impact assessment.

Table 9.4.10: MU and Density Estimates Taken Forward for Impact Assessment. Values in Brackets Show 95% Confidence Intervals.

Species	MU	Abundance	Density (#/km^2)	Density Source
Harbour seal	Moray Firth	1,304 (1,067 – 1,739)	4x4 km grid specific densities	Bailey (2017)
Grey seal	Moray Firth	3,534 (3,255 – 3,866)	5x5 km grid specific densities	Russell *et al.* (2017)
Bottlenose dolphin	Coastal East Scotland	195 (164 - 224)	4x4 km grid specific revised densities	Revised from Moray Offshore Renewables Ltd (2012)
Harbour porpoise	North Sea	345,373 (246,526 – 495,752)	4x4 km grid specific densities	Moray Offshore Renewables Ltd (2012)
Minke whale	Celtic and Greater North Seas	23,528 (13,989 - 39,572)	4x4 km grid specific densities*	Paxton *et al.* (2014)

*grid cells without a density estimate will be assigned the SCANS III block wide density estimate.

9.4.3 Future Baseline

9.4.3.1 The marine mammal baseline is not static and will exhibit some degree of natural change over time, with or without the Development in place, due to naturally occurring cycles and processes. Therefore, when undertaking impact assessments, it will be necessary to place any potential impacts in the context of the envelope of change that might occur naturally over the timescale of the Development. As such, the marine mammal baseline in the Moray Firth is a 'snapshot' of the present best estimate of marine mammal population sizes and distributions, although current population trends and trajectories have been presented to inform predictions of impact.

9.5 Assessment Methodology

9.5.1 Impacts Identified as Requiring Assessment

9.5.1.1 Table 9.5.1 lists all potential impacts on marine mammals identified as requiring consideration as part of the assessment. This list of impacts has been informed by the marine mammal impact assessment carried out for the Moray East Development (Moray East ES 2012), data collected since 2012, expert judgement and reflects responses provided by statutory consultees and other stakeholders in the offshore wind farm and OfTI Scoping Opinions.

Table 9.5.1: Impacts on Marine Mammals Requiring Assessment

Potential Impact	Nature of Impact (Direct or Indirect)	Inter-Relationships with Other EIA topics / Receptors
Construction Impacts		
Underwater noise – piling	Direct	N/A
Underwater noise from construction activities (excluding piling)	Direct	Chapter 12: Shipping and Navigation
Risk of collision with vessels	Direct	Chapter 12: Shipping and Navigation
Reduction in prey availability	Indirect	Chapter 7: Benthic & Intertidal Ecology Chapter 8: Fish & Shellfish Ecology Chapter 11: Commercial Fisheries
Reduction in foraging ability	Indirect	Chapter 6: Physical Processes & Water Quality
Operation and Maintenance (O&M) Impacts		
Collision risk from vessels	Direct	Chapter 12: Shipping and Navigation
Reduction in prey availability	Indirect	Chapter 7: Benthic & Intertidal Ecology Chapter 8: Fish & Shellfish Ecology Chapter 11: Commercial Fisheries
Decommissioning Impacts		
Underwater noise – cutting	Direct	N/A
Underwater noise from construction activities (excluding piling)	Direct	Chapter 12: Shipping and Navigation
Risk of collision with vessels	Direct	Chapter 12: Shipping and Navigation

Table 9.5.1: Impacts on Marine Mammals Requiring Assessment		
Potential Impact	**Nature of Impact (Direct or Indirect)**	**Inter-Relationships with Other EIA topics / Receptors**
Reduction in prey availability	Indirect	Chapter 7: Benthic & Intertidal Ecology Chapter 8: Fish & Shellfish Ecology Chapter 11: Commercial Fisheries
Reduction in foraging ability	Indirect	Chapter 6: Physical Processes & Water Quality

9.5.2 Scoped Out Impacts

9.5.2.1 As outlined in the Moray West Offshore Wind Farm Scoping Report (Moray Offshore Renewables Limited 2016) and confirmed in the subsequent Moray West Offshore Wind Farm Scoping Opinion (August 2016), the following potential impacts on marine mammals have been scoped out of the assessment:

- Toxic contamination;
- Disturbance leading to long-term avoidance as a result of operational noise; and
- Stranding due to electromagnetic fields.

9.5.3 Assessment of Potential Effects

9.5.3.1 The criteria for determining the significance of effects is a two-stage process that involves defining the sensitivity of the receptors and the magnitude of the impacts. This section describes the criteria applied in this chapter to assign values to the sensitivity of receptors and the magnitude of potential impacts. The general approach to the assessment of the significance of each impact is detailed in Chapter 5 EIA Methodology and an explanation of how this is applied to the marine mammal assessment is described below.

Sensitivity Criteria

9.5.3.2 The sensitivities of different marine mammal species have been based on a four-point scale that takes account of the sensitivity of individual receptors in terms of the effect of the impact on the individual's ability to feed, reproduce and ultimately survive. The definitions of sensitivity are provided in Table 9.5.2 and include consideration of the receptor's ability to adapt to, tolerate or recover from the effect.

Table 9.5.2: Sensitivity of the Marine Mammal Receptor	
Receptor Sensitivity	**Description / Reason**
High	• No ability to adapt behaviour so that survival and reproduction rates are affected. • No tolerance – Effect will cause a change in both reproduction and survival rates. • Limited ability for the animal to recover from the effect.
Medium	• Limited ability to adapt behaviour so that survival and reproduction rates may be affected. • Limited tolerance – Effect may cause a change in both reproduction and survival rates. • Some ability for the animal to recover from the effect.

Table 9.5.2: Sensitivity of the Marine Mammal Receptor	
Receptor Sensitivity	**Description / Reason**
Low	• Ability to adapt behaviour so that survival and reproduction rates are unlikely to be affected. • Some tolerance – Effect unlikely to cause a change in both reproduction and survival rates. Ability for the animal to recover from the effect.
Negligible	• Receptor is able to adapt behaviour so that survival and reproduction rates are not affected. • Receptor is able to tolerate the effect without any impact on reproduction and survival rates. • Receptor is able to return to previous behavioural states/ activities almost immediately.

Impact Magnitude

9.5.3.3 Impact magnitude has been considered in terms of the duration of the effect and the number of animals affected with sufficient severity to alter the future population trajectory and change the conservation status or long term viability of the population. The definitions of impact magnitude are provided in Table 9.5.3.

Table 9.5.3: Impact Magnitude	
Magnitude	**Definition**
High	The impact would affect the behaviour and distribution of sufficient numbers of individuals, with sufficient severity, to affect the favourable conservation status and/ or the long-term viability of the population at a generational scale.
Medium	Temporary changes in behaviour and/ or distribution of individuals at a scale that would result in potential reductions to lifetime reproductive success to some individuals although not enough to affect the population trajectory over a generational scale. Permanent effects on individuals that may influence individual survival but not affecting enough individuals to alter population trajectory over a generational scale.
Low	Short-term and/or intermittent and temporary behavioural effects in a small proportion of the population. Reproductive rates of individuals may be impacted in the short term (over a limited number of breeding cycles). Survival and reproductive rates very unlikely to be impacted to the extent that the population trajectory would be altered.
Negligible	Very short term, recoverable effect on the behaviour and/or distribution in a very small proportion of the population. No potential for the any changes in the individual reproductive success or survival therefore no changes to the population size or trajectory.

Significance Criteria

9.5.3.4 The significance of the effect upon marine mammals is determined using a matrix of the magnitude of the impact and the sensitivity of the receptor. The particular method employed for this assessment is presented in Table 9.5.4.

9.5.3.5 For the purposes of this assessment, any effects with a significance level of minor or less have been concluded to be not significant in terms of the EIA Regulations.

Table 9.5.4: Effect Significance				
Impact Magnitude	**Sensitivity**			
	High	**Medium**	**Low**	**Negligible**
High	Major	Major	Moderate	Minor
Medium	Major	Moderate	Minor	Negligible
Low	Moderate	Minor	Minor	Negligible
Negligible	Minor	Minor	Negligible	Negligible

9.5.4 Data Limitation and Key Uncertainties

Predicting Future Spatial and Temporal Distributions of Marine Mammals

9.5.4.1 There are uncertainties relating to the ability of any existing data set to accurately predict the likely future spatial and temporal distributions of marine mammals. Being highly mobile and generally wide ranging, the abundance and distribution of marine mammals can vary to a great deal both temporally and spatially. However, the Moray Firth represents an exceptionally well characterised region from the perspective of marine mammals, being the site of several long term monitoring programmes and much research activity. As such there is high confidence in the datasets used to characterise the baseline and inform the quantitative assessment of impact.

Predicting the Exposure of Animals to Underwater Noise

9.5.4.2 There are uncertainties relating to the ability to predict the exposure of animals to underwater noise, as well as in predicting the response to that exposure. These uncertainties relate to a number of factors: the ability to predict the level of noise that animals are exposed to, particularly over long periods of time; the ability to predict the numbers of animals affected, and the ability to predict the individual and ultimately population consequences of exposure to noise. These are explored in further detail in the paragraphs below.

9.5.4.3 The propagation of underwater noise is relatively well understood and modelled using standard methods. However, there are uncertainties regarding how the pulse characteristics change with range from the source which are not currently accounted for in the assessment. There are also uncertainties regarding the position of receptors in relation to received levels of noise, particularly over time and understanding how position in the water column may affect received level. Noise monitoring is not always carried out at ranges relevant to the ranges predicted for effects on marine mammals so effects at far ranges remain un-validated in terms of actual received levels. The extent to which ambient noise and other anthropogenic sources of noise may mask signals from the offshore wind farm are not specifically addressed. The dose-response curves for porpoise and seals include behavioural responses at noise levels down to 120 dB SELs.

Predicting the Response of Animals to Underwater Noise

9.5.4.4 There are also uncertainties relating to the ability to predict the responses of animals to underwater noise. There is limited empirical data available to confidently predict the extent to which animals may experience auditory damage or display responses to noise. The current methods for prediction of behavioural responses are based on received sound levels, but it is likely that factors other than noise levels alone will also influence the probability of response and the strength of response (e.g. previous experience, behavioural and physiological context, proximity to activities, characteristics of the sound other than level, such as duty cycle and pulse characteristics). However, at present, it is impossible to adequately take these factors into account in a predictive sense.

9.5.4.5 There is also a lack of information on how observed effects (e.g. short-term displacement around pile-driving activities) manifest themselves in terms of effects on individual fitness, and ultimately population dynamics. For example, it could be assumed that the displacement of an animal from a foraging area could result in increased energy expenditure to move away in addition to decreased foraging opportunities if the animal is displaced to an area that is of lower quality for foraging. This could ultimately result in a reduction in energy gain which has the potential to lead to reductions in fecundity. However, the amount of disturbance and displacement that is required to impact an animal's fitness is unknown. In this assessment it is assumed that displacement away from the area will result in an impact to that individual, over the period over which it is displaced. Animals are expected to recover quickly and will return to the area after piling stops.

9.5.4.6 Studies at Horns Rev 2 demonstrated that porpoises returned to the area between 1 and 3 days (Brandt *et al.,* 2011) and monitoring at the Dan Tysk wind farm as part of the DEPONS project found return times of around 12 hours (cited in van Beest *et al.,* 2015). Two studies at Alpha Ventus demonstrated using aerial surveys that the return of porpoises was about 18 hours after piling (Dähne *et al.,* 2013). The available data for return times for seals suggests much shorter recovery period with harbour seals returning to site around two hours after piling at the Lincs wind farm in the Wash (Russell *et al.,* 2016). The worst case assumption is that displaced animals may experience reduced foraging opportunities which may lead to effects on breeding success in the year they have experienced displacement. This means that for the Moray West Offshore Wind Farm construction period, animals that are predicted to experience disturbance may be at risk of these effects for over a maximum of two breeding seasons. However, it is likely that the majority of animals will find suitable alternative foraging areas and impacts on breeding success will be small.

9.5.4.7 There are no empirical data on the threshold for auditory injury in the form of Permanent Threshold Shift (PTS) onset for either porpoise or seals, as to test this would be inhumane. Therefore, PTS onset thresholds are estimated based on extrapolating from Temporary Threshold Shift (TTS) onset thresholds. For pulsed noise, such as piling, NMFS have set the onset of TTS at the lowest level that exceeds natural recorded variation in hearing sensitivity (6 dB), and assumes that PTS occurs from exposures resulting in 40 dB or more of TTS measured approximately 4 min after exposure. The use of PTS-onset thresholds does not mean that all animals will experience PTS, rather, PTS thresholds are used to indicate the range beyond which there is certainty that no PTS will occur. PTS-onset is therefore indicative of the numbers of animals potentially at risk of PTS, rather than those predicted to actually develop PTS.

9.5.4.8 In addition to this, the consequences of PTS for individuals are unknown. It is likely that the consequences will depend on the frequency band which has experienced PTS, and whether or not this frequency band is in the critical hearing sensitivity band for that species. For example, it is possible that PTS at frequencies outside of the critical hearing frequencies for a species will result in little effect. However, a PTS at frequencies that are required for critical activities such as echolocation, foraging and communication could have more severe impacts on individuals, potentially leading to changes in fitness and vital rates. Most piling noise is relatively low frequency, and therefore the effect of PTS at low frequencies, on a high frequency specialist species, such as the harbour porpoise, may be minimal.

Predicting the Population Consequences of Disturbance

9.5.4.9 The interim Population Consequences of Disturbance (iPCoD) framework (Harwood *et al.,* 2014, King *et al.,* 2015) was used to predict the potential population consequences of the predicted amount of disturbance resulting from the piling at Moray West. iPCoD uses a stage structured model of population dynamics with nine age classes and one stage class (adults 10 years and older). The model is used to run a number of simulations of future population trajectory with and without the predicted level of impact to allow an understanding of the potential future population level consequences of predicted behavioural responses and auditory injury.

9.5.4.10 There is a lack of empirical data on the way in which changes in behaviour and hearing sensitivity may affect the ability of individual marine mammals to survive and reproduce. Therefore, in the absence of empirical data, the iPCoD framework uses the results of an expert elicitation process conducted according to the protocol described in Donovan *et al. (*2016) to predict the effects of disturbance and PTS on survival and reproductive rate. The process generates a set of statistical distributions for these effects and then simulations are conducted using values randomly selected from these distributions that represent the opinions of a "virtual" expert. This process is repeated many 100s of times to capture the uncertainty among experts. While the iPCoD model is subject to many assumptions and uncertainties relating to the link between impacts and vital rates, the model presents the best available scientific expert opinion at this time.

9.5.4.11 Despite these limitations and uncertainties, this assessment has been carried out according to best practice and using the best available scientific information. The information provided is therefore considered to be sufficient to carry out an adequate assessment.

9.6 Design Envelope Parameters

9.6.1 Realistic Worst Case Design Scenario

9.6.1.1 As identified in Chapter 4 Development Description, Moray West is considering a range of potential construction methods and design options for the Development. The Design Envelope presented in Chapter 4 presents the range (minimum and maximum) of design parameters for each of the options under consideration e.g. substructure type or turbine model.

9.6.1.2 In order to determine potential impacts of the various options it is necessary to define the 'realistic worst case scenario'. The realistic worst case scenario represents, for any given receptor and potential impact on that receptor, various options in the Design Envelope that would result in the greatest potential for change to the receptor in question.

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

9.6.1.4 Table 9.6.1 presents the realistic worst case scenario for potential impacts on marine mammals during construction, operational and maintenance and decommissioning phases of the Development and provides justification as to why the options and design parameters identified are considered to be the realistic worst case scenario.

Table 9.6.1: Design Envelope Parameters Relevant to the Marine Mammal Impact Assessment

Potential Impact	Realistic Worst Case Scenario	Justification
Construction		

Underwater noise – piling	**<u>WTG</u>**
	Maximum number of turbines = 85
	Maximum piling period expected to be 10 months
	<u>Worse case (spatial extent, largest impact footprint)</u>
	Pile-driving of up to 85 monopile foundations using the following worst case parameters:
	• Maximum hammer driving energy 5,000 kJ
	• Hammer energy profile:
	  ○ 1,000 kJ for 150 mins
	  ○ 2,000 kJ for 90 mins
	  ○ 3,000 kJ for 50 mins
	  ○ 4,000 kJ for 40 mins
	  ○ 5,000 kJ for 30 mins
	• Soft start maximum 30 blows per min
	• Maximum 40 blows per minute
	• Average 30 blows per minute
	• Maximum installation time 8 hours per foundation
	• Maximum 2 piles per 24 hours (assuming simultaneous piling events)
	• Maximum 2 simultaneous piling events
	• Total number of piling days 87 (single vessel), 44 (two vessel)
	<u>Worst-case (temporal extent, longest duration of piling)</u>
	Pile-driving of 85 quadropod/jacket foundations:
	• Up to four pin-piles per foundation – total of a maximum of 340 pin-piles
	• Maximum hammer driving energy 3,000 kJ
	• Hammer energy profile
	  ○ 500 kJ for 170 mins
		The installation of monopiles with the highest maximum hammer energy will result in the highest overall levels of underwater noise, resulting in the largest impact footprint for each piling operation.
		While the maximum number of WTG installations assessed is 85, it is important to note that the design envelope option for 85 WTGs relates to the Model 1 scenario which consists of 10 m diameter foundations that will require a maximum hammer energy of 4,000 kJ. The Model 4 scenario is for a maximum of 62, larger (15 m) monopiles that will require a maximum hammer energy of 5000 kJ. There is uncertainty as to which of these scenarios would be worse, i.e. a higher number of monopiles at a slightly lower hammer energy or a lower number of monopiles at a higher energy. To ensure precaution in the assessment, and allow maximum flexibility given this uncertainty, a worst case of 85 monopiles installed using the maximum hammer energy of 5000 kJ formed the basis of the worst case scenario assessed.
		The longest duration of underwater noise from piling operations will occur with the installation of quadropod jacket foundations, requiring four pin-piles per foundation. Similar to above, a combination of maximum hammer energy and maximum total number of WTGs formed the basis for the worst case, even if this combination will not be realised.
		Modelling locations were selected for each species separately that would result in noise effects over the areas

Table 9.6.1: Design Envelope Parameters Relevant to the Marine Mammal Impact Assessment		
Potential Impact	**Realistic Worst Case Scenario**	**Justification**
	○ 1,000 kJ for 83.3 mins ○ 1,500 kJ for 67 mins ○ 2,000 kJ for 83.3 mins ○ 3,000 kJ for 66.7 mins • Soft start maximum 30 blows per min • Maximum 40 blows per minute • Average 30 blows per minute • Maximum 6 piles per 24 hours (assuming 2 simultaneous piling events) • Maximum 2 simultaneous piling events • Total number of piling days 170 (single vessel), 85 (two vessel) **<u>OSP(s)</u>** <u>Worse case (spatial extent, largest impact footprint)</u> Pile driving of 2 OSPs with monopiles: • Maximum 2 piles per foundation • Maximum hammer driving energy 5,000 kJ • Hammer energy profile as above for WTG monopile installation • Soft start max hammer energy 500 kJ • Maximum 40 blows per minute • Average 30 blows per minute • Maximum 2 piles per 24 hours (assuming simultaneous piling) • Maximum 2 simultaneous piling events <u>Worst-case (temporal extent, longest duration of piling)</u> Pile driving of 2 OSPs with pin-piles: • Maximum 16 pin-piles (based on 8 pin-piles per foundation) • Maximum hammer driving energy 3,000 kJ • Hammer energy profile as above for WTG pin-pile installation • Soft start maximum 30 blows per min	of highest density to ensure a precautionary approach was adopted. Locations were chosen for noise modelling for each species to reflect a maximum design scenario in terms of highest numbers potentially affected for each species and the maximum sound propagation conditions.

Table 9.6.1: Design Envelope Parameters Relevant to the Marine Mammal Impact Assessment		
Potential Impact	**Realistic Worst Case Scenario**	**Justification**
	• Soft start max hammer energy 500 kJ • Maximum 40 blows per minute • Average 30 blows per minute • Maximum 2 simultaneous piling events	
Underwater noise from construction activities (including vessel noise and other activities but excluding piling)	Maximum number of turbines = 85 Duration of construction period = over a period of 36 months (2022 to 2024) Presence of various construction vessels during the construction period (up to 25 at any one time, comprising of installation, support, transport and cable lay vessels, tugs and barges). **Cable Installation activities with the potential to generate underwater noise:** Seabed preparation requirements: • Dredging/boulder clearance Methods under consideration: • Pre-trench and post-lay burial using plough • Free lay and post-lay burial using cutting or jetting trenching tool • Simultaneous lay and burial using cable plough or trenching tool • Rock placement	The main source of underwater noise during construction activities will be from vessel noise. The use of trenching, dredging, ploughing tools during seabed preparation and cable installation activities will also generate additional noise.
Risk of collision with vessels	Presence of various construction vessels during the construction period (up to 25 at any one time, comprising of installation, support, transport and cable lay vessels, tugs and barges).	The risk of collision will scale with the total number of vessels in use as well as the number of vessel movements and transits. The installation of pin-piles is likely to result in the longest duration of construction and therefore the longest period of additional vessels transiting to and from and around the site.

Table 9.6.1: Design Envelope Parameters Relevant to the Marine Mammal Impact Assessment		
Potential Impact	**Realistic Worst Case Scenario**	**Justification**
Reduction in prey availability	The maximum adverse design scenario for the Benthic and Intertidal habitats is presented in Chapter 7: Benthic & Intertidal Ecology. The maximum adverse design scenario for the fish and shellfish ecology assessment is presented in Chapter 8: Fish & Shellfish Ecology.	Any impacts to marine mammals are dependent on the significance of impacts on fish and shellfish ecology and benthic habitats, therefore the maximum adverse scenarios for those receptors are those considered for prey related impacts on marine mammals.
Reduction in foraging ability	The maximum adverse design scenario for the increase in suspended sediments arising from construction activities is outlined in Chapter 6: Physical Processes & Water Quality.	Seabed preparation could be required prior to installation of gravity base and suction caisson foundations. Two realistic worst case scenarios are identified, corresponding to the greatest volume of sediment disturbance locally (from individual foundations) and across the offshore wind farm (from all foundations). The greatest volume of dredging related sediment disturbance for a single WTG foundation is associated with the largest diameter gravity base (Model 1), whereas, for all WTGs it is associated with a larger number of smaller diameter gravity base foundations (Model 4).
Operation and Maintenance		
Vessel Interactions: disturbance and collision risk	Approximately 150-200 return trips per year. If O&M activity is coordinated entirely from an onshore base, this would mean small crew vessels sailing to and from the Moray West Site on a daily basis from shore. If the SOV option is preferred, the majority of small crew vessels would be operated on a daily basis from a single SOV, although further support vessels are also still likely to transit to and from shore each day. OSPs would require one visit a week maximum.	A number of vessel visits to each turbine and OSP would be required each year to allow for scheduled and unscheduled maintenance. The risk of collision and disturbance from operational vessels will scale with the total number of vessels in use as well as the number of vessel movements and transits. Maximum number of vessel movements to and from the array would create maximum disturbance and collision risk.
Change in prey resources resulting from changes in benthic habitats and/or	The maximum adverse design scenario for the Benthic and Intertidal habitats is presented in Chapter 7: Benthic & Intertidal Ecology.	Any impacts to marine mammals are dependent on the significance of impacts on fish and shellfish ecology and benthic habitats, therefore the maximum adverse scenarios

Table 9.6.1: Design Envelope Parameters Relevant to the Marine Mammal Impact Assessment		
Potential Impact	**Realistic Worst Case Scenario**	**Justification**
changes in the fish and shellfish community from impacts during operation	The maximum adverse design scenario for the fish and shellfish ecology assessment is presented in Chapter 8: Fish & Shellfish Ecology.	for those receptors are those considered for prey related impacts on marine mammals.
Decommissioning		
Impacts from decommissioning are expected to be similar to those listed above for construction, if infrastructure is removed from the seabed at the end of the development's operational life. If it is deemed closer to the time of decommissioning that removal of certain parts of the development (e.g. cables) would have a greater environmental impact than leaving in-situ, it may be preferable to leave those parts in-situ. In this case, the impacts would be similar to those described for the operational phase.		

9.6.2 Embedded Measures

9.6.2.1 Mitigation measures that have been identified and adopted as part of the evolution of the Development (embedded into the Development design) and that are relevant to marine mammals are listed in Table 9.6.2.

Table 9.6.2: Embedded Measures Relating to Marine Mammals	
Parameter	**Measures Embedded into the Design of the Development**
General	
Vessels	A vessel management plan (VMP) will be developed which will determine vessel routing to and from construction areas and ports to avoid areas of high risk. This will also include codes of conduct for vessel behaviour and for vessel operators including advice to operators to not deliberately approach marine mammals and to avoid abrupt changes in course or speed should marine mammals approach the vessel to bow-ride. This plan will be informed by emerging information from the monitoring at Beatrice Offshore Wind Farm.
Construction	
Pile-driving WTG	**<u>Monopiles (5,000 kJ maximum hammer energy)</u>** A soft start is included, whereby the piling hammer energy is gradually increased over a period of time to ensure that any remaining animals will move out of the area before full hammer energy is reached. A ramp-up has been assumed for monopiles that reach a maximum of up to 5,000 kJ hammer energy. This ramp up involves a constant strike rate of 30 strikes per minute and the following schedule: • 1,000 kJ for 150 mins • 2,000 kJ for 90 mins • 3,000 kJ for 50 mins • 4,000 kJ for 40 mins • 5,000 kJ for 30 mins **<u>Monopiles (3,500 kJ maximum hammer energy)</u>** A ramp-up has been assumed for monopiles that reach a maximum of up to 3,500 kJ hammer energy. This ramp up involves a constant strike rate of 30 strikes per minute and the following schedule: • 1,000 kJ for 150 mins • 2,000 kJ for 90 mins • 2,500 kJ for 50 mins • 3,000 kJ for 40 mins • 3,500 kJ for 30 mins **<u>Quadropod/jacket (3,000 maximum hammer energy)</u>** A ramp-up has been assumed for monopiles that reach a maximum of up to 3,000 kJ hammer energy. This ramp up involves a constant strike rate of 30 strikes per minute and the following schedule: • 500 kJ for 170 mins • 1,000 kJ for 83 mins • 1,500 kJ for 67 mins • 2,000 kJ for 83 mins • 3,000 kJ for 67 mins

Table 9.6.2: Embedded Measures Relating to Marine Mammals	
Parameter	**Measures Embedded into the Design of the Development**
All Pile-driving	A Piling Strategy, incorporating a Marine Mammal Mitigation Plan (MMMP) will be produced for approval by the Scottish Ministers in advance of construction and will subsequently be followed during the construction phase. This will outline the final piling approach, the soft-start procedure, monitoring, and any other agreed mitigation options deemed necessary, to reduce to acceptable levels the potential risk of injury or death to marine mammals in close proximity to piling operations.
Pollution prevention	An appropriate Environmental Management Plan (EMP) will be produced and followed to cover the construction, operation and maintenance phases of the Development. In addition, an appropriate Marine Pollution and Contingency Plan (MPCP) will be produced and followed to cover the construction, operation and maintenance phases of the Development. This will include planning for accidental spills, address all potential contaminant releases and include pollution event response protocols. A Decommissioning Programme will be developed to cover the decommissioning phase. The purpose of the measures to be implemented ensure that potential for contaminant release is strictly controlled and therefore provides protection to marine life across all phases of the life of the Development.
Decommissioning	
Embedded mitigation measures implemented in the decommissioning phase are likely to be similar to those implemented during the construction phase.	

9.7 Assessment of Potential Effects

9.7.1 Potential Construction Effects – Underwater Noise from Piling

9.7.1.1 Marine mammals use sound for a variety of reasons (foraging, orientation and navigation, communication, detection and predator avoidance) and are therefore potentially susceptible to elevated levels of anthropogenic noise. Extremely high levels of noise can cause physical damage as a result of barotrauma due to high intensity of noise within a short period of time. Elevated anthropogenic noise can cause physical damage to the hearing systems of marine mammals, in addition to disrupting normal behaviour and masking auditory cues used for foraging, navigation and communication. The following section describes the potential effects of underwater noise from piling on marine mammals. Potential effects of underwater noise from other construction activities are discussed in Section 9.7.2.

9.7.1.2 With regards to piling noise, monopile foundation scenarios were determined to present the worst-case spatial impact, i.e. would result in the largest overall impact range, whereas the installation of jacket foundations using pin-piles would result in the worst-case temporal impact as the total duration of piling will be longer compared to monopile installation.

9.7.1.3 For monopiles, the maximum hammer energy that was modelled is up to 5,000 kJ, with a start-up hammer energy of 20% (1,000 kJ). For pin-pile installation the maximum hammer energy that was modelled was up to 3,000 kJ with a start-up hammer energy of 500 kJ.

9.7.1.4 Initial assessment of the effects of underwater noise on key marine mammal species was based on the definition of absolute worst case (WC) piling parameters for each turbine foundation type. The WC parameters were intended to cover the absolute worst case piling parameters that would ever be required to install a foundation (worst case in terms of maximal hammer energies and longest piling durations). At this stage (pre-consent) there is a large amount of uncertainty in the prevailing geotechnical (ground) conditions given the early stage of site investigations and therefore the worst case piling parameters are considered to be very precautionary and are intended to retain flexibility in Development design whilst ensuring a precautionary assessment.

9.7.1.5 However, recent experience when installing foundations at offshore wind farms has shown that the hammer energies used have typically been much lower than has been defined during the assessments (e.g. BOWL piling report). In recognition of this, a 'most-likely' (ML) scenario was defined which is intended to be more representative of the likely activity that will occur at the majority of pile installations. It is expected that a large proportion of the foundations will be installed with the maximum hammer energy as defined under the ML parameters, with only a small number of instances installed under the WC, where, for example, challenging ground conditions are encountered.

9.7.1.6 The ML scenarios were defined only for monopiles (see Table 9.7.1 and Table 9.7.2) due to the potential requirement for an overall higher maximum hammer energy of 5,000 kJ. Details for the piling parameters assessed for pin-piles are provided in Table 9.7.3.

Table 9.7.1: The Modelled Ramp Up for the 'Worst Case' Installation of a Monopile Which Reaches a Maximum Hammer Energy of 5,000 kJ

Hammer Energy (kJ)	Duration (mins)	Strike Rate (# strikes/min)	# Strikes	% of Total Piling Time
1,000	150	30	4,500	42%
2,000	90	30	2,700	25%
3,000	50	30	1,500	14%
4,000	40	30	1,200	11%
5,000	30	30	900	8%

Table 9.7.2: The Modelled Ramp Up for the 'Most Likely' Installation of a Monopile Which Reaches a Maximum Hammer Energy of 3,500 kJ

Hammer Energy (kJ)	Duration (mins)	Strike Rate (# strikes/min)	# Strikes	% of Total Piling Time
1,000	150	30	4,500	42%
2,000	90	30	2,700	25%
2,500	50	30	1,500	14%
3,000	40	30	1,200	11%
3,500	30	30	900	8%

Table 9.7.3: The Modelled Ramp Up for the 'Worst Case' Installation of a Pin-Pile Which Reaches a Maximum Hammer Energy of 3,000 kJ

Hammer Energy (kJ)	Duration (mins)	Strike Rate (# strikes/min)	# Strikes	% of Total Piling Time
500	90.5	39	3,500	36%
1,000	64.6	39	2,500	18%
1,500	64.6	39	2,500	14%
2,000	64.6	39	2,500	18%
3,000	51.7	39	2,000	14%

Noise Modelling Locations

9.7.1.7 A total of three locations were selected for the noise modelling assessment (Volume 3a - Figure 9.7.1). Each location was chosen due to its proximity to important areas for a particular species. These locations were agreed in consultation with SNH and MSS.

9.7.1.8 Location 1 is located at the south west corner of the Moray West Site and was used to model impacts for bottlenose dolphins, harbour seals and grey seals as this is the location closest to both the Moray Firth SAC of which bottlenose dolphin are a designated feature, and the grey and harbour seal haul-outs and areas of higher at-sea usage.

9.7.1.9 Location 2 is located at the north east of the Moray West Site and was used to model impacts on harbour porpoise as this is located in the area of highest predicted porpoise densities.

9.7.1.10 Model location 3 is located at the south east corner of the Moray West Site and was used to model impacts on minke whales as it is the location within the Moray West Site that is closest to the Southern Trench pMPA where minke whale densities are highest in the Moray Firth.

Thresholds

9.7.1.11 Various authors define thresholds for the prediction of specific impacts relating to underwater noise. These are based on the assumption that animals receiving a noise level at and above this threshold will be impacted, while animals receiving a lower noise level will not be impacted. These noise thresholds allow the modelling of noise impact footprints (also referred to as impact area) which define an area within which the noise is above the certain threshold. This allows the calculation of the number of animals likely to be present within the footprint and therefore the number of animals potentially impacted under a given scenario. Thresholds proposed by different authors, or even from the same authors, may be based on different sound metrics. In the following section we describe the noise thresholds for the auditory injury and behavioural disturbance that will be adopted in this assessment.

Thresholds - Lethal and Physical Injury

9.7.1.12 Very high sound pressures may cause physical injury that is lethal to body parts of a marine mammal independent of its species. The threshold adopted for the assessment of lethal injury is a peak sound pressure level (SPL_{zp}) 240 dB re 1 µPa (Parvin *et al.,* 2007).

9.7.1.13 High sound pressures may cause non-lethal physical injury to body parts of a marine mammal independent of its species. The threshold adopted for the assessment of physical injury is SPL_{zp} 220 dB re 1 µPa (Parvin *et al.,* 2007).

Thresholds – Auditory Injury: PTS

9.7.1.14 Exposure to loud sounds can lead to a reduction in hearing sensitivity, which can be (and in general is) restricted to particular frequencies. This reduction (threshold shift) results from physical injury to the auditory system and may be temporary or permanent. In July 2016, the US National Oceanic and Atmospheric Administration (NOAA) released updated guidance on noise assessment metrics for auditory injury (National Marine Fisheries Service 2016): National Marine Fisheries Service (2016) Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing: Underwater Acoustic Thresholds for Onset of Permanent and Temporary Threshold Shifts. This guidance was compiled by a number of the same authors and updates the criteria for assessment provided by (Southall *et al.,* 2007) and is used to assess the potential for PTS. The US National Oceanographic and Atmospheric Administration (NOAA) Fisheries has compiled, interpreted, and synthesized the best available science to produce updated acoustic thresholds for the onset of auditory injury. The acoustic thresholds in this document identify the levels of sound, which after they are exceeded, NOAA anticipates (after evaluating and interpreting all available science) changes in auditory sensitivity (temporary or permanent threshold shift). The use of the NOAA thresholds has been agreed for the Moray West Offshore Wind Farm with the Statutory Nature Conservation Bodies (SNCBs) and MSS.

9.7.1.15 This impact assessment presents PTS impact ranges for piling events, using the NOAA thresholds for all species. The thresholds are based on a dual criteria approach whereby both should be evaluated and that predicting the largest range of impact, should be considered for the impact assessment. The first metric is pressure based, taken as zero-to-peak sound pressure level (SPL_{zp}) or as peak-to-peak sound pressure level (SPL_{pp}). Any single exposure at or above this pressure based metric is considered to have the potential to cause PTS, regardless of the exposure duration (cf. Southall *et al. (*2007)). The second metric is energy based, and is a measure for the accumulated sound energy an animal is exposed to over an exposure period, referred to as sound exposure level (SEL) when considering single pulses, or cumulative sound exposure levels (SEL_{cum}) when considering exposure periods with multiple pulses.

9.7.1.16 The sound exposure level metric is based on the 'equal-energy assumption', having its origin in human research, and stating that *sounds of equivalent energy will have generally similar effects on the auditory systems of exposed human subjects, even if they differ in SPL, duration, and /or temporal exposure pattern* (Southall *et al.,* 2007). While the sound pressure levels are analysed unweighted, the National Marine Fisheries Service (2016) describe species (and author) specific frequency filters to be applied before the sound exposure level is calculated. The threshold values are given in Table 9.7.4 for harbour porpoise (High Frequency (HF) cetacean), bottlenose dolphins (Mid-Frequency (MF) cetacean), minke whales (Low Frequency (LF) Cetacean) and harbour and grey seals (Phocids in Water (PW)) and details on the thresholds are given in the following sections.

Table 9.7.4: Thresholds for Auditory Injury Adopted for the Impact Assessment

Parameter (Unit)	Harbour Porpoise (HF Cetacean)	Bottlenose Dolphin (MF Cetacean)	Minke Whale (LF Cetacean)	Harbour and Grey Seal (PW)
SPL_{zp} dB re 1 µPa unweighted	202	230	219	218
SEL_{cum} dB re 1 µPa²s NOAA weighted, species	155	185	183	185

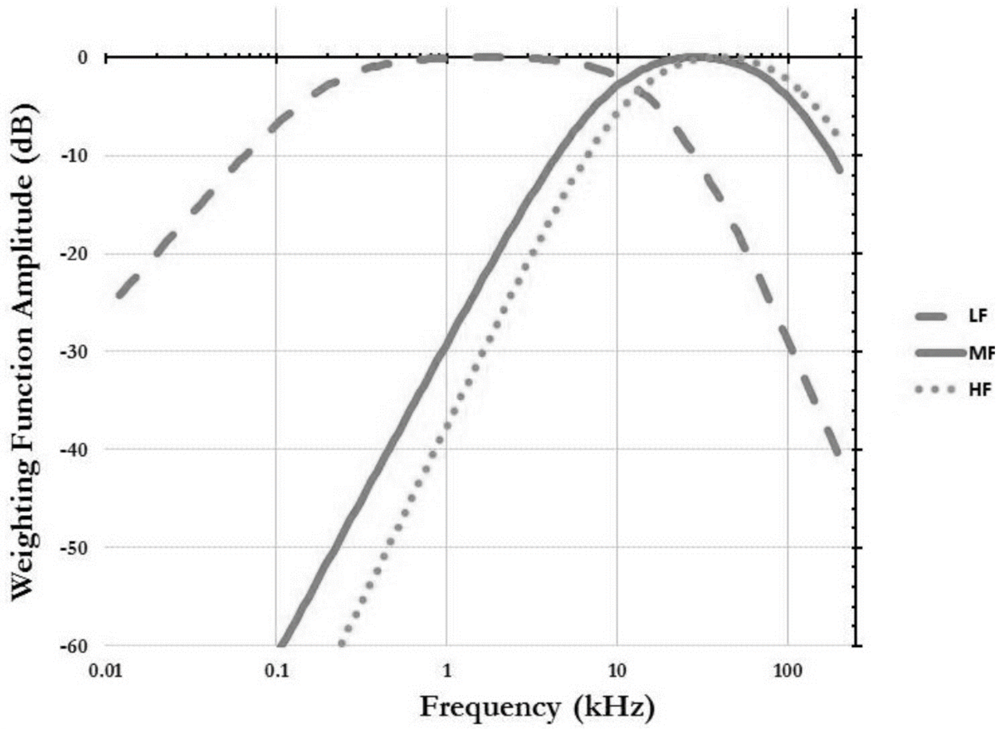
NOAA Thresholds

9.7.1.17 National Marine Fisheries Service (2016) provides threshold values for a set of 'functional hearing groups' adapted from Southall *et al.* (2007). For impulsive sounds such as those generated during pile driving, as in Southall *et al.* (2007), dual metric acoustic thresholds are provided for each hearing group: one unweighted SPL_{zp} value for instantaneously induced PTS, and one weighted SEL_{cum} value for PTS induced by cumulative sound exposure. National Marine Fisheries Service (2016) propose that SPL_{zp} should be either unweighted or flat weighted across the entire frequency band of a hearing group. Hearing ranges are defined and generalised for the entire group as a composite as follows:

- PW: 50 Hz to 86 kHz;
- LF: 7 Hz to 35 kHz;
- MF: 150 Hz to 160 kHz; and
- HF: 275 Hz to 160 kHz.

9.7.1.18 For determining the $SEL_{cum,}$ piling noise is weighted based on weighting curves given in Graph 9.7.1 (referred to as NOAA weighting). Compared to the M weighting from Southall *et al.* (2007), the filter defined in the NOAA weighting is much narrower and weights the sound levels according to a generalised hearing threshold for each species group. This means that the NOAA weighting is much more specific to the hearing abilities of the receiver than Southall's M weighting.

9.7.1.19 The SEL-thresholds for PTS take into account the received level and the duration of exposure, accounting for the accumulated exposure over the duration of an activity within a 24-hour period. National Marine Fisheries Service (2016) recommends the application of SEL_{cum} for the individual activity within 24 hours (e.g. one piling event with multiple strikes) rather than for multiple activities occurring within the same area or over the same time (e.g. concurrent piling). National Marine Fisheries Service (2016) threshold values are given in Table 9.7.4.



Graph 9.7.1: Auditory weighting functions for low-frequency (LF), mid-frequency (MF) and high-frequency (HF) cetaceans as described in National Marine Fisheries Service (2016)

9.7.1.20 To determine the number of animals experiencing energy-induced PTS, one has to calculate the accumulated energy over the course of the series of pile strikes. Here assumptions have to be made on swimming speed and direction of movement, which introduces a degree of uncertainty in the estimated number of animals experiencing PTS. See paragraph 9.7.1.32 for more discussion on these assumptions.

Thresholds - Disturbance

9.7.1.21 Unlike for thresholds of auditory injury, there are currently no established regulatory guidance documents and few published scientific articles providing clear advice on the appropriate thresholds for behavioural response to pile driving noise. Behavioural responses to noise are highly variable and are dependent on a variety of animal dependent and environmental factors. Animal dependent factors include past experience, individual hearing sensitivity, activity patterns, motivational and behavioural state at the time of exposure. Demographic factors such as age, sex and presence of dependent offspring can also have an influence. Environmental factors include the habitat characteristics, presence of food, predators, proximity to shoreline or other features.

9.7.1.22 Influenced by these factors, responses can be highly variable, from small changes in behaviour such as longer intervals between surfacing (Richardson 1995) or a cessation in vocalisation (Watkins 1986) to more dramatic escape responses (Götz and Janik 2016). This variability makes it extremely difficult to predict the likelihood of responses to underwater noise from piling. Even where empirical data exist on responses of animals in one particular environment, the context related variability makes it difficult to extrapolate from one study to a new situation. It is important to note that, all any impact assessment can do, is predict the potential for behavioural responses, as definitive predictions of likelihood or magnitude are particularly difficult.

9.7.1.23 Two approaches have generally been used in UK environmental impact assessments for underwater noise, the traditional approach being the use of a fixed threshold value for determining an impact area, similar to the approach for auditory injury as detailed above. The use of a fixed threshold assumes that all animals within the predicted impact area display a behavioural reaction, while none of the animals outside this area will react.

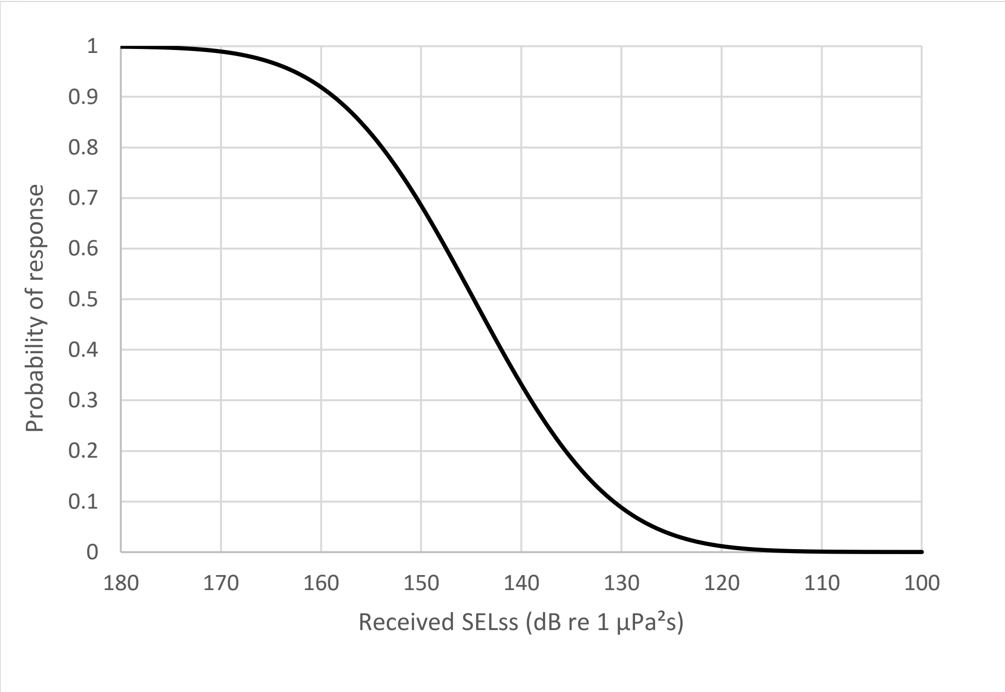
9.7.1.24 A second approach, is the adoption of a dose-response function, assuming that the proportion of animals displaying a behavioural reaction will depend on the received sound level. The characteristics of the received sound changes (e.g., received level decreases but other features of the sound may also change) with increasing distance to the sound source, and with it the proportion of animals reacting to the sound. This assessment has adopted the second of these approaches to provide an indication of the number of animals at risk of behavioural disturbance.

9.7.1.25 For the dose-response assessment, a series of isopleths have been used, i.e. contours of equal sound levels around the sound source, with a stepwise decreasing unweighted single strike SEL of 180 to 120 dB re 1 $\mu Pa^2 s$, with a step size of 5 dB.

9.7.1.26 In order to calculate the number of individuals that might be predicted to respond to the piling noise using the dose-response approach, the estimated density for the area in-between adjacent contours was multiplied by the total area within each of these contour 'rings' and then multiplied by a value that represents the proportion of animals expected to respond within that contour. The proportion of animals expected to respond within each contour is based on multiplication factors derived from a dose-response relationship described for each target species in the sections below.

Harbour porpoise

9.7.1.27 The dose-response curve adopted in this assessment was developed by Graham *et al.* (2017a) and was generated from data collected during the first six weeks of piling for Phase 1 of the Beatrice Offshore Wind Farm monitoring program. It reflects the proportional decrease in occurrence of harbour porpoises with decreasing range from the piling site, as measured using CPODs. The dose-response curve detailed in Graham *et al.* (2017a) reveals the relationship between the proportion of animals responding and the corresponding received SEL_{ss} level (Graph 9.7.2). From the dose-response curve, the proportion of animals responding to a certain SEL value has been used as a multiplier to calculate the number of animals responding within each contour ring.



Graph 9.7.2: Relationship between the proportion of animals responding and the received SELss, based on passive acoustic monitoring results obtained during Phase 1 of the Beatrice Offshore Wind Farm monitoring program (Graham *et al.,* 2017).

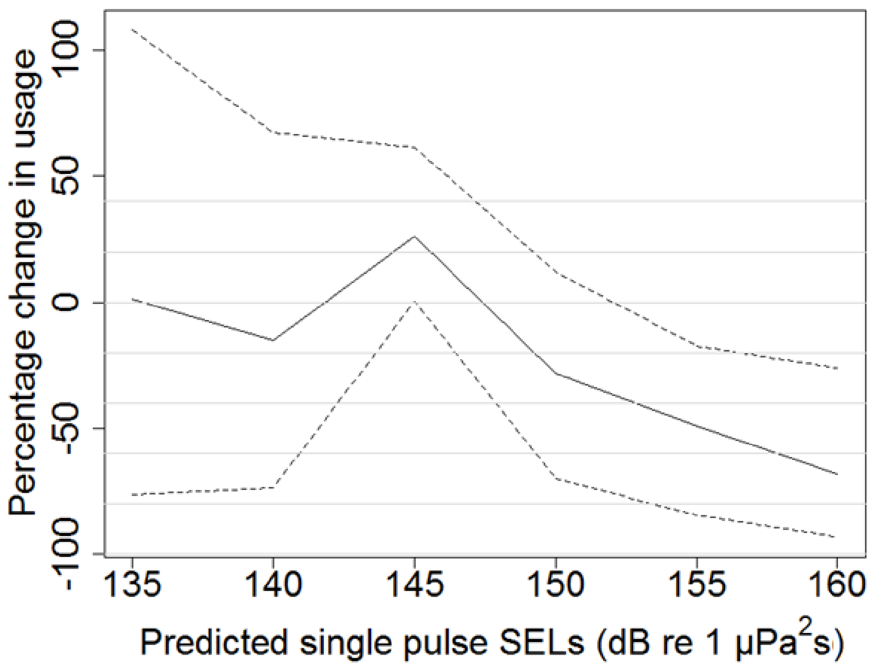
Bottlenose dolphin and minke whale

9.7.1.28 There are currently no data available on the behavioural responses of either bottlenose dolphins or minke whales, and so no species specific dose-response curves are available for these two species. In the absence of a species specific dose-response curve, the dose-response curve for harbour porpoise was implemented for both bottlenose dolphins and minke whales. Harbour porpoises are thought to be generally more responsive to underwater noise than other species, therefore the application of the harbour porpoise curve to other cetacean species is considered precautionary and potentially may overestimate the predicted impact for bottlenose dolphins and minke whales.

Seals

9.7.1.29 A recent study by Russell *et al.* (2016) on the behaviour of 24 tagged harbour seals during pile driving at an offshore wind farm in the Wash, off the east coast of England provides the opportunity to incorporate recent, empirical data on behavioural responses in seals into piling noise assessments. The authors divided the study area in 5 x 5 km² grid cells and predicted the seal density and a corresponding change in density for each cell between periods of piling and periods of non-piling. SEL_{ss} values were modelled and averaged across the installation of all piles to generate a mean received SEL in the part of the water column with the lowest (and highest, respectively) predicted level for each of the grid cells. This allowed SEL values to be assigned to the predicted change in seal density. This analysis demonstrated that predicted seal abundance was reduced overall during piling activity across an area with a radius of 25 km from the piling activity, relative to seal abundance when no piling was taking place. It is important to note that during this study displacement was limited to piling activity only and within 2 hours of piling ending, seals were distributed as per during non-piling periods. Based on the data obtained by Russell *et al.* (2016), a dose-response curve was derived for depth-averaged received levels (mean SELss) (Graph 9.7.3) to match those predicted by the noise modelling. See Russell and Hastie, (2018) for details of how this curve was derived.

9.7.1.30 There are no data available to generate a grey seal dose-response curve and so the harbour seal curve was applied to both species of seal; and although there is uncertainty associated with the extrapolation of the harbour seal curve for the prediction of impacts on grey seals, grey seals are generally thought to be more robust than harbour seals, based on their larger body size and larger capacity for fasting, their wide ranging and highly mobile nature and the large and increasing North Sea population, therefore this is considered precautionary.



Graph 9.7.3: The predicted percentage change in harbour seal usage given mean SELs at 5 dB increments. Please note each increment represents the next 5 dB. E.g. the predicted percentage change in usage value at 135dB represents the mean for cells with estimated SELs of 135dB ≤ 140dB.

<u>Modelling Approaches</u>

9.7.1.31 Noise modelling was conducted by Cefas and is detailed in their noise modelling report (Appendix 9.2). Cefas provided GIS shapefiles containing isopleths corresponding to the NOAA weighted or unweighted SEL and unweighted SPL threshold values mentioned above.

9.7.1.32 For assessing the cumulative effect of sound exposure, the exposure model calculated the SEL_{cum} over one piling event (i.e. the construction of one foundation including a series of hammer strikes, using the ramp up details provided in Table 9.7.1, Table 9.7.2 and Table 9.7.3). This modelling assumes that animals will move away from the source of the piling noise at a constant swim speed. The appropriate swim speeds to adopt were discussed and agreed with SNH and

Marine Scotland Science (MSS) and are detailed in Table 9.7.5. This provides an estimate of the closest distance to the piling that a receptor could start swimming away without experiencing auditory injury. The details of how animal movement and resulting calculations of cumulative exposure are described further in Appendix 9.2: Underwater Noise Modelling.

9.7.1.33 There are data to suggest that these selected swim speeds are precautionary and that animals are likely to flee at much higher speeds, at least initially. Minke whales have been shown to flee from ADDs at a mean swimming speed of 4.2 m/s (McGarry *et al.,* 2017) which is double the swimming speed used in the fleeing model here. A recent study by Kastelein *et al. (*2018) showed that a captive harbour porpoise responded to playbacks of pile driving sounds by swimming at speeds significantly higher than baseline mean swimming speeds, with greatest speeds of up to 1.97 m/s which were sustained for the 30 minute test period.

9.7.1.34 In another study, van Beest *et al. (*2018) showed that a harbour porpoise responded to an airgun noise exposure with a fleeing speed of 2 m/s. These recent studies have demonstrated porpoise and minke whale fleeing swim speeds that are greater than that used in the fleeing model here, which makes the modelled speeds used in this assessment precautionary.

Table 9.7.5: Species Specific Fleeing Swimming Speeds Used in the Modelling

	Harbour Porpoise	Bottlenose Dolphin	Minke Whale	Phocid Seal
Swimming speed (m/s)	1.4	1.52	2.1	1.8
Source	Scottish Natural Heritage (2016)	Median swim speed of unpublished tracking data from the Moray Firth (Helen Bailey and Gordon Hastie, unpublished data)	Scottish Natural Heritage (2016)	Scottish Natural Heritage (2016)

9.7.1.35 It is recognised that animals will not continue moving away from the source indefinitely but there is considerable uncertainty about the manner of animal response to inform the assumptions used in modelling. The modelling was carried out assuming that animals would stop when they reached a distance of 25 km from the source. There is a possibility that animals may stop responding within this distance but given the inherent precautions built into the fleeing model with the precautionary animal swim speeds (detailed above), the 25 km fleeing distance was chosen as the most appropriate fleeing model for this assessment. This approach was agreed with SNH and MSS.

Number of Animals Impacted

9.7.1.36 The sound level isopleths provided by Cefas were plotted in ESRI® ArcMap™ 10.5.1. In order to calculate the size of the area within each sound level isopleth, the species specific density grid cells were intersected by the isopleths (using the Geoprocessing Intersect tool) and the area for each grid cell within the isopleth was extracted. The number of animals within each area was calculated by multiplying the area by the relevant animal density.

Single and Concurrent Piling Scenarios

9.7.1.37 Sound propagation was modelled for scenarios where only a single piling operation would be occurring at any one point and also for scenarios where a second piling vessel would be operating and therefore piling could be occurring at two occasions concurrently. The worst case scenario for concurrent piling would be at the two furthest apart wind turbine foundation positions (represented by piling occurring at location 1 and 3 – see Volume 3a - Figure 9.7.1).

9.7.1.38 The methodology for modelling the cumulative exposure to animals from concurrent piling scenarios required adaptation from the single pile scenarios to ensure that animals would not be assumed to continue moving away from one sound source directly towards another. In the absence of empirical data describing how individual receptors would be expected to respond behaviorally to multiple sources of noise, a number of common-sense assumptions were made. In collaboration with Cefas it was agreed that the following methodology would be adopted:

- The model still assumes that the animal agents are fleeing at the same constant speeds as in the case of single location pile driving, but their fleeing direction is being re-evaluated at every time step according to their position relative to the location of the two piles; and
- Specifically, at a given time, the fleeing direction is calculated by summing up the two vectors originating at the current animal agent position, pointing straight away from the two sources, and having their magnitude proportional with the specific dose responses of the animal for the current single strike SEL from the two sources, respectively.

Population Modelling

9.7.1.39 For species for which there were HRA considerations, if the predicted level of impact for any species assessed were considered to be high enough to potentially result in a significant adverse effect on the protected feature, a population modelling exercise was carried out to explore the population level consequences of this level of impact on individuals.

9.7.1.40 The interim Population Consequences of Disturbance (iPCoD) framework (Harwood *et al.,* 2013) was used for this population level modelling exercise. iPCoD uses a stage structured model of population dynamics with nine age classes and one stage class (adults ten years and older). The model is used to run a number of simulations of future population trajectory with and without the predicted level of impact to allow an understanding of the potential future population level consequences of predicted behavioural responses and auditory injury.

9.7.1.41 In the absence of empirical data on the extent to which disturbance affects individual survival and fecundity, the iPCoD framework uses the results of an expert elicitation process conducted according to the protocol described in Donovan *et al. (*2016) to predict the effects of disturbance and PTS on individual survival and reproductive rates. The process generates a set of statistical distributions for these effects and then population modelling simulations are conducted using values randomly selected from these distributions that represent the opinions of a "virtual" expert. This process is repeated many 100s of times to capture the uncertainty among experts.

9.7.1.42 Simulations were run comparing projections of the baseline population (i.e. under current conditions, assuming current estimates of demographic parameters persist into the future) with a series of paired 'impact' scenarios with identical demographic parameters, incorporating a range of estimates for disturbance. Each simulation was repeated 1,000 times and each simulation draws parameter values from a distribution describing the uncertainty in the parameters. This creates 1,000 matched pairs of population trajectories, differing only with respect to the effect of the disturbance and the distributions of the two trajectories can be compared to demonstrate the magnitude of the long term effect of the predicted impact on the population, as well as demonstrating the uncertainty in predictions.

Piling Schedule

9.7.1.43 The piling schedule was developed in discussion with Moray West and assumes that piling can occur on consecutive days with randomised gaps in piling activity due to issues such as weather downtime, breakdowns etc. (Table 9.7.6).

Table 9.7.6: Summary of the Piling Schedule for Both Monopiles and Pin-Piles				
	Monopile Single Vessel	**Monopile Two Vessels**	**Pin-Pile Single Vessel**	**Pin-Pile Two Vessels**
Total # WTG	85		85	
Total # of Piles	85		340	
Piling Start	01/04/2022		01/04/2022	
Piling End	09/09/2022	26/06/2022	05/02/2023	27/07/2022
Total number of days (including downtime due to weather, breakdown and other availability)	161	87	311	118
Total # Active Piling Days	87	44	133	67
Average # Piles Installed per Day	0.98	1.93	2.6	5.1

Species Parameters

9.7.1.44 The demographic parameters such as survival rates and fertility rates that are used in the iPCoD model to describe the baseline population parameters are obtained from Harwood and King (2017) who present suggested demographic parameters for marine mammal population management units in the UK.

Sensitivity of Marine Mammals to Noise Impacts from Pile-Driving

Lethal Effect or Injury

9.7.1.45 The sensitivity of all marine mammal species to noise above thresholds that are lethal or cause physical non-auditory injury is assessed as **high** as individuals animals will have no ability to recover from the effect.

PTS

The ecological consequences of PTS for marine mammals is unknown. It is likely that the consequences will depend on the frequency band which has experienced PTS, and whether or not this frequency band is in the critical hearing sensitivity band for that species. For example, it is possible that PTS at frequencies outside of the critical hearing frequencies for a species will result in little effect. However, a PTS at frequencies that are required for critical activities such as echolocation, foraging and communication could have more severe impacts on individuals, potentially leading to changes in fitness and vital rates. Most piling noise is relatively low frequency, and therefore the effect of PTS at low frequencies, on a high or mid frequency specialist species, such as the harbour porpoise and the bottlenose dolphin respectively, may be minimal. The low frequency noise produced during piling may be more likely to affect low frequency cetacean species such as minke whales as a low frequency PTS could potentially overlap with their hearing range to a greater degree. Despite this, given the current uncertainty and how critical sound is for echolocation, foraging and communication in cetaceans, all cetaceans have been assessed as having a **high** sensitivity to PTS.

9.7.1.46 Seals are less dependent on hearing for foraging but may rely on sound for communication and predator avoidance (e.g. Deecke *et al.,* 2002). Hastie *et al. (*2015) reported that, based on calculations of SEL of tagged seals during the Lincs OWF construction, at least half of the tagged seals would have received a dose of sound greater than published thresholds for PTS. Based on the extent of the OWF construction in the Wash over the last ten years and the degree of overlap with the foraging ranges of harbour seals in the region (e.g. Russell *et al.,* 2016), it would not be unreasonable to suggest that a large number of individuals of the Wash population may have experienced levels of sound with the potential to cause hearing loss. The Wash harbour seal population has been increasing over this period which may provide an indication that either: a) seals are not developing PTS despite predictions of exposure that would indicate that they should; or b) that the survival and fitness of individual seals are not affected by PTS. A) would indicate that methods for predicting PTS are unreliable and over precautionary, b) would suggest a lack of sensitivity to the effects of PTS. As a result of the fact that seals do not generally use hearing as their primary sensory modality for finding prey and navigation, in the same way as cetaceans do, the sensitivity of seals to PTS has been assessed as **medium**.

Behavioural effect: displacement

9.7.1.47 Previous studies have shown that harbour porpoise are displaced from the vicinity of piling events. For example, studies at wind farms in the German North Sea have recorded large declines in porpoise detections close to the piling (> 90% decline at noise levels above 170 dB) with decreasing effect with increasing distance from the pile (25% decline at noise levels between 145 and 150 dB) (Brandt *et al.,* 2016). The detection rates revealed that porpoise were only displaced from the piling area in the short term (1 - 3 days) (Brandt *et al.,* 2011, Dähne *et al.,* 2013, Brandt *et al.,* 2016). Harbour porpoise are small cetaceans which makes them vulnerable to heat loss and requires them to maintain a high metabolic rate with little energy remaining for fat storage. This makes them vulnerable to rapid starvation if they are unable to obtain sufficient levels of prey intake. Studies using Digital Acoustic Recording Tags (DTAGs) have shown that porpoise tagged after captured in pound nets foraged on small prey nearly continuously during both the day and the night on their release (Wisniewska *et al.,* 2016). However, Hoekendjik *et al* (2018) point out that this could be an extreme short term response to capture in nets, and may not reflect natural harbour porpoise behaviour. Nevertheless, if the foraging efficiency of harbour porpoise is disturbed or if they are displaced from a high-quality foraging ground, and are unable to find suitable alternative feeding grounds, they could potentially be at risk of changes to their overall fitness if they are not able to compensate and obtain sufficient food intake in order to meet their metabolic demands.

9.7.1.48 The results from Wisniewska *et al. (*2016) could also suggest that porpoises have an ability to respond to short term reductions in food intake, implying a resilience to disturbance. As Hoekendjik *et al. (*2018) argue, this could help explain why porpoises are such an abundant and successful species. However, it is important to note that the studies providing evidence for the responsiveness of harbour porpoises to piling noise have not provided any evidence for subsequent individual consequences. In this way, responsiveness to disturbance cannot reliably be equated to sensitivity to disturbance and porpoises may well be able to compensate by moving quickly to alternative areas to feed, while at the same time increasing their feeding rates. However due to observed responsiveness to piling, and their income breeder life history, harbour porpoises have been assessed here as having a **medium** sensitivity to disturbance and resulting displacement from foraging grounds.

9.7.1.49 Bottlenose dolphins have been shown to be displaced from an area as a result of the noise produced by offshore construction activities; for example avoidance behaviour in bottlenose dolphins has been shown in relation to dredging activities (Pirotta *et al.,* 2013).

9.7.1.50 In a recent study on bottlenose dolphins in the Moray Firth (in relation to the construction of the Nigg Energy Park in the Cromarty Firth), small effects of pile driving on dolphin presence have been observed however, dolphins were not excluded from the vicinity of the piling activities (Graham *et al.,* 2017b). In this study the median peak-to-peak source levels recorded during impact piling were estimated to be 240 dB re 1µPa (range 8 dB) with a single pulse source level of 198 dB re 1 $\mu Pa^2 s$. The pile driving resulted in a slight reduction of the presence, detection positive hours and the encounter duration for dolphins within the Cromarty Firth, however, this response was only significant for the encounter durations. Encounter durations decreased within the Cromarty Firth (though only by a few minutes) and increased outside of the Cromarty Firth on days of piling activity. These data highlight a small spatial and temporal scale disturbance to bottlenose dolphins as a result of impact piling activities.

9.7.1.51 There is the potential for behavioural disturbance and displacement to result in a disruption in foraging and resting activities and an increase in travel and energetic costs, however, it has been previously shown that bottlenose dolphins have the ability to compensate for behavioural responses as a result of increased commercial vessel activity (New *et al.,* 2013). Therefore, while there remains the potential for disturbance and displacement to affect individual behaviour and therefore vital rates and population level changes, bottlenose dolphins do have some capability to adapt their behaviour and tolerate certain levels of disturbance. Therefore, bottlenose dolphins have been assessed as having a **medium** sensitivity to disturbance and resulting displacement.

9.7.1.52 There is little information available on the behavioural responses of minke whales to underwater noise. Minke whales have been shown to change their diving patterns and behavioural state in response to disturbance from whale watching vessels; and it was suggested that a reduction in foraging activity at feeding grounds could result in reduced reproductive success in this capital breeding species (Christiansen *et al.,* 2013). Since minke whales are known to forage in the Moray Firth during the summer and autumn months (e.g. Robinson and Tetley 2007, Tetley *et al.,* 2008, Robinson *et al.,* 2009), there is the potential for displacement from foraging areas to impact on reproductive rates. Therefore, minke whales have been assessed as having a **medium** sensitivity to disturbance and resulting displacement from foraging grounds.

9.7.1.53 A study of tagged harbour seals in the Wash has shown that they are also displaced from the vicinity of piles during pile-driving activities. Russell *et al. (*2016) showed that seal abundance was significantly reduced within an area with a radius of 25 km from a pile during piling activities, with a 19 - 83% decline in abundance during pile-driving compared to during breaks in piling. The duration of the displacement was only in the short-term as seals returned to non-piling distributions within two hours after the end of a pile-driving event. Unlike harbour porpoise, both harbour and grey seals store energy in a thick layer of blubber, which means that they are more tolerant of periods of fasting when hauled out and resting between foraging trips, and when hauled out during the breeding and moulting periods. Therefore, they are unlikely to be particularly sensitive to short-term displacement from foraging grounds during periods of active piling. Juvenile harbour seals may be more sensitive to displacement from foraging grounds due to a smaller body size and higher energetic needs. Harbour seals also need to continue feeding during lactation to support their pups, and therefore may be more sensitive at particular times of year. Therefore, harbour seals have been assessed as having **medium** sensitivity to disturbance and resulting displacement from foraging grounds during pile-driving events.

9.7.1.54 Grey seals are capital breeders and store energy in a thick layer of blubber, which means that, in combination with their large body size, they are tolerant of periods of fasting as part of their normal life history. Grey seals are also highly adaptable to a changing environment and are capable of adjusting their metabolic rate and foraging tactics, to compensate for different periods of energy demand and supply (e.g. Beck *et al.,* 2003, Sparling *et al.,* 2006). Grey seals are also very wide ranging and are capable of moving large distances between different haul-out and foraging regions (e.g. Russell *et al.,* 2013). Therefore, they are unlikely to be particularly sensitive to displacement from foraging grounds during periods of active piling. As such, grey seals seal have been assessed as having **low** sensitivity to disturbance and resulting displacement from foraging grounds during pile-driving events.

9.7.1.55 A summary of the sensitivity of each species to piling noise related effects is provided in Table 9.7.7.

Table 9.7.7: Summary of Marine Mammal Sensitivity to Each Potential Pile-Driving Noise Impact			
Species	**Lethal Effect or Injury**	**Permanent Threshold Shift (PTS)**	**Behavioural Disturbance/ Potential Avoidance**
Harbour porpoise	High	High	Medium
Bottlenose dolphin	High	High	Medium
Minke whale	High	High	Medium
Harbour seal	High	Medium	Medium
Grey seal	High	Medium	Low

Results of Piling Noise Assessment: Lethal and Physical Injury

9.7.1.56 The predicted ranges for lethal or physical injury from a single strike was <50 m for all marine mammal species. This suggests that alongside the adoption of appropriate mitigation the risk of lethal or physical injury to any marine mammal species is negligible.

Results of Piling Noise Assessment: Auditory Injury Single Vessel

Harbour porpoise

9.7.1.57 Using the peak (SPL_{zp}) threshold, the predicted range of PTS was 335 m for the monopile maximum hammer energy of up to 5,000 kJ and 206 m for the pin-pile maximum hammer energy of up to 3,000 kJ (Table 9.7.8). This suggests that alongside the adoption of a piling strategy including appropriate mitigation (e.g. a piling soft start and the use of acoustic deterrent devices (ADDs), the risk of PTS to any harbour porpoise as a result of exposure to a single strike will be negligible.

9.7.1.58 Using the SEL_{cum} threshold, and a fleeing threshold of 25 km, the predicted range of PTS was 90 m for the WC monopile ramp up, and 81 m for pin-piles.

9.7.1.59 The sensitivity of harbour porpoise to PTS has been assessed as **high** and the impact magnitude has been assessed as **negligible**, therefore the effect for PTS on harbour porpoise is of **minor s**ignificance, which is **not significant** in EIA terms.

Table 9.7.8: Maximum Impact Ranges (m) for Harbour Porpoise Auditory Injury when Installing Monopiles and Pin-Piles at 100 % Blow Energy at Location 2		
	Monopile WC (5,000 kJ)	**Pin-Pile (3,000 kJ)**
Unweighted SPL_{zp} 202 dB	335	206
$NOAA_{HF}$ weighted SEL_{cum} 155 dB (25 km fleeing threshold)	90	81

Bottlenose dolphin

9.7.1.60 Using the peak (SPL_{zp}) threshold, the predicted range of PTS was <50 m for the maximum hammer energy for both monopiles and pin-piles (Table 9.7.9). This suggests that alongside the adoption of an appropriate piling strategy including appropriate mitigation (e.g. soft start and the use of ADDs) the risk of PTS to any bottlenose dolphin as a result of exposure to a single strike is negligible.

9.7.1.61 Using the SEL_{cum} threshold, and a fleeing threshold of 25 km, the predicted range of PTS was <50 m for the WC ramp up, and <50 m for pin-piles.

9.7.1.62 The sensitivity of bottlenose dolphins to PTS has been assessed as **high** and the magnitude has been assessed as **negligible**, therefore the effect for PTS on bottlenose dolphins is of **minor** significance, which is **not significant** in EIA terms.

Table 9.7.9: Maximum Impact Ranges (m) for Bottlenose Dolphin Auditory Injury when Installing Monopiles and Pin-Piles at 100 % Blow Energy at Location 1

	Monopile (5,000 kJ)	Pin-Pile (3,000 kJ)
Unweighted SPL_{zp} 230 dB	<50	<50
$NOAA_{HF}$ weighted SEL_{cum} 185 dB (25 km fleeing threshold)	<50	<50

Minke whale

9.7.1.63 Using the peak (SPL_{zp}) threshold, the predicted range of PTS was <50 m for the maximum hammer energy for both monopiles and pin-piles (Table 9.7.10). This suggests that alongside the adoption of appropriate mitigation (e.g. the use of an ADD prior to a soft start) the risk of PTS to any minke whale as a result of exposure to a single strike is negligible.

9.7.1.64 Using the SEL_{cum} threshold, and a fleeing threshold of 25 km, the predicted range of PTS was 542 m for the WC ramp up, and 846 m for pin-piles. Based on the results of the field trials of McGarry *et al.* (2017), the adoption of an ADD based mitigation (e.g. the use of an ADD prior to a soft start) the risk of PTS to any minke whale can be reduced to negligible.

9.7.1.65 The sensitivity of minke whales to PTS has been assessed as **high** and the magnitude has been assessed as **negligible**, therefore the effect for PTS on minke whales is of **minor** significance, which is **not significant** in EIA terms.

Table 9.7.10: Maximum Impact Ranges (m) for Minke Whale Auditory Injury When Installing Monopiles and Pin-Piles at 100% Blow Energy at Location 3

	Monopile (5,000 kJ)	Pin-Pile (3,000 kJ)
Unweighted SPL_{zp} 219 dB	<50	<50
$NOAA_{HF}$ weighted SEL_{cum} 183 dB (25 km fleeing threshold)	542	846

Seals

9.7.1.66 Using the peak (SPL_{zp}) threshold, the predicted range of PTS was <50 m for the maximum hammer energy for both monopiles and pin-piles (Table 9.7.11). This suggests that alongside the adoption of appropriate mitigation (e.g. the use of an ADD prior to a soft start) the risk of PTS to any seals as a result of exposure to a single strike is negligible.

9.7.1.67 Using the SEL_{cum} threshold, and a fleeing threshold of 25 km, the predicted range of PTS was <50 m for the WC ramp up, and <50 m for pin-piles.

9.7.1.68 The sensitivity of seals to PTS has been assessed at **medium** and the magnitude has been assessed as **negligible**, therefore the significance of the effect for PTS on seals is **negligible** and **not significant** in EIA terms.

Table 9.7.11: Maximum Impact Ranges (m) for Seal Auditory Injury when Installing Monopiles and Pin-Piles at 100 % Blow Energy at Location 1.

	Monopile (5,000 kJ)	Pin-Pile (3,000 kJ)
Unweighted SPL_{zp} 218 dB	<50	<50
$NOAA_{HF}$ weighted SEL_{cum} 185 dB (25 km fleeing threshold)	<50	<50

Results of Piling Noise Assessment: Auditory Injury Concurrent Piling (two piling vessels)

9.7.1.69 Using the SEL_{cum} threshold, and a fleeing threshold of 25 km, the predicted impact area of PTS from concurrent piling was <50 m for the maximum hammer energy for both monopiles and pin-piles for harbour porpoise, bottlenose dolphins and both seal species. Therefore, impact magnitude is **negligible**, and the effect of PTS is of **minor** significance for the cetacean species given their high sensitivity and **negligible** significance for seals. These are **not significant** in EIA terms.

9.7.1.70 Using the SEL_{cum} threshold, and a fleeing threshold of 25 km, the predicted range of PTS from concurrent piling for minke whales was up to a maximum distance of 28.5 km at Location 2 and 3.6 km from location 3 for pin-piles at maximum hammer energy (Table 9.7.12). This large range for location 2 is a result of the fleeing algorithm used which meant that any whales fleeing to the north-west of location 2 would be restricted due to the coastline, and would unable to reduce exposure by further responsive movement away from the pile source (Volume 3a - Figure 9.7.2). However, this area of impact overlaps with very low predicted densities of minke whales (most cells have an estimated density of 0 whales/km^2), and so while the impact range is large, the number of animals predicted to be within this area and therefore available to be impacted is negligible. Even if very small numbers of minke whales were exposed to PTS as a result of cumulative exposure over the installation of pin-piles over 24 hours, there is no likelihood that this would affect enough individuals to have any affect at the population level. In addition, based on the results of the field trials of McGarry *et al. (*2017), the adoption of an ADD based mitigation (e.g. the use of an ADD prior to a soft start) the risk of PTS to any minke whale as a result of exposure to piling noise can be reduced. The sensitivity of minke whales to PTS has been assessed at **high** and the magnitude has been assessed as **negligible**, therefore the effect of PTS on minke whales is of **minor significance** which is **not significant** in EIA terms.

Table 9.7.12: Concurrent Piling Auditory Injury Impact Ranges

	Monopile WC (5,000 kJ)	Pin-Pile (3,000 kJ)
Minke whale $NOAA_{LF}$ weighted SEL_{cum} 183 dB	Location 1: 922 m Location 3: 559 m	Location 2: 28.5 km Location 3: 3.6 km

9.7.1.71 In summary, the predicted risk of auditory injury from instantaneous exposure to single pile strikes at maximum hammer energies is considered to be extremely low – the maximum range for 'instantaneous' PTS using the SPL_{pk} metric was 335 m for harbour porpoises, and <50 m for all other species. At the densities involved, this results in negligible risk to individuals. Furthermore, it is highly likely that the presence of vessels and associated activity will ensure that this range is free of marine mammals by the time that piling begins. The adoption of appropriate mitigation, including the use of acoustic deterrent devices, would reduce the risk to negligible for these species.

Results of Piling Noise Assessment: Auditory Injury – Uncertainties in calculating Cumulative Exposure over the duration of piling events in relation to the Moray West Offshore Wind Farm

9.7.1.72 The potential for cumulative sound energy at levels which could cause PTS is dependent on the assumptions made in the modelling relating to animal responsive movement and as such, are associated with a high level of uncertainty.

9.7.1.73 Several studies have shown that harbour porpoises and seals tend to leave the construction area during pile driving (e.g. Brandt *et al.,* 2016, Russell *et al.,* 2016), which supports assumption of movement generally directed away from the sound source (negative phonotaxis). Hastie *et al. (*2015) reports dive profiles of harbour seals while being exposed to pile driving sound, which do not noticeably differ from undisturbed dive profiles, with seals spending most of their time at sea either at or near the sea surface, or near the sea floor. Harbour porpoises on the other hand spend most of their time in the upper 10 m of the water column (Teilmann *et al.,* 2007). The sound energy from piling at the sea surface tends to be lowest, while the highest energy can often be found at the sea floor (e.g. Hastie *et al.,* 2015). The current assessment presents sound modelling results based on levels expected in the middle of the water column, and does not consider any dive profile of the animals. This means that the impact ranges are precautionary. These uncertainties should be considered when interpreting the results.

9.7.1.74 Another uncertainty is introduced by the assumption of the "equal energy hypothesis". As discussed in National Marine Fisheries Service (2016), and also in Southall *et al. (*2007), this hypothesis may not hold for all situations due to the complexity of predicting PTS. The duty cycle of the exposure is one example of a factor that may not provide support to the equal-energy-hypothesis: before PTS is induced the animal experiences Temporary Threshold Shift (TTS), which is a temporary, recoverable shift in the hearing threshold. When exposed to multiple pulses, the shift in the threshold may recover to some extent during the time in-between pulses, leading to a delay in the onset of PTS, and therefore to an overestimation of the impact when considering the equal energy hypothesis. A number of studies have shown that the equal energy hypothesis does not always hold (Mooney *et al.,* 2009, Kastelein *et al.,* 2012b, Kastelein *et al.,* 2013, Popov *et al.,* 2014). However, National Marine Fisheries Service (2016), as well as Southall *et al. (*2007), adopt the equal-energy-hypothesis for multiple pulse sound types, as there is currently no supported alternative method to accumulate exposure that takes this recovery into account (National Marine Fisheries Service 2016). In light of this, the PTS ranges calculated as a result of predicted exposure over time, are likely to overestimate the potential for PTS.

9.7.1.75 Estimates of cumulative exposure adopted the assumption that animals would stop responding to noise when they reached 25 km from the source. This was considered a more precautionary methodology when compared to previous assessments where no thresholds were set for fleeing distance and animals were assumed to continue fleeing indefinitely.

9.7.1.76 Where animals were predicted to stop responding to piling noise at 25 km from the source, under single vessel scenarios, the maximum ranges for PTS were low, 90 m for harbour porpoises, 542 m for minke whales and <50 m for bottlenose dolphins and seals. The adoption of appropriate mitigation (the use of observers to ensure a marine mammal free mitigation zone), along with the use of acoustic deterrent devices, would reduce the risk to negligible for these species.

Results of Piling Noise Assessment: Disturbance Single Vessel

Harbour Porpoise

9.7.1.77 Figures 9.7.3 and 9.7.4 (Volume 3a) display unweighted noise contours with single strike SEL values decreasing in 5 dB steps from the source, overlain on the harbour porpoise density surface as a result of a single operation installing a monopile using up to 5,000 kJ hammer energy and a single operation installing a pin-pile at up to 3,000 kJ hammer energy. The number of animals predicted to be affected under each scenario are 1,377 porpoises for the 5,000 kJ monopile installation and 639 porpoises for the 3,000 kJ pin-pile installation. These represent a maximum of 0.4 % and 0.2 % of the harbour porpoise reference population (North Sea MU) respectively (Table 9.7.13). The total number of days of disturbance is up to 87 for monopiles and up to 340 days for pin-piles, with all disturbance relating to monopile installation occurring within a single year and the activity for pin-pile installation occurring over two years. Therefore, either a total of 1,377 individuals may be affected over one breeding cycle or 639 porpoises may be affected over two breeding cycles; although it is important to consider that actual active piling will only be for a small proportion of this time. According to the best available knowledge on the topic, as provided by the opinions of the experts involved in the iPCoD expert elicitation: "*Most experts felt that disturbance lasting more than 50-100 days may result in reduced foraging efficiency which could affect fertility, or induce pregnancy failure, and interfere with mating opportunities due to habitat displacement. Experts also highlighted that elevated stress levels as a result of being displaced from a known location may impact fecundity. The maximum effect on the probability of giving birth was thought to be a 50% reduction*" (Harwood *et al.,* 2013). It was not considered that disturbance had the potential to affect adult survival.

9.7.1.78 Although there is uncertainty around individual behavioural responses, the availability of alternative foraging areas and return times, it is unlikely that individuals will experience disturbance throughout the whole of the foundation installation period, although the worst case assumption is that every affected individual is affected to this extent. Due to the high mobility of harbour porpoises and the availability of alternative foraging areas at the scale of the wider management unit, the survival of individuals is unlikely to be affected. The worst case outcome would be that each affected harbour porpoise would fail to breed. Therefore, this would result in a maximum of 0.4 % of the population failing to breed for a single breeding season under the monopile scenario, or 0.2% of the population failing to breed across a maximum of two breeding seasons. This level of effect may cause a very small and temporary change in the population growth rate, over one or two years, but is highly unlikely to significantly affect the size or overall health of the harbour porpoise population at the Management Unit scale.

9.7.1.79 In terms of the very low proportion of the population affected (up to 0.4%), and the very limited number of breeding cycles affected, the magnitude of the impact is considered **negligible**.

9.7.1.80 The sensitivity of harbour porpoise to behavioural disturbance was assessed at **medium**, therefore the effect of behavioural disturbance as a result of a single vessel scenario for either monopiles or pin-piles on harbour porpoise is of **minor significance**, and is therefore **not significant** in EIA terms.

Table 9.7.13: Number of Harbour Porpoise Potentially Disturbed by Monopile (5,000 kJ) and Pin-Pile (3,000 kJ) Foundation Installation at Location			
Foundation Type	**Max. Hammer Energy (kJ)**	**# Porpoise Impacted**	**% Population**
Monopile	5,000	1377	0.40%
Pin-pile	3,000	639	0.19%

Bottlenose Dolphin

9.7.1.81 Figures 9.7.5 and 9.7.8 (Volume 3a) display unweighted noise contours with SEL values decreasing in 5 dB steps from the source, overlain on the bottlenose dolphin density surface as a result of installing a monopile at 5,000 kJ hammer energy and installing a pin-pile at 3,000 kJ hammer energy.

9.7.1.82 Due to the presence of a nearby SAC and the requirement for HRA, and based on the percentages affected from these scenarios (all were greater than 5% of the total reference population, see Table 9.7.14), a more refined assessment was undertaken for bottlenose dolphin, recognising that the majority of the foundation installations would require less energy than the worst case parameters would suggest. This involved using a 'most likely' maximum hammer energy of 3,500 kJ (defined as the maximum hammer energy likely to be required on most of the foundation installations) see Graph 9.7.4: Predicted levels of bottlenose dolphin behavioural disturbance throughout the piling ramp up for monopiles under the 'most likely' (3,500 kJ) and the 'worst case' (5,000 kJ) maximum hammer energies for monopile installation using the harbour porpoise dose-response curve . The number of animals potentially disturbed was calculated for all hammer energies in the ramp up leading up to both maximum hammer energies.

9.7.1.83 The corresponding number of animals predicted to be affected under each scenario are given in Table 9.7.14. The total numbers of animals predicted to respond within each sound contour is detailed in Table 9.7.15. A total of 13 dolphins are predicted to be disturbed when piling is occurring at 5,000 kJ for monopile installation (worst case maximum hammer energy). For the 'most likely' maximum hammer energy of 3,500 kJ for monopiles, this number reduces to 11. These represent 6.8% and 5.7% of the bottlenose dolphin reference population (East Coast MU) respectively. The equivalent number for the worst case maximum hammer energy for pin-pile installation is 9.4 dolphins, representing 4.8% of the population. The total number of days of disturbance is up to 87 for monopiles and up to 340 days for pin-piles, with all disturbance relating to monopile installation occurring within a single year and the activity for pin-pile installation occurring over two years. According to the opinions of the experts involved in the expert elicitation for PCoD, which forms our best available knowledge on the topic, disturbance would be most likely to affect bottlenose dolphin calf survival, where: "*Experts felt that disturbance could affect calf survival if it exceeded 30-50 days, because it could result in mothers becoming separated from their calves and this could affect the amount of milk transferred from the mother to her calf."* Harwood *et al. (*2013). Therefore, there is a risk of decreased calf survival over a maximum of two years of piling. The magnitude of the impact is therefore considered medium in terms of the numbers of animals expected to be affected, but low in terms of the intensity and duration of the impact.

9.7.1.84 The figures below and Table 9.7.15 highlight that the majority of the affected dolphins occur within the 130-140 dB contours, which occur in the coastal areas of high predicted bottlenose dolphin density, relatively distant from the piling locations, where there is a high level of uncertainty in both received levels, and the probability of response. Graph 9.7.4 displays the increase in predicted levels of disturbance as the hammer energy ramps up – indicating that the maximum levels of disturbance are only present for a short space of time relative to the whole ramp up period.

9.7.1.85 There is uncertainty around individual behavioural responses and, given the availability of alternative foraging areas, it is unlikely that individual dolphins will experience disturbance throughout the whole of the foundation installation period. Due to the high mobility of bottlenose dolphins and the availability of alternative known foraging areas and other areas of high usage within the Moray Firth, short-term displacement is unlikely to result in any effect on the survival of individuals.

9.7.1.86 The sensitivity of bottlenose dolphins to behavioural disturbance has been assessed at **medium** and impact magnitude has been assessed as **medium**, therefore the effect of behavioural disturbance on bottlenose dolphins is of **moderate significance** in the short term. Therefore, further population modelling has been undertaken to determine the significance of this level of individual disturbance in terms of the population (see paragraph 9.7.1.112 *et seq.*).

9.7.1.87 It is important to bear in mind that this is a precautionary assessment and that there is significant uncertainty in both the received levels in the shallower coastal areas. Table 9.7.14 and Figures 9.7.5 and 9.7.6 (Volume 3a) indicate that the noise levels where dolphins are predicted to be are in the region of 140-120 dB, approaching likely ambient noise levels in coastal environments. These areas are likely to be relatively noisy with vessel traffic and wave action contributing to ambient noise, potentially at levels that may mask the piling noise at these ranges from source.

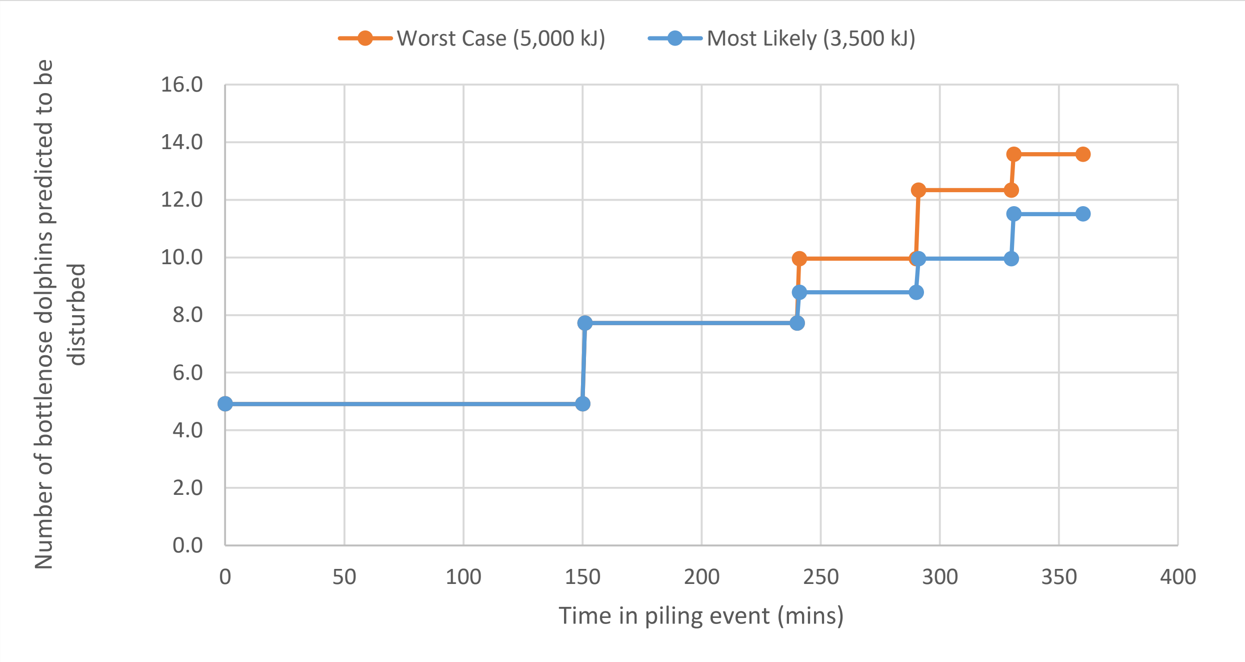
9.7.1.88 There is also uncertainty about the likelihood of response from bottlenose dolphins, the adoption of the harbour porpoise dose response curve is likely to be precautionary.

Table 9.7.14: Number of dolphins potentially disturbed by monopile (5,000 kJ) and pin-pile (3,000 kJ) foundation installation at Location 1 using the harbour porpoise dose-response curve. Results are shown including and excluding the animals present within the contours between 120 and 130 dB

Foundation Type	Hammer Energy (kJ)	120 – 170 dB		130 – 170 dB	
		# Dolphins Impacted	% Population	# Dolphins Impacted	% Population
Monopile	5,000	13.6	6.96%	13.2	6.76%
	3,500	11.5	5.90%	11.0	5.65%
	3,000	10.0	5.10%	9.4	4.84%
	2,500	8.8	4.51%	8.2	4.22%
	2,000	7.7	3.96%	7.1	3.65%
	1,000	4.9	2.52%	3.9	2.01%
Pin-pile	3,000	10.0	5.10%	9.4	4.84%

Table 9.7.15: Number of dolphins potentially disturbed in each dose-response contour (5 dB steps) by monopile (various hammer energies) and pin-pile (3,000 kJ) foundation installation at Location 1 using the harbour porpoise dose-response curve. The shading in the table indicates the contour bands with the highest numbers of dolphins present for each hammer energy

	Monopile							Pin-Pile
dB	**5,000 kJ**	**4,000 kJ**	**3,500 kJ**	**3,000 kJ**	**2,500 kJ**	**2,000 kJ**	**1,000 kJ**	**3,000 kJ**
170	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
165	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
160	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
155	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
150	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
145	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
140	4.3	2.8	2.2	1.7	1.2	0.6	0.0	1.7
135	7.5	7.7	7.2	5.2	4.0	3.2	1.1	5.2
130	1.2	1.3	1.5	2.5	2.9	3.3	2.8	2.5
125	0.4	0.4	0.4	0.5	0.5	0.5	0.8	0.5
120	0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.1
Total	**13.6**	**12.3**	**11.5**	**10.0**	**8.8**	**7.7**	**4.9**	**10.0**



Graph 9.7.4: Predicted levels of bottlenose dolphin behavioural disturbance throughout the piling ramp up for monopiles under the 'most likely' (3,500 kJ) and the 'worst case' (5,000 kJ) maximum hammer energies for monopile installation using the harbour porpoise dose-response curve

Minke Whale

9.7.1.89 Figure 9.7.9 and Figure 9.7.10 (Volume 3a) display unweighted noise contours with SEL values decreasing in 5 dB steps from the source, overlain on the minke whale density surface as a result of a single operation installing a monopile using 5,000 kJ hammer energy and installing a pin-pile at 3,000 kJ hammer energy. The numbers of animals predicted to be affected by disturbance were calculated by applying the proportion of animals expected to respond (from the dose-response curve) to the abundance of animals within each 5 dB contour. The corresponding number of animals predicted to be affected under each scenario are 29 minke whales for the 5,000 kJ monopile installation and 23 minke whales for the 3,000 kJ pin-pile installation (Table 9.7.16). These represent a maximum of 0.12 % and 0.10 % of the minke whale reference population (Celtic and Greater North Sea MU) respectively (Table 9.7.16). The total number of days of disturbance is up to 87 for monopiles and up to 340 days for pin-piles, with all disturbance relating to monopile installation occurring within a single year and the activity for pin-pile installation occurring over two years.

9.7.1.90 The magnitude of the impact is therefore considered negligible.

9.7.1.91 The sensitivity of minke whales to behavioural disturbance has been assessed at m**edium** and the magnitude of the impact has been assessed as **negligible**, therefore the effect of behavioural disturbance on minke whales is of **minor significance**, which is **not significant** in EIA terms.

Table 9.7.16: Number of Minke Whales Disturbed by Monopile (5,000 kJ) and Pin-Pile (3,000 kJ) Foundation Installation at Location 3

Foundation Type	Hammer Energy (kJ)	# Whales Impacted	% Population
Monopile	5,000	29	0.12%
Pin-pile	3,000	23	0.10%

Harbour Seal

9.7.1.92 Figure 9.7.11 and Figure 9.7.12 (Volume 3a) display unweighted noise contours with SEL values decreasing in 5 dB steps from the source, overlain on the harbour seal density surface as a result of a single operation installing a monopile using 5,000 kJ hammer energy and a single operation installing a pin-pile at 3,000 kJ hammer energy. The corresponding number of animals predicted to be affected under each scenario are 12 seals for the 5,000 kJ monopile installation and seven seals for the 3,000 kJ pin-pile installation. These represent a maximum of 0.9% and 0.5% of the harbour seal reference population (Moray Firth Seal Management Area) respectively (Table 9.7.17).

9.7.1.93 The total number of days of disturbance is up to 87 for monopiles and up to 340 days for pin-piles, with all disturbance relating to monopile installation occurring within a single year and the activity for pin-pile installation occurring over two years. Therefore, either a total of 29 individuals may be affected over one breeding cycle or 23 seals may be affected over two breeding cycles. Although it is important to consider that actual active piling will only be for a small proportion of this time. According to the opinions of the experts involved in the PCoD expert elicitation: "*Most experts believe that a substantial amount of disturbance (150-280 days) was necessary to reduce the probability of giving birth down to 0.5*" (Harwood *et al.,* 2013). Adult survival was not thought to be affected.

9.7.1.94 Although there is uncertainty around individual behavioural responses, the availability of alternative foraging areas and return times, it is unlikely that individuals will experience disturbance throughout the whole of the foundation installation period, although the worst case assumption is that every affected individual is affected to this extent. Due to the high mobility of harbour seals and the availability of alternative foraging areas at the scale of the wider management unit, survival of individual adults is unlikely to be affected. The worst case outcome would be that each affected harbour seal would fail to breed. Therefore, this would result in a maximum of 0.12% of the population failing to breed for a single breeding season under the monopile scenario, or 0.10% of the population failing to breed across a maximum of two breeding seasons. This level of effect may cause a very small and temporary change in the population growth rate, over one or two years, but is highly unlikely to significantly affect the size or overall health of the harbour seal population at the Management Unit scale. The magnitude of the impact is therefore considered **negligible**.

9.7.1.95 The sensitivity of harbour seals to behavioural disturbance has been assessed at **medium** and the magnitude of the impact has been assessed as **negligible**, therefore the effect of behavioural disturbance on harbour seals is of **minor significance**, and therefore **not significant** in EIA terms.

Table 9.7.17: Number of Harbour Seals Disturbed by Monopile (5,000 kJ) and Pin-Pile (3,000 kJ) Foundation Installation at Location 1

Foundation Type	Hammer Energy (kJ)	# Seals Impacted	% Population
Monopile	5,000	11.7	0.9%
Pin-pile	3,000	6.4	0.5%

Grey seal

9.7.1.96 Figure 9.7.13 and Figure 9.7.14 (Volume 3a) display unweighted noise contours with SEL values decreasing in 5 dB steps from the source, overlain on the grey seal density surface as a result of a single operation installing a monopile using 5,000 kJ hammer energy and a single operation installing a pin-pile at 3,000 kJ hammer energy. The corresponding number of animals predicted to be affected under each scenario are 119 grey seals for the 5,000 kJ monopile installation and 74 grey seals for the 3,000 kJ pin-pile installation. These represent a maximum of 3.35% and 2.09% of the grey seal reference population (Moray Firth Seal Management Area) respectively (Table 9.7.18).

9.7.1.97 The total number of days of disturbance is up to 87 for monopiles and up to 340 days for pin-piles, with all disturbance relating to monopile installation occurring within a single year and the activity for pin-pile installation occurring over two years. The expert elicitation for iPCoD resulting in the following results for grey seals: "*Experts felt disturbance may result in reduced foraging efficiency which could affect fertility and interfere with mating opportunities due to habitat displacement. There was broad agreement that animals could tolerate a small number of days of disturbance before it had any effect on fertility. However, some experts believed that 50 days of disturbance would reduce the probability of giving birth by 50%, whereas others thought that around 100 days would only reduce the probability of giving birth to 0.7 (i.e. a reduction of 0.3)*" (Harwood *et al.,* 2013). Therefore, either a total of 119 individuals may be affected over one breeding cycle or 74 seals may be affected over two breeding cycles; although it is important to consider that actual active piling will only be for a small proportion of this time and that expert opinion varied quite considerably on the duration of disturbance predicted to result in a reduction in fecundity.

9.7.1.98 The predicted level of effect may cause a very small and temporary change in the population growth rate, over one or two years, but is highly unlikely to significantly affect the size or overall health of the grey seal population at the Management Unit scale. The magnitude of the impact is therefore considered **low**.

9.7.1.99 The sensitivity of grey seals to behavioural disturbance has been assessed as **low** and impact magnitude has been assessed as **low**, therefore the effect of behavioural disturbance on grey seals is of **minor** significance, which is therefore **not significant** in EIA terms.

Table 9.7.18: Number of Grey Seals Disturbed by Monopile (5,000 kJ) and Pin-Pile (3,000 kJ) Foundation Installation at Location 1

Foundation Type	Hammer Energy (kJ)	# Grey Seals Impacted	% Population
Monopile	5,000 (worst case)	119	3.35%
Pin-pile	3,000	74	2.09 %

Results of Piling Noise Assessment: Disturbance During Concurrent Piling Operations (2 vessels)

Harbour Porpoise

9.7.1.100 Figure 9.7.15 (Volume 3a) displays unweighted noise contours with SEL values decreasing in 5 dB steps from the source, overlain on the harbour porpoise density surface as a result of a multiple vessel operation installing two monopiles using a maximum 5,000 kJ hammer energy. The corresponding number of animals predicted to be affected is 1,609 porpoises. This represents a maximum of 0.49% of the harbour porpoise reference population (North Sea MU) (Table 9.7.19). The concurrent installation scenario results in an overall shorter period of disturbance (44 days compared to 87 days of piling for monopile installation) therefore despite the small increase in the number of individuals predicted to be affected, the magnitude of the impact is considered to be **negligible** (0.49% of the population affected for a maximum of a single breeding cycle).

9.7.1.101 The sensitivity of harbour porpoise to behavioural disturbance as a result of concurrent monopile installation has been assessed as **medium** and the magnitude of the impact has been assessed as **negligible**, therefore the effect of behavioural disturbance as a result of concurrent monopile installation on harbour porpoise is of **minor significance,** and is therefore **not significant** in EIA terms.

Table 9.7.19: Number of Harbour Porpoise Predicted to Experience Behavioural Disturbance as a Result of the Concurrent Installation of Monopiles and Pin-Piles at Location 1 and 3

Foundation Type	Hammer Energy (kJ)	# Porpoise Impacted	% Population
Monopile locations 1 & 3	5,000	1,609	0.49%
Monopile locations 1 & 3	3,500	1,448	0.42%
Pin-pile locations 1 & 3	3,000	1,348	0.39%

Bottlenose Dolphin

9.7.1.102 Figure 9.7.16 (Volume 3a) displays unweighted noise contours with SEL values decreasing in 5 dB steps from the source, overlain on the bottlenose dolphin density surface as a result of installing two monopiles concurrently at 5,000 kJ hammer energy.

9.7.1.103 The number of animals predicted to be affected are given in Table 9.7.20. A total of 15 dolphins are predicted to be disturbed when piling occurs at 5,000 kJ for two concurrent monopile installations (worst case maximum hammer energy). This is considered the maximum spatial extent of effect based on the biggest possible total area of impact.

9.7.1.104 As discussed previously, the majority of the affected dolphins occur within the 120-140 dB contours, which overlap with the coastal areas of high potential bottlenose dolphin density, relatively distant from the piling locations, where the uncertainty in these predictions of received levels of noise is high. A slightly higher number of animals are predicted to be affected relative to single vessel operations (a maximum of 15 animals during concurrent operations compared to 14 during single operations), however, the concurrent piling of monopiles would result in a total of only 44 days of piling compared to 87 days for single monopile installation.

9.7.1.105 The sensitivity of bottlenose dolphins to behavioural disturbance as a result of concurrent monopile installation has been assessed at **medium** and the magnitude of the impact has been assessed as **medium**, therefore the effect of behavioural disturbance as a result of concurrent monopile installation on bottlenose dolphins is of **moderate significance**. Therefore, further population modelling has been undertaken to determine the significance of this level of individual disturbance in terms of the population (paragraph 9.7.1.112 *et seq*.).

Table 9.7.20: Number of Bottlenose Dolphins Predicted to Experience Behavioural Disturbance as a Result of the Concurrent Installation of Monopiles and Pin-Piles at Location 1 and 3

Foundation Type	Hammer Energy (kJ)	120 - 180		130 - 180	
		# Dolphins Impacted	% Population	# Dolphins Impacted	% Population
Monopile locations 1 & 3	5,000	14.6	7.5%	14.2	7.3%
Monopile locations 1 & 3	3,500	12.6	6.5%	12.2	6.2%
Pin-pile locations 1 & 3	3,000	11.9	6.1%	11.4	5.8%

Minke Whale

9.7.1.106 Figure 9.7.17 (Volume 3a) displays unweighted noise contours with SEL values decreasing in 5 dB steps from the source, overlain on the minke whale density surface as a result of a multiple vessel operation installing two monopiles using 5,000 kJ hammer energy. The number of animals predicted to be affected is 30 minke whales. This represents a maximum of 0.13% of the minke whale reference population (Celtic and Greater North Sea MU) (Table 9.7.21).

9.7.1.107 The sensitivity of minke whales to behavioural disturbance as a result of concurrent monopile installation has been assessed at **medium** and the magnitude of the impact has been assessed as **negligible**, therefore the effect of behavioural disturbance as a result of concurrent monopile installation on minke whales is of **minor significance**, and therefore **not significant** in EIA terms.

Table 9.7.21: Number of Minke Whales Predicted to Experience Behavioural Disturbance as a Result of the Concurrent Installation of Monopiles and Pin-Piles at Location 1 and 3.

Foundation Type	Hammer Energy (kJ)	# Whales Impacted	% Population
Monopile locations 1 & 3	5,000	30.1	0.13%
Monopile locations 1 & 3	3,500	28.8	0.12%
Pin-pile locations 1 & 3	3,000	24.5	0.10%

Harbour Seal

9.7.1.108 Figure 9.7.18 (Volume 3a) displays unweighted noise contours with SEL values decreasing in 5 dB steps from the source, overlain on the harbour seal density surface as a result of multiple operations installing two monopiles using 5,000 kJ hammer energy. The number of animals predicted to be affected under this scenario is 20 harbour seals. This represents a maximum of 1.5% of the harbour seal reference population (Moray Firth Seal Management Area) (Table 9.7.22).

9.7.1.109 The sensitivity of harbour seals to behavioural disturbance as a result of concurrent monopile installation has been assessed at **medium** and the magnitude of the impact has been assessed as **low**, therefore the effect of behavioural disturbance as a result of concurrent monopile installation on harbour seals is of **minor significance**, and therefore **not significant** in EIA terms.

Table 9.7.22: Number of Harbour Seals Predicted to Experience Behavioural Disturbance as a Result of the Concurrent Installation of Monopiles and Pin-Piles at Location 1 and 3

Foundation Type	Hammer Energy (kJ)	# Seals Impacted	% Population
Monopile locations 1 & 3	5000	19.6	1.50%
Monopile locations 1 & 3	3,500	13.1	1.00%
Pin-pile locations 1 & 3	3,000	11.0	0.84%

Grey Seal

9.7.1.110 Figure 9.7.19 (Volume 3a) displays unweighted noise contours with SEL values decreasing in 5 dB steps from the source, overlain on the grey seal density surface as a result of multiple operations installing two monopiles using 5,000 kJ hammer energy. The number of animals predicted to be affected under this scenario is 207 grey seals. This represents a maximum of 5.85% of the grey seal reference population (Moray Firth Seal Management Area) respectively (Table 9.7.23). Under a concurrent piling scenario, all piling and resulting disturbance would take place within one breeding cycle and, according to the currently available expert knowledge, this could result in reduced foraging efficiency which could affect fertility, though as discussed above, expert opinion varied as to the extent to which fertility might be affected at this level of disturbance. Under the concurrent piling scenarios there is a maximum of 44 days of piling monopiles and 67 days of piling for concurrent pin-piles (compared to 87 and 133 days for single monopile and pin-pile installation). The predicted level of effect may cause a very small and temporary change in the population growth rate over one year as a result of reduced fertility, but is highly unlikely to significantly affect the size or overall health of the grey seal population at the Management Unit scale. The magnitude of the impact is therefore considered **low**.

9.7.1.111 The sensitivity of grey seals to behavioural disturbance as a result of concurrent monopile installation has been assessed at **low** and the magnitude of the impact has been assessed as **low**, therefore the effect of behavioural disturbance as a result of concurrent monopile installation on grey seals is of **minor significance**, and therefore **not significant** in EIA terms.

Table 9.7.23: Number of Grey Seals Predicted to Experience Behavioural Disturbance as a Result of the Concurrent Installation of Monopiles and Pin-Piles at Location 1 and 3

Foundation Type	Hammer Energy (kJ)	# Seals Impacted	% Population
Monopile locations 1 & 3	5,000	207	5.85%
Monopile locations 1 & 3	3,500	144	4.08%

Table 9.7.23: Number of Grey Seals Predicted to Experience Behavioural Disturbance as a Result of the Concurrent Installation of Monopiles and Pin-Piles at Location 1 and 3			
Foundation Type	**Hammer Energy (kJ)**	**# Seals Impacted**	**% Population**
Pin-pile locations 1 & 3	3,000	125	3.54%

Results of Piling Noise Assessment: Population Modelling

9.7.1.112 Due to the connectivity with SACs, population modelling was carried out for both harbour seals and bottlenose dolphins to explore the potential for long term effects in the population from the predicted levels of disturbance. No PTS effects were included in the population models due to the very small impact ranges predicted and the lack of any overlap in piling activity with areas used by bottlenose dolphins or harbour seals. Population modelling was carried out for the construction scenarios described below.

Single Piling Operation

9.7.1.113 Monopile installation using worst case maximum hammer energy (5,000 kJ) – this assessment assumes that during each day of piling, the number of dolphins predicted to be disturbed is 13.6 (see Table 9.7.14). The equivalent number of harbour seals is 12 (Table 9.7.17).

9.7.1.114 Monopile installation using most likely maximum hammer energy (3,500 kJ) – this assessment assumes that during each day of piling, the number of dolphins predicted to be disturbed is 11.5 (see Table 9.7.14). Assessment of this refined scenario was not considered necessary for harbour seals due to the level of impacts predicted from the worst case maximum hammer energy.

9.7.1.115 Pin pile installation using maximum hammer energy (3,000 kJ) – this assessment assumes that during each day of piling, the number of dolphins predicted to be disturbed is 10 (see Table 9.7.14). The equivalent number of harbour seals is 7 (Table 9.7.17).

9.7.1.116 The total number of predicted active piling days was 87 days for monopiles and 133 days for pin-piles.

Concurrent Vessel Operations

9.7.1.117 Concurrent installation of two monopiles using worst case maximum hammer energy (5,000 kJ) – this assessment assumes that during each day of piling, the number of dolphins predicted to be disturbed is 15 (see Table 9.7.20) and the number of harbour seals is 20 (Table 9.7.22).

9.7.1.118 Monopile installation using most likely maximum hammer energy (3,500 kJ) – this assessment assumes that during each day of piling, the number of dolphins predicted to be disturbed is 12.6 (see Table 9.7.20).

9.7.1.119 Pin-pile installation using maximum hammer energy (3,000 kJ) – this assessment assumes that during each day of piling, the number of dolphins predicted to be disturbed is 11.9 (see Table 9.7.20) and the number of harbour seals is 11 (Table 9.7.22)

9.7.1.120 The total number of predicted piling days was 44 days for monopiles and 67 days for pin-piles

Species Parameters

9.7.1.121 Harwood and King (2017) present suggested demographic parameters for bottlenose dolphin population management units in the UK, including specific demographic parameters for the Coastal East Scotland MU. The East Coast Scotland MU population size and growth rate of 1.018 was obtained from Cheney *et al. (*2013) and the other demographic rates were obtained from the results of capture-recapture analysis of the dolphin photo-ID study (Lusseau 2013). The parameters chosen for the simulations carried out are given in Table 9.7.24.

9.7.1.122 Harwood and King (2017) also present suggested demographic parameters for harbour seal population management units in the UK, including specific demographic parameters for the Moray Firth MU. The growth rate and adult survival rate for this MU was derived by Cordes *et al. (*2011) using photo-ID data. Pup survival rates were based on Thompson *et al. (*2013) and both pup and juvenile rates were subsequently adjusted to obtain a stable population (growth rate = 1).

Table 9.7.24: Demographic Parameters for Bottlenose Dolphins as Used in the Population Assessment

Parameter	Bottlenose Dolphin	Harbour Seal
MU	Coastal East Scotland	Moray Firth
Population size	195	1306
Growth rate	1.018	1
Vulnerable subpopulation	Yes, 0.5	No
Calf/pup survival	0.9	0.5809
Juvenile survival	0.94	0.596
Adult survival	0.945	0.97
Fecundity rate	0.3	0.88
Age at independence	2	1
Age at first breeding	9	5
Density dependence	no	yes

Bottlenose Dolphin iPCoD Results

9.7.1.123 The compiled summary results of the iPCoD modelling for bottlenose dolphins across all scenarios are presented in Table 9.7.25. This highlights that there was very little difference in the iPCoD predicted population outcomes between the six scenarios run. The single installation of pin-piles produced fractionally worse population level outcomes compared to the other five scenarios (as highlighted by the red text in Table 9.7.25); therefore the full results for this scenario are presented in more detail below. Based on these results, the additional disturbance caused by monopile installation is offset by the increased duration of the pin-pile installation. However, there is very little difference between the pin-pile single and concurrent scenarios suggesting that when considering pin-pile installation alone, there is no overall difference in impact between a shorter more intense period of disturbance and a longer period of low disturbance.

Table 9.7.25: Results of the iPCoD modelling for bottlenose dolphins under 6 scenarios: single vessel installation of monopiles (5,000 kJ), concurrent installation of monopiles (5,000 kJ), single vessel installation of monopiles (3,500 kJ), concurrent installation of monopiles (3,500 kJ), single vessel installation of pinpiles (3,000 kJ) and concurrent installation of pin-piles (3,000 kJ). Red text denotes which of the 6 scenarios had the worst case result for each output metric

Result Parameter		MP 5000 Single	MP 5000 Concurrent	MP 3500 Single	MP 3500 Concurrent	PP_3000 _Single	PP_3000_Concurrent
Median Population Size Year 24	Baseline	274	273	272	274	272	277
	Impacted	270	272	268	274	268	272
	Difference in Pop^n size	4	1	4	0	4	5
	Impacted as % of baseline	98.5%	99.6%	98.5%	100.0%	98.5%	98.2%
Additional Risk of a 1% Decline	Yr 1	0.078	0.077	0.045	0.072	0.065	0.092
	Yr 6	0.045	0.032	0.047	0.025	0.053	0.03
	Yr 12	0.015	0.017	0.013	0.008	0.018	0.006
	Yr 18	0.005	0.008	0.007	0.003	0.003	0.003
	Yr 24	0	0.001	0.003	0.002	0.002	0
Ratio of the impacted to un-impacted population size	Yr 1 Min	0.8652	0.8925	0.8687	0.8804	0.8523	0.8706
	Yr 6 Min	0.8596	0.8295	0.8272	0.8627	0.8447	0.8496
	Yr 12 Min	0.8346	0.8118	0.8283	0.8571	0.8276	0.8182
	Yr 18 Min	0.8352	0.8077	0.8182	0.8657	0.8333	0.8174
	Yr 24 Min	0.8345	0.8182	0.8344	0.8693	0.8333	0.7941
	Yr 1 Median	1	1	1	0.9905	1	1
	Yr 6 Median	0.9914	0.9916	0.9915	0.9921	0.9904	0.9911
	Yr 12 Median	1	1	1	1	0.9912	0.9926
	Yr 18 Median	1	1	1	1	0.9928	1
	Yr 24 Median	1	1	1	1	0.9946	1
	Yr 1 Mean	0.9913	0.991	0.9922	0.9919	0.9929	0.9917
	Yr 6 Mean	0.9873	0.9915	0.9875	0.9924	0.9863	0.9881
	Yr 12 Mean	0.9879	0.9917	0.9885	0.9928	0.9869	0.989
	Yr 18 Mean	0.9878	0.9916	0.9885	0.9932	0.9869	0.9885
	Yr 24 Mean	0.9874	0.9917	0.9888	0.9932	0.9869	0.9889
Ratio of impacted to un-impacted	Yr 1 Min	0.8918	0.91	0.8632	0.8996	0.8533	0.8703
	Yr 6 Min	0.9596	0.9692	0.9703	0.9587	0.9444	0.9673
	Yr 12 Min	0.9747	0.9764	0.9788	0.9835	0.9806	0.9804

Table 9.7.25: Results of the iPCoD modelling for bottlenose dolphins under 6 scenarios: single vessel installation of monopiles (5,000 kJ), concurrent installation of monopiles (5,000 kJ), single vessel installation of monopiles (3,500 kJ), concurrent installation of monopiles (3,500 kJ), single vessel installation of pinpiles (3,000 kJ) and concurrent installation of pin-piles (3,000 kJ). Red text denotes which of the 6 scenarios had the worst case result for each output metric

Result Parameter		MP 5000 Single	MP 5000 Concurrent	MP 3500 Single	MP 3500 Concurrent	PP_3000 _Single	PP_3000_Concurrent
annual growth rate	Yr 18 Min	0.9819	0.9801	0.978	0.9839	0.9766	0.9796
	Yr 24 Min	0.9816	0.9722	0.9818	0.9735	0.9691	0.9727
	Yr 1 Median	0.9914	0.9995	0.9913	0.9998	0.99	0.993
	Yr 6 Median	1	1	1	1	1	1
	Yr 12 Median	1	1	1	1	1	1
	Yr 18 Median	1	1	1	1	1	1
	Yr 24 Median	1	1	1	1	1	1
	Yr 1 Mean	0.9905	0.9967	0.9899	0.9972	0.9857	0.9923
	Yr 6 Mean	0.9988	0.9995	0.9987	0.9995	0.9989	0.9989
	Yr 12 Mean	0.9997	0.9998	0.9996	1	0.9998	0.9997
	Yr 18 Mean	0.9999	1	1	1	0.9999	1
	Yr 24 Mean	1	1	1	0.9999	0.9999	0.9997
Centile for un-impacted population which matches the 50th centile for the impacted population	Yr 1	36	36	44	40	42	35
	Yr 6	45	46	44	45	42	43
	Yr 12	44	49	48	48	45	47
	Yr 18	46	47	48	47	48	47
	Yr 24	47	49	47	50	47	46

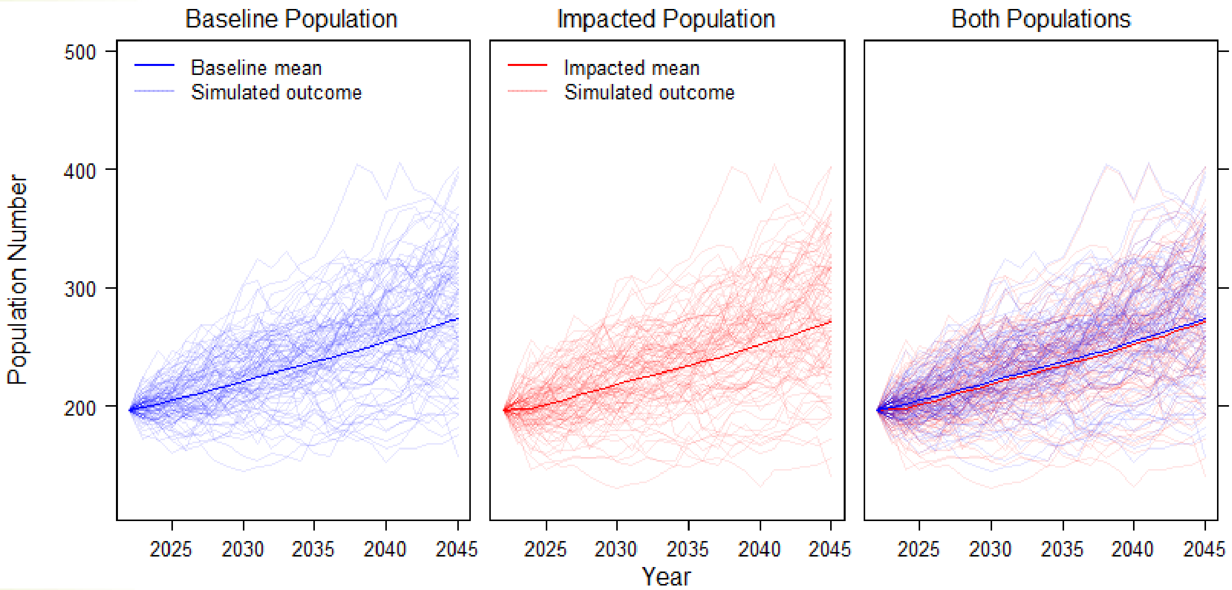
Bottlenose dolphin iPCoD Results: Single vessel installation of pin-piles (3,000 kJ)

9.7.1.124 The standard output provided by the iPCoD model provides the probabilistic risk of a 1, 2 and 5% decline in both the baseline and the impacted population at a series of time points in the simulation. The output also includes a calculation of the difference between the two, providing a measure of the additional risk of decline posed by the modelled disturbance.

9.7.1.125 The simulations demonstrated that in probabilistic terms, there was a very small increase in the risk of population decline in the impacted population in the first year of simulation with a maximum of a 6.5% increase in the probability of a 1% population decline, a 8.2% increase in the probability of a 2% population decline and an 8% increase in the probability of a 5% decline (Graph 9.7.5). This impact was short term, and by year 12, the increase in the probability of a 1% decline was only 1.8% and by year 18 it was 0.3% (Table 9.7.25).

9.7.1.126 The median predicted population size for the baseline population after 24 years was 272 (95% CI 176 - 384). The median predicted population size for the impacted population after 24 years was 268 (95% CI 172 – 382) which is 98.5% of the size of the baseline population. This means that after a simulated 24 years the size difference between the median baseline and impacted population was 4 animals, with a large overlap in confidence intervals. Therefore, there was no significant difference between the predicted baseline (unimpacted) and impacted population sizes as a result of the predicted levels of disturbance.

9.7.1.127 None of the bottlenose dolphin impact scenarios resulted in a significant long term population effect. The population trajectory for both the baseline and the impacted populations (the mean and each individual 1,000 simulated outcomes) are presented in Graph 9.7.5. This demonstrates that the mean impacted population is predicted to experience an initial decline in growth rate relative to the baseline population, after which it then returns to the same growth rate as the baseline population and continues to increase at the same rate as the baseline population for the remainder of the simulations.



Graph 9.7.5: Simulated bottlenose dolphin population sizes for both the baseline and the impacted populations after single piling of pin-piles at 3,000 kJ.

9.7.1.128 The iPCoD modelling involves pairs of simulations, identical in all aspects other than the effect of disturbance. Therefore, further exploration of the ratios between each pair in a variety of metrics was carried out.

Comparing population size between baseline and impacted simulations

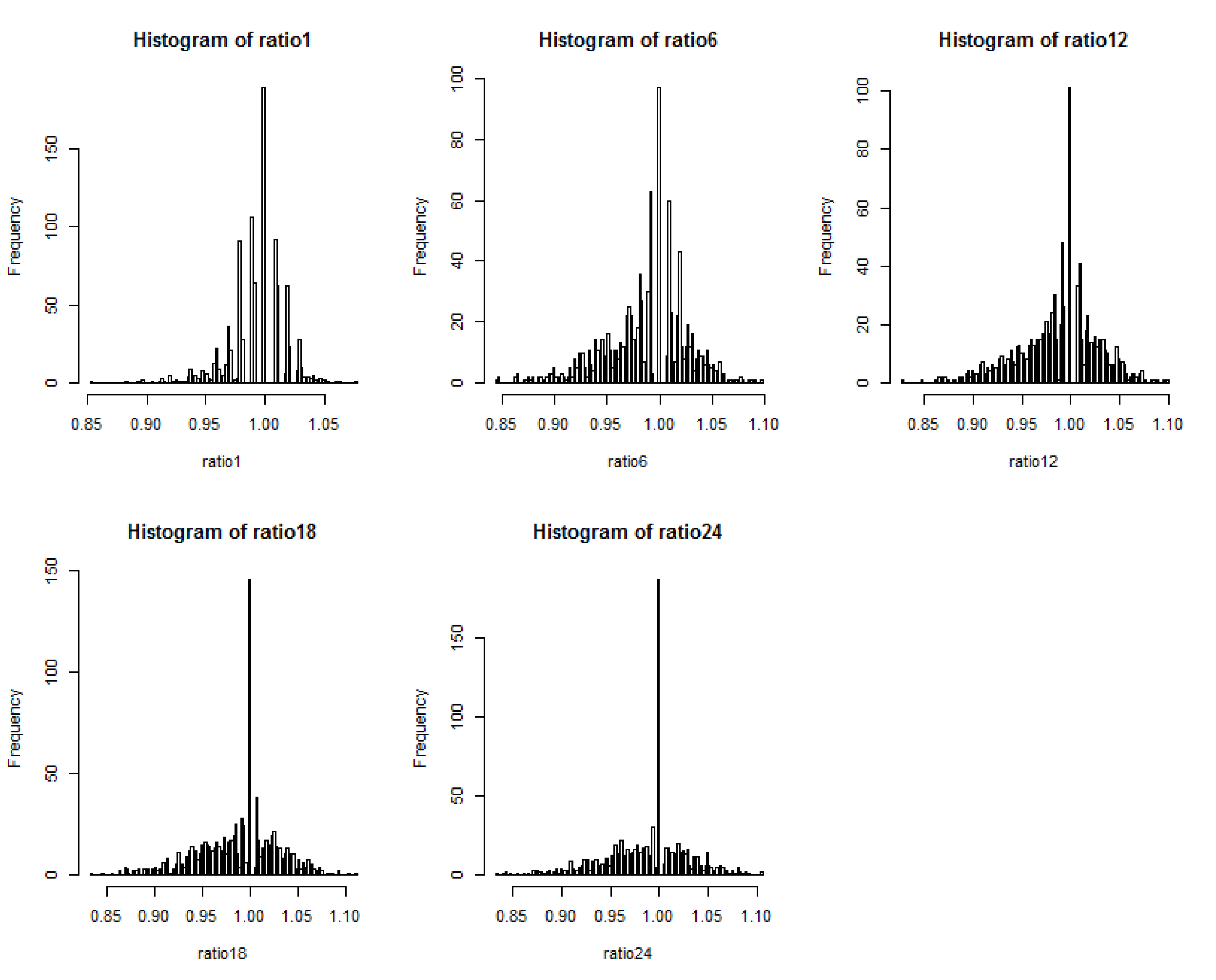
9.7.1.129 Across all 1,000 paired simulations, the median ratio of baseline and impacted population sizes ranged between 0.9904 and 1.0000 and the mean ratio of the baseline and impacted population sizes ranged between 0.9869 and 0.9929. This means that a small number of the simulations resulted in impacted populations that were smaller than the paired baseline population in all simulation years, although the effect was very small.

9.7.1.130 The maximum ratio of the impacted to the baseline population ranged between 1.076 and 1.111, which means that in a small number of the 1,000 paired simulations, the impacted population size was greater than that of the baseline population size. The minimum ratio between the impact and the baseline population size was between 0.8276 and 0.8523, which means that the minimum impacted population size across all pairs was between 82.76% and 85.23% of the size of the baseline population.

9.7.1.131 This is further demonstrated in Graph 9.7.6: which provides a series of histograms of the ratio of the impacted population to the baseline population across all 1,000 paired simulations at a range of time steps in the simulation. Across all years examined (1, 6, 12, 18 and 24), in most of the 1,000 paired simulations there was little/no difference between the impacted and the baseline population size (as depicted by the histogram bar at and around x value 1.00).

Table 9.7.26: Summary Statistics for the Ratio of the Impacted to Un-Impacted Population Size Between 1,000 Paired Bottlenose Dolphin Simulations for the Installation of Single Pin-Piles (3,000 kJ)

Year of simulation	Minimum	1st Quartile	Median	Mean	3rd Quartile	Maximum
1	0.8523	0.9796	1	0.9929	1.01	1.076
6	0.8447	0.963	0.9904	0.9863	1.016	1.097
12	0.8276	0.9625	0.9912	0.9869	1.015	1.1
18	0.8333	0.96	0.9928	0.9869	1.015	1.111
24	0.8333	0.9608	0.9946	0.9869	1.013	1.105



Graph 9.7.6: Ratio of bottlenose dolphin impacted to un-impacted bottlenose dolphin population size for years 1, 6, 12, 18 and 24 for the single vessel installation on pin-piles at 3,000 kJ

Comparing growth rates between baseline and impacted simulations

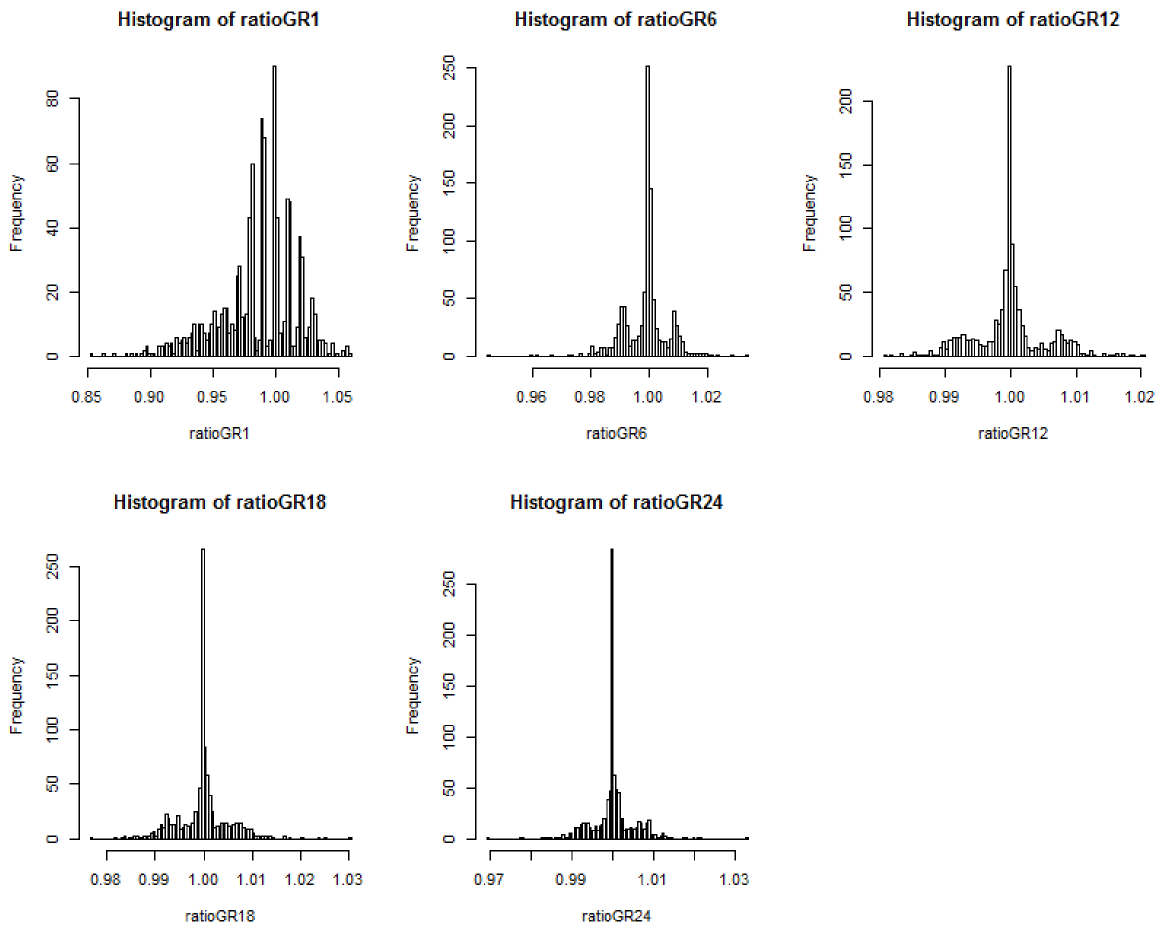
9.7.1.132 Across all 1,000 paired simulations, the mean ratio of the baseline and impacted annual growth rates in all the years examined, was between 0.9857 and 0.9999. This means that a small number of the simulations resulted in a change from one year to the next that was lower for the impacted population compared to the paired baseline population in all simulation years, although the effect was very small.

9.7.1.133 The maximum ratio of annual growth rates ranged between 1.02 and 1.059, which means that in a very small number of the 1,000 paired simulations, the growth rate was higher in the impacted population. The minimum annual growth rate range was between 0.85 (in year 1) and 0.98 (in year 12).

9.7.1.134 This is further demonstrated in Graph 9.7.7: which provides a histogram of the ratio of the growth rates across all 1,000 paired simulations.

Table 9.7.27: Summary Statistics for the Ratio of the Impacted to Un-Impacted Annual Growth Rate Across Years for the Bottlenose Dolphin Simulations (Relative to Baseline) for the Installation of Single Pin-Piles (3,000 kJ)

Year of simulation	Minimum	1st Quartile	Median	Mean	3rd Quartile	Maximum
1	0.8533	0.9698	0.99	0.9857	1.009	1.059
6	0.9444	0.996	1	0.9989	1.001	1.034
12	0.9806	0.9982	1	0.9998	1.001	1.02
18	0.9766	0.9985	1	0.9999	1.001	1.03
24	0.9691	0.9986	1	0.9999	1.001	1.033



Graph 9.7.7: Ratio of bottlenose dolphin impacted to un-impacted annual growth rate for years 1, 6, 12, 18 and 24 for the single vessel installation on pin-piles at 3,000 kJ

9.7.1.135 Overall, when considering the difference in annual growth rates and predicted population sizes between the matched pairs, the single pin-pile scenario resulted in fractionally more of a population level impact compared to the other scenarios. After 24 years of simulation, the median radio of the impacted to the un-impacted population size was 0.9946 and the mean ratio of the impacted to un-impacted growth rate was 0.999. None of the bottlenose dolphin impact scenarios resulted in a significant long term population effect. The population trajectory for both the baseline and the impacted populations demonstrates that the mean impacted population is predicted to experience an initial decline in growth rate relative to the baseline population, after which it then returns to the same growth rate as the baseline population and continues to increase at the same rate as the baseline population for the remainder of the simulations. Overall, the level of disturbance cause by the single vessel installation of pin-piles (3,000 kJ) is unlikely to result in any significant differences between the baseline and the impacted population.

9.7.1.136 The sensitivity of bottlenose dolphins to behavioural disturbance as a result of single and concurrent, monopile and pin-pile installation has been assessed as **medium** and, given the results of the iPCoD population modelling, across all scenarios with the lack of an overall long term difference in population growth rates or predicted size, the magnitude of the impact has been assessed as **low**, in terms of the effect on the long term population trajectory, therefore the effect behavioural disturbance as a result of single and concurrent, monopile and pin-pile installation on bottlenose dolphins is of **minor significance**, and therefore **not significant** in EIA terms.

Harbour Seal iPCoD Results

9.7.1.137 The summary results of the iPCoD modelling for harbour seals are presented in Table 9.7.28. This highlights that there was very little difference in the iPCoD results between the four scenarios run. For example, in all four scenarios there was no difference between the baseline and impacted population size at year 24. The additional risk of a 1% decline in year 1 was insignificant across all scenarios with a maximum of a 0.3% additional risk of a 1% decline in year 1. The single installation of monopiles produced fractionally worse population level outcomes compared to the other three scenarios (as highlighted by the red text in Table 9.7.28); therefore the full results for this scenario are presented below.

Table 9.7.28: Results of the iPCoD modelling for harbour seals under 4 scenarios: single vessel installation of monopiles (5,000 kJ), concurrent installation of monopiles (5,000 kJ), single vessel installation of pinpiles (3,000 kJ) and concurrent installation of pinpiles (3,000 kJ). Red text denotes which of the 4 scenarios had the worst case result for each results parameter.

Result Parameter		MP Single	MP Concurrent	PP_Single	PP_Concurrent
Median population size Year 24	Baseline	1300	1310	1310	1312
	Impacted	1300	1310	1310	1312
	Difference in Popn size	0	0	0	0
	Impacted as % of baseline	100%	100%	100%	100%
Additional risk of decline	Yr 1	-0.001	0.003	0.001	0.002
	Yr 6	0.001	0	0	0
	Yr 12	0	0	0	0
	Yr 18	0	0	0	0
	Yr 24	0	0	0	0
Ratio of the impacted to unimpacted population size	Yr 1 Min	0.9882	0.9891	0.9846	0.9787
	Yr 6 Min	0.9955	0.9954	0.9937	0.9909
	Yr 12 Min	0.9944	0.9955	0.989	0.9923
	Yr 18 Min	0.9931	0.9951	0.9913	0.9952
	Yr 24 Min	0.9917	0.9936	0.9919	0.9964
	Yr 1 Median	1	1	1	1
	Yr 6 Median	1	1	1	1
	Yr 12 Median	1	1	1	1
	Yr 18 Median	1	1	1	1
	Yr 24 Median	1	1	1	1
	Yr 1 Mean	0.9999	0.9998	0.9999	0.9999
	Yr 6 Mean	1	1	1	1
	Yr 12 Mean	0.9999	1	0.9999	1
	Yr 18 Mean	0.9999	1	0.9999	1
	Yr 24 Mean	0.9999	1	1	1
Ratio of the impacted to unimpacted growth rate	Yr 1 Min	0.9835	0.9956	0.9731	0.9784
	Yr 6 Min	0.9967	0.9984	0.9984	0.9983
	Yr 12 Min	0.9972	0.998	0.9955	0.9983

Table 9.7.28: Results of the iPCoD modelling for harbour seals under 4 scenarios: single vessel installation of monopiles (5,000 kJ), concurrent installation of monopiles (5,000 kJ), single vessel installation of pinpiles (3,000 kJ) and concurrent installation of pinpiles (3,000 kJ). Red text denotes which of the 4 scenarios had the worst case result for each results parameter.

Result Parameter		MP Single	MP Concurrent	PP_Single	PP_Concurrent
Ratio of the impacted to unimpacted growth rate	Yr 18 Min	0.9973	0.9985	0.9979	0.9982
	Yr 24 Min	0.9973	0.9967	0.9982	0.9982
	Yr 1 Median	1	1	1	1
	Yr 6 Median	1	1	1	1
	Yr 12 Median	1	1	1	1
	Yr 18 Median	1	1	1	1
	Yr 24 Median	1	1	1	1
	Yr 1 Mean	0.9997	1	1	0.9999
	Yr 6 Mean	1	1	1	1
	Yr 12 Mean	1	1	1	1
	Yr 18 Mean	1	1	1	1
	Yr 24 Mean	1	1	1	1
Centile for unimpacted population which matches the 50th centile for the impacted population	Yr 1	49	49	50	49
	Yr 6	50	50	50	50
	Yr 12	50	50	50	50
	Yr 18	50	50	50	50
	Yr 24	50	50	50	50

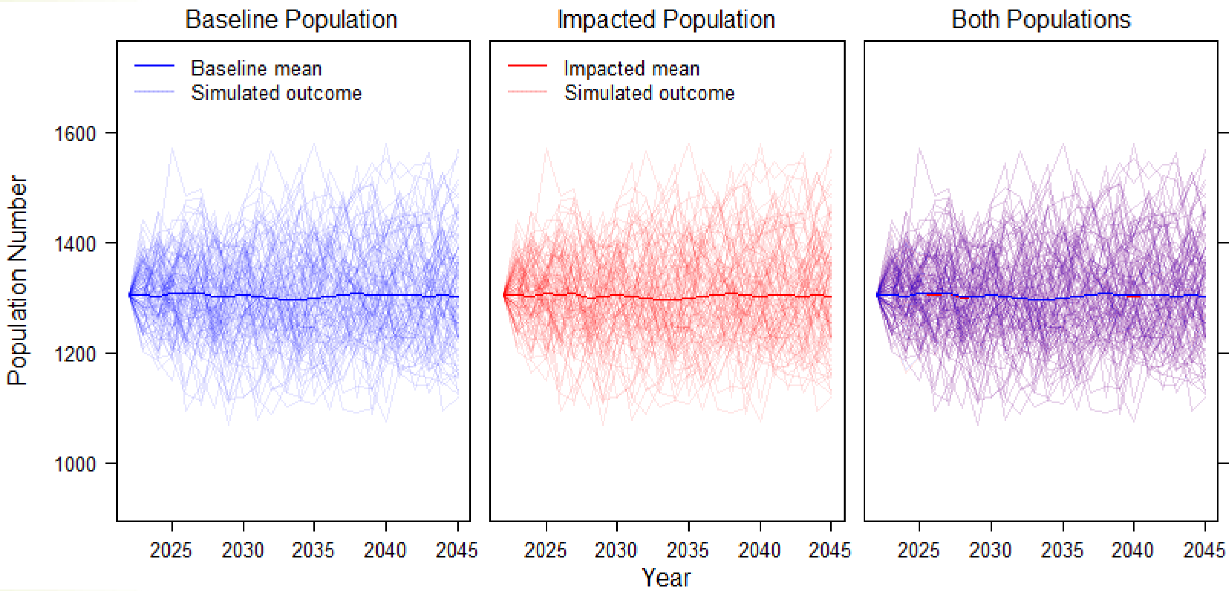
Harbour Seal iPCoD Results: Single Installation of Monopiles (5,000 kJ)

9.7.1.138 The simulations demonstrated that in probabilistic terms there was essentially no additional risk of a population decline (Table 9.7.29) as a result of the modelled impact. The highest predicted additional risk was a 0.01% increase in the probability of a 1% decline in year 6.

9.7.1.139 The median population size was identical for both the baseline and the impacted population after 24 years (1,300 95% CI 1080 – 1524). There was no evidence of a population level impact of this level of disturbance on the harbour seal population (Graph 9.7.8).

Table 9.7.29: Additional Risk of a 1, 2 and 5% Decline Across Years for the Harbour Seal Population Simulations Resulting from the Simulated Disturbance Predicted during the Installation of Single Monopiles (5,000 kJ)

Year of simulation	Additional probability of a 1% decline	Additional probability of a 2% decline	Additional probability of a 5% decline
1	-0.001	0	0
6	0.001	0	0
12	0	0	0
18	0	0	0
24	0	0	0



Graph 9.7.8: Simulated harbour seal population sizes for both the baseline and the impacted populations after single piling of monopiles at 5,000 kJ

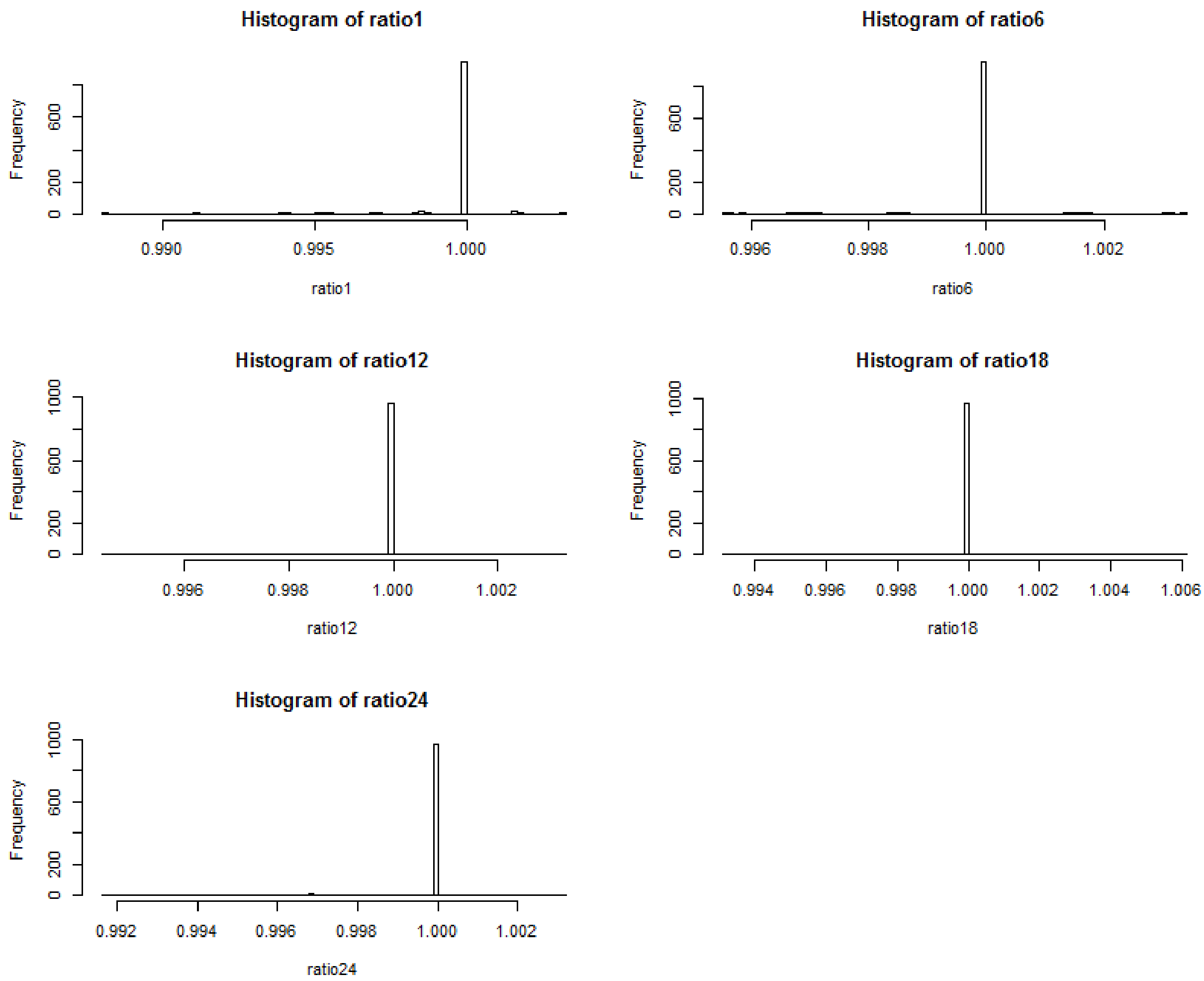
Comparing population size between baseline and impacted simulations

9.7.1.140 There was no difference in the median ratio of the impacted to the baseline population for the 1,000 paired simulations for any years of the simulation under either the concurrent or the single piling scenarios (Table 9.7.30). The mean ratio of the impacted population size to the paired baseline population shows that the mean impacted population size is fractionally smaller than the paired baseline population in all simulation years (except year 6), however this difference is very small and the mean impacted population size is 99.99% of the paired baseline population size (Table 9.7.30). The maximum ratio of the impacted to the baseline population ranges between 1.003 and 1.006, which means that in some of the 1,000 paired simulations run, the impacted population size was greater than that of the baseline population size.

9.7.1.141 This is further demonstrated in Graph 9.7.9 which provides a histogram of the ratio of the impacted population to the baseline population calculated across all 1,000 paired simulations. Across all years (1, 6, 12, 18 and 24), in over 800 of the 1,000 paired simulations there was no difference between the impacted and the baseline population size (as depicted by the histogram bar at x value 1.00).

Table 9.7.30: Summary Statistics for the Ratio of the Impacted to Un-Impacted Population Size Across Years for the Harbour Seal Population Simulations (Relative to Baseline) for the Installation of Single Monopiles (5,000 kJ)

Year of simulation	Minimum	1st Quartile	Median	Mean	3rd Quartile	Maximum
1	0.9882	1.0000	1.0000	0.9999	1.0000	1.0030
6	0.9955	1.0000	1.0000	1.0000	1.0000	1.0030
12	0.9944	1.0000	1.0000	0.9999	1.0000	1.0030
18	0.9931	1.0000	1.0000	0.9999	1.0000	1.0060
24	0.9917	1.0000	1.0000	0.9999	1.0000	1.0030



Graph 9.7.9: Ratio of impacted to un-impacted population size for years 1,6, 12, 18 and 24 for the single vessel installation on monopiles at 5,000 kJ.

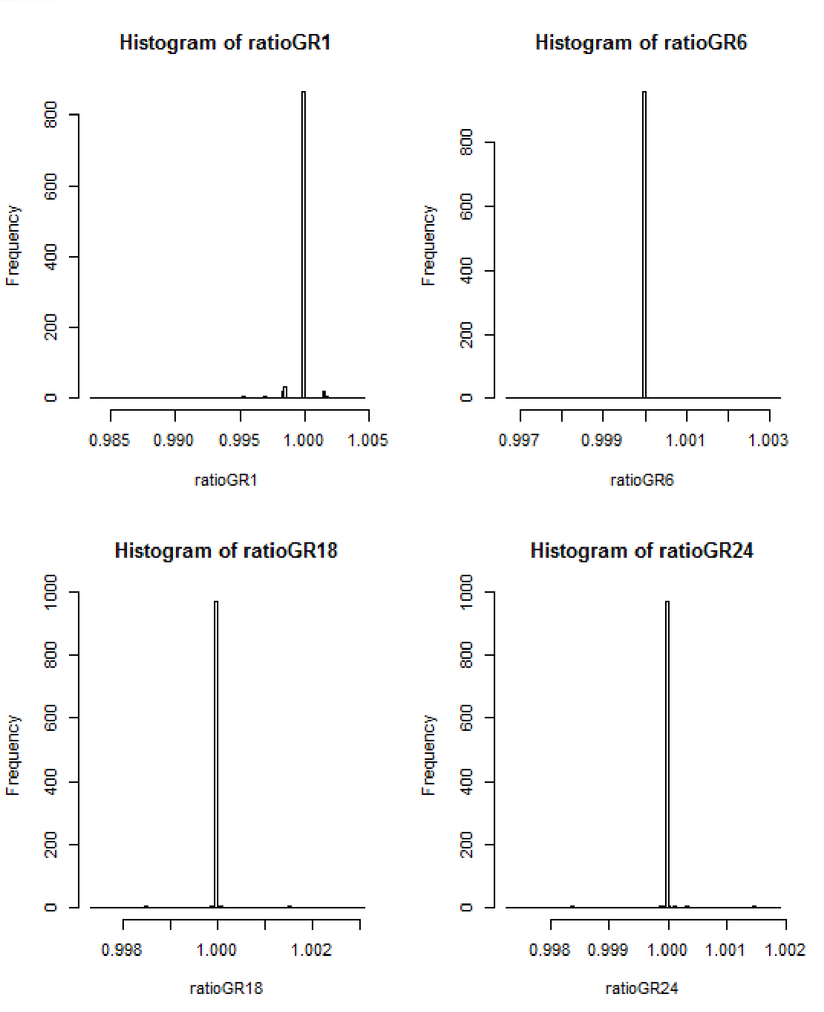
Comparing growth rates between baseline and impacted simulations

9.7.1.142 There was no difference in the median ratio of the impacted to the baseline annual growth rates for any years of the simulation under either the concurrent or the single piling scenarios (Table 9.7.31). The mean ratio of the impacted population size to the paired baseline population shows that the mean impacted annual growth rate is fractionally smaller than the paired baseline population growth rate in only year 1, however this difference is very small and the mean impacted population growth rate is 99.97% of the paired baseline population growth rate (Table 9.7.31). The maximum ratio of the impacted to the baseline population growth rates is between 1.002 and 1.005, which means that in some of the 1,000 paired simulations run, the impacted population growth rate was greater than that of the paired baseline population.

9.7.1.143 This is further demonstrated in Graph 9.7.10: which provides a histogram of the ratio of the impacted population growth rate to the baseline population growth rate calculated across all 1,000 paired simulations. Across all years (1, 6, 12, 18 and 24), in over 800 of the 1,000 paired simulations there was no difference between the impacted and the baseline population growth rates (as depicted by the histogram bar at x value 1.00).

Table 9.7.31: Summary Statistics of the Ratio of the Impacted to Unimpacted Annual Growth Rate Across Years for the Harbour Seal Population Simulations for the Installation of Single Monopiles (5,000 kJ).

Year of simulation	Minimum	1st Quartile	Median	Mean	3rd Quartile	Maximum
1	0.9835	1.0000	1.0000	0.9997	1.0000	1.0050
6	0.9967	1.0000	1.0000	1.0000	1.0000	1.0030
12	0.9972	1.0000	1.0000	1.0000	1.0000	1.0020
18	0.9973	1.0000	1.0000	1.0000	1.0000	1.0030
24	0.9973	1.0000	1.0000	1.0000	1.0000	1.0020



Graph 9.7.10: Ratio of impacted to un-impacted annual growth rate for years 1,6, 12, 18 and 24 for the single vessel installation on monopiles at 5,000 kJ.

9.7.1.144 Overall, when considering the difference in annual growth rates and predicted population sizes between the matched pairs the level of disturbance cause by the single vessel installation of monopiles (5,000 kJ) is unlikely to result in any significant differences between the baseline and the impacted population.

9.7.1.145 The sensitivity of harbour seals to behavioural disturbance as a result of worst case scenario single monopile installation has been assessed as **medium** and, given the results of the iPCoD population modelling, across all scenarios with the lack of an overall long term difference in population growth rates or predicted size, the magnitude of the impact has been assessed as **low**, in terms of the effect on the long term population trajectory, therefore the effect behavioural disturbance as a result of single and concurrent pin-pile installation on harbour seals is of **minor significance**, and therefore **not significant** in EIA terms.

Piling Results: Summary

9.7.1.146 In summary, no significant lethal, physical injury or PTS ranges were predicted for any species. This suggests that alongside the adoption of a piling strategy with appropriate mitigation the risk of lethal or physical injury or PTS to any marine mammal species is negligible.

9.7.1.147 The predicted levels of disturbance were relatively low for all species assessed and across all piling scenarios. Given the presence of the SAC for bottlenose dolphins and the fact that the modelling resulted in >2% of the population predicted to experience disturbance, a population assessment using the iPCoD framework was conducted which suggested no significant long term population effects from this level of disturbance. The iPCoD model results indicated that single installation of monopiles or pin-piles predicted very slightly higher population level impacts than concurrent installation.

9.7.2 Other Potential Construction Effects

Underwater Noise from Construction Activities (Including Vessels and other Construction Activities but Excluding Piling)

9.7.2.1 In addition to underwater noise from pile-driving during the installation of WTG foundations, there is also potential for marine mammals to be affected by underwater noise generated from other construction activities such as vessel activity, seabed preparation for installation of gravity base structure foundations (e.g. dredging) and other activities in relation to cable installation (such as trenching). Potential effects associated with the other construction activities are discussed below.

9.7.2.2 Increased vessel traffic during construction has the potential to result in disturbance of marine mammals. Disturbance from vessel noise is only likely to occur where increased noise from vessel movements associated with the construction of the Development is greater than the background ambient noise. The current maximum design scenario assumes a total of two installation vessels (JUVs or HLVs) on site at the same time and that each of these vessels may be accompanied by several other support vessels, tugs, and / or transport barges.

9.7.2.3 Comparative analysis undertaken by Subacoustech Ltd (presented as part of the Moray East ES, 2012)) of potential noise sources during construction ranked noise from construction vessels as least noisy when compared to other construction activities such as piling, seabed preparation (dredging), cable trenching, cable laying and rock placement. During the period of piling operations, it is therefore considered unlikely that vessel noise will impact marine mammal receptors at level additional to the piling activity itself. In fact, it is difficult to separate out the effect of vessel presence and activity from the effect of pile driving in isolation, since the data collected to date on the response of animals to pile driving, will have included a degree of vessel activity in combination with the piling, therefore it could be considered that the typical vessel activity related to pile driving, may be already assessed to some extent under the pile driving assessment. Individuals have more potential to be impacted by increased vessel movements during periods when piling is not taking place. The piling modelling assessment above assumes that individuals are disturbed on each day of piling, regardless of the duration of piling, plus a number of residual days of disturbance – this inclusion of residual disturbance and the assumption of all day disturbance, even when piling may only take a few hours, may account for the additional disturbance from vessels over and above piling related disturbance.

9.7.2.4 The magnitude and characteristics of vessel noise varies depending on ship type, ship size, mode of propulsion, operational factors and speed. Vessels of varying size produce different frequencies, generally becoming lower frequency with increasing size. The predominant sound frequencies associated with large vessels are below several hundred Hz. Thomsen *et al.* (2006) used species hearing detection thresholds to conclude that noise from larger vessels around 0.25 kHz will be detected by harbour porpoise at distances of approximately one km, and noise from smaller vessels around two kHz will be detected at around three km. Harbour and grey seals are expected to detect two kHz ship noise at approximately three km and 0.25 kHz at ranges of 20 km (Table 9.7.32). These frequencies were chosen because most noise from construction / maintenance vessels is exhibited at these ranges (Richardson 1995). The distance at which animals may react is difficult to predict. Behavioural responses can vary a great deal depending on context and data specific to harbour porpoises and seals are sparse. According to Thomsen *et al.* (2006) both porpoises and seals might be expected to respond to vessels of this type at approximately 400 m.

Table 9.7.32: Ranges at Which Different Species Will Detect Different Vessel Types According to Thomsen *et al.* (2006)

Vessel Type	Harbour Porpoise	Harbour and Grey Seals
Large vessels 0.25 kHz	1 km	20 km
Smaller vessels 2 kHz	3 km	3 km

9.7.2.5 Given their high-frequency hearing range, it has been suggested that porpoise are more likely to be sensitive to vessels that produce medium to high frequency noise components (e.g. Hermannsen *et al.,* 2014). Harbour porpoise are known to avoid vessels and behavioural responses have been shown in porpoise exposed to vessel noise that contains low levels of high-frequency components (e.g. Dyndo *et al.,* 2015). Therefore, the sensitivity of porpoise to vessel noise will likely depend on the frequency of the noise components produced by the vessel.

9.7.2.6 There is a possibility that responses to vessels are not related to noise per se and that the simple presence of vessels may result in a response. Pirotta *et al.* (2015) demonstrated that the response of bottlenose dolphins in the Moray Firth was related to the number of boats present but did not vary significantly with the levels of overall noise. While this result does provide evidence that a perception of risk can be related to the presence of boats, silent and stationary boats did not elicit a response. It is therefore difficult to disentangle the effect of presence of boats with the noise they emit, although it is expected that observed responses are at least in part due to noise disturbance and in part due to perceived risks of collision.

9.7.2.7 There is very little published information on the responses of seals at sea to vessels. Jones *et al.* (2017) presents an analysis of the predicted co-occurrence of ships and seals at sea which demonstrates that UK wide there is a large degree of predicted co-occurrence between ships and seals at sea, particularly within 50 km of the coast close to seal haul-outs. There is no evidence relating decreasing seal populations with high levels of co-occurrence between ships and animals and areas where seal populations are increasing (e.g. south east England) and where ship co-occurrences are highest, are experiencing the highest levels of growth (Jones *et al.,* 2017).

9.7.2.8 The vessels expected to be involved in construction activities are detailed in Chapter 4: Description of Development. The maximum number of vessels expected to be required during installation is 25, although not all at the same time. Installation of the WTGs is likely to require up to two installation vessels accompanied by support vessels, tugs and/or transport barges. For the installation of the inter-array cables and offshore export cable this identifies cable lay vessels or barges (with anchor handling vessels if using anchors). For the installation of OSPs, a heavy lift vessel will be required (with anchor handling vessels if using anchors). There is the potential for all these vessels to be working in the Moray West Site and along the Offshore Export Cable Corridor simultaneously.

9.7.2.9 A study published by SNH predicts the consequences of disturbances from increased vessel traffic in the Moray Firth on the resident bottlenose dolphin population (Lusseau *et al.,* 2013). This study found that increases of up to 800 vessel movements were not expected to have population level effects as a result of disturbance. The authors concluded that the amount of time dolphins were likely to spend in the vicinity of boats as a result of these increases is unlikely to result in an effect, based on the small increase in exposure predicted combined with the fact that commercial traffic is predictable in nature. It is anticipated that the construction activities at the Moray West Site will result in a maximum of 46 return trips for installation vessels, 16 return trips for support vessels, and a maximum of five additional transport vessel trips per week. This results in vessel movement increases of well below the levels predicted by Lusseau *et al. (*2013) to have population level effects as a result of disturbance and will not result in levels of vessel traffic anywhere close to the threshold of 80 vessels per day suggested by the analysis in (Heinänen and Skov 2015) for significant reductions in harbour porpoise density.

9.7.2.10 There is limited information available on the responses of minke whales to vessels. Therefore minke whales have been assumed to be of similar sensitivity as harbour porpoises.

9.7.2.11 The installation of the cable laying activities are expected to take up to six months using dredging and trenching techniques which are expected to have a very localised disturbance footprint. This conclusion is based on noise modelling carried out for the Moray East Offshore Wind Farm EIA where the largest behavioural impact range for any activity (other than piling) for any marine mammal species was predicted to be 640 m for trenching for harbour porpoise. Therefore these activities are not expected to give rise to significant disturbance to any marine mammal species, particularly because these activities are of relatively short duration.

9.7.2.12 Although the landfall location is on the southern coast of the Moray Firth in an area of relatively high bottlenose dolphin and minke whale usage, any activities close to the coast will temporary and short duration (export cable installation across entire Offshore Export Cable Corridor expected to take up to six months). A maximum of two cable installation vessels and two support vessels will be present during these activities. Any disturbance from either the vessels themselves or the trenching or dredging operations will be localised (within a kilometre at most) and temporary.

9.7.2.13 There are no seal haul-outs close to the landfall location (the closest are 3-4 km away – see Volume 3a - Figures 9.4.8 and 9.4.11) and therefore no disturbance is predicted to occur to hauled-out seals as a result of offshore cable installation landfall activities (horizontal directional drilling or open cut trenching).

9.7.2.14 In conclusion, the impact of disturbance from vessel noise and other associated construction activities (dredging, cable laying etc.) is predicted to be of local spatial extent, short term duration and reversible. The magnitude of impact is therefore considered to be low for all marine mammal species. Given the baseline use of the Moray West Site by other vessels (on average four vessels per day in the summer and two vessels per day in winter (see Volume 2 - Chapter 12: Shipping and Navigation), it is likely that marine mammals using this area are habituated, to some degree, to the underwater noise produced by vessels and will tolerate vessel presence.

9.7.2.15 The adoption of a Vessel Management Plan (VMP) will also reduce the potential for disturbance. Overall the magnitude of disturbance from vessel activity and other construction activities has been assessed as **low**. The sensitivity for all marine mammal species to disturbance from vessel activity and other construction activities is determined as **medium**. The effect will therefore be of **minor significance** which is **not significant** in EIA terms.

Collision Risk from Vessels

9.7.2.16 During construction of the wind farm, another potential source of impact from increased vessel activity is physical trauma from collision with a boat or ship (disturbance as a result of vessel noise has already been assessed). These injuries include blunt trauma to the body or injuries consistent with propeller strikes. The risk of collision of marine mammals with vessels would be directly influenced by the type of vessel and the speed with which it is travelling (Laist *et al.,* 2001) and indirectly by ambient noise levels underwater and the behaviour the marine mammal is engaged in. Laist *et al. (*2001) predicted that the most severe injuries from collision with vessels travelling at over 14 knots and Vanderlaan and Taggart (2007) predicted that the probability of lethal injury of a large whale species (North Atlantic right whale) decreases from 0.79 at speeds of 15 knots to 0.21 at 8.6 knots.

9.7.2.17 However, there is currently a lack of information on the frequency of occurrence of boat collisions as a source of marine mammal mortality. Non-lethal collision has also been reported by Van Waerebeek *et al. (*2007). Collisions between vessels and marine mammals are therefore not necessarily fatal.

9.7.2.18 There is little evidence from harbour porpoise, bottlenose dolphins and minke whales stranded in the UK that injury from vessel collisions is an important source of mortality. Of all the post mortems carried out on harbour porpoise strandings in the UK between 2010 and 2014, ship strikes were noted as cause of death for only a very small percentage of deaths (~ four percent) over the five year period (CSIP 2015). None of the 53 harbour porpoise post mortem examinations in 2015 identified physical trauma from ship strike as the cause of death (CSIP 2015), nor was ship strike identified as the cause of death in the four stranded minke whales necropsied in 2015. Of the 1,922 reported harbour porpoise strandings in the UK between 2005 and 2010, 478 were investigated by post mortem and cause of death established for 457 individuals, of these 22 had died from physical trauma of unknown origin, which could include vessel strikes (Deaville and Jepson 2011). There were 52 stranded bottlenose dolphins reported round the UK between 2005 and 2010, 18 of which were studied at post mortem and none of which were confirmed as having died as a result of physical trauma related to vessel collisions (Deaville and Jepson 2011). Of the 87 stranded minke whales in the UK between 2005 and 2010, 11 were investigated at post mortem where one individual was determined to have died of physical trauma following probable impact from a ship or boat (Deaville and Jepson 2011).

9.7.2.19 There is a body of evidence on collisions between large whales and vessels (e.g. Laist *et al.,* 2001, Jensen and Silber 2004), where fin whales, humpback and North Atlantic right whales are the most commonly recorded species colliding with vessels. While there have been confirmed reports of minke whales that have died as a result of vessel collisions (e.g. Laist *et al.,* 2001, Jensen and Silber 2004), few minke whales have been reported to collide with vessels compared to other large whale species (5% of large whale vessel collision records in the United States between 1975 and 1996) (Laist *et al.,* 2001).

9.7.2.20 There is evidence of individual bottlenose dolphins that have survived vessel collisions who have been photographed with propeller strike scars and injuries (Dwyer *et al.,* 2014). However, the long term survival and reproductive rates of these individuals are largely unknown.

9.7.2.21 As stated in Chapter 4: Description of Development, it is expected that up to two installation vessels (JUVs or HLVs) would be involved in foundation and WTG installation at any one time. Each of these vessels may be accompanied by several other support vessels, tugs, and/or transport barges. This does not represent a significant increase in vessel activity in the Moray West Site, where baseline summer vessel transits through the Moray West Site is on average four vessels per day and in winter is on average two vessels per day (see Chapter 12: Shipping and Navigation for further baseline information). There are very few studies that indicate a critical level of activity in relation to risk of collisions but an analysis presented in Heinänen and Skov (2015) suggested that harbour porpoise density was significantly lower in areas with vessel transit rates of greater than 80 per day. Vessel traffic in the Moray Firth, even considering the addition of construction traffic will still be well below this figure.

9.7.2.22 Harbour porpoises, bottlenose dolphins and seals are relatively small and highly mobile, and given observed responses to noise (as detailed above), are expected to detect vessels in close proximity and largely avoid collision.

9.7.2.23 Predictability of vessel movement by marine mammals is known to be a key aspect in minimising the potential risks imposed by vessel traffic (Nowacek *et al.,* 2001; Lusseau, 2003; 2006). The vessel management plan developed for the Development will ensure that vessel traffic moves along predictable routes.

9.7.2.24 It is not expected that the level of vessel activity during construction would cause an increase in the risk of mortality from collisions. The adoption of a vessel management plan during construction that includes preferred transit routes and guidance for vessel operations in the vicinity of marine mammals and around seal haul-outs will minimise the potential for any impact. The magnitude of the impact has therefore been assessed as **low**. The sensitivity to this impact is assessed as **low** for all species given available evidence. The effect is therefore assessed as **minor significance** for all marine mammal species and therefore **not significant** in EIA terms.

Reduction in Prey Availability as a result of impacts on Prey Species or Benthic habitats

9.7.2.25 Given that marine mammals are dependent on fish prey, there is the potential for indirect effects on marine mammals as a result of impacts upon fish species or on the habitats that support them. The main fish species identified as being present in the study area are detailed in Chapter 8: Fish and Shellfish Ecology. These included demersal species such as haddock, monkfish, whiting, cod and plaice, and pelagic species such as herring, sandeels, lemon sole and sprat. There are also diadromous migratory species such as salmon and sea trout which may be an important part of the diet of marine mammals in certain locations.

9.7.2.26 Harbour porpoises are opportunistic feeders who feed on a variety of small fish from both demersal and pelagic habitats (Santos *et al.,* 2004). Although prey can vary both spatially and seasonally, porpoises in any one area, tend to feed primarily on a small number of species. In Scottish waters porpoises are thought to feed primarily on whiting and sandeels (Santos and Pierce 2003).

9.7.2.27 Bottlenose dolphins eat a wide variety of fish, squid and crustaceans. In Scottish waters, cod, saithe and whiting were found to be the most common prey items in stomach contents of stranded and bycaught bottlenose dolphins (Santos *et al.,* 2001).

9.7.2.28 Grey seals also feed on a variety of prey species, including sandeels, and gadids such as cod, saithe, whiting and haddock, and flatfish such as plaice, lemon sole and dab. In Orkney and the Northern North Sea region, sandeels dominate the diet although plaice and cod also contributed (Hammond and Wilson 2016).

9.7.2.29 Harbour seals around the UK also feed on a variety of prey including sandeel, gadids, flatfish, herring, sprat, octopus and squid (Wilson and Hammond 2015). In the Moray Firth, sandeels dominate the diet in all seasons, and in the summer, where sandeel contribution to the diet was lowest, flatfish were important prey (Wilson and Hammond 2015).

9.7.2.30 Although several species of fish including sandeel and herring, are considered to be sensitive to habitat disturbance and loss as a result of construction activities, the magnitude of the impact was considered to be low and effect significance assessed as minor.

9.7.2.31 Based on noise modelling, any impacts on fish species as a result of construction (piling) noise were also considered to be of low magnitude, with the significance of the effect assessed as minor, even for more sensitive species such as herring, cod and salmonids.

9.7.2.32 Although there is potential for direct impacts on the spawning habitats of sandeel and herring in particular, the magnitude of long term habitat loss as a result of the presence of foundations, scour protection and cable protection, was assessed as low and the significance of the effect assessed as minor.

9.7.2.33 Overall, the fish and shellfish ecology assessment (Chapter 8: Fish & Shellfish Ecology) did not predict any significant effects on any fish populations considered to be an important prey resource for marine mammals as a result of any activities associated with the construction of the Development.

9.7.2.34 Similarly, the benthic and intertidal ecology assessment (Chapter 7: Benthic & Intertidal Ecology) did not predict any significant effects on benthic or intertidal habitats and species as a result of any activities associated with the construction of the Development. Therefore it is unlikely that there will be any changes to the habitats supporting marine mammal prey.

9.7.2.35 The commercial fisheries assessment (Chapter 11: Commercial Fisheries) also concluded that there would be no significant effects on any commercial fishing practices in the area resulting from construction of the Development.

As significant effects on prey species or the habitats supporting them are not predicted, it is reasonable to assume that secondary effects on marine mammals would also not be significant, although in the short term, some small changes in prey availability may occur. Therefore the magnitude of the impact of changes in prey availability is expected to be **low**. It is also recognised that most marine mammal species are opportunistic feeders and feed on a variety of prey around UK coasts and therefore will feed on a variety of species. Therefore the sensitivity of the marine mammal species considered in this assessment to changes in prey availability is considered **low**. Therefore, the effect of reduced prey availability is considered to be of **minor** significance and therefore, **not significant** in EIA terms**.**

<u>Reduction in Foraging Ability</u>

9.7.2.36 Disturbance to water quality as a result of construction operations can have both direct and indirect impacts on marine mammals. Indirect impacts would include effects on prey species which have already been covered in the previous section. Direct impacts include the impairment of visibility and therefore foraging ability which might be expected to reduce foraging success.

9.7.2.37 As outlined in Chapter 6: Physical Processes & Water Quality, increases in SSC may arise from the seabed preparation for gravity base structures. It is assumed that dredging would be undertaken and that disposal of dredged material is assumed to take place nearby (i.e. within a few hundred metres) of the seabed preparation site. Much of the Moray West Site comprises of coarse gravel and sand which will not create persistent plumes and any SSC will settle to the seabed quickly. However, finer grain sediments may form a sediment plume. SSC levels would decrease through horizontal dispersion to a few thousand mg/l within the order of low hundreds of meters and a few tens of mg/l within the order of one thousand meters distance from the source and following the end of dredging or spoil release, the sediments would be expected to be redeposited to the seabed in the order of 0.5 to 15 minutes, depending on the sediment grain size and the water depth.

9.7.2.38 Marine mammals are well known to forage in tidal areas where water conditions are turbid and visibility conditions poor. Harbour porpoise and harbour seals in the UK have been documented foraging in areas with high tidal flows (e.g. Pierpoint 2008, Marubini *et al.,* 2009, Hastie *et al.,* 2016); therefore, low light levels, turbid waters and suspended sediments are unlikely to negatively impact marine mammal foraging success. When the visual sensory systems of marine mammals are compromised, they are able to sense the environment in other ways, for example, seals can detect water movements and hydrodynamic trails with their mystacial vibrissae (whiskers); while porpoise and dolphins can use echolocation (e.g. Hanke and Dehnhardt 2013) to navigate and find food in darkness. Therefore, the sensitivity to increased SSC is **low** for marine mammals. The expected magnitude of impact related to decreased foraging opportunities as a result of increased SSC levels is **low** for all marine mammal species. Therefore, the significance of the effect is considered to be **minor** and **not significant** in EIA terms.

9.7.3 Potential Operational Effects

Collision Risk and Disturbance from Vessels

9.7.3.1 During the operational phase there will be increased vessel activity above baseline levels for ongoing wind farm O&M activities (but lower than vessel activity during the construction phase). The potential effects of additional vessels include disturbance from vessel noise and physical trauma (including mortality) from collision with a boat or ship.

9.7.3.2 As stated in Chapter 4: Description of Development, and detailed in Table 9.6.1, a number of vessel visits to each turbine and OSP would be required each year to allow for scheduled and unscheduled maintenance. If O&M activity is coordinated entirely from an onshore base, this would mean small crew vessels sailing to and from the Moray West Site on a daily basis from shore. If the Service Operation Vessel (SOV) option is preferred, the majority of small crew vessels would be operated on a daily basis from a single SOV, although further support vessels are also still likely to transit to and from shore each day. This does not represent a significant increase in vessel activity in the Moray West Site, where baseline summer vessel transits are on average 15 vessels per day and in winter is on average eight vessels per day (see Chapter 12: Shipping and Navigation for further baseline information).

9.7.3.3 As discussed above under construction impacts, the risk of collision of marine mammals with vessels would be directly influenced by the type of vessel and the speed with which it is travelling (Laist *et al.,* 2001) and indirectly by ambient noise levels underwater and the behaviour the marine mammal is engaged in.

9.7.3.4 Harbour porpoises, bottlenose dolphins and seals are relatively small and highly mobile, and given observed responses to noise (as detailed above), are expected to detect vessels in close proximity and largely avoid collision.

9.7.3.5 As discussed above under construction impacts, there is the potential for disturbance as a result of increased vessel noise from increased vessel traffic during the operation phase. The regular additional transits will be lower than levels of vessel activity during construction but activity will continue over the whole operational period of the wind farm. However, the levels of increase will not represent a significant increase above baseline levels of ship activity in the Moray Firth and is not expected to increase the potential for disturbance above that already experienced in the region. It is not expected that the level of vessel activity during operation would cause an increase in the risk of mortality from collisions, nor will it add significantly to levels of noise disturbance. The adoption of a vessel management plan during operation and maintenance that includes preferred transit routes and guidance for vessel operation in the vicinity of marine mammals and around seal haul-outs will minimise the potential for any impact.

9.7.3.6 The magnitude of the impact has therefore been assessed as **low**. The sensitivity to this impact is assessed as **low** for all species given available evidence. The effect is therefore assessed as **minor significance** for all marine mammal species and therefore **not significant** in EIA terms.

Reduction in Prey Availability

9.7.3.7 The benthic and intertidal ecology assessment (Chapter 7: Benthic & Intertidal Ecology) did not predict any significant effects on benthic and intertidal habitats and species as a result of any activities associated with the operation of the Development. Therefore, **no indirect impacts** on marine mammals are anticipated due to any changes in prey availability as a result of changes to benthic habitats.

9.7.3.8 The fish and shellfish ecology assessment (Chapter 8: Fish & Shellfish Ecology) did not predict any significant effects on any fish species as a result of any activities associated with the operation of the Development. Therefore, **no indirect impacts** on marine mammals are anticipated due to any changes in prey availability as a result of changes to fish populations.

9.7.3.9 The commercial fisheries assessment (Chapter 11: Commercial Fisheries) did not predict any significant effects on any commercial fishing practices in the area as a result of any activities associated with the operation of the Development. Therefore, **no indirect impacts** on marine mammals are anticipated due to any changes in prey availability as a result of changes to commercial fishing activity.

9.7.3.10 It is known that the presence of anthropogenic structures in the marine environment can act as fish aggregating devices and artificial reef systems (Guerin *et al.,* 2007, Zawawi *et al.,* 2012). There is evidence that both grey and harbour seals can target anthropogenic structures such as subsea pipelines and WTG structures (Russell *et al.,* 2014). This telemetry data strongly suggests that the tagged seals were targeting these structures for foraging purposes. Therefore, it is possible that the underwater structures associated with the Development could provide an ecological benefit by providing new foraging opportunities to marine mammals in the area. Other studies at operational offshore wind farms have also suggested that foraging opportunities may be enhanced, potentially as a result of reduced commercial fishing activity (e.g. Scheidat *et al.,* 2012). It is anticipated that there will be no significant indirect negative impacts to marine mammals through changes in prey abundance and distribution. Any potential habitat change as a result of fish aggregation or artificial reefs is expected to positively affect marine mammals by providing novel foraging opportunities and is therefore assessed as being of **minor beneficial significance** to marine mammals.

9.7.4 Potential Decommissioning Effects

9.7.4.1 Decommissioning would involve the dismantling of structures and complete removal of all offshore structures above the seabed, in reverse order to the construction sequence. The effects of these activities on marine mammals are considered to be similar to or less (as a result of there being no piling) than those occurring as a result of construction. Therefore, the effects of decommissioning are considered to be no greater than those described for the construction phase. A Decommissioning Plan will be developed in consultation with the relevant advisors.

9.7.4.2 A description of the main potential effects of decommissioning on marine mammals is provide below.

Underwater Noise - Cutting

9.7.4.3 The decommissioning of the WTGs will most likely involve cutting the structures just below the seabed. The exact cutting method has yet to be defined, so examples of different cutting methods are considered below as well as an assessment of their potential impact on marine mammals. There are very few examples of empirical data describing the source level of underwater cutting noise. One study found that sound radiated from a diamond wire cutting operation was not easily discernible above the background noise during cutting operations (Panjerc *et al.,* 2016). Other forms of cutting (e.g. abrasive water jet cutting) are considered to be low impact (Brandon *et al.,* 2000, Kaiser *et al.,* 2005). In the underwater noise technical report submitted in an application for the East Anglia Three wind farm, it was suggested by the National Physics Laboratory that for abrasive cutting the noise level would not be expected to be significantly higher than general surface vessel noise (East Anglia Three Ltd, 2015). Given the data presented in Panjerc *et al. (*2016) it is highly unlikely that the noise generated by cutting to remove structures has the potential to disturb any species of marine mammal. It can be concluded therefore that due to the low potential for disturbance and the temporary nature of the activities that the use of diamond wire cutting tools will result in a **negligible effect** on marine mammals.

Collision Risk from Vessels

9.7.4.4 During the decommissioning of the Development there would be increased vessel activity. It is estimated that vessel numbers will be similar to those during the construction period and therefore the impacts of collision risk and noise disturbance will be of similar impact magnitude. The resulting effects were assessed for construction as being of **minor significance** and therefore not significant in EIA terms and the same assessment applies for decommissioning.

Reduction in Prey Availability

9.7.4.5 The benthic and intertidal ecology assessment (Chapter 7: Benthic & Intertidal Ecology) did not predict any significant effects on benthic and intertidal habitats and species as a result of any activities associated with the decommissioning of the Development. Therefore, **no indirect impacts** on marine mammals are anticipated due to any changes in prey availability as a result of changes to benthic habitats.

9.7.4.6 The fish and shellfish ecology assessment (Chapter 8: Fish & Shellfish Ecology) did not predict any significant effects on any fish species as a result of any activities associated with the decommissioning of the Development. Therefore, **no indirect impacts** on marine mammals are anticipated due to any changes in prey availability as a result of changes to fish populations.

9.7.4.7 The commercial fisheries assessment (Chapter 11: Commercial Fisheries) did not predict any significant effects on any commercial fishing practices in the area as a result of any activities associated with the decommissioning of the Development. Therefore, **no indirect impacts** on marine mammals are anticipated due to any changes in prey availability as a result of changes to commercial fishing activity.

Reduction in Foraging Ability

9.7.4.8 Disturbance to the water quality can potentially impair of visibility and therefore foraging ability which might be expected to reduce foraging success.

9.7.4.9 As discussed above for construction related activities, marine mammals are well known to forage in tidal areas where water conditions are turbid and visibility conditions poor. Therefore, the sensitivity to increased SSC is **low** for marine mammals, the magnitude of any impact is expected to be low and temporary and therefore the significance of the effect is considered to be **minor**, and therefore **not significant** in EIA terms.

9.7.5 Summary of Development Specific Effects

9.7.5.1 Table 9.7.33 below summarises the results of the marine mammal impact assessment. Overall, the assessment concluded that there are predicted to be no significant effects of the Development on any species of marine mammal in terms of the EIA Regulations.

Table 9.7.33: Summary of Development Specific Effects						
Potential Impacts	**Receptor**	**Impact Magnitude**	**Sensitivity of Receptor**	**Effect Significance**	**Mitigation (in addition to embedded mitigation)**	**Residual Significance**
Construction						
'Instantaneous' PTS from piling noise	Harbour porpoise	Negligible	High	Minor Adverse	N/A	Minor Adverse
	Bottlenose dolphin	Negligible	High	Minor Adverse	N/A	Minor Adverse
	Minke whale	Negligible	High	Minor Adverse	N/A	Minor Adverse
	Harbour seal	Negligible	Medium	Negligible	N/A	Negligible
	Grey Seal	Negligible	Medium	Negligible	N/A	Negligible
PTS from prolonged cumulative exposure to piling noise	Harbour porpoise	Negligible	High	Minor Adverse	N/A	Minor Adverse
	Bottlenose dolphin	Negligible	High	Minor Adverse	N/A	Minor Adverse
	Minke whale	Negligible	High	Minor Adverse	N/A	Minor Adverse
	Harbour seal	Negligible	Medium	Negligible	N/A	Negligible
	Grey Seal	Negligible	Medium	Negligible	N/A	Negligible
Disturbance from piling (displacement)	Harbour porpoise	Low	Medium	Minor Adverse	N/A	Minor Adverse
	Bottlenose dolphin	Low	Medium	Minor Adverse	N/A	Minor Adverse
	Minke whale	Negligible	Medium	Minor Adverse	N/A	Minor Adverse
	Harbour seal	Low	Medium	Minor Adverse	N/A	Minor Adverse
	Grey Seal	Low	Low	Minor Adverse	N/A	Minor Adverse
Disturbance from other construction noise	Harbour porpoise	Low	Low	Minor Adverse	N/A	Minor Adverse
	Bottlenose dolphin	Low	Low	Minor Adverse	N/A	Minor Adverse
	Minke whale	Low	Low	Minor Adverse	N/A	Minor Adverse

Table 9.7.33: Summary of Development Specific Effects						
Potential Impacts	**Receptor**	**Impact Magnitude**	**Sensitivity of Receptor**	**Effect Significance**	**Mitigation (in addition to embedded mitigation)**	**Residual Significance**
(including vessels)	Harbour seal	Low	Low	Minor Adverse	N/A	Minor Adverse
	Grey Seal	Low	Low	Minor Adverse	N/A	Minor Adverse
Vessel collision risk	All species	Low	Low	Minor Adverse	N/A	Minor Adverse
Reduction in prey availability	All species	Low	Low	Minor Adverse	N/A	Minor Adverse
Reduction in foraging ability	All species	Low	Low	Minor Adverse	N/A	Minor Adverse
Operational						
Vessel collision risk and disturbance	All species	Low	Low	Minor Adverse	N/A	Minor Adverse
Reduction in prey availability	All species	Low	Low	Minor Beneficial	N/A	Minor Beneficial
Decommissioning						
Underwater noise	All species	Medium	Low	Minor Adverse	N/A	Minor Adverse
Vessel collision risk	All species	Medium	Low	Minor Adverse	N/A	Minor Adverse

Table 9.7.33: Summary of Development Specific Effects						
Potential Impacts	**Receptor**	**Impact Magnitude**	**Sensitivity of Receptor**	**Effect Significance**	**Mitigation (in addition to embedded mitigation)**	**Residual Significance**
Reduction in prey availability	All species	Low	Low	Minor Adverse	N/A	Minor Adverse
Reduction in foraging ability	All species	Low	Low	Minor Adverse	N/A	Minor Adverse

9.8 Assessment of Cumulative Effects

9.8.1.1 Cumulative effects refer to effects upon receptors arising from the development of Moray West Offshore Wind Farm when considered alongside other proposed developments and activities and any other *reasonably foreseeable project(s)* proposals (Table 9.8.1). In this context the term *projects* is considered to refer to any project with comparable effects and is not limited to offshore wind projects.

9.8.1.2 The offshore search area extent for marine mammals is within the relevant management unit for each key species. For seals this is the Moray Firth Seal Management Area and for bottlenose dolphins this is the East Coast management unit. For harbour porpoise and minke whales, whose management units extend over very large areas beyond the Moray Firth, quantitative assessment of cumulative impacts is carried out for projects in the wider Moray Firth and Scottish east coast region (including Forth and Tay developments) where there is sufficient detailed information, cumulative impacts with other projects throughout the North Sea are considered qualitatively.

9.8.1.3 The main cumulative impacts on marine mammals are likely to be:

- Disturbance / displacement as a result of underwater noise from pile driving associated with other offshore wind farms together with disturbance / displacement as a result of underwater noise from other construction activities (port and harbour developments) acting cumulatively with the Moray West Offshore Wind Farm; and
- Impacts from increased vessel use as a result of construction and operational activities (disturbance and increased collision risk) associated with other offshore wind farms acting cumulatively with the Moray West Offshore Wind Farm.

9.8.1.4 In assessing the potential cumulative impact(s) for Moray West, it is important to note that for some projects, predominantly those 'proposed' or identified in development plans etc. may or may not actually be taken forward. A list of all projects considered in the cumulative assessment for marine mammals is provided in Table 9.8.1 below and illustrated in Figure 9.8.1.

Table 9.8.1: Projects for Cumulative Assessment

Project	Status (as of May 2018)	Construction Period	Potential Overlap in Construction?	Species for Which Project is Scoped into the Assessment
Offshore Wind Farm Projects				
Beatrice Offshore Wind Farm	Under construction	2017 to 2019	No	ALL
Dounreay Trì Floating Wind Demonstration	Project suspended	Unknown	Unknown	Harbour porpoise, Minke whale
Hornsea One	Under construction	To be operational 2020	No	Harbour porpoise, Minke whale
East Anglia One	Under construction	2018-2019	No	Harbour porpoise, Minke whale
Race Bank	Under construction	Completed	No	Harbour porpoise, Minke whale
Dudgeon	Under construction	Completed	No	Harbour porpoise, Minke whale

Table 9.8.1: Projects for Cumulative Assessment				
Project	**Status (as of May 2018)**	**Construction Period**	**Potential Overlap in Construction?**	**Species for Which Project is Scoped into the Assessment**
Galloper	Under construction	Completed	No	Harbour porpoise, Minke whale
Aberdeen Offshore Wind Farm	Under construction	To be completed September 2018	No	Harbour porpoise, Minke whale
Moray East (consented Telford, Stevenson and MacColl)	Consented	2019 - 2021	No	ALL
Kincardine Floating Offshore Windfarm	Consented	2018-2020	No	Harbour porpoise, Bottlenose dolphin, Minke whale
Forthwind Wind Farm Demonstrator Project – Phase 1	Consented	2018	No	Harbour porpoise, Bottlenose dolphin, Minke whale
Dogger Bank Creyke Beck A & B	Consented	2021-2024	Yes	Harbour porpoise, Minke whale
Dogger Bank Teesside A	Consented	2022-2024	Yes	Harbour porpoise, Minke whale
Dogger Bank Teesside B (now Sofia)	Consented	2022-2024	Yes	Harbour porpoise, Minke whale
Hornsea Two	Consented	2020-2022	Yes	Harbour porpoise, Minke whale
Triton Knoll	Consented	2018-2021	No	Harbour porpoise, Minke whale
East Anglia Three	Consented	2020-2022	Yes	Harbour porpoise, Minke whale
Inch Cape	Consented (revised design proposed)	2020 and 2021	Yes	Harbour porpoise, Bottlenose dolphin, Minke whale
Neart na Gaoithe	Consented (revised design proposed)	2020 and 2021	Yes	Harbour porpoise, Bottlenose dolphin, Minke whale
Seagreen Phase I	Consented (revised design proposed)	2022, 2023 and 2024	Yes	Harbour porpoise, Bottlenose dolphin, Minke whale
Hornsea Three	Pre-planning application – PEIR submitted	2.5 years potential split into 2 phases, 6 years apart from 2022	Yes	Harbour porpoise, Minke whale

Table 9.8.1: Projects for Cumulative Assessment				
Project	**Status (as of May 2018)**	**Construction Period**	**Potential Overlap in Construction?**	**Species for Which Project is Scoped into the Assessment**
Hornsea Four	Pre-planning application	Unknown	Unknown	Harbour porpoise, Minke whale
East Anglia North Tranche 2 (Norfolk Boreas)	Pre-planning application	Unknown	Unknown	Harbour porpoise, Minke whale
East Anglia North Tranche 1 West (Norfolk Vanguard West)	Pre-planning application– PEIR submitted	2022-24	Yes	Harbour porpoise, Minke whale
East Anglia North Tranche 1 East (Norfolk Vanguard East)	Pre-planning application– PEIR submitted	2022-24	Yes	Harbour porpoise, Minke whale
East Anglia One North	Pre-planning application	Unknown	Unknown	Harbour porpoise, Minke whale
East Anglia Two	Pre-planning application	Unknown	Unknown	Harbour porpoise, Minke whale
Forthwind Wind Farm Demonstrator Project – Phase 2	Pre-planning application	Unknown	Unknown	Harbour porpoise, Minke whale, Bottlenose dolphin
Tidal Energy Projects				
MeyGen Pentland Firth Phase 1B	Consented	2019	No	Harbour porpoise, Minke whale,
MeyGen Pentland Firth Phase 1C	Consented	Unknown	No	Harbour porpoise, Minke whale,
Churchill Barriers	Proposed	Unknown	Unknown	Harbour porpoise, Minke whale,
Ness of Duncansby Tidal Array	Proposed	Unknown	Unknown	Harbour porpoise, Minke whale,
Lashy Sound Tidal Array	Proposed	Unknown	Unknown	Harbour porpoise, Minke whale,
Ports and Harbours				
Aberdeen Harbour Expansion	Under construction	2017-20??	No	Harbour porpoise, Minke whale, Bottlenose dolphin
Port of Ardersier	Consented	Unknown	Unknown	ALL
Port of Cromarty Firth*	Proposed	Unknown	Unknown	ALL

Table 9.8.1: Projects for Cumulative Assessment

Project	Status (as of May 2018)	Construction Period	Potential Overlap in Construction?	Species for Which Project is Scoped into the Assessment
Port of Nigg / Nigg Yard	Plan stage	Unknown	Unknown	ALL
* Information on the Port of Cromarty Firth development is based on information available at the time that the assessment was undertaken (e.g. as presented in the Scoping Report). It is noted that an application has since been made prior to submission of this application. Where appropriate updated information on this project has been provided in the assessment. However, no additional modelling has been undertaken.				

9.8.2 *Cumulative Construction Effects – disturbance resulting from underwater noise from pile driving in combination with underwater noise caused by construction noise at other plans and projects*

9.8.2.1 During the offshore construction of Moray West, the main source of cumulative increase in underwater noise is likely to occur as a result of piling operations and other construction activities (e.g. blasting) from other projects, plans and activities. The projects included in this cumulative impact assessment are detailed in Table 9.8.2 and include offshore wind farms and coastal developments within the wider North Sea MU where piling, or other activities with the potential to generate significant underwater noise (e.g. blasting) is considered likely to occur during construction phases of these projects, and where there is potential for direct overlap of piling phases. Projects with piling activities that immediately precede or follow piling at the Moray West Site are also included. As activities such as cable laying (trenching and dredging) have been assessed as having only a very localised and temporary impact, underwater noise from these activities have not been assessed cumulatively.

Table 9.8.2: Projected Estimated Timelines of Construction in Projects Included in the Cumulative Assessment and the Potential to Overlap with Moray West Pile Driving. Shaded Cells Indicate the Proposed Period of Construction. Red Outlined Cells Indicate the Period of Pile Driving for Moray West

Project	2018	2019	2020	2021	2022	2023	2024	2025
Beatrice								
Moray East								
Aberdeen Harbour Expansion								
Hornsea One								
East Anglia One								
Forthwind Wind Farm Demonstrator Project – Phase 1								
Hornsea Two								
Triton Knoll								
Inch Cape								

Table 9.8.2: Projected Estimated Timelines of Construction in Projects Included in the Cumulative Assessment and the Potential to Overlap with Moray West Pile Driving. Shaded Cells Indicate the Proposed Period of Construction. Red Outlined Cells Indicate the Period of Pile Driving for Moray West

Project	2018	2019	2020	2021	2022	2023	2024	2025
Neart na Gaoithe								
Seagreen								
Hornsea Three								
Norfolk Vanguard								
East Anglia One North								
East Anglia Two								
Forthwind Wind Farm Demonstrator Project – Phase 2								
MEG Offshore (now Merkur offshore windfarm)								
Nissum Bredning (Denmark)								
Nordergruende								
Norther (Belgium)								
Rentel Area A (Belgium)								
Seastar (Belgium)								
Dogger Bank Creyke A & B								
Dogger Bank Teeside A								
Dogger Bank Teeside B (now Sofia)								
East Anglia Three								
Thanet Extension								

Harbour Porpoise

9.8.2.2 Given the large area covered by the harbour porpoise North Sea MU, the cumulative assessment was approached quantitatively for projects on a regional scale (i.e. within the Moray Firth and the East coast of Scotland) and qualitatively considering other projects in the wider North Sea management unit. This approach was detailed in the Moray West CIA Position Paper submitted to MS-LOT.

Quantitative Assessment

9.8.2.3 Table 9.8.3 presents compiled information on the predicted effects from a range of projects included in the cumulative assessment for harbour porpoise. For the Forth and Tay projects which are currently undergoing assessment for revised project design envelopes (Seagreen, Inch Cape and Neart na Gaoithe), the worst case between the old and revised assessments was considered in the assessment. So that a direct comparison can be made, both consented and revised parameters are included in Table 9.8.3, with the parameters included in the assessment highlighted.

9.8.2.4 It is important to note that these assessments have used a variety of different methods and thresholds to indicate levels of disturbance and they are not generally comparable. Given uncertainty in the degree of temporal and spatial overlap of these activities summing these figures would give an overestimate of the total number of animals impacted. There is also the possibility that the same individuals might be affected on multiple occasions across projects sequentially.

9.8.2.5 Given uncertainties surrounding animal turnover and movements at this temporal and spatial scale it is very challenging to predict a realistic overall level of disturbance. However, the total numbers summed across all projects listed in Table 9.8.3 below (based on the maximum number of individuals from each project, and taking the maximum from either the consented or revised envelopes for the Forth and Tay offshore wind projects) is 8,882, which represents 2.6% of the total reference population. If we assume that the unquantified projects are of similar impact magnitude as Moray West, this would increase this value to approximately 3-4%. Based on the worst case assumption detailed in the project alone assessment that each year of disturbance would result in a failure to breed for each disturbed individual, this is considered **low** magnitude relative to the overall size of the MU population.

Table 9.8.3: Harbour Porpoise Cumulative Assessment – Numbers Predicted to be Disturbed as a Result of Underwater Noise from Construction Activities. For Projects Which Have Both Consented and Revised Parameters, the Row shaded in Green is the One Considered in the Cumulative Assessment.

Project	Methodology / Disturbance Threshold	# WTG	Total # Piles	Scenario	Assumed # Piles/day/ vessel	# Piling Days	Max # Animals Affected per Piling Day
Moray West	**Dose response curve Graham *et al.* (2017)**	**85**	**85**	**Single MP**	**0.98**	**87**	**1377**
				Concurrent MP	**1.93**	**44**	**1609**
		85	**340**	**Single PP**	**2.6**	**133**	**639**
				Concurrent PP	**2.6**	**67**	**1348**
Beatrice	75 dB$_{ht}$	-	-	-	-	-	Not quantified
Aberdeen Harbour Expansion Project (blasting)	140 dB re 1 µPa (RMS) “low level disturbance” out to 7.18 km	na	na	Blasting	2 blasts	36	4
	160 dB re 1 µPa (RMS) “US Level B Harassment” out to 1.7 km						61
Moray East	Dose response curve (Thompson *et al.*, 2013)	100	400	Single	3	134	2933
				Concurrent	3	67	3442

Table 9.8.3: Harbour Porpoise Cumulative Assessment – Numbers Predicted to be Disturbed as a Result of Underwater Noise from Construction Activities. For Projects Which Have Both Consented and Revised Parameters, the Row shaded in Green is the One Considered in the Cumulative Assessment.

Project	Methodology / Disturbance Threshold	# WTG	Total # Piles	Scenario	Assumed # Piles/day/ vessel	# Piling Days	Max # Animals Affected per Piling Day
Neart na Gaoithe (consented)	90 dBht	125	500	Single	2	250	460
Neart na Gaoithe (revised)	Dose response curve (Brandt *et al.,* 2016)	54	324	Single	6	54	144
				Concurrent	6	27	1880
Inch Cape (consented)	90 dBht	213	852	ML single	2	426	108
				WC concurrent	4	107	137
Inch Cape (revised)	Dose response curve (Graham *et al.,* 2017)	76	304	ML single	4	76	117
				WC single	6	51	175
				ML concurrent	4	38	142
				WC concurrent	6	26	207
Seagreen (consented)	90 dBht	75	300	Alpha	1	300	1501
		75	300	Bravo	1	300	1683
		150	600	Alpha then Bravo	1	600	1501 then 1683
Seagreen (revised)	Dose response curve (Graham *et al.,* 2017)	120	480	Alpha then Bravo	2	240	971 then 1103
				Alpha + Bravo concurrent	2	140	1177

9.8.2.6 Totalling across these projects provides the maximum number that would be impacted if all projects were constructing at once, assuming no overlap in impact ranges. The greater the temporal overlap across these individual projects, the shorter the period of impact but the more intense the impact will be. The bottlenose dolphin simulations carried out in Section 9.7.1 demonstrated that sequential activities were predicted to have a greater effect on the population than concurrent activities although the total number of animals impacted at any one time was lower. Inclusion of the other North Sea offshore wind farms will increase the magnitude of impact, although it has not been possible to include these projects quantitatively.

Wider North Sea Qualitative Assessment

9.8.2.7 A simulation modelling exercise carried out by (Booth *et al.,* 2017) used the iPCoD framework to predict the long term consequences of planned offshore wind developments in the eastern North Sea concluded that, even with a total of 15% of the population being predicted to be disturbed, with that disturbance occurring over a period of 12 years, there was no evidence for any significant risk to the long term health of the North Sea harbour porpoise population. As discussed above, there is no empirical information to inform the consequences of disturbance from pile driving at the population level, but the iPCoD model represents best available scientific expert judgement on the links between individual disturbance and vital rates.

9.8.2.8 More recent population modelling using the DEPONS model has demonstrated that the North Sea harbour porpoise population was not affected by the construction of 65 offshore wind farms within the North Sea (assuming porpoise responded in the same way as recorded during construction at the Gemini wind farm) (Nabe-Nielsen *et al.,* 2018). The modelling results demonstrated that, at the North Sea scale, the population dynamics of the impacted population (when responding out to 8.9 km from construction sites) was indistinguishable from the baseline scenario.

9.8.2.9 In addition, harbour porpoise have a very widespread distribution and individuals have been documented moving relatively large distances on a daily basis (Sveegaard *et al.,* 2011). The availability of alternative suitable habitat elsewhere in the management unit and the mobility of the species suggests that individuals will move to alternative foraging grounds and at most will suffer a reduction in breeding success in a limited number of breeding cycles.

9.8.2.10 Based on this, the magnitude of this level of disturbance is considered to be **low**.

9.8.2.11 Based on this assessment and given that the sensitivity of harbour porpoise to disturbance is **medium**, the significance of the effect of disturbance as a result of underwater construction noise from the Moray West Offshore Wind Farm cumulatively with underwater noise from the construction of other plans and projects is of **minor** significance.

<u>Bottlenose Dolphin</u>

9.8.2.12 The potential impact of disturbance from underwater noise from the construction of the Moray West Offshore Wind Farm cumulatively with other projects and plans was assessed quantitatively for bottlenose dolphin. Where available, the quantitative estimates for impact magnitude and duration of disturbance were included in the iPCoD modelling.

9.8.2.13 The following projects were not included in the bottlenose dolphin iPCoD modelling:

- Beatrice: the disturbance impact ranges provided in the ES did not overlap with grid cells that contained dolphins using the final bottlenose dolphin density surface used in the assessment for Moray West. Therefore, no bottlenose dolphins were predicted to have been disturbed during the piling at Beatrice;
- Port Of Ardersier: Port of Ardersier Ltd went into administration in 2015 and future construction plans for this site are currently unknown;
- Port of Cromarty Firth: based on information presented in EIA Report submitted May 2018 it is understood that Phase 4 (construction of the Quay Wall) will involve both percussion and vibropiling which will take place between November 2018 and March 2019. Maximum hammer energy is 500 kj. The assessment concludes that the development will not give rise to any significant levels of bottlenose dolphin disturbance;
- Kincardine Floating Offshore Windfarm: pile driving will not be used and SNH have previously advised that this wind farm will not give rise to any significant levels of bottlenose dolphin disturbance;

- Forthwind Wind Farm: pile driving will not be used and SNH have previously advised that this wind farm will not give rise to any significant levels of bottlenose dolphin disturbance; and
- Aberdeen Offshore Wind Farm: pile driving will not be used and SNH have previously advised that this wind farm will not give rise to any significant levels of bottlenose dolphin disturbance.

9.8.2.14 The Population Viability Analysis (PVA) modelling carried out for the Appropriate Assessment for the Aberdeen Harbour Expansion Project (AHEP) assumed that all 53 bottlenose dolphins likely to be present between Aberdeen and Stonehaven over the course of the construction had the potential to be subject to disturbance. This accounts of 27.2% of the total MU population. Assuming 8 calves would be produced per year, the effect of disturbance from the Aberdeen Harbour Expansion project would result in the removal of 2 calves. This type of disturbance result is not compatible with the iPCoD framework code, which requires the number of animals disturbed on each day of construction (piling) activities. Therefore, another approach has been taken.

9.8.2.15 The predicted disturbance range of 7.17 km resulting from blasting activities at AHEP will be assumed to apply across all days of blasting. This impact range has been overlain on the bottlenose density surface to predict that on average, there are likely to be 3.5 dolphins within this impact range on each day of blasting. A schedule for the blasting activity has also been developed based on the following:

- Blasting is expected to take place once or twice a day and will be followed by dredging for a period of up to one week (i.e. a break in blasting for up to one week);
- These works are expected to last for up to seven consecutive months;
- Based on this information, one day of blasting followed by a seven day break over a seven month period is a reasonable and precautionary estimate of the blasting schedule;
- Blasting is assumed to commence in May 2018; and
- No piling is included since only rotary piling is to be used at the project.

9.8.2.16 The scenario assessed here for Moray East is based upon advice from Moray East and the Moray East Piling Strategy (Moray Offshore Renewables Ltd 2016). The Moray East Piling Strategy is based on the construction of 100 WTGs (Project One of the Telford, Stevenson and MacColl consents), rather than the 339 WTGs assessed in the Moray East ES (2012). The Piling Strategy is therefore considered to be more representative of the realistic worst case scenario for the Moray East offshore wind farm development which comprises 100 turbines and three OSPs. The Piling Strategy is also based on the use of two concurrent vessels (as opposed to six concurrent piling vessels presented in the Moray East ES (2012)) using the number of animals disturbed on one day of piling as presented in the Moray East ES (2012).

9.8.2.17 Information presented in the Moray East ES (2012) anticipated piling over a maximum of five years (2016 to 2020). However, this has been also revised. Within the Moray East Piling Strategy (Moray East, 2017) it is stated that piling could take up to two years, however at recent Moray Firth Regional Advisory Group (MFRAG) meetings (MFRAG main and subgroup minutes of meetings of the 21-22 February available within Marine Scotland website) it was stated that construction of Moray East, based on the realistic worst case scenario, now expected to take up to one year to complete, commencing in 2019.

9.8.2.18 The number of bottlenose dolphins predicted to experience disturbance as a result of the Moray East assessment is likely to be a significant overestimate of actual disturbance due to the fact that the Moray East assessment used the previous bottlenose dolphin density surface which predicted bottlenose dolphin presence in the outer Moray Firth and along the Northern coast.

The results of the ECOMMAS surveys have found that these dolphins are more likely to be Risso's or white-beaked dolphins based on their click characteristics. As a result, the bottlenose dolphin density surface used in the Moray East assessment was revised for the Moray West Offshore Wind Farm assessment by re-distributing bottlenose dolphins from the northern coast to the coastal inner Moray Firth. Since the Moray East development is further northeast and more offshore than the Moray West Site, it is actually more likely that the number of bottlenose dolphins predicted to experience behavioural disturbance from Moray East will be lower than that for the Moray West Offshore Wind Farm as the Moray East Site is further from the density surface grid cells that are predicted to contain bottlenose dolphins. However, keeping the predictions of impact from the Moray East assessment will ensure a precautionary assessment.

Bottlenose Dolphin Cumulative Construction Scenarios

9.8.2.19 As was carried out for the Development alone, iPCoD was used to run simulations including the worst case parameters from the projects indicated in Table 9.8.3. Two scenarios were explored: the maximum spatial extent of impact and the shortest duration (concurrent, multiple vessel outcomes) and the smallest spatial extent but longest duration from each project (single vessel sequential outcomes). Publicly available information from Environmental Statements were used to develop the piling schedules for use in the model.

9.8.2.20 As noted in Table 9.8.1 the application for development of the Cromarty Port was submitted in May 2018. The EIA Report supporting this application indicates that Phase 4 (which will involve both percussion piling and vibropiling) is expected to take place between November 2018 and March 2019. Due to the timing of the availability of information on this development, it has not been possible to include this potential impact quantitatively. However, given that the piling / vibropiling activities are not expected to overlap with construction of the Moray West Offshore Wind Farm and that the assessment has not identified any significant effects on the bottlenose dolphin population it is not expected that this project would add significantly to potential disturbance at the management unit/population scale.

9.8.2.21 The only project which predicted any bottlenose dolphins would experience PTS was the consented Inch Cape Project which predicted that up to 1.2 dolphins would experience PTS per piling day under the single scenario, and up to 1.9 dolphins would experience PTS per piling day under the concurrent scenario. To understand the effect of the predicted level of PTS on the population level consequences and to differentiate it from the effects of disturbance, the worst case cumulative scenario was also run without any PTS included.

Table 9.8.3: **Modelled Scenarios for the Cumulative Impact Assessment**

Project	**# WTG**	**# Piles**	**# Vessels**	**# Piles/Day/ vessel**	**Total Piling Days**	**Piling**	**# Dolphins Disturbed per Activity**	**Years**	**Source**
Concurrent piling, shortest duration									
Moray East	100	400	2	3	67	Year round	19	2019-2020	Moray East Piling Strategy
Inch Cape (consented)	213	852	2	2	213	Year round	3	2020-2021	Inch Cape ES old
NNG (revised)	54	324	2	6	27	year round	2	1/7/21 - 30/9/22	NNG ES 2018

Table 9.8.3: Modelled Scenarios for the Cumulative Impact Assessment									
Project	**# WTG**	**# Piles**	**# Vessels**	**# Piles/Day/ vessel**	**Total Piling Days**	**Piling**	**# Dolphins Disturbed per Activity**	**Years**	**Source**
Seagreen (revised)	120	480	2	2	140	year round (80% betwee n Apr-Oct)	4	2022-2023	Pre-application information
Moray West	85	85	2	1	44	Year round	15	2022-2023	This ES
Aberdeen Harbour Expansion	NA	NA	NA	2 blasts	36	May-Nov	4	2018	AHEP & MS-LOT
Single piling, longest duration									
Moray East	100	400	2	3	134	Year round	17	2019-2020	Moray East Piling Strategy
Inch Cape (consented)	213	852	1	2	426	Year round	3	2020-2021	Inch Cape ES old
NNG (revised)	54	324	1	6	54	year round	2	1/7/21 - 30/9/22	NNG ES 2018
Seagreen (revised)	120 (70 A, 50 B)	480	1	2	240	year round (80% betwee n Apr-Oct)	3 A 2 B	2022-2023	Pre-application information
Moray West	85	85	1	3	133	Year round	10	2022-2023	This ES
Aberdeen Harbour Expansion	NA	NA	NA	2 blasts	36	May-Nov	4	2018	AHEP & MS-LOT

9.8.2.22 The iPCoD scenario runs from the start of 2017 for 25 years, beginning at the start of the Beatrice Offshore Wind Farm construction period. However, no impact was predicted to bottlenose dolphins as a result of BOWL piling and the effects of AHEP do not begin until 2018 and piling at Moray East does not commence until 2019, therefore the first two years of the simulation (2017 to 2019) will experience very little disturbance impact. Overall, the single vessel piling (longest duration) cumulative assessment scenario resulted in higher levels of population level impact compared to the shortest duration scenario (as shown by the red text in Table 9.8.4). For example, the resulting median impacted population size after 24 years was 47.4% of the size of the median baseline population under the longest duration scenario with PTS, compared to 51.8% under the shortest duration scenario with PTS. This indicates that for bottlenose dolphins in the Moray Firth, a shorter more intense period of disturbance is associated with lower predicted levels of population impact, compared to a longer period of less disturbance. Therefore the results from this single vessel (longest duration) scenario are presented in full below and, for comparison, the longest duration scenario was also assessed without the impact of PTS from Inch Cape.

Table 9.8.4: Results of the iPCoD Modelling for Bottlenose Dolphins Under 3 Cumulative Scenarios: Concurrent Piling (Shortest Duration) with PTS, Single Piling (Longest Duration) with PTS and Single Piling (Longest Duration) without PTS. Red text denotes which of the 2 scenarios with PTS had the worst case result for each results parameter. Shaded cells highlight the median counterfactual values

Result Parameter		Shortest Duration (with PTS)	Longest Duration (with PTS)	Longest Duration (no PTS)
Median Population Size Year 24	Baseline	274	274	272
	Impacted	142	130	256
	# animals difference	132	144	16
	Impacted as % of baseline	51.8%	47.4%	94.1%
Additional Risk of a 1% Decline	Yr 1	0	0	0
	Yr 6	0.463	0.481	0.171
	Yr 12	0.618	0.636	0.082
	Yr 18	0.614	0.648	0.037
	Yr 24	0.55	0.589	0.018
Ratio of the impacted to un-impacted population size	Yr 1 Min	1	1	1
	Yr 6 Min	0.3084	0.2712	0.6638
	Yr 12 Min	0.1383	0.06977	0.6471
	Yr 18 Min	0.09091	0.07246	0.5918
	Yr 24 Min	0.1045	0.06034	0.54
	Yr 1 Median	1	1	1
	Yr 6 Median	0.8439	0.84	0.9912
	Yr 12 Median	0.6489	0.627	0.9917
	Yr 18 Median	0.5559	0.5296	0.9932
	Yr 24 Median	0.5167	0.4922	1
	Yr 1 Mean	1	1	1
	Yr 6 Mean	0.8236	0.8187	0.946
	Yr 12 Mean	0.6319	0.6121	0.9479
	Yr 18 Mean	0.5523	0.5277	0.9446
	Yr 24 Mean	0.5246	0.4988	0.9456
Ratio of impacted to un-impacted annual growth rate	Yr 1 Min	0.964	0.9608	0.9688
	Yr 6 Min	0.9395	0.9529	0.9612
	Yr 12 Min	0.7179	0.7065	0.9688

Table 9.8.4: Results of the iPCoD Modelling for Bottlenose Dolphins Under 3 Cumulative Scenarios: Concurrent Piling (Shortest Duration) with PTS, Single Piling (Longest Duration) with PTS and Single Piling (Longest Duration) without PTS. Red text denotes which of the 2 scenarios with PTS had the worst case result for each results parameter. Shaded cells highlight the median counterfactual values				
Result Parameter		**Shortest Duration (with PTS)**	**Longest Duration (with PTS)**	**Longest Duration (no PTS)**
	Yr 18 Min	0.8136	0.785	0.9674
	Yr 24 Min	0.8891	0.8412	0.9595
	Yr 1 Median	1	1	1
	Yr 6 Median	1.064	1.076	1
	Yr 12 Median	0.9668	0.9654	1
	Yr 18 Median	0.9896	0.9865	1
	Yr 24 Median	1.006	1.008	1
	Yr 1 Mean	0.9995	0.9994	0.9995
	Yr 6 Mean	1.083	1.097	1.021
	Yr 12 Mean	0.9613	0.9571	1
	Yr 18 Mean	0.9878	0.9844	1
	Yr 24 Mean	1.006	1.009	1
Centile for un-impacted population which matches the 50th centile for the impacted population	**Yr 1**	43	50	50
	Yr 6	12	8	36
	Yr 12	1	1	36
	Yr 18	1	1	38
	Yr 24	1	1	39

Bottlenose Dolphin Cumulative Assessment: Single Vessel (longest duration)

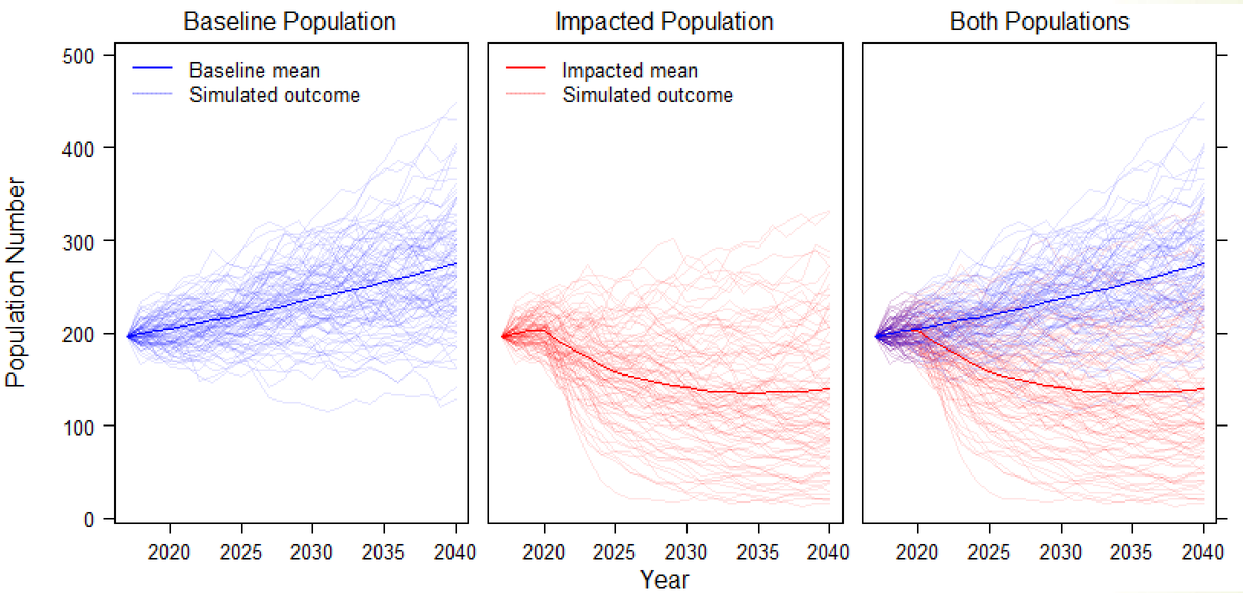
9.8.2.23 Under the longest duration cumulative scenario with PTS, the simulations demonstrated that in probabilistic terms, there was a large increase in the risk of population decline in the impacted population. In the sixth year of simulation there was a maximum of a 48.1% increase in the probability of a 1% population decline and a 40.5% increase in the risk of a 2% decline (Table 9.8.5). This impact was long term, and by year 24, the increase in the probability of a 1% decline was still high at 58.9%.

9.8.2.24 After 24 years of simulation, the median baseline population size (across 1,000 simulations) was 274 (95% CI: 174 - 388), and the median impacted population size (across 1,000 simulations) was 130 (95% CI: 30 - 302). This means that after a simulated 24 years the size difference between the median baseline and impacted population was a total of 144 individuals and the impacted population size was only 47% of the baseline population size. Therefore, there was a very significant difference between the predicted baseline (unimpacted) and impacted population sizes as a result of the predicted levels of disturbance and PTS.

9.8.2.25 The population trajectory for both the baseline and the impacted populations (the mean and each individual of the 1,000 simulated outcomes) are presented in Graph 9.8.1:. This demonstrates that the mean impacted population is predicted to experience a large decline in population size at the end of year 2020 and continues to decline in size from a mean population size of 202 at the start of 2020 to a lowest mean population size of 136 at the start of year 2033, after which it increases slightly to a mean population size of 140 by the start of 2040. This therefore demonstrates a significant long term population effect of the cumulative scenario with PTS on the bottlenose dolphin population.

Table 9.8.5: Additional Risk of a 1, 2 and 5% Decline across Years as a Result of the Simulated Disturbance Impact Resulting from the Longest Duration Cumulative Scenario with PTS

Year of Simulation	Additional Probability of a 1% Decline	Additional Probability of a 2% Decline	Additional Probability of a 5% Decline
1	0	0	0
6	0.481	0.405	0.217
12	0.636	0.548	0.283
18	0.648	0.531	0.232
24	0.589	0.451	0.141

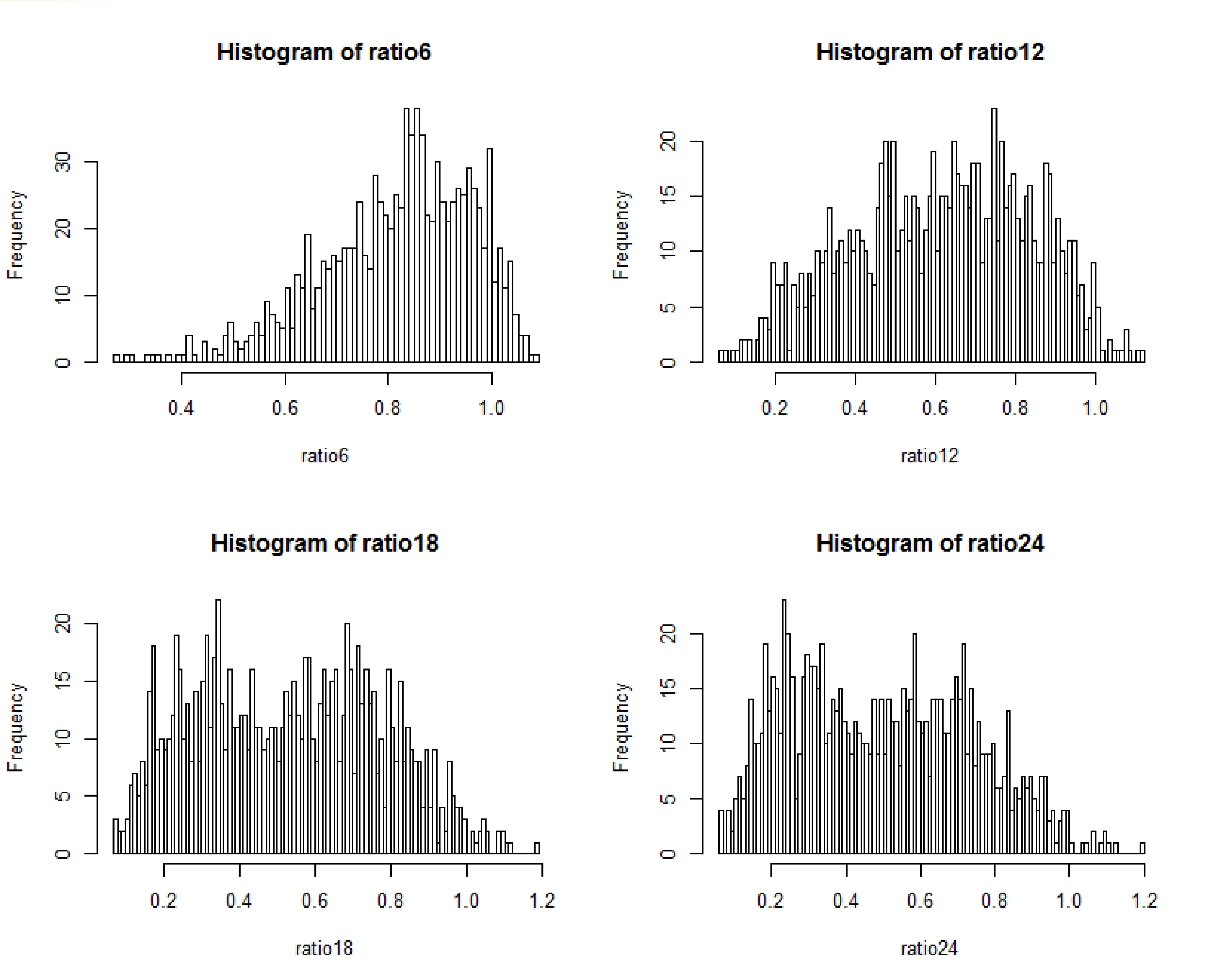


Graph 9.8.1: Simulated bottlenose dolphin population sizes for both the baseline and the impacted populations under the longest duration cumulative scenario including disturbance and PTS.

Comparing baseline and impacted population sizes

9.8.2.26 Across all 1,000 paired simulations, the median ratio of baseline and impacted population sizes was between 0.49 and 0.84, the mean ratio of the impacted to the baseline population was between 0.50 and 0.82 and the 3rd quartile ratio was between 0.50 and 0.93 (excluding year 1) which indicates that most of the simulations resulted in impacted populations that were smaller than the paired baseline population in all simulation years (excluding year 1) (Table 9.8.6). This is also demonstrated in Graph 9.8.2 which shows that most of the simulations have a ratio of <1 which means that the impacted population size is smaller than the paired baseline population size.

Table 9.8.6: The Ratio of Impacted to Baseline Population Size in Years 1, 6, 12, 18 and 24 Across All 1,000 Paired Bottlenose Dolphin Population Simulations for the Longest Duration Cumulative Scenario						
Year	**Min.**	**1st Qu.**	**Median**	**Mean**	**3rd Qu.**	**Max.**
1	1	1	1	1	1	1
6	0.2712	0.7299	0.84	0.8187	0.9301	1.083
12	0.06977	0.4531	0.627	0.6121	0.7879	1.11
18	0.07246	0.3247	0.5296	0.5277	0.7184	1.183
24	0.06034	0.2948	0.4922	0.4988	0.6903	1.191



Graph 9.8.2: The ratio of the impacted population size to the baseline population size for each of the 1,000 paired simulations run for year 6, 12, 18 and 24 under the longest duration cumulative scenario including PTS and disturbance

9.8.2.27 In conclusion, the longest duration cumulative scenario with PTS resulted in a significant long term population level effect on the bottlenose dolphin population.

9.8.2.28 However, there are a number of issues which question whether the inclusion of PTS impacts as a result of the previous assessment is appropriate. There are a number of differences between the methodology used in the original Inch Cape assessment and current best practice. The primary reasons are detailed below:

- The assessment used the Southall *et al. (*2007) PTS SEL threshold and weighting for impulsive noise (M_{lf} weighted SEL 198 dB re 1 µPa^2/s) which is likely to have overestimated the PTS risk relative to the use of the updated National Marine Fisheries Service (2016) weighting which is more closely aligned to the functional group's audiogram compared to the 'flat' weighting of the Southall M weighting functions; and
- The assessment used the SAFESIMM framework to predict the number of animals at risk; SAFESIMM adopts highly precautionary assumptions in relation to animal responsive movement, where animals move in a 'directed random walk' in response to exposure rather than the direct 'fleeing' assumed in other models. In addition the swim speeds adopted are much lower than the values agreed in the current assessment.

9.8.2.29 As a result of these considerations, if the consented Inch Cape piling parameters were assessed using the same methodology applied in the revised assessment, no PTS would be predicted. Therefore the longest duration cumulative scenario was repeated without the inclusion of PTS at Inch Cape. This is considered to be a more likely and realistic scenario, given the results of the revised Inch Cape modelling.

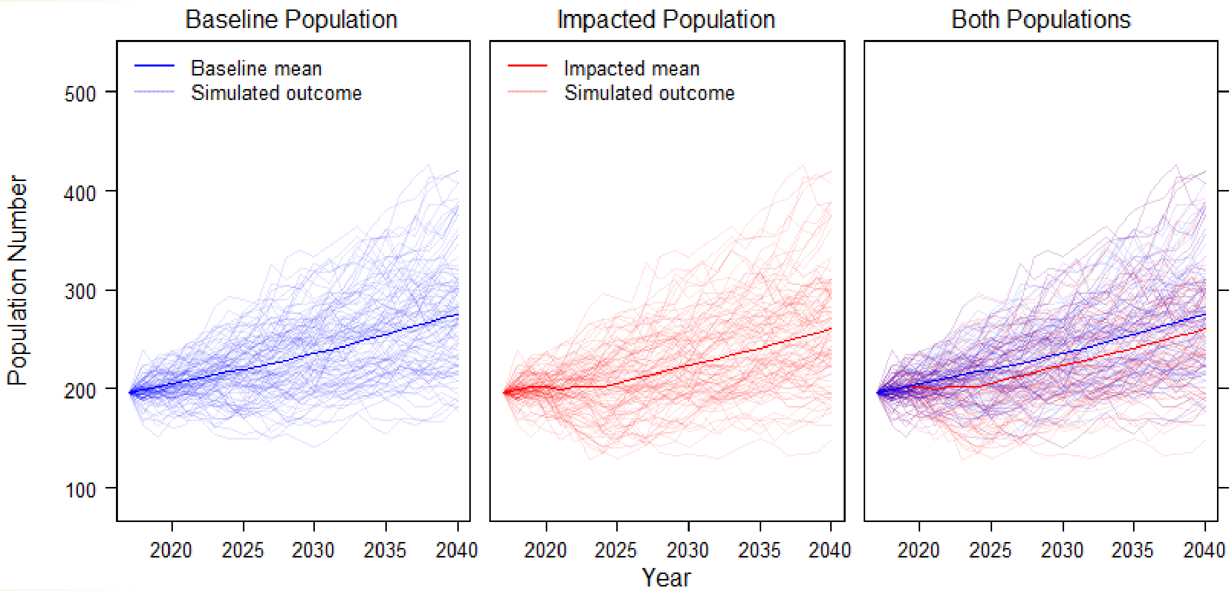
Bottlenose Dolphin Cumulative Assessment: Single vessel (longest duration) without PTS

9.8.2.30 The removal of PTS at Inch Cape clearly had a significant effect on the population trajectory results compared to the scenario with PTS. The longest duration scenario with PTS resulted in an impacted population size after 24 years that was only 47.4% of the size of the baseline population, however, when exactly the same scenario was run without the impact of PTS at Inch Cape, the impacted population size after 24 years was 94.1% of the size of the baseline population. With PTS included, the model predicted a 48% increase in the risk of a 1% decline in year 6 (Table 9.8.5), compared to the model with no PTS which predicted only a 17% increase in the risk of a 1% decline in year 6 (Table 9.8.7).

9.8.2.31 The model without PTS resulted in no significant long term population effect. The population trajectory for both the baseline and the impacted populations (the mean and each individual of the 1,000 simulated outcomes) are presented in Graph 9.8.3. This demonstrates that the mean impacted population is predicted to experience an initial decline in growth rate relative to the baseline population, after which it then returns to the same growth rate as the baseline population and continues to increase at the same rate as the baseline population for the remainder of the simulations.

Table 9.8.7: Additional Risk of a 1, 2 and 5% Decline Across Years as a Result of the Simulated Disturbance Impact Resulting from the Longest Duration Cumulative Scenario without PTS

Year of Simulation	Additional Probability of a 1% Decline	Additional Probability of a 2% Decline	Additional Probability of a 5% Decline
1	0	0	0
6	0.171	0.138	0.025
12	0.082	0.027	0
18	0.037	0.014	0
24	0.018	0.003	0



Graph 9.8.3: Simulated bottlenose dolphin population sizes for both the baseline and the impacted populations under the longest duration cumulative scenario without PTS.

Comparing baseline and impacted population sizes

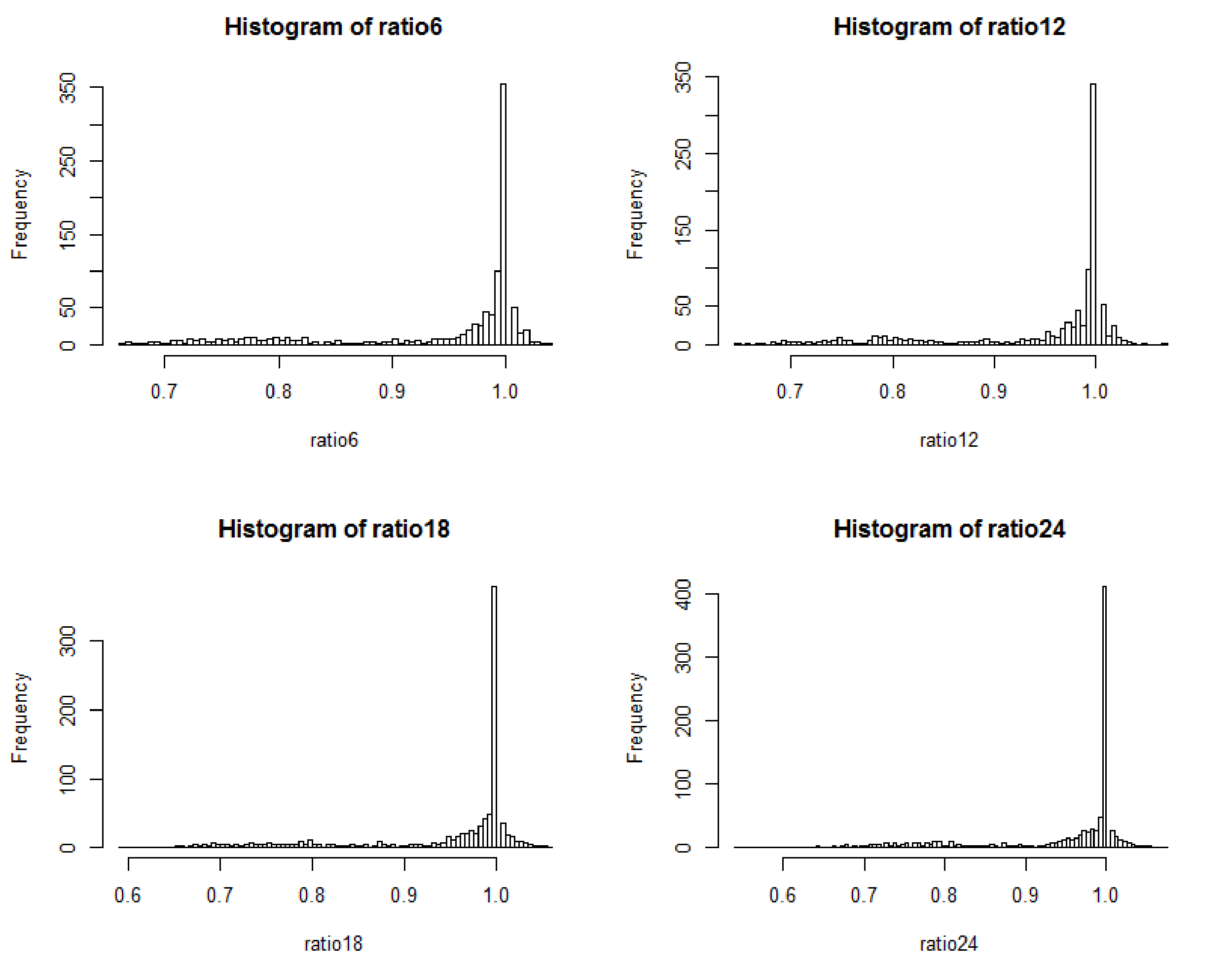
9.8.2.32 Across all 1,000 paired simulations, the median ratio of baseline and impacted population sizes was between 0.99 and 1.00 and the mean ratio of the impacted to the baseline population was around 0.94 (excluding year 1) which indicates that a small number of the simulations resulted in impacted populations that were smaller than the paired baseline population in all simulation years, although the effect was very small; mean ratios (excluding year 1) were between 94.5 and 94.8% of the paired baseline population size (Table 9.8.8). The maximum ratio of the impacted to the baseline population (excluding year 1) ranged between 1.04 and 1.07, which means that in a very small number of the 1,000 paired simulations, the impacted population size was greater than that of the baseline population size. The minimum ratio between the impact and the baseline population size (excluding year 1) was between 0.54 and 0.66, which means that in a small number of the paired simulations, the minimum impacted population size was between 54% and 66% of the size of the baseline population.

9.8.2.33 The ratio of the impacted to baseline population size is further demonstrated in Graph 9.8.4 which clearly demonstrates that in most of the 1,000 paired simulations, the impacted population size is equal to or only slightly less than the baseline population size.

9.8.2.34 This is a significantly different result to that presented in Table 9.8.6. For example, the median ratio of the impacted to baseline population size was 0.49 for the PTS scenario compared to 1.00 under the non PTS scenario.

Table 9.8.8: The Ratio of Impacted to Baseline Population Size in Years 1, 6, 12, 18 and 24 Across All 1,000 Paired Bottlenose Dolphin Population Simulations for the Longest Duration Cumulative Scenario Without PTS

Year	Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
1	1	1	1	1	1	1
6	0.6638	0.9444	0.9912	0.946	1	1.039
12	0.6471	0.94	0.9917	0.9479	1	1.067
18	0.5918	0.9393	0.9932	0.9446	1	1.059
24	0.54	0.9405	1	0.9456	1	1.074



Graph 9.8.4: The ratio of the impacted population size to the baseline population size for each of the 1,000 paired simulations run for year 6, 12, 18 and 24 under the longest duration cumulative scenario without PTS.

9.8.2.35 Overall, for the longest duration cumulative scenario without PTS, the bottlenose dolphin population showed a small initial decline relative to the baseline as a result of the disturbance events, after which it then returns to the same growth rate as the baseline population and continued to increase at the same rate as the baseline population for the remainder of the simulations. Therefore, there is no predicted long term effect on the East Coast Scotland bottlenose dolphin population as a result of the cumulative disturbance from Moray East, Moray West, AHEP, Neart na Gaoithe, Seagreen and Inch Cape. Due to the lack of any density dependent mechanism being included in the modelling, the mean impacted population is not predicted to increase above the baseline growth rate and therefore although the population growth rate is expected to recover once the period of disturbance is over, the population size may remain slightly lower than the equivalent baseline population.

9.8.2.36 It is unclear exactly why the inclusion of PTS has such a large effect on the simulated impacted population trajectory but it is linked to the results of the expert elicitation process that was carried out when the iPCoD framework was developed. Given the uncertainty and lack of empirical data on the individual consequences of PTS for individuals, a precautionary approach was taken by some experts who felt that the effect of PTS on survival and fecundity could be quite high. Additional work carried out since then on the magnitude and frequency of PTS as a result of exposure to noise has demonstrated that the amount of PTS that bottlenose dolphins could receive from exposure to piling noise is relatively limited and that it would be likely limited to specific frequency bands largely outside the region of highest hearing sensitivity (Kastelein *et al.,* 2012a, Kastelein *et al.,* 2012b, Finneran 2015, Kastelein *et al.,* 2017). A recent revisit of the expert elicitation process for the iPCoD framework, as yet unpublished, concluded that the effects of PTS were likely to be far less than specified during the original expert elicitation (C. Booth, SMRU Consulting, pers comm). Nevertheless, regardless of the consequences of PTS, the more realistic scenario is that no bottlenose dolphins are likely to experience PTS as a result of any piling activity in the East Coast Management Unit and therefore this assessment is based on the latter set of iPCoD modelling results presented above.

9.8.2.37 The sensitivity of bottlenose dolphins to behavioural disturbance has been assessed as **medium** and, given the results of the longest duration cumulative assessment iPCoD population modelling without PTS, with the lack of an overall long term difference in population growth rates, and a median ratio of growth rates and population size between matched pairs of one across all years examined, the magnitude has been assessed as **low** in terms of the impact on the long term population trajectory. Therefore the effect behavioural disturbance as a result of the construction of Moray East, Moray West, AHEP, Neart na Gaoithe, Seagreen and Inch Cape on the East Coast Scotland bottlenose dolphin population is of **minor significance**, and therefore **not significant** in EIA terms.

Minke Whale

9.8.2.38 Given the large area covered by the minke whale Celtic and Greater North Sea MU, the cumulative assessment was approached in the following way: projects within the Moray Firth and the East coast of Scotland were assessed quantitatively while the other projects in the wider North Sea were considered qualitatively way.

9.8.2.39 The numbers of minke whales potentially affected by disturbance from a range of projects is presented in Table 9.8.14. Based on the worst case in terms of total numbers of animals affected from each project, (and the worst of consented vs revised for the Forth and Tay projects), the total number of minke whales affected is 814, this is equivalent to 3.5 % of the Management Unit population. The maximum numbers are generally associated with the concurrent piling scenarios which are of the shortest duration in terms of overall disturbance. Based on the longest duration of disturbance the proportion of the population affected will be lower, although the duration of the effect will be longer.

9.8.2.40 Minke whales are highly mobile and are generally seasonal visitors to the Moray Firth and East coast. As such individuals displaced from the areas of pile driving and other noise activity are likely to find suitable alternative habitat.

9.8.2.41 The number of individuals, if summed, represents a relatively low proportion of the overall population. Even if every affected minke whale failed to breed during the years of disturbance, this would not result in a significant change in the trajectory of the population.

9.8.2.42 Unlike for harbour porpoise, no wider strategic assessment has been carried out at the scale of the management unit for minke whales. Although not included quantitatively in the table below, there are a total of four other projects in the wider minke whale management unit that have been listed in Table 9.8.1 as having the potential for overlapping construction periods with construction at Moray West. One of these projects includes the Cromarty Port development. However, based on information presented in the EIA Report (May 2018), it is unlikely that there will be any overlap in construction periods (construction of Phase 4 which involves percussion piling and vibropiling is expected to take place between November 2018 and March 2019). Potential for cumulative effects during construction are therefore unlikely.

9.8.2.43 It is not anticipated that these spatial wider scale impacts will significantly increase the magnitude of the impact as assessed here quantitatively, therefore, overall, this level of impact is considered of **low** magnitude at the management unit scale. The sensitivity of minke whales to disturbance is considered **medium** and therefore the effect of underwater noise form piling and construction is of **minor significance** and **not significant** in EIA terms.

Table 9.8.9: **Minke Whale Cumulative Assessment – Numbers Predicted to be Disturbed as a Result of Underwater Noise from Construction Activities**

Project	Methodology/ Disturbance Threshold	# WTG	Total # Piles	Scenario	Assumed # Piles/Day/ Vessel	# Piling Days	Max # Animals Affected per Piling Day
Moray West	**Dose response curve Graham et al (2017)**	**85**	**85**	**single MP**	**0.98**	**87**	**29**
				concurrent MP	**1.93**	**44**	**30.1**
		85	**340**	**single PP**	**2.6**	**133**	**23**
				concurrent PP	**2.6**	**67**	**24.5**
Aberdeen Harbour Expansion Project (blasting)	140 dB re 1 µPa (RMS) "low level disturbance" out to 7.18 km	na	na	blasting	2 blasts	36	<1
	160 dB re 1 µPa (RMS) "US Level B Harassment" out to 1.7 km						4
Moray East	Dose response curve (Thompson et al., 2013)	100	400	single	3	134	168
				concurrent	3	67	185
Neart na Gaoithe (consented)	90 dBht	125	500	single	2	250	88
Neart na Gaoithe (revised)	NOAA	54	324	single	6	54	23
				concurrent	6	27	123
Inch Cape (consented)	90 dBht	213	852	ML single	2	426	159
				WC concurrent	4	107	191
Inch Cape (revised)	Dose response curve (Graham et al., 2017)	76	304	ML single	4	76	63
				WC single	6	51	93
				ML concurrent	4	38	76

Table 9.8.9: Minke Whale Cumulative Assessment – Numbers Predicted to be Disturbed as a Result of Underwater Noise from Construction Activities

Project	Methodology/ Disturbance Threshold	# WTG	Total # Piles	Scenario	Assumed # Piles/Day/ Vessel	# Piling Days	Max # Animals Affected per Piling Day
				WC concurrent	6	26	110
Seagreen (consented)	90 dBht	75	300	Alpha	1	300	238
		75	300	Bravo	1	300	313
		150	600	Alpha then Bravo	1	600	238 then 313
Seagreen (revised)	Dose response curve (Graham et al., 2017)	120	480	Alpha then Bravo	2	240	63 then 71
				Alpha + Bravo concurrent	2	140	76

Harbour Seal

9.8.2.44 Table 9.8.4 presents compiled information on the predicted effects from a range of projects included in the cumulative assessment for harbour seals within the Moray Firth Management Area. As above, it is important to note that these assessments have used different methods and thresholds to indicate levels of disturbance and they are not generally comparable. In addition, the potential disturbance as a result of the construction of the Beatrice offshore wind farm was not quantified. These projects are not expected to overlap in time therefore there is the possibility that some individuals may be repeatedly disturbed over a longer period (over one year during the Beatrice construction period, up to one year during construction at Moray East and then up to nine months during construction at Moray West. Given uncertainties surrounding animal turnover and movements at this temporal and spatial scale it is very challenging to predict the overall level of disturbance. Population modelling carried out to inform the assessment for Moray East demonstrated that this level of disturbance would not be expected to have a long term effect on the harbour seal population in the Moray Firth based on the assumption that each seal experiencing any disturbance would fail to breed in that year.

Table 9.8.10: Modelled Scenarios for the Shortest and Longest Duration Cumulative Impact Scenarios

Project	Pile Type	# WTG	# Piles	# Vessels	# Piles/ Day	Total Piling Days	Piling	# Seals Disturbed	Construction Years	Source
Shortest Duration (Concurrent Vessel Installation)										
Moray East	PP	100	400	2	6	67	Year round	629	2019-2020	Moray East Piling Strategy
Moray West	MP	85	85	2	2	44	Year round	20	2022-2023	This ES
Longest Duration (Single Vessel Installation)										
Moray East	PP	100	400	1	3	134	Year round	522	2019-2020	Moray East Piling Strategy
Moray West	PP	85	340	1	3	133	Year round	7	2022-2023	This ES

9.8.2.45 The iPCoD scenario runs from the start of 2017 for 25 years, however, piling at Moray East does not commence until 2019, therefore the first two years of the simulation will experience no disturbance impact. For this reason, the additional risk of a 1% decline in year 1 is 0 and the ratio of the population size and growth rate in year 1 is 1. Overall the single piling concurrent scenario (longest duration) produced higher levels of population level impact, therefore the results from this scenario are presented in full below.

Table 9.8.11: Results of the iPCoD Modelling for Harbour Seals under 2 Cumulative Scenarios: Concurrent Piling (Shortest Duration) and Single Piling (Longest Duration). Red Text Denotes Which of the 2 Scenarios had the Worst Case Result for Each Results Parameter

Result Parameter		Shortest Duration	Longest Duration
Median Population Size Year 24	**Baseline**	1,306	1,312
	Impacted	1,268	1,268
	Impacted as % of baseline	97.09%	96.65%
Additional Risk of a 1% Decline	**Yr 1**	0	0
	Yr 6	0.188	0.229
	Yr 12	0.087	0.099
	Yr 18	0.039	0.045
	Yr 24	0.021	0.013
Ratio of the impacted to un-impacted population size	**Yr 1 Min**	1	1
	Yr 6 Min	0.8279	0.7821
	Yr 12 Min	0.8214	0.8213
	Yr 18 Min	0.8392	0.8169
	Yr 24 Min	0.8364	0.8245

Table 9.8.11: Results of the iPCoD Modelling for Harbour Seals under 2 Cumulative Scenarios: Concurrent Piling (Shortest Duration) and Single Piling (Longest Duration). Red Text Denotes Which of the 2 Scenarios had the Worst Case Result for Each Results Parameter

Result Parameter		Shortest Duration	Longest Duration
	Yr 1 Median	1	1
	Yr 6 Median	0.9773	0.9661
	Yr 12 Median	0.9803	0.9751
	Yr 18 Median	0.9823	0.9769
	Yr 24 Median	0.9839	0.9793
	Yr 1 Mean	1	1
	Yr 6 Mean	0.9645	0.955
	Yr 12 Mean	0.9678	0.9631
	Yr 18 Mean	0.9703	0.966
	Yr 24 Mean	0.9724	0.9687
Ratio of impacted to un-impacted annual growth rate	Yr 1 Min	1	1
	Yr 6 Min	0.943	0.932
	Yr 12 Min	0.9921	0.991
	Yr 18 Min	0.9922	0.9893
	Yr 24 Min	0.9877	0.9882
	Yr 1 Median	1	1
	Yr 6 Median	0.9954	0.991
	Yr 12 Median	1	1
	Yr 18 Median	1	1
	Yr 24 Median	1	0.9999
	Yr 1 Mean	1	1
	Yr 6 Mean	0.9919	0.9883
	Yr 12 Mean	1.001	1.001
	Yr 18 Mean	1	1.001
	Yr 24 Mean	0.9995	0.9996
Centile for un-impacted population which matches the 50th centile for the impacted population	Yr 1	49	50
	Yr 6	14	10
	Yr 12	33	31
	Yr 18	36	33
	Yr 24	37	36

Harbour Seal Cumulative Assessment: Single Vessel (Longest Duration)

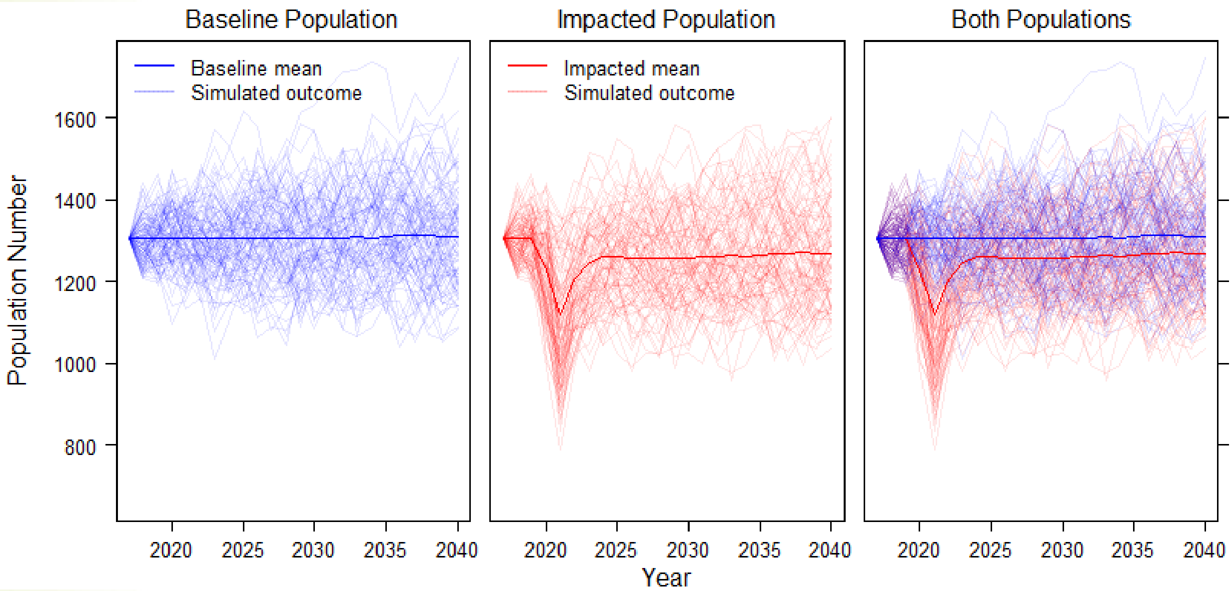
9.8.2.46 Under the longest duration cumulative scenario, the simulations demonstrated that in probabilistic terms, there was an increase in the risk of population decline in the impacted population. In the sixth year of simulation there was a maximum of a 22.9% increase in the probability a 1% population decline and a 14.9% increase in the risk of a 2% decline (Table 9.8.12). This impact was short term, and by year 12, the increase in the probability of a 1% decline decreased from 22.9% to 9.9%, by year 18 had decreased to 4.5%, and by year 24 had decreased to 1.3%.

9.8.2.47 After 24 years of simulation, the median baseline population size (across 1,000 simulations) was 1312 (95% CI: 1108 - 1514), and the median impacted population size (across 1,000 simulations) was 1268 (95% CI: 1048 - 1492), This means that after a simulated 24 years the size difference between the median baseline and impacted population was 44 seals, but with a large overlap in confidence intervals.

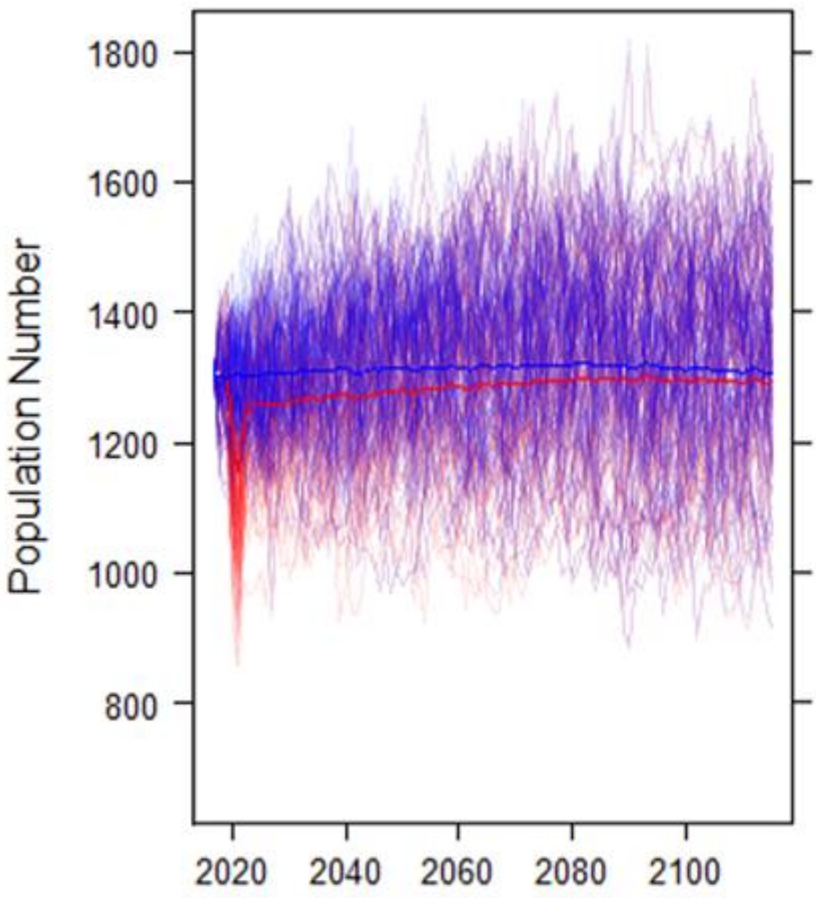
9.8.2.48 The population trajectory for both the baseline and the impacted populations (the mean and each individual 1,000 simulated outcomes) are presented in Graph 9.8.5:. This demonstrates that the mean impacted population is predicted to experience a decline in population size relative to the baseline population as a result of the impact, however, following the end of the disturbance the growth rate increases and the population size increases rapidly to a level where the population size is only slightly smaller than the baseline population size. The growth rate then slows down but remains slightly elevated above the baseline growth rate. When extending the duration of the population simulations to a longer period, it is evident that the impacted population size is predicted to eventually return to the same as the unimpacted population (Graph 9.8.6:).

Table 9.8.12: Additional Risk of a 1, 2 and 5% Decline Across Years for the Harbour Seal Population Simulations Resulting from the Simulated Disturbance Predicted During the Longest Duration Cumulative Scenario.

Year of Simulation	Additional Probability of a 1% Decline	Additional Probability of a 2% Decline	Additional Probability of a 5% Decline
1	0	0	0
6	0.229	0.149	0
12	0.099	0.007	0
18	0.045	0	0
24	0.013	0	0



Graph 9.8.5: Simulated harbour seal population sizes for both the baseline and the impacted populations under the longest duration cumulative scenario



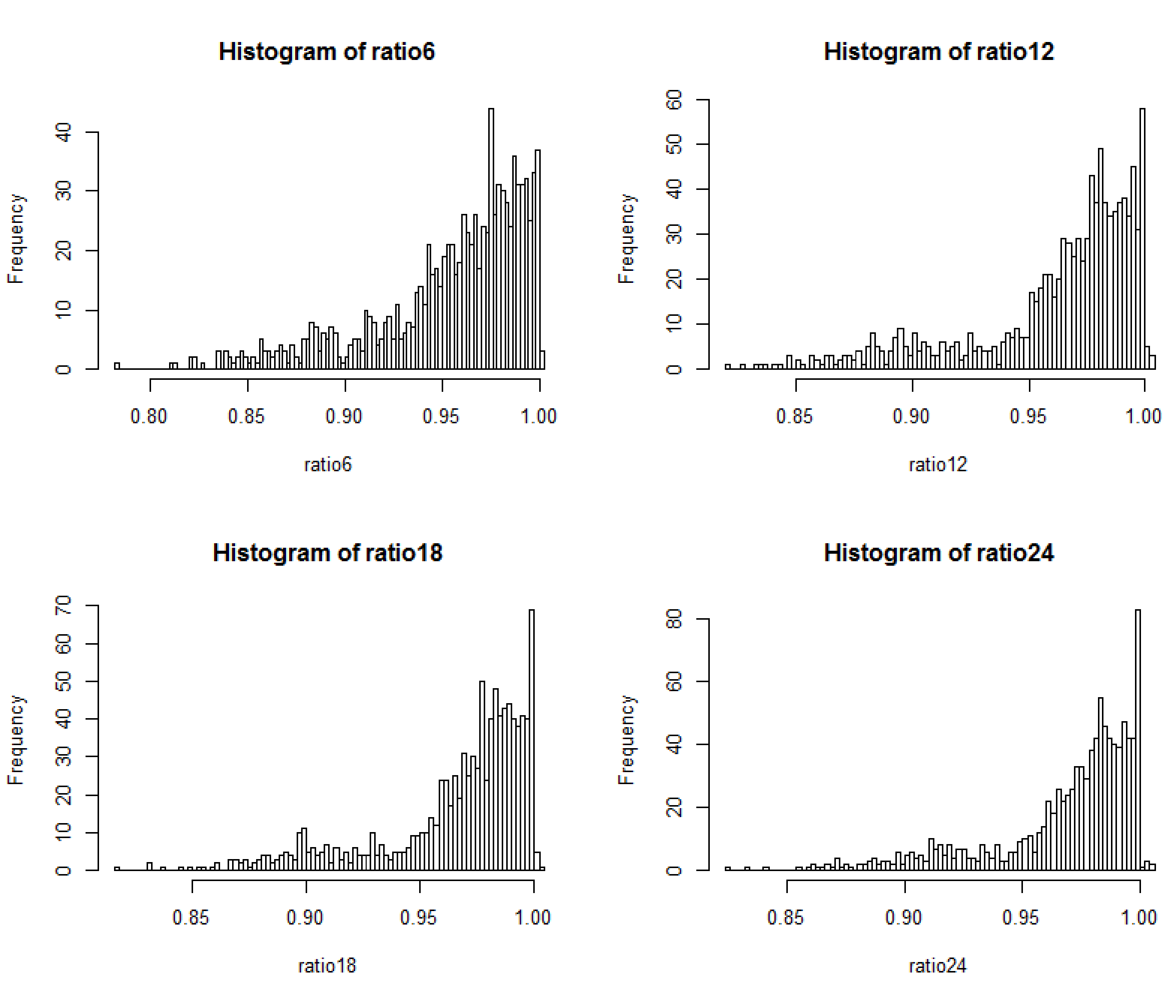
Graph 9.8.6: Simulated harbour seal population sizes for both the baseline and the impacted populations under the longest duration cumulative scenario over an extended period of 100 years

Comparing population size between baseline and impacted simulations

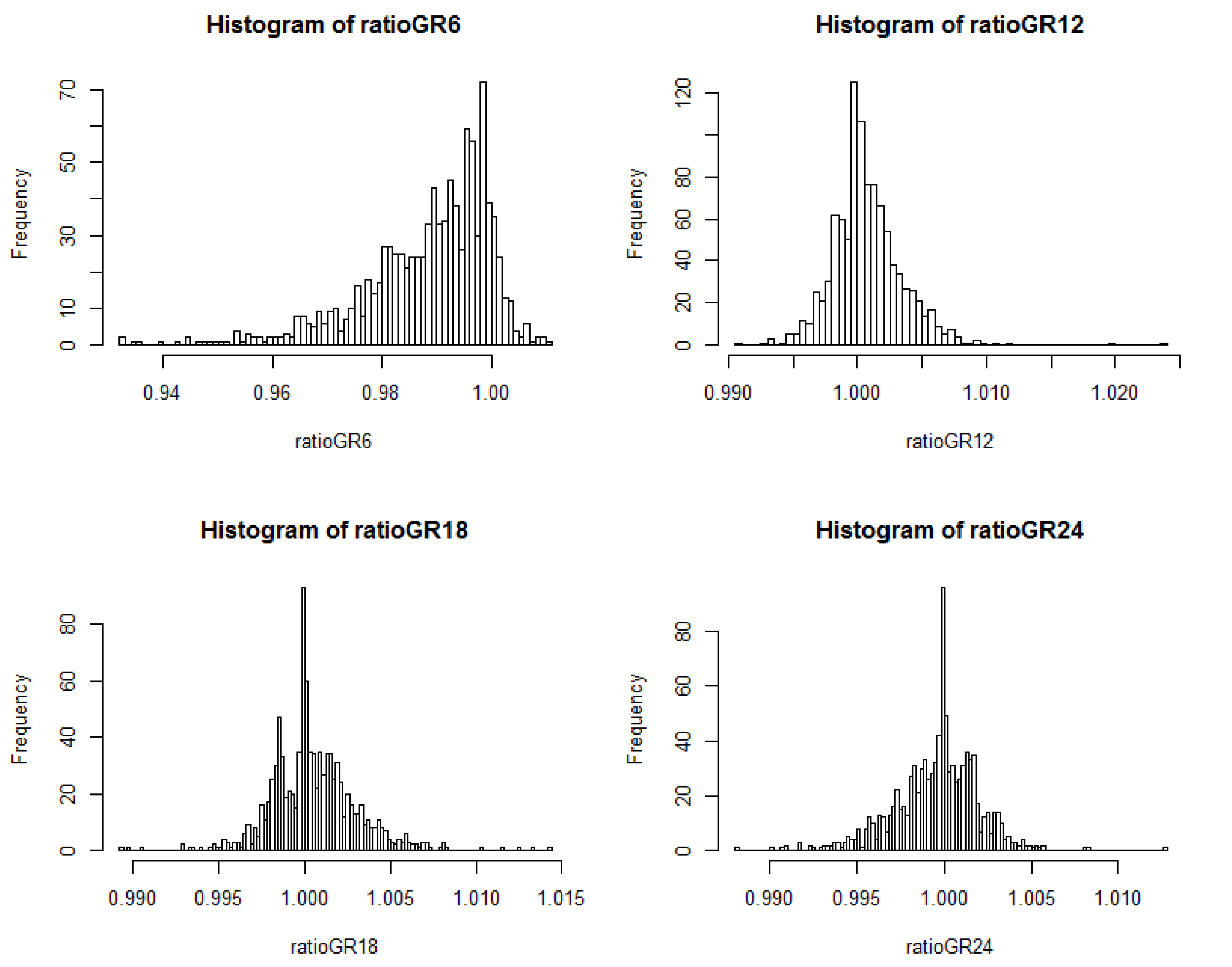
9.8.2.49 Across all 1,000 paired simulations, the median ratio of baseline and impacted population sizes was between 0.9661 and 0.9793 and the mean ratio of the impacted to the baseline population was between 0.955 and 9687 (excluding year 1) which indicates that some of the simulations resulted in impacted populations that were smaller than the paired baseline population in all simulation years, although the effect was very small; mean ratios (excluding year 1) were between 95.5 and 96.9% of the paired baseline population size (Table 9.8.13). The maximum ratio of the impacted to the baseline population (excluding year 1) ranged between 1.002 and 1.005, which means that in a very small number of the 1,000 paired simulations, the impacted population size was greater than that of the baseline population size. The minimum ratio between the impact and the baseline population size (excluding year 1) was between 0.78 and 0.82, which means that the minimum impacted population size (the lowest out of 1,000 simulations) was between 78.21% and 82.45% of the size of the baseline population.

Table 9.8.13: Summary Statistics of the Ratio of the Impacted to Un-Impacted Population Size Across Years for the 1,000 Harbour Seal Population Simulations for the Longest Duration Cumulative Scenario

Year of simulation	Minimum	1st Quartile	Median	Mean	3rd Quartile	Maximum
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	0.7821	0.9395	0.9661	0.9550	0.9842	1.0020
12	0.8213	0.9536	0.9751	0.9631	0.9880	1.0030
18	0.8169	0.9578	0.9769	0.9660	0.9894	1.0030
24	0.8245	0.9609	0.9793	0.9687	0.9903	1.0050



Graph 9.8.7: The ratio of the impacted population size to the baseline population size for each of the 1,000 paired simulations run for year 6, 12, 18 and 24 under the longest duration cumulative scenario.



Graph 9.8.8: The ratio of the impacted population growth rate to the baseline population growth rate for each of the 1,000 paired simulations run for year 6, 12, 18 and 24 under the longest duration cumulative scenario.

9.8.2.50 Since the Project alone scenarios (Section 9.7.1) showed no impact on the harbour seal population as a result of disturbance from the Moray West Offshore Wind Farm, the population size shown in this cumulative assessment is driven entirely by the level of impact predicted for Moray East.

9.8.2.51 There is a considerable difference between the numbers of harbour seals predicted to experience disturbance from the Moray East assessment in comparison to the Moray West Offshore Wind Farm assessment. This is due to the differences in the methods; in particular the difference in thresholds, dose response curves and density surfaces used.

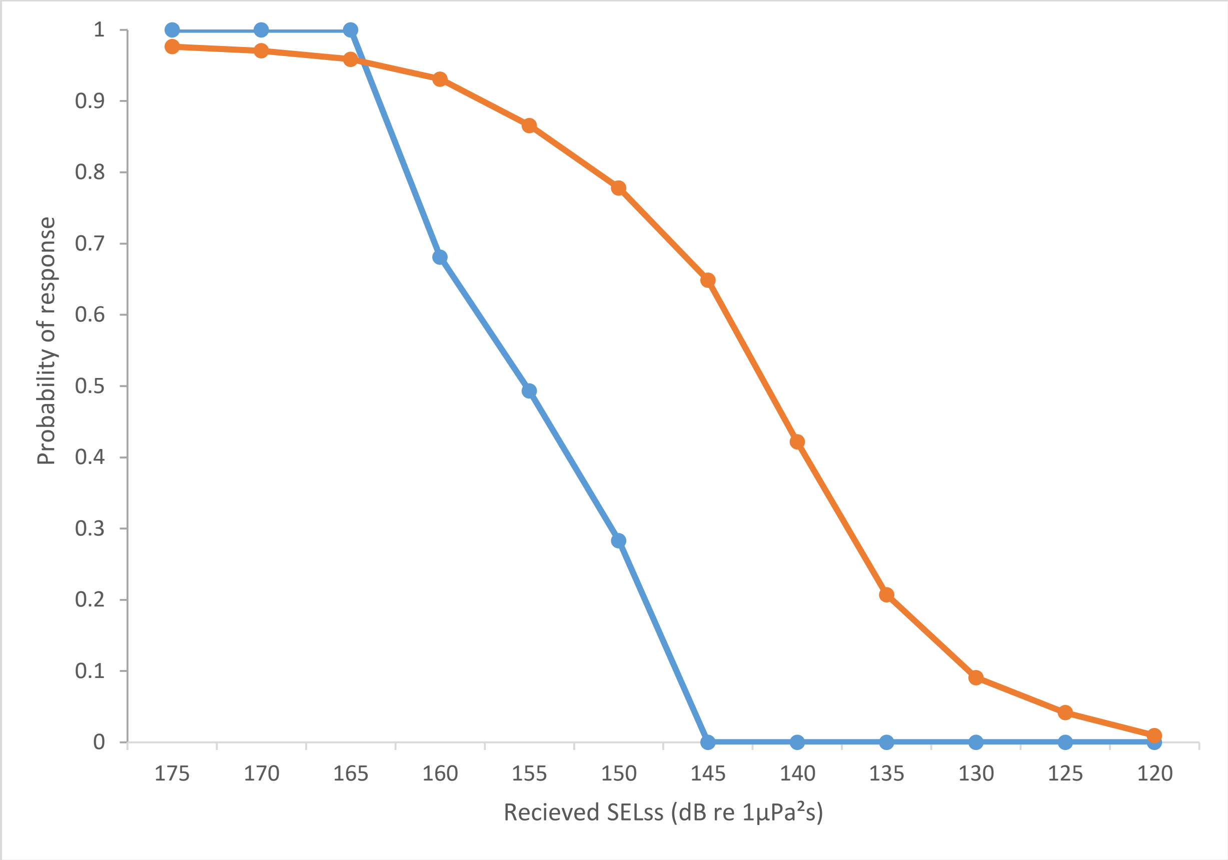
9.8.2.52 For the behavioural assessment, the Moray East project used the previous harbour seal density surface based on telemetry data obtained between 1989 and 2009. In comparison the Moray West Offshore Wind Farm assessment used an updated density surface, incorporating 2014 and 2015 telemetry data into the habitat modelling. This resulted in the revised density surface having significantly fewer seals predicted in grid cells offshore and around both wind farm sites, compared to the earlier surface. In addition to this, the behavioural dose-response curve differed significantly between the two assessments. The Moray East assessment used the Thompson *et al. (*2013) dose response curve, produced using harbour porpoise data from Horns Rev II (Brandt *et al.,* 2011). The Moray West Offshore Wind Farm assessment used the new dose-response curve based on harbour seal response data from Russell *et al. (*2016). By comparison, the seal dose response curve from Russell and Hastie (2017) predicts a much lower probability of response below received SEL_{ss} of 170 dB compared to the Thompson *et al. (*2013) dose response curve (Graph 9.8.9:). The combination of the different density surface and the different dose response curve results in significantly fewer harbour seals predicted to experience disturbance in the Moray West Offshore Wind Farm assessment in comparison to the Moray East assessment.

9.8.2.53 As a result of the use of the more conservative harbour porpoise dose response curve and older telemetry data, the Moray East predictions are likely to be significant overestimates of the potential for disturbance. The predicted noise levels from the piling activity were not significantly higher than the noise levels from the activity assessed for the Moray West Offshore Wind Farm. As such, if this assessment was updated, using refined piling parameters from the Moray East Piling Strategy, and the updated methodology, the magnitude of impact would be expected to be similar to the quantified level of impact from the Moray West Offshore Wind Farm. There is no overlap in the timing of piling across both Moray Firth projects so any impact would be sequential therefore the overall impact would be expected to be of the magnitude of a single project, but extending over multiple projects.

9.8.2.54 Despite the predicted decline in population size as a result of the overestimated impacts of the Moray East piling, the harbour seal population is expected to recover after the disturbance and therefore no lasting population level effects are predicted. Since the numbers of seal predicted to be impacted by Moray East are likely to be significant overestimates, the true predicted population level effect would be much smaller than that presented in this cumulative assessment.

9.8.2.55 As noted in Table 9.8.1 the application for development of the Cromarty Port was submitted in May 2018. The EIA Report supporting this application indicates that Phase 4 (which will involve both percussion piling and vibropiling) is expected to take place between November 2018 and March 2019. Due to the timing of the availability of information on this development, it has not been possible to include this potential impact quantitatively. However, given that the piling / vibropiling activities are not expected to overlap with construction of the Moray West Offshore Wind Farm and that the assessment has not identified any significant effects on the harbour seal population it is not expected that this project would add significantly to potential disturbance at the management unit/population scale.

9.8.2.56 The sensitivity of harbour seals to behavioural disturbance has been assessed as **medium** and, given the results of the cumulative assessment iPCoD population modelling, the magnitude has been assessed as **low** in terms of the impact on the long term population trajectory and the eventual recovery of the population. Therefore the effect of behavioural disturbance as a result of the construction of the Moray East and Moray West Offshore Wind Farms on the Moray Firth harbour seal population is of **minor significance**, and therefore **not significant** in EIA terms.



Graph 9.8.9: Comparison of the dose response curves used for harbour seals in the current assessment (blue line) based on Russell and Hastie (2017) compared to the dose response curve used in the Moray East assessment, published in Thompson *et al.* (2017) (orange line).

<u>Grey Seal</u>

9.8.2.57 As with harbour seals, the numbers of grey seals presented in Table 9.8.14 are considered to be a significant overestimate for Moray East due to the reasons outlined above regarding developments in seal specific dose response curves and a reduced envelope for what will actually be constructed at Moray East relative to what was assessed.

9.8.2.58 Grey seals are highly mobile and not tied to sites in the Moray Firth. Individuals often move large distances between haul-out sites (Russell *et al.,* 2013) and travel long distances to sea to forage (McConnell *et al.,* 1999). Grey seals are also known to be able to adjust behaviourally and physiologically in response to changes in energy supply and demand (Beck *et al.,* 2003, Sparling *et al.,* 2006) and as such are much less vulnerable to disturbance. There are several large concentrations of grey seals elsewhere on the East and North coasts of Scotland, well within typical grey seal movement range. As such individuals displaced from the areas of pile driving and other noise activity are likely to find suitable alternative habitat.

9.8.2.59 Although the large number of individuals affected leads to a conclusion of **medium** impact magnitude, the sensitivity of grey seals to disturbance is **low** and therefore the effect is of **minor** significance and **not significant** in EIA terms.

Table 9.8.14: Grey Seal Cumulative Assessment – Numbers Predicted to be Disturbed as a Result of Underwater Noise from Construction Activities		
Project	**Disturbance Threshold**	**Worst Case #Animals Affected**
Moray West	**DR Curve Graham *et al.* (2017)**	**207**
Beatrice	75 dB_{ht}	*Not quantified*
Moray East	DR Curve Thompson *et al.,* 2013	1184

9.8.3 Impacts from Increased Vessel use as a Result of Construction and Operational Activities (disturbance and increased collision risk)

9.8.3.1 Increased ship traffic during the construction of the Moray West Offshore Wind Farm could result in an increased risk of disturbance to, or collisions with marine mammals during construction, operation or decommissioning of other plans and projects.

9.8.3.2 Upon examination of data available for offshore wind, pipeline and cable, and coastal developments, it is clear that the greatest potential for cumulative increase in vessel movements arises from the development in combination with other OWF projects. Table 9.8.15 summarises the available information on likely vessel movements through both construction and operational phases of all projects for which information was available within the cumulative assessment.

Table 9.8.15: Predicted Vessel Movements as a Result of Moray West Cumulatively with Other Plans and Projects at Both the Moray Firth and Wider North Sea Management Unit scale		
Project	**Construction – Number of Vessel Movements (Return Trips)**	**Operation and Maintenance – Number of Vessel Movements (Return Trips)**
Moray West	Up to two installation vessels (up to 46 return trips) and two support vessels (up to 16 return trips) and up to five transport vessels per week (over a nine month period).	150 to 200 per year
Beatrice	Approximately 1,350 over construction period (approx. 675 per year)	Approximately 365 per year
Moray East	1,355 per construction period (4,065 total)	Not available/assessed as not significant
Seagreen (consented)	28 vessels in total at any one time over construction period	1,760 per year
Inch Cape (consented)	3,500 over 1.5 years	Not available/assessed as not significant
Neart na Gaoithe (consented)	9,792 over 17 month construction period	1,550 per year
Kincardine	Minimal	78 per year (minimal)
Aberdeen Bay Demonstrator	Minimal	Minimal
Hywind Scotland Pilot Park	Minimal	Minimal

Table 9.8.15: Predicted Vessel Movements as a Result of Moray West Cumulatively with Other Plans and Projects at Both the Moray Firth and Wider North Sea Management Unit scale		
Project	**Construction – Number of Vessel Movements (Return Trips)**	**Operation and Maintenance – Number of Vessel Movements (Return Trips)**
Hornsea Project Two	6,200 in total over up to 7.5 years	2,817 per year
Hornsea Project Three	11,776 over two 2.5 year phases with 6 years apart	2,832 per year
Norfolk Vanguard East & West	1,695 in total over 3 years	Assumed to be similar to the construction phase (or less)
Dogger Bank Creyke A & B	3,460 in total over 3 years	683 per year
Dogger Bank Teeside A & B (now Sofia)	5,810 in total over 6 years	730 per year
East Anglia Three	8,000 (two phase approach) over 3.75 years	4,067 per year
Thanet Extension	1160 over 3 years	157 per year

9.8.3.3 Overall, baseline vessel use within the North Sea MU is considered to be relatively high due to the presence of known shipping routes, ferry routes, and recreational vessel usage. Construction periods within the Moray Firth region are unlikely to overlap and therefore increases in vessel numbers will occur sequentially rather than concurrently. This will lead to a more sustained, but lower level of impact over the duration of both consecutive construction periods. In total, the numbers of vessels using the management units of all the five marine mammal species considered here, will increase as a result of all of the plans and projects considered in the assessment. This will increase the potential for disturbance from vessel noise and direct interactions as a result of collisions with vessels.

9.8.3.4 As discussed in the Development alone assessment, a study commissioned by SNH (Lusseau *et al.,* 2011) predicts that an increase in vessel use of 800 vessels from two separate locations within the Moray Firth is unlikely to result in population effects that could lead to a decline in the bottlenose dolphin population size, based on the small increase in exposure predicted combined with the fact that commercial traffic is predictable and less likely to have an effect on bottlenose dolphins than unpredictable recreational vessels.

9.8.3.5 Also as discussed in the Development alone assessment, harbour porpoises have been shown to respond to vessel activity (Wisniewska *et al.,* 2018) and vessel densities in excess of 80 transits per day at the scale of 5 km^2 grid cells have been associated with relatively lower areas of harbour porpoise density (Heinänen and Skov 2015). It is unlikely that the projects listed above will results in levels of that magnitude at this spatial scale.

9.8.3.6 There is little evidence regarding minke whale interactions with vessels but for the purposes of assessment it has been assumed that they are of a similar sensitivity to harbour porpoise. Jones *et al. (*2017) demonstrated a large degree of predicted co-occurrence between ships and seals at sea, particularly within 50 km of the coast close to seal haul-outs. There is no evidence relating decreasing seal populations with high levels of co-occurrence between ships and animals and areas where seal populations are increasing (e.g. south east England) and where ship co-occurrences are highest, are experiencing the highest levels of growth (Jones *et al.,* 2017).

9.8.3.7 Given the localised spatial extent of vessel movements from the offshore wind projects considered, with most activity confined to within the defined project areas and transiting via existing routes, it is considered likely that marine mammals will tolerate the additional noise disturbance due to the increased vessel movements.

9.8.3.8 In general, as discussed in Section 9.7.2, collisions with vessels constitute a very small proportion of cause of death for stranded animals, suggesting that vessel strikes are not a significant cause of mortality to marine mammals around the UK. With the adoption of Vessel Management Plans as standard across offshore wind farm construction and other marine construction projects as standard, the risk of collision will be minimised.

9.8.3.9 It is considered that marine mammals will become accustomed to the new vessel traffic and any impacts will be of **low** magnitude. Marine mammals have been assessed as of **medium** sensitivity to vessel related impacts, therefore, the effect of increased vessel activity as a result of construction and operation of Moray West, cumulatively with all other plans and projects included in this cumulative assessment is therefore assessed as being **minor significance** to all marine mammal species and **not significant** in EIA terms.

9.8.4 Summary of the Cumulative Assessment

9.8.4.1 No significant effects were predicted for any marine mammal species as a result of the cumulative impact assessment (Table 9.8.16).

Table 9.8.16: Summary of the Results of the Cumulative Assessment

Likely Effect	Receptor	Impact Magnitude	Sensitivity of Receptor	Effect Significance
Construction noise (disturbance)	Harbour porpoise	Low	Medium	Minor Adverse
	Bottlenose dolphin	Low	Medium	Minor Adverse
	Minke whale	Low	Medium	Minor Adverse
	Harbour seal	Low	Medium	Minor Adverse
	Grey seal	Medium	Low	Minor Adverse
Vessels (disturbance and collision)	All species	Low	Medium	Minor Adverse

9.9 References

Bailey, H. 2017. Moray West Marine Mammal Impact Assessment: Habitat-based density modeling of harbour seals.

Bailey, H., P. S. Hammond, and P. M. Thompson. 2014. Modelling harbour seal habitat by combining data from multiple tracking systems. Journal of Experimental Marine Biology and Ecology **450**:30-39.

Beck, C. A., W. D. Bowen, and S. J. Iverson. 2003. Sex differences in the seasonal patterns of energy storage and expenditure in a phocid seal. Journal of Animal Ecology **72**:280-291.

Booth, C., J. Harwood, R. Plunkett, S. Mendes, and R. Walker. 2017. Using The Interim PCoD Framework To Assess The Potential Effects Of Planned Offshore Wind Developments In Eastern English Waters On Harbour Porpoises In The North Sea – Final Report. SMRUC-NEN-2017-007, Provided to Natural England and the Joint Nature Conservation Committee, March 2017, SMRU Consulting.

Brandon, J. W., B. Ramsey, J. W. Macfarlane, and D. Dearman. 2000. Abrasive water-jet and diamond wire-cutting technologies used in the removal of marine structures.*in* Offshore Technology Conference. Offshore Technology Conference.

Brandt, M. J., A. Diederichs, K. Betke, and G. Nehls. 2011. Responses of harbour porpoises to pile driving at the Horns Rev II offshore wind farm in the Danish North Sea. Marine Ecology Progress Series **421**:205-216.

Brandt, M. J., A. Dragon, A. Diederichs, A. Schubert, V. Kosarev, G. Nehls, V. Wahl, A. Michalik, A. Braasch, C. Hinz, C. Katzer, D. Todeskino, M. Gauger, M. Laczny, and W. Piper. 2016. Effects of offshore pile driving on harbour porpoise abundance in the German Bight.

Brookes, K. L., H. Bailey, and P. M. Thompson. 2013. Predictions from harbor porpoise habitat association models are confirmed by long-term passive acoustic monitoring. Journal of the Acoustical Society of America **134**:2523-2533.

Cheney, B., P. M. Thompson, S. N. Ingram, P. S. Hammond, P. T. Stevick, J. W. Durban, R. M. Culloch, S. H. Elwen, L. Mandleberg, V. M. Janik, N. J. Quick, V. Islas-Villanueva, K. P. Robinson, M. Costa, S. M. Eisfeld, A. Walters, C. Phillips, C. R. Weir, P. G. Evans, P. Anderwald, R. J. Reid, J. B. Reid, and B. Wilson. 2013. Integrating multiple data sources to assess the distribution and abundance of bottlenose dolphins Tursiops truncatus in Scottish waters. Mammal Review **43**:71-88.

Christiansen, F., M. Rasmussen, and D. Lusseau. 2013. Whale watching disrupts feeding activities of minke whales on a feeding ground. Marine Ecology Progress Series **478**:239-+.

Cordes, L. S., C. D. Duck, B. L. Mackey, A. J. Hall, and P. M. Thompson. 2011. Long-term patterns in harbour seal site-use and the consequences for managing protected areas. Animal Conservation **14**:430-438.

CSIP. 2015. UK Cetacean Strandings Investigation Programme: Annual Report for the period 1st January – 31st December 2015.

Dähne, M., A. Gilles, K. Lucke, V. Peschko, S. Adler, K. Krugel, J. Sundermeyer, and U. Siebert. 2013. Effects of pile-driving on harbour porpoises (*Phocoena phocoena*) at the first offshore wind farm in Germany. Environmental Research Letters **8**.

Deaville, R., and P. D. Jepson. 2011. UK Cetacean Strandings Investigation Programme. Final Report for the period 1st January 2005 – 31st December 2010. Available at: http://ukstrandings.org/csip-reports/.

Deecke, V. B., P. J. Slater, and J. K. Ford. 2002. Selective habituation shapes acoustic predator recognition in harbour seals. Nature **420**:171-173.

Donovan, C., J. Harwood, S. King, C. Booth, B. Caneco, and C. Walker. 2016. Expert elicitation methods in quantifying the consequences of acoustic disturbance from offshore renewable energy developments. Pages 231-237 The Effects of Noise on Aquatic Life II. Springer.

Dwyer, S., L. Kozmian-Ledward, and K. Stockin. 2014. Short-term survival of severe propeller strike injuries and observations on wound progression in a bottlenose dolphin. New Zealand Journal of Marine and Freshwater Research **48**:294-302.

Dyndo, M., D. M. Wiśniewska, L. Rojano-Doñate, and P. T. Madsen. 2015. Harbour porpoises react to low levels of high frequency vessel noise. Scientific Reports **5**:11083.

ETC/BD. 2014. Article 17 Reporting – Assessments of conservation status at the EU biogeographical level - Public consultation. ETC/BD Technical paper 3/2014, Paris.

Finneran, J. J. 2015. Noise-induced hearing loss in marine mammals: A review of temporary threshold shift studies from 1996 to 2015. The Journal of the Acoustical Society of America **138**:1702-1726.

Götz, T., and V. Janik. 2016. The startle reflex in acoustic deterrence: an approach with universal applicability? Animal Conservation **19**:225-226.

Graham, I. M., B. Cheney, R. C. Hewitt, L. S. Cordes, G. D. Hastie, D. J. F. Russell, M. Arso Civil, P. S. Hammond, and P. M. Thompson. 2016. Strategic Regional Pre-Construction Marine Mammal Monitoring Programme Annual Report 2016. University of Aberdeen.

Graham, I. M., A. Farcas, N. D. Merchant, and P. Thompson. 2017a. Beatrice Offshore Wind Farm: An interim estimate of the probability of porpoise displacement at different unweighted single-pulse sound exposure levels. Prepared by the University of Aberdeen for Beatrice Offshore Windfarm Ltd.

Graham, I. M., E. Pirotta, N. D. Merchant, A. Farcas, T. R. Barton, B. Cheney, G. D. Hastie, and P. M. Thompson. 2017b. Responses of bottlenose dolphins and harbor porpoises to impact and vibration piling noise during harbor construction. Ecosphere **8**.

Guerin, A. J., A. Jensen, and D. Jones. 2007. Artificial reef properties of North Sea oil and gas production platforms. Pages 1-6 *in* OCEANS 2007-Europe. IEEE.

Hammond, P., C. Lacey, A. Gilles, S. Viquerat, P. Börjesson, H. Herr, K. Macleod, V. Ridoux, M. Santos, M. Scheidat, J. Teilmann, J. Vingada, and N. Øien. 2017. Estimates of cetacean abundance in European Atlantic waters in summer 2016 from the SCANS-III aerial and shipboard surveys.

Hammond, P., and L. Wilson. 2016. Grey seal diet composition and prey consumption. Scottish Marine and Freshwater Science **7**:20-47.

Hammond, P. S., K. MacLeod, P. Berggren, D. L. Borchers, L. Burt, A. Cañadas, G. Desportes, G. P. Donovan, A. Gilles, D. Gillespie, J. Gordon, L. Hiby, I. Kuklik, R. Leaper, K. Lehnert, M. Leopold, P. Lovell, N. Øien, C. G. M. Paxton, V. Ridoux, E. Rogan, F. Samarra, M. Scheidat, M. Sequeira, U. Siebert, H. Skov, R. Swift, M. L. Tasker, J. Teilmann, O. Van Canneyt, and J. A. Vázquez. 2013. Cetacean abundance and distribution in European Atlantic shelf waters to inform conservation and management. Biological Conservation **164**:107-122.

Hanke, W., and G. Dehnhardt. 2013. Sensory biology of aquatic mammals. Journal of Comparative Physiology **199**:417.

Harwood, J., and S. King. 2017. The Sensitivity of UK Marine Mammal Populations to Marine Renewables Developments - Revised Version.

Harwood, J., S. King, R. Schick, C. Donovan, and C. Booth. 2013. A Protocol For Implementing The Interim Population Consequences Of Disturbance (PCoD) Approach: Quantifying And Assessing The Effects Of Uk Offshore Renewable Energy Developments On Marine Mammal Populations. Report Number SMRUL-TCE-2013-014. Scottish Marine And Freshwater Science, 5(2). .

Harwood, J., S. King, R. Schick, C. Donovan, and C. Booth. 2014. A Protocol For Implementing The Interim Population Consequences Of Disturbance (PCoD) Approach: Quantifying And Assessing The Effects Of Uk Offshore Renewable Energy Developments On Marine Mammal Populations. Report Number SMRUL-TCE-2013-014. Scottish Marine And Freshwater Science, 5(2).

Hastie, G. D., D. J. Russell, S. Benjamins, S. Moss, B. Wilson, and D. Thompson. 2016. Dynamic habitat corridors for marine predators; intensive use of a coastal channel by harbour seals is modulated by tidal currents. Behavioral Ecology and Sociobiology:1-14.

Hastie, G. D., D. J. F. Russell, B. McConnell, S. Moss, D. Thompson, and V. M. Janik. 2015. Sound exposure in harbour seals during the installation of an offshore wind farm: predictions of auditory damage. Journal of Applied Ecology **52**:631-640.

Heinänen, S., and H. Skov. 2015. The identification of discrete and persistent areas of relatively high harbour porpoise density in the wider UK marine area. JNCC Report No. 544, JNCC, Peterborough.

Hermannsen, L., K. Beedholm, J. Tougaard, and P. T. Madsen. 2014. High frequency components of ship noise in shallow water with a discussion of implications for harbor porpoises (Phocoena phocoena). The Journal of the Acoustical Society of America **136**:1640-1653.

IAMMWG. 2015. Management Units for cetaceans in UK waters. JNCC Report 547, ISSN 0963-8091.

Jensen, A., and G. Silber. 2004. Large Whale Ship Strike Database. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-OPR.

JNCC. 2013. The UK Approach to Assessing Conservation Status for the 2013 EU Habitats Directive Article 17 Reporting. Peterborough.

Jones, E., G. Hastie, S. Smout, J. Onoufriou, N. D. Merchant, K. Brookes, and D. thompson. 2017. Seals and shipping: quantifying population risk and individual exposure to vessel noise. Journal of Applied Ecology.

Kaiser, M. J., D. V. Mesyanzhinov, and A. G. Pulsipher. 2005. Modeling structure removal processes in the Gulf of Mexico. US Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region.

Kastelein, R., S. Van de Voorde, and N. Jennings. 2018. Swimming Speed of a Harbor Porpoise (*Phocoena phocoena*) During Playbacks of Offshore Pile Driving Sounds. Aquatic Mammals **44**:92-99.

Kastelein, R. A., R. Gransier, and L. Hoek. 2013. Comparative temporary threshold shifts in a harbor porpoise and harbor seal, and severe shift in a seal (L). Journal of the Acoustical Society of America **134**:13-16.

Kastelein, R. A., R. Gransier, L. Hoek, A. Macleod, and J. M. Terhune. 2012a. Hearing threshold shifts and recovery in harbor seals (*Phoca vitulina*) after octave-band noise exposure at 4 kHz. Journal of the Acoustical Society of America **132**:2745-2761.

Kastelein, R. A., R. Gransier, L. Hoek, and J. Olthuis. 2012b. Temporary threshold shifts and recovery in a harbor porpoise (*Phocoena phocoena*) after octave-band noise at 4kHz. Journal of the Acoustical Society of America **132**:3525-3537.

Kastelein, R. A., L. Helder-Hoek, S. Van de Voorde, A. M. von Benda-Beckmann, F.-P. A. Lam, E. Jansen, C. A. de Jong, and M. A. Ainslie. 2017. Temporary hearing threshold shift in a harbor porpoise (Phocoena phocoena) after exposure to multiple airgun sounds. The Journal of the Acoustical Society of America **142**:2430-2442.

King, S. L., R. S. Schick, C. Donovan, C. G. Booth, M. Burgman, L. Thomas, and J. Harwood. 2015. An interim framework for assessing the population consequences of disturbance. Methods in Ecology and Evolution **6**:1150-1158.

Laist, D. W., A. R. Knowlton, J. G. Mead, A. S. Collet, and M. Podesta. 2001. Collisions between ships and whales. Marine Mammal Science **17**:35-75.

Lusseau, D. 2013. The cumulative effects of development at three ports in the Moray Firth on the bottlenose dolphin interest of the special area of conservation. Report prepared for Scottish Natural Heritage by the University of Aberdeen.

Macleod, K., M. Burt, A. Cañadas, E. Rogan, B. Santos, A. Uriarte, O. Van Canneyt, J. Vázquez, and P. Hammond. 2009. Design-based estimates of cetacean abundance in offshore European Atlantic waters. Appendix I in the Final Report of the Cetacean Offshore Distribution and Abundance in the European Atlantic.

Marubini, F., A. Gimona, P. G. Evans, P. J. Wright, and G. J. Pierce. 2009. Habitat preferences and interannual variability in occurrence of the harbour porpoise Phocoena phocoena off northwest Scotland. Marine Ecology Progress Series **381**:297-310.

McConnell, B., M. Fedak, P. Lovell, and P. Hammond. 1999. Movements and foraging areas of grey seals in the North Sea. Journal of Applied Ecology **36**:573-590.

McGarry, T., O. Boisseau, S. Stephenson, and R. Compton. 2017. Understanding the Effectiveness of Acoustic Deterrent Devices (ADDs) on Minke Whale (*Balaenoptera acutorostrata*), a Low Frequency Cetacean. ORJIP Project 4, Phase 2. RPS Report EOR0692. Prepared on behalf of The Carbon Trust. November 2017.

Mooney, T. A., P. E. Nachtigall, and S. Vlachos. 2009. Sonar-induced temporary hearing loss in dolphins. Biology Letters:rsbl-2009.

Moray East ES. 2012. Telford, Stevenson, MacColl Wind Farms and associated Transmission Infrastructure Environmental Statement: Technical Appendix 4.4 A Marine Mammals Baseline.

Moray Offshore Renewables Limited. 2016. Environmental Impact Assessment Scoping Report. Western Development Area Offshore Wind Farm Infrastructure: Offshore Wind Turbines, Foundations / Substructures and Inter-Array Cables.

Moray Offshore Renewables Ltd. 2012. Moray Offshore Renewables Limited Environmental StatementTechnical Appendix 7.3 A - Marine Mammals EnvironmentalImpact Assessment. Produced by Natural Power on behalf of Moray Offshore Renewables Ltd.

Moray Offshore Renewables Ltd. 2016. Piling Strategy: Telford, Stevenson and MacColl Offshore Wind Farms – Project 1 Produced by Royal Haskoning DHV on behalf of Moray Offshore Renewables Ltd

Nabe-Nielsen, J., J. Tougaard, J. Teilmann, and S. Sveegaard. 2011. Effects of wind farms on harbour porpoise behaviour and population dynamics.

Nabe-Nielsen, J., F. van Beest, V. Grimm, R. Sibly, J. Teilmann, and P. M. Thompson. 2018. Predicting the impacts of anthropogenic disturbances on marine populations. Conservation Letters.

National Marine Fisheries Service. 2016. Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing: Underwater Acoustic Thresholds for Onset of Permanent and Temporary Threshold Shifts. Page 189. U.S. Department of Commerce, Silver Spring.

New, L. F., J. Harwood, L. Thomas, C. Donovan, J. S. Clark, G. Hastie, P. M. Thompson, B. Cheney, L. Scott-Hayward, and D. Lusseau. 2013. Modelling the biological significance of behavioural change in coastal bottlenose dolphins in response to disturbance. Functional Ecology **27**:314-322.

Palmer, K., K. Brookes, and L. Rendell. 2017. Categorizing click trains to increase taxonomic precision in echolocation click loggers. The Journal of the Acoustical Society of America **142**.

Panjerc, T., S. Robinson, P. Theobald, and L. Galley. 2016. Underwater sound measurement data during diamond wire cutting: first description of radiated noise.*in* The Effect of Noise on Aquatic Life, Dublin.

Parvin, S., J. Nedwell, and E. Harland. 2007. Lethal and physical injury of marine mammals, and requirements for Passive Acoustic Monitoring. Subacoustech Report Reference: 565R0212, February.

Paxton, C., L. Scott-Hayward, M. Mackenzie, E. Rexstad, and L. Thomas. 2016. Revised Phase III Data Analysis of Joint Cetacean Protocol Data Resources.

Paxton, C., L. Scott-Hayward, and E. Rexstad. 2014. Statistical approaches to aid the identification of Marine Protected Areas for minke whale, Risso's dolphin, white-beaked dolphin and basking shark. Scottish Natural Heritage Commissioned Report No. 594., Scottish Natural Heritage Commissioned Report No. 594.

Pierpoint, C. 2008. Harbour porpoise (Phocoena phocoena) foraging strategy at a high energy, near-shore site in south-west Wales, UK. Journal of the Marine Biological Association of the UK **88**:1167-1173.

Pirotta, E., B. E. Laesser, A. Hardaker, N. Riddoch, M. Marcoux, and D. Lusseau. 2013. Dredging displaces bottlenose dolphins from an urbanised foraging patch. Marine Pollution Bulletin **74**:396-402.

Pirotta, E., N. D. Merchant, P. M. Thompson, T. R. Barton, and D. Lusseau. 2015. Quantifying the effect of boat disturbance on bottlenose dolphin foraging activity. Biological Conservation **181**:82-89.

Popov, V. V., A. Y. Supin, V. V. Rozhnov, D. I. Nechaev, and E. V. Sysueva. 2014. The limits of applicability of the sound exposure level (SEL) metric to temporal threshold shifts (TTS) in beluga whales, Delphinapterus leucas. The Journal of Experimental Biology **217**:1804-1810.

Reid, J. B., P. G. Evans, and S. P. Northridge. 2003. Atlas of cetacean distribution in north-west European waters. Joint Nature Conservation Committee.

Richardson, W. 1995. Marine mammals and noise., Toronto: Academic Press.

Robinson, K. P., and M. J. Tetley. 2007. Behavioural observations of foraging minke whales (Balaenoptera acutorostrata) in the outer Moray Firth, north-east Scotland. Journal of the Marine Biological Association of the United Kingdom **87**:85-86.

Robinson, K. P., M. J. Tetley, and E. G. Mitchelson-Jacob. 2009. The distribution and habitat preference of coastally occurring minke whales (Balaenoptera acutorostrata) in the outer southern Moray Firth, northeast Scotland. Journal of Coastal Conservation **13**:39-48.

Russell, D., E. Jones, and C. Morris. 2017. Updated Seal Usage Maps: The Estimated at-sea Distribution of Grey and Harbour Seals. Scottish Marine and Freshwater Science **Vol 8, No 25**.

Russell, D. J., S. M. Brasseur, D. Thompson, G. D. Hastie, V. M. Janik, G. Aarts, B. T. McClintock, J. Matthiopoulos, S. E. Moss, and B. McConnell. 2014. Marine mammals trace anthropogenic structures at sea. Current Biology **24**:R638-R639.

Russell, D. J., G. D. Hastie, D. Thompson, V. M. Janik, P. S. Hammond, L. A. Scott-Hayward, J. Matthiopoulos, E. L. Jones, and B. J. McConnell. 2016. Avoidance of wind farms by harbour seals is limited to pile driving activities. Journal of Applied Ecology.

Russell, D. J., B. T. McClintock, J. Matthiopoulos, P. M. Thompson, D. Thompson, P. S. Hammond, E. L. Jones, M. L. MacKenzie, S. Moss, and B. J. McConnell. 2015. Intrinsic and extrinsic drivers of activity budgets in sympatric grey and harbour seals. Oikos **124**:1462-1472.

Russell, D. J. F., B. McConnell, D. Thompson, C. Duck, C. Morris, J. Harwood, and J. Matthiopoulos. 2013. Uncovering the links between foraging and breeding regions in a highly mobile mammal. Journal of Applied Ecology **50**:499-509.

Santos, M., and G. Pierce. 2003. The diet of harbour porpoise (Phocoena phocoena) in the northeast Atlantic. Oceanography and Marine Biology: an Annual Review **41**:355-390.

Santos, M., G. Pierce, R. Reid, I. Patterson, H. Ross, and E. Mente. 2001. Stomach contents of bottlenose dolphins (Tursiops truncatus) in Scottish waters. Journal of the Marine Biological Association of the United Kingdom **81**:873-878.

Santos, M., G. J. Pierce, J. A. Learmonth, R. Reid, H. Ross, I. Patterson, D. Reid, and D. Beare. 2004. Variability in the diet of harbor porpoises (Phocoena phocoena) in Scottish waters 1992–2003. Marine Mammal Science **20**:1-27.

Scheidat, M., G. Aarts, A. Bakker, S. Brasseur, J. Carstensen, P. Wim van Leeuwen, M. Leopold, T. van Polanen Petel, P. Reijnders, J. Teilmann, J. Tougaard, and H. Verdaat. 2012. Assessment of the effects of the offshore wind farm Egmond aan Zee (OWEZ) for harbour porpoise (comparison T0 and T1).

SCOS. 2016. Scientific Advice on Matters Related to the Management of Seal Populations: 2016.

SCOS. 2017. Scientific Advice on Matters Related to the Management of Seal Populations: 2017.

Scottish Natural Heritage. 2016. Assessing collision risk between underwater turbines and marine wildlife.

Sharples, R. J., J. Matthiopoulos, and P. S. Hammond. 2008. Distribution and movements of harbour seals around the coast of Britain: Outer Hebrides, Shetland, Orkney, the Moray Firth, St Andrews Bay, The Wash and the Thames. Sea Mammal Research Unit, University of St Andrews: 65 pp.

SNH. 2014. Scottish MPA Project: Data confidence assessment: Southern Trench MPA Proposal.

Southall, B. L., A. E. Bowles, W. T. Ellison, J. J. Finneran, R. L. Gentry, C. R. J. Greene, D. Kastak, D. R. Ketten, J. H. Miller, P. E. Nachtigall, W. J. Richardson, J. A. Thomas, and P. L. Tyack. 2007. Marine mammal noise exposure criteria: initial scientific recommendations. Aquatic Mammals **33**:411-414.

Sparling, C. E., J. R. Speakman, and M. A. Fedak. 2006. Seasonal variation in the metabolic rate and body composition of female grey seals: fat conservation prior to high-cost reproduction in a capital breeder? Journal of Comparative Physiology B **176**:505-512.

Sveegaard, S., J. Teilmann, P. Berggren, K. N. Mouritsen, D. Gillespie, and J. Tougaard. 2011. Acoustic surveys confirm the high-density areas of harbour porpoises found by satellite tracking. ICES Journal of Marine Science **68**:929-936.

Teilmann, J., C. T. Christiansen, S. Kjellerup, R. Dietz, and G. Nachman. 2013. Geographic, seasonal, and diurnal surface behavior of harbor porpoises. Marine Mammal Science **29**:E60-E76.

Teilmann, J., F. Larsen, and G. Desportes. 2007. Time allocation and diving behaviour of harbour porpoises (Phocoena phocoena) in Danish and adjacent waters. Journal of Cetacean Research and Management **9**:201-210.

Tetley, M., E. Mitchelson-Jacob, and K. Robinson. 2008. The summer distribution of coastal minke whales (Balaenoptera acutorostrata) in the southern outer Moray Firth, NE Scotland, in relation to co-occurring mesoscale oceanographic features. Remote Sensing of Environment **112**:3449-3454.

Thompson, P., K. Brookes, B. Cheney, H. Bates, N. Richardson, and T. Barton. 2011. Assessing the potential impact of oil and gas exploration operations on cetaceans in the Moray Firth. Second year report to DECC, Scottish Government, COWRIE and Oil & Gas UK.

Thompson, P., K. Brookes, B. Cheney, A. Cândido, H. Bates, N. Richardson, and T. R. Barton. 2010. Assessing the potential impacts of oil and gas exploration operations on cetaceans in the Moray Firth. First year report to DECC, Scottish Government, COWRIE and Oil & Gas UK.

Thompson, P., G. Hastie, J. Nedwell, R. Barham, A. G. Brooker, K. L. Brookes, L. Cordes, H. Bailey, and N. McLean. 2012. Framework for assessing the impacts of pile-driving noise from offshore wind farm construction on Moray Firth harbour seal populations.

Thompson, P., B. McConnell, and D. Tollit. 1996. Comparative distribution, movements and diet of harbour and grey seals from the Moray Firth, NE Scotland. Oceanographic Literature Review **6**:622.

Thompson, P. M., K. L. Brookes, and L. S. Cordes. 2014. Integrating passive acoustic and visual data to model spatial patterns of occurrence in coastal dolphins. ICES Journal of Marine Science:11.

Thompson, P. M., G. D. Hastie, J. Nedwell, R. Barham, K. L. Brookes, L. S. Cordes, H. Bailey, and N. McLean. 2013. Framework for assessing impacts of pile-driving noise from offshore wind farm construction on a harbour seal population. Environmental Impact Assessment Review **43**:73-85.

Thompson, P. M., A. Mackay, D. J. Tollit, S. Enderby, and P. S. Hammond. 1998. The influence of body size and sex on the characteristics of harbour seal foraging trips. Canadian Journal of Zoology **76**:1044-1053.

Thompson, P. M., D. J. Tollit, D. Wood, H. M. Corpe, P. S. Hammond, and A. Mackay. 1997. Estimating harbour seal abundance and status in an estuarine habitat in north-east Scotland. Journal of Applied Ecology **34**:43-52.

Thomsen, F., K. Lüdemann, R. Kafemann, and W. Piper. 2006. Effects of offshore wind farm noise on marine mammals and fish. Biola, Hamburg, Germany on behalf of COWRIE Ltd **62**.

Tollit, D., A. Black, P. Thompson, A. Mackay, H. Corpe, B. Wilson, S. Parijs, K. Grellier, and S. Parlane. 1998. Variations in harbour seal Phoca vitulina diet and dive-depths in relation to foraging habitat. Journal of Zoology **244**:209-222.

van Beest, F. M., J. Teilmann, L. Hermannsen, A. Galatius, L. Mikkelsen, S. Sveegaard, J. D. Balle, R. Dietz, and J. Nabe-Nielsen. 2018. Fine-scale movement responses of free-ranging harbour porpoises to capture, tagging and short-term noise pulses from a single airgun. Royal Society Open Science **5**:170110.

Van Waerebeek, K., A. N. Baker, F. Félix, J. Gedamke, M. Iñiguez, G. P. Sanino, E. Secchi, D. Sutaria, A. van Helden, and Y. Wang. 2007. Vessel collisions with small cetaceans worldwide and with large whales in the Southern Hemisphere, an initial assessment. Latin American Journal of Aquatic Mammals **6**:43-69.

Vanderlaan, A. S., and C. T. Taggart. 2007. Vessel collisions with whales: the probability of lethal injury based on vessel speed. Marine Mammal Science **23**:144-156.

Watkins, W. A. 1986. Whale reactions to human activities in Cape Cod waters. Marine Mammal Science **2**:251-262.

Williamson, L., K. Brookes, B. Scott, I. Graham, and P. Thompson. 2017. Diurnal variation in harbour porpoise detection potential implications for management. Marine Ecology Progress Series **570**:223-232.

Williamson, L. D., K. L. Brookes, B. E. Scott, I. M. Graham, G. Bradbury, P. S. Hammond, and P. M. Thompson. 2016. Echolocation detections and digital video surveys provide reliable estimates of the relative density of harbour porpoises. Methods in Ecology and Evolution **7**:762-769.

Wilson, L., and P. Hammond. 2015. Harbour seal diet composition and diversity. Marine Mammal Scientific Support Research Programme MMSS/001/11 CSD 3.2. Report to the Scottish Government.

Wisniewska, D. M., M. Johnson, J. Teilmann, L. Rojano-Doñate, J. Shearer, S. Sveegaard, L. A. Miller, U. Siebert, and P. T. Madsen. 2016. Ultra-high foraging rates of harbor porpoises make them vulnerable to anthropogenic disturbance. Current Biology **26**:1441-1446.

Wisniewska, D. M., M. Johnson, J. Teilmann, U. Siebert, A. Galatius, R. Dietz, and P. T. Madsen. 2018. High rates of vessel noise disrupt foraging in wild harbour porpoises (Phocoena phocoena). Page 20172314 *in* Proc. R. Soc. B. The Royal Society.

Zawawi, N. W. A., M. Liew, and K. Na. 2012. Decommissioning of offshore platform: A sustainable framework. Pages 26-31 *in* Humanities, Science and Engineering (CHUSER), 2012 IEEE Colloquium on. IEEE.

MORAY WEST OFFSHORE WINDFARM

Offshore EIA Report

Moray Offshore Windfarm (West) Limited

Chapter 10 Offshore Ornithology

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Acronyms	
Acronym	**Expanded Term**
BDMPS	Biologically Defined Minimum Population Scale
BOWL	Beatrice Offshore Windfarm Limited
BTO	British Trust for Ornithology
CIEEM	Chartered Institute of Ecology and Environmental Management
COWRIE	Collaborative Offshore Wind Research into the Environment
DAS	Digital Aerial Survey
DCO	Development Consent Order
DECC	Department for Energy and Climate Change
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
ES	Environmental Statement
EU	European Union
EWG	Expert Working Group
FAME	Future of the Atlantic Marine Environment
HRA	Habitats Regulations Assessment
HVAC	High Voltage Alternating Current
JNCC	Joint Nature Conservation Committee
LAT	Lowest Astronomical Tide
MCA	Maritime and Coastguard Authority
MHWS	Mean High Water Spring
MPCP	Marine Pollution & Contingency Plan
MSS	Marine Scotland Science
OSP	Offshore Substation Platform
OSPAR	Convention for the Protection of the Marine Environment of the North-east Atlantic
PCH	Potential Collision Height
PEIR	Preliminary Environmental Information Report
pSPA	Potential Special Protection Area
RIAA	Report to Inform Appropriate Assessment
RSPB	Royal Society for the Protection of Birds
SD	Standard Deviation
SMP	Seabird Monitoring Programme
SNCB	Statutory Nature Conservation Body
SNH	Scottish Natural Heritage
SPA	Special Protection Area

Acronyms	
Acronym	**Expanded Term**
SSSI	Site of Special Scientific Interest
VMP	Vessel Management Plan
Valued Ornithological Receptor	Valued Ornithological Receptor
WTG	Wind Turbine Generator
ZoI	Zone of Influence

Glossary of Terms	
Term	**Definition**
Bathymetry	The measurement of water depth in oceans, seas and lakes
Birds Directive	European Parliament and Council Directive 2009/147/EC on the conservation of wild birds – a key legislative measure for the protection of birds in the European Union
Environmental Statement	Includes relevant information required to assess the likely significant environmental effects of the development listed
Mean High Water Spring (MHWS)	The height of mean high water during spring tides in a year.
Statutory Nature Conservation Bodies	Comprised of JNCC, Natural Resources Wales, Department of Agriculture, Environment and Rural Affairs/Northern Ireland Environment Agency, Natural England and Scottish Natural Heritage these agencies provide advice in relation to nature conservation to government

10 Offshore Ornithology

10.1 Introduction

10.1.1.1 This chapter considers the likely significant effects associated with the construction, operation and decommissioning of Moray West Offshore Wind Farm and associated Offshore Transmission Infrastructure (OfTI) ("the Development") on bird species occurring offshore (seaward of Mean High Water Spring (MHWS)). The likely significant effects on bird species occurring landward of MHWS are considered separately in the Onshore EIA Report, prepared in support of the application for Planning Permission in Principle (PPiP) for the Onshore Transmission Infrastructure (OnTI).

10.1.1.2 The specific objectives of the chapter are to:

- Identify the relevant planning legislation and policy relevant to offshore ornithology;
- Detail the consultation relevant to offshore ornithology that has informed this assessment;
- Describe the offshore ornithological baseline;
- Describe the assessment methodology and significance criteria used in completing the impact assessment;
- Describe the potential effects, including direct, indirect and cumulative effects;
- Describe the mitigation measures proposed to address likely significant effects; and
- Assess the residual effects remaining following the implementation of mitigation.

10.1.1.3 The assessment has been carried out by Ian Ellis MCIEEM, Tristan Folland CBiol and Matthew Hazleton GradCIEEM of NIRAS Consulting ltd. NIRAS provide both project management and expert advice services for marine plans and projects. NIRAS have extensive experience in the provision expert advice and technical support on a range of environmental issues, including ornithology. This includes lead authorship of offshore ornithology EIA Reports / ES chapters in addition to Habitats Regulations Appraisal (HRA) for a number of (more than ten) offshore wind farm developments in the UK.

10.1.1.4 An Habitat Regulations Appraisal (HRA) has been carried out in parallel to the EIA. The results from the HRA are presented in a Report to Inform and Appopriate Assessment (RIAA). This RIAA will be submitted with the EIA Report to Scottish Ministers as part of the Sectoin 36 and Marine Licence Applications for the Development.

10.1.1.5 This chapter is supported by the following documents:

- Technical Appendix 10.1: Ornithology Technical Report and Annex 10.1A: Baseline Data Decision Support System (DSS) Analysis;
- Technical Appendix 10.2: Ornithology Collision Risk Modelling;
- Technical Appendix 10.3: Ornithology Displacement; and
- Report to Inform an Appropriate Assessment (RIAA) Technical Appendix 4.2: Phenology and Apportioning.

10.1.1.6 The aims and objectives of each document pertaining to offshore ornithology are described in Table 10.1.1.

Table 10.1.1: Offshore Ornithology Technical Appendices – Document Aims and Objectives		
Document Reference	**Title**	**Aims and objectives**
10.1	Ornithology Technical Report	Presents baseline data collected by the aerial survey programme at Moray West. Identifies value of species and populations (i.e. Valued Ornithological Receptors) that require assessment in the EIA.
10.1A	Ornithology Technical Report Annex: Baseline Data Decision Support System (DSS)	Presents Moray West aerial survey data in context of historical data collected in the Moray Firth. Follows a step wise process to select appropriate baseline data from all sources presented in order to populate impact assessment analyses.
10.2	Collision Risk Modelling	Takes appropriate baseline data from Appendix 10.1 – Annex 10.1A suitable for collision risk analyses. Provides model outputs for key species accounting for worst case project design parameters and appropriate seabird biometric information.
10.3	Displacement	Takes appropriate baseline data from Appendix 10.1 – Annex 10.1A suitable for displacement analyses. Provides matrix outputs for key species accounting for worst case project design parameters and agreed displacement / mortality rates.
RIAA Technical Appendix 4.4	Phenology and Apportioning	Provides an overview of seabird population structure in vicinity of Moray West. Concludes appropriate apportioning rates for predicted impacts from Moray West to source seabird colonies.
10	Environmental Assessment (this chapter)	Provides a legislative framework for assessing impacts on offshore ornithological receptors. Takes information gathered in all technical appendices (primarily appendixes 10.2 and 10.3) and assesses the significance of predicted impacts from Moray West alone and cumulatively with other projects.

10.2 Legislation, Policy and Guidance Framework

10.2.1.1 Potential effects on offshore birds are assessed in the context of the following:

- The potential for the Development to adversely affect qualifying ornithological features of nearby designated sites (Special Protection Areas (SPAs), proposed Special Protection Areas (pSPAs), Sites of Special Scientific Interest (SSSIs) and Ramsar sites);
- The potential for the Development to adversely affect seabirds of highest conservation concern, listed on Annex I of the Birds Directive and/or Schedule 1 of the Wildlife and Countryside Act 1981 (as amended); and
- The potential for the Development to adversely affect other species in internationally, nationally, or regionally important numbers, overwinter, during migration, or whilst commuting locally between foraging and breeding grounds.

10.2.1.2 Information on relevant legislation and Scottish Government policy and strategy documents, in particular policy 'Renewables 5' of Scotland's National Marine Plan (NMP), are described below.

10.2.2 Relevant Legislation

10.2.2.1 Key legislation is summarised in Table 10.2.1 below.

Table 10.2.1: Relevant Legislation to Offshore Ornithology Considered	
Legislation Reference	**Legislation Detail**
The Conservation of Offshore Marine Habitats and Species Regulations 2017	
Part 2	Implements Article 6(3) and 6(4) of the Habitats Directive beyond 12 nm making it a requirement for: • A competent authority before deciding to undertake, or give any consent, permission or other authorisation for a relevant plan or project must make an appropriate assessment of the implications for the site in view of that site's conservation objectives. A relevant plan or project plan is one which is likely to have a significant effect on a European offshore marine site or a European site (either alone or in combination with other plans or projects) and is not directly connected with or necessary to the management of the site. A person applying to a competent authority for any such consent, permission or other authorisation shall provide such information as the competent authority may reasonably require for the purposes of the assessment.
Conservation (Natural Habitats, &c.) Regulations 1994 (as amended in Scotland) [Conservation of Habitats and Species Regulations 2010 in relation to certain specific activities]	
Part IV	Implements Article 6(3) and 6(4) of the European Parliament Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (the 'Habitats Directive') in Scotland and within 12 nm making it a requirement for: • A competent authority — before deciding to undertake, or give any consent, permission or other authorisation for a plan or project which is likely to have a significant effect on a European site in Great Britain or a European offshore marine site (either alone or in combination with other plans or projects) and that is not directly connected with or necessary to the management of the site — shall make an appropriate assessment of the implications for the site in view of that site's conservation objectives. A person applying for any such consent, permission or other authorisation shall provide such information as the competent authority may reasonably require for the purposes of the assessment.
Wildlife and Countryside Act 1981 (as amended in Scotland)	
Part 1	Implements Article 1 and 5 of the European Parliament Council Directive 2009/147/EC on the conservation of wild birds (the 'Birds Directive') making it an offence to intentionally or recklessly: • Kill, injure or take any wild bird; • Take, damage, destroy or otherwise interfere with the nest of any wild bird while that nest is in use or being built; • At any other time take, damage, destroy or otherwise interfere with any nest habitually used by any wild bird included in Schedule A1; • Harasses any wild bird included in Schedule 1A; and • Obstruct or prevent any wild bird from using its nest. Take or destroy an egg of any wild bird.
Nature Conservation (Scotland) Act 2004 (as amended)	
Part 2	Makes it an offence for a public body or office-holder to carry out or cause or permit to carry out any operation which is likely to damage any natural feature specified in a SSSI notification except, *inter alia*, with the written consent of SNH given on an application. Public body includes a statutory undertaker.

Designated Sites

10.2.2.2 The key international conventions promoting the conservation of birds are the Convention on Wetlands of International Importance especially as Waterfowl Habitat (the 'Ramsar Convention'), the Convention on the Conservation of Migratory Species of Wild Animals (the 'Bonn Convention') and the Convention on the Conservation of European Wildlife and Natural Habitats (the 'Bern Convention').

10.2.2.3 The Ramsar Convention allows contracting parties to the convention to designate suitable wetlands within their own territory for inclusion in the 'List of Wetlands of International Importance' (the List). Contracting parties are required to incorporate into their planning the conservation of the areas included in the List.

10.2.2.4 Within the European Union, the key legislative measures providing for the protection of birds are Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds (the 'Birds Directive') and Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora (the 'Habitats Directive').

10.2.2.5 The Birds Directive aims to maintain the populations of wild bird species across their natural range and allows for the designation of SPAs for rare and vulnerable species listed in Annex I of the Directive and regularly occurring migratory birds.

10.2.2.6 The Habitats Directive promotes the maintenance of biodiversity by requiring Member States to maintain or restore natural habitats and wild species listed in the Annexes to the Directive and by introducing protection for habitats and species of European importance. The Habitats Directive contributes to a coherent European ecological network of protected sites by designating Special Areas of Conservation (SACs) for habitats listed on Annex I and for species listed on Annex II of the Directive. Together, SACs and SPAs create a Europe-wide network of designated sites known as Natura 2000.

10.2.2.7 The Habitats Directive and Birds Directives have been transposed into UK legislation through the Conservation of Habitats and Species Regulations 1994 (as amended) (the 'Habitats Regulations') and the Offshore Marine Habitats, and Species Regulations 2017 (the 'Offshore Habitats Regulations'). These Regulations allow for the designation of SACs and SPAs and set out a mechanism for the protection of those sites.

10.2.2.8 A separate assessment of the effects of the Development on European sites (SACs and SPAs) has been carried out in parallel to this EIA in accordance with the Habitats Regulations. Findings from this Habitats Regulations Appraisal (HRA) are presented in the Moray West Offshore Wind Farm and OfTI Report to Inform an Appopriate Assessment (RIAA) which will be submitted with the Offshore EIA Report as part of the Marine Licence and Section 36 Consent applications for the Development.

International Conventions

10.2.2.9 The Bonn Convention provides for contracting parties to work together to conserve migratory species and their habitats by providing strict protection for endangered migratory species (listed in Appendix I of the Convention), by concluding multilateral agreements for the conservation and management of migratory species which require or would benefit from international cooperation (listed in Appendix II), and by undertaking cooperative research activities.

10.2.2.10 The Bern Convention aims to ensure conservation and protection of wild plant and animal species and their natural habitats (listed in Appendices I and II of the Convention). It also aims to increase cooperation between contracting parties and regulate the exploitation of those species (including migratory species) listed in Appendix III.

10.2.3 Relevant Policy

10.2.3.1 In Scotland, biodiversity related policy and strategy documents implement international commitments to biodiversity, including birds in the marine environment. These international biodiversity commitments are included in:

- The European Biodiversity Strategy for 2020 — setting out six targets and 20 actions to halt the loss of biodiversity and ecosystem services in the EU;
- The United Nations' (UN) Convention on Biological Diversity; including the 'Aichi' biodiversity targets;
- The Convention for the Protection of the Marine Environment of the North-East Atlantic (the OSPAR Convention);
- The Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention); and
- 'Scotland's Biodiversity: It's in Your Hands' together with '2020 Challenge for Scotland's Biodiversity' together comprise the Scottish Biodiversity Strategy. The strategy, by implementing international biodiversity commitments, seeks to:
  - Halt the loss of biodiversity and continue to reverse previous losses; and
  - Protect, restore and enhance biodiversity.

10.2.3.2 The Scottish Biodiversity Strategy aims are subsequently included in the National Marine Plan. The Marine (Scotland) Act 2010 required Scottish Ministers to prepare and adopt a national marine plan for the Scottish marine area. The plan states the policies for, amongst other things, sustainable development in the Scottish marine area. The key policies relevant to sustainable wind energy developments and birds in the marine environment are provided in Table 10.2.2.

Table 10.2.2: Relevant Scotland National Marine Plan Policies

Policy Reference	Policy Issue
Renewables 5	Renewable energy projects must demonstrate compliance with Environmental Impact Assessment and Habitats Regulations Appraisal legislative requirements.
Renewables 6	Cable and network owners and marine users should ensure a co-ordinated and strategic approach to development and activities to minimise impacts on the marine natural environment.
Renewables 9	Marine planners and decision makers should support the development of joint research and monitoring programmes for offshore wind and marine renewables energy development.

10.2.3.3 Scottish Planning Policy (February 2010) is that that sites designated under the Ramsar Convention are also European sites and/or Sites of Special Scientific Interest (SSSI) and are protected under the relevant statutory regimes. Therefore, where the qualifying interest features of Ramsar sites correspond with those of overlapping European sites, "there is no need to consider them separately" (Scottish Government, 2011).

10.2.4 Relevant Guidance

10.2.4.1 The principal guidance documents used to inform the assessment of potential impacts on ornithology are given in Table 10.2.3. A literature review was undertaken to provide information on the bird interests of the Moray West Offshore Wind Farm (see study area defined in Section 10.4.1) and its importance in a regional, national and international context. This review included general seabird ecology, migration behaviour, population sizes and conservation status, particularly in the Moray Firth, the North Sea, and Britain as a whole.

Table 10.2.3: Summary of Key Guidance and Reference Documents Consulted for Moray West			
Title	**Source**	**Year**	**Author**
JNCC Online SPA standard data forms for Natura 2000 sites.	http://jncc.defra.gov.uk/page-1400	Multiple	Multiple
Existing offshore wind farm Environmental Statements and Monitoring Reports.	Multiple	Multiple	Multiple
Moray West Scoping Opinion.	Scoping Response from Marine Scotland	Multiple	Multiple
Wetland Bird Survey (WeBS) Annual Reports and Report Online Interface.	Wetland Bird Survey partnership	Multiple	Multiple
British Trust for Ornithology (BTO) online profiles of birds occurring in Britain and Ireland, BirdFacts.	British Trust for Ornithology	2016	Robinson
Biologically appropriate, species-specific, geographically non-breeding season population estimates for seabirds.	Natural England	2015	Furness
At-Sea Turnover of Breeding Seabirds	Marine Scotland	2015	Searle *et al.*
Population consequences of displacement from proposed offshore wind energy developments for seabirds breeding at Scottish SPAs	Marine Scotland	2014	Searle *et al.*
Population estimates of birds in Great Britain and the UK.	British Birds journal	2013	Musgrove *et al.*
Survey data and technical report on the baseline ornithological studies and the impact assessments relating to the Moray East Offshore Wind Farm.	Moray East	2012	Moray Offshore Renewables Ltd
Seabird foraging ranges as a preliminary tool for identifying candidate Marine Protected Areas.	British Trust for Ornithology	2012	Thaxter *et al.*
Assessing the risk of offshore wind farm development to migratory birds designated as features of UK SPAs.	Strategic Ornithological Support Services	2012	Wright *et al.*
An analysis of the numbers and distribution of seabirds within the British Fishery Limit aimed at identifying areas that qualify as possible marine SPAs.	JNCC	2010	Kober *et al.*
A review of assessment methodologies for offshore wind farms.	British Trust for Ornithology	2009	Maclean *et al.*
The Migration Atlas.	British Trust for Ornithology	2002	Wernham *et al.*
Atlas of seabird distribution in northwest European waters.	JNCC	1995	Stone *et al.*
East Caithness Cliffs SPA gull Tracking Report 2014.	University of Exeter	2014	Archibald *et al.*
Beatrice Offshore Wind Farm – Ornithology Technical report.	BOWL	2012	RPS

Table 10.2.3: Summary of Key Guidance and Reference Documents Consulted for Moray West			
Title	**Source**	**Year**	**Author**
A handbook on environmental impact assessment: Guidance for Competent Authorities, Consultees and others involved in the Environmental Impact Assessment Process in Scotland.	SNH	2013	SNH
Barriers to movement: Modelling energetic costs of avoiding marine wind farms amongst breeding seabirds.	Marine Pollution Bulletin	2010	Masden *et al.*
Developing guidance on ornithological cumulative impact assessment for offshore windfarm developers.	COWRIE	2009	King *et al.*
Developing an avian collision risk model to incorporate variability and uncertainty.	Scottish Marine and Freshwater Science Report	2015	Masden *et al.*
Mapping Seabird Sensitivity to Offshore Wind Farms.	PLOS ONE Journal	2014	Bradbury *et al.*
Non-breeding season populations of seabirds in UK waters.	Natural England	2015	Furness
Joint SNCB Interim Displacement Guidance Note.	JNCC	2017	JNCC *et al.*

10.3 Consultation

10.3.1.1 Moray West has framed its assessment of potential effects on offshore ornithology through consultation with key stakeholders.

10.3.1.2 Table 10.3.1 details the key issues raised in relation to offshore ornithology in the Moray West Offshore Wind Farm Scoping Opinion (August 2016) and the OfTI Scoping Opinion (August 2017) and summarises other issues / concerns that have been raised during additional consultation activities undertaken as part of the EIA process and how these have been addressed in the preparation of this EIA Report.

Table 10.3.1: Summary of Consultation Relating to Offshore Ornithology		
Consultee and Date	**Issue Raised**	**Moray West Approach**
Wind Farm Scoping Responses		
Moray West Offshore Wind Farm Scoping Report SNH and JNCC joint Scoping Response - advice Scottish Ministers - August 2016	Currently, in respect of SPA breeding colonies, the HRA assessment has focused on the breeding season as the period of key concern where there could be significant impacts on SPA breeding populations. The consequences of impacts outwith the breeding season are less clearly understood and further discussions with Marine Scotland are required on ornithological interests to be scoped in or out, reference populations and assessment approaches for HRA, EIA and CIA	A quantitative non-breeding season assessment is presented in this EIA Report where data is available followed agreed approach broadly following geographical scales defined in Furness (2015).

Table 10.3.1: Summary of Consultation Relating to Offshore Ornithology		
Consultee and Date	**Issue Raised**	**Moray West Approach**
	processes as part of the pre-application discussions.	
	Moray Firth pSPA - It is possible that disturbance of birds within the pSPA may need to be considered in relation to vessel movements and/or placement of the export cable. These issues should be further considered, if necessary, as part of any HRA and/or in relation to any subsequent scoping consultation for the offshore transmission works.	The potential impacts of disturbance from Moray West's transmission infrastructure on qualifying features of the Moray Firth pSPA are assessed in this EIA Report (see Section 10.7.1).
	Migratory species - A strategic assessment provides an overall estimate of collision risk that Scottish offshore wind farms may present to birds on migration, and SNH have confidence in the outputs for non-seabird migratory interests such as wildfowl and waders. While Moray West is not explicitly addressed in the assessment, SNH note that the modelling was done on a worst case basis, and considered there to be sufficient "flex" in the report to indicate that any potential impacts from Moray West lie well within the level of strategic collision risk that's been advised for migratory (non-seabird) interests.	This advice is accounted for with respect to the species assessed in the EIA Report (Section 10.7.2).
	Moray West intend to undertake a single year of survey work and will also undertake environmental co-variate modelling in order to make predictions about seabird, based on all available seabird data collected for the Moray Firth . JNCC and SNH confirmed that they think there is merit in this approach (reference in scoping to an email, 27th April 2016).	The final outputs of the approach applied are detailed in Volume 4 – Technical Appendix 10.1 - Annex 10.1A.
	Seabird sensitivity - there have been some updates in relation to guidance on seabird sensitivity to offshore wind development, Wade *et al.,* (2016) is the most up-to-date reference to use.	This guidance has been referenced throughout the EIA Report.
	Apportioning - SNH/JNCC advised that predicted impacts will need to be apportioned between the breeding colonies (SPA and other) within foraging range. They were also aware that Marine Scotland has commissioned a project on apportioning which is currently underway. Depending on timescales and outputs, this may need further discussion in respect of the assessments for Moray West.	The full apportioning approach applied in the HRA is detailed in RIAA Technical Appendix 4.2: Phenology and Apportioning. The tool for apportioning commissioned by Marine Scotland has not at the time of writing been published and is not applied.

Table 10.3.1: Summary of Consultation Relating to Offshore Ornithology		
Consultee and Date	**Issue Raised**	**Moray West Approach**
	Collision risk – welcome the proposed use of Masden (2015) in the assessment.	As highlighted by stakeholders, errors have prevented the current use of Masden (2015) in this EIA Report (see Section 10.7.2.86) An additional stochastic CRM model commissioned by Marine Scotland is not yet available for use in this EIA Report. The Moray West assessment is therefore based on Band (2012) which is consistent with all other recent projects.
	Displacement - There has been extensive discussion of methods to address seabird displacement, particularly at the workshop held 6 & 7 May 2015. Following this, the SNCBs have been working together to produce joint guidance on assessing seabird displacement, due to be published shortly.	The published guidance (JNCC *et al.*, 2015) has been applied throughout the assessment of displacement in this EIA Report in addition to Volume 4 – Technical Appendix 10.3: Ornithology Displacement.
Moray West Offshore Wind Farm Scoping Report MSS scoping advice to Scottish Ministers August 2016	Discussion with SNH, JNCC and MSS regarding how the Masden (2015) version of the Band Collision Risk Model will be used to estimate the number of collisions, and how these outputs will be used, is strongly advised. Similarly, discussion with SNH, JNCC and MSS on the PVA approaches to be used to assess population level consequences of estimated effects should take place. The analyses of the various seabird data sets available for the area have the potential to be complex and challenging due to the varying methods used, spatial and temporal scales of survey, and ages of data. Regular updates on progress made and challenges encountered, alongside discussions on how the outputs could/ will be used should therefore take place with SNH, JNCC and MSS.	As highlighted by stakeholders, errors have prevented the current use of Masden (2015) in this EIA Report. An additional stochastic CRM model commissioned by Marine Scotland is not yet available for use in this EIA Report. The Moray West assessment is therefore based on Band (2012). Full details of the CRM approach are presented in Volume 4 – Technical Appendix 10.2: Ornithology Collision Risk Modelling. PVA approaches applied are presented in Appendix 4.3 to the RIAA. Outputs of the processes applied to characterise the ornithological baseline are given in Appendices 10.1 and 10.1A
Moray West Offshore Wind Farm Scoping Report Royal Society for the Protection of Birds response to Scoping Opinion	RSPB strongly recommend that the "draft" Moray Firth marine SPA now (pSPA) should also be included in the assessment.	Features of the Moray Firth pSPA are assessed within this EIA Report (see Section 10.7.1) while the site is fully assessed within the HRA Report.
	RSPB consider that the sites with the potential to be most significantly affected, and thus meriting the greatest attention in the ES and HRA Report	All SPA considered relevant in the breeding and non-breeding

Table 10.3.1: Summary of Consultation Relating to Offshore Ornithology		
Consultee and Date	**Issue Raised**	**Moray West Approach**
August 2016	SPAs classified for breeding seabirds, with those closest to the project being those most likely to be affected, but with effects also possible to sites further afield, depending on the foraging range of qualifying species.	seasons are assessed within the HRA Report.
	Consideration should also be given to Wade *et al.* (2016) as well as Furness *et al.* (2013) when assessing sensitivity to disturbance.	This reference forms a core source of defining sensitivity within this EIA Report.
	Any Population Viability Analysis or similar model-based population-level assessment of impact should be interpreted in light of Cook *et al.* (2015, 2016) and Green *et al.* (2016), all listed in our comment on Section 3.6.1 above.	Appendix 4.3 to the RIAA presents the approach and results of PVA. This has followed guidance from these references.
	If possible, data on flight speed should be collected during aerial survey.	It was not possible to collect flight speed data from the digital aerial survey programme. More contemporary information on flight speed (Skov *et al.,* 2018) is discussed and applied within this EIA Report (see Section 10.7.2).
Moray West Offshore Transmission Infrastructure (OfTI) Scoping Report Scottish Ministers - Scoping Opinion August 2017	The Scottish Ministers agree with the effects highlighted in the Scoping Report and the proposal to scope them in and out of the EIA assessment accordingly. Potential disturbance to waterfowl and waders is considered by SNH as a key ornithological impact associated with the export cable and landfall and both RSPB and SNH noted the indirect impact on seabirds from potential impact to their prey species. SNH and RSPB also highlighted the need to assess impacts on species and habitats associated with the Moray Firth pSPA and others sites. SNH further highlighted the consideration of offshore substation lighting requirements in respect of seabirds would be welcome. RSPB suggested contacting Aberdeenshire Bird Recorder and nesBREC for most up to date records in the Landfall Area.	The impacts on key species potentially affected by offshore transmission infrastructure are assessed in this EIA Report including the effects of lit structures (see Section 10.7.1).
Moray West Offshore	SNH to confirm reference populations for puffin and other relevant species to Marine Scotland, for subsequent issue to Moray West.	These reference populations have been applied in this EIA Report.

Table 10.3.1: Summary of Consultation Relating to Offshore Ornithology		
Consultee and Date	**Issue Raised**	**Moray West Approach**
Transmission Infrastructure (OfTI) Scoping Report Meeting with MS-LOT, MSS and SNH (March 2017)	All agreed that 1-year of aerial survey data, contextualised using existing data, is a valid basis for proceeding with the approach set out in information provided by Moray West, assuming the aerial data does not identify anything unusual. All agreed that gathering of additional baseline data will not necessarily result in improved impact assessment.	The outcome of this process is summarised in Annex10.1A.
Consultations Subsequent to Wind Farm Scoping Responses		
Meeting with MS-LOT, MSS and SNH (August 2017)	MSS and SNH confirmed the list of key bird species to be assessed (guillemot, fulmar, gannet, puffin, razorbill, kittiwake, herring gull and great back-backed gull).	All species included as Valued Ornithological Receptor in the EIA Report and assessed in the HRA.
	Use of Johnston *et al.* for provision of flight heights as long further narrative is provided and a comparison is undertaken with the 2010/2011 boat based data. All agreed Options 2 and 3 of the proposal to be progressed.	Options 1, 2 and 3 are presented in Volume 4 – Technical Appendix 10.2. The assessment of collision impacts is based on options 2 or 3.
	SNH requested further model refinement on baseline characterisation and for provision of further information on co-variates and uncertainty maps. SNH & MSS to collate a series of questions on the modelling approach and model diagnostics.	Further information was provided to MSS and SNH. This approach was subseqnuently superseded by the Decision Support System (DSS) described in Technical Appendix 10.1 – Annex 10.1A (Volume 4).
Meeting with RSPB (September 2017)	RSPB content with principle of approach to baseline characterisation and will confirm this following receipt of the Moray West Ornithology Baseline Characterisation Report.	As above – approach to baseline characterisation updated with DSS (Technical Appendix 10.1 – Annex 10.1A (Volume 4)).
	RSPB advocate the use of newly emerging assessment tools, noting that there is a cut off in terms of when these can still be applied to the Moray West assessment.	None of the tools commissioned by MSS and others Relevant to offshore wind farm impact assessment are available at the time of writing. In line with an agreed approach with MS-LOT these have not therefore been applied to this EIA Report.
	RPSB acknowledged that the aerial survey flight height data is not suitable to inform collision risk modelling.	Generic flight height data for Option 2 and historic boat-based data from Moray East for options 1 and 3 are applied in Volume 4 – Technical Appendix 10.2.
Meeting with MSS and SNH (January 2018)	Meeting with SNH and MSS to present Decision Support System (DSS) for use to determine inter-annual variability as part of baseline characterisation for the Moray West Site. The DSS compared the point density estimates from the Moray West DVAS data with the	Further information on the DSS and outputs from the application of the DSS is provided in Volume 4 – Technical Appendix 10.1 – Annex 10.1A.

Table 10.3.1: Summary of Consultation Relating to Offshore Ornithology		
Consultee and Date	**Issue Raised**	**Moray West Approach**
	corresponding upper and lower confidence interval from other data sources in other years (e.g. Moray East boat surveys and BOWL pre-construction digitial aerial surveys. The DSS then provided a recommended density value to use, which was then extrapolated to the Moray West Site plus 2 km buffer, for displacement assessment, or to the Moray West Site only, for collision risk modelling. It was also agreed this approach supercedes previous modelling using environmental co-variates to characterise the baseline.	
Meeting with MSS and SNH (January 2018)	Meeting to present results from the baseline characterisation including application of the DSS and to present initial results from the impact assessment.	Information presented at this meeting forms the basis of the information presented in this EIA Report Chapter and supporting technical appendices.

10.4 Baseline Conditions

10.4.1 Baseline Characterisation Approach

<u>Study Area</u>

10.4.1.1 In accordance with CIEEM (in prep.) the study area (see Figure 10.4.1) encapsulates all the areas, no matter how remote, that are likely to be affected by biophysical changes as a result of the construction, operation and decommissioning of the Development ("the zone of influence" [ZoI]).

10.4.1.2 It is often appropriate to identify different zones of influence for different features (CIEEM, in prep.). In this chapter the ZoIs are defined by the area of direct impact, the area where the physical footprint will occur, the area of indirect impact surrounding the footprint and remote seabird breeding colonies where foraging ranges overlap with the Development. The ZoIs therefore include:

- The area within which the Moray West Offshore Wind Farm will be located (defined as the Moray West Site) which covers an area of 225 km^2. This area is taken to be the extent at which collision and barrier effects will occur;
- An area defined by a 4 km buffer around the Moray West Site comprising the full area covered by site specific Digital Aerial Surveys (DAS – see below). Effects via displacement or disturbance are determined within this ZoI at spatial scales including either a 2 or 4 km buffer depend on species vulnerability (JNCC *et al.,* 2017);
- Offshore Export Cable Corridor which will run from the Moray West Site to the Aberdeenshire coast;
- Seabird breeding colonies remote from the Moray West Site where measurable population effects are likely to occur. The seabird colonies included in the ZoI are defined in the Moray West Offshore Wind Farm Scoping Opinion (Marine Scotland, 2016) and include the East Caithness Cliffs SPA, North Caithness Cliffs SPA, Troup, Pennan & Lion's Head SPA, Moray Firth pSPA; and

- In the non-breeding season, seabirds are not constrained by colony location and can, depending on individual species, range widely within UK seas and beyond. The ZoI for seabird species where an assessment in the non-breeding season is deemed to be required is based on Furness (2015) which presents Biologically Defined Minimum Population Scales (BDMPS[1]).

[1] BDMPS combines both a spatial scale and a population scale within which the number and origin of the birds present in a particular season are defined

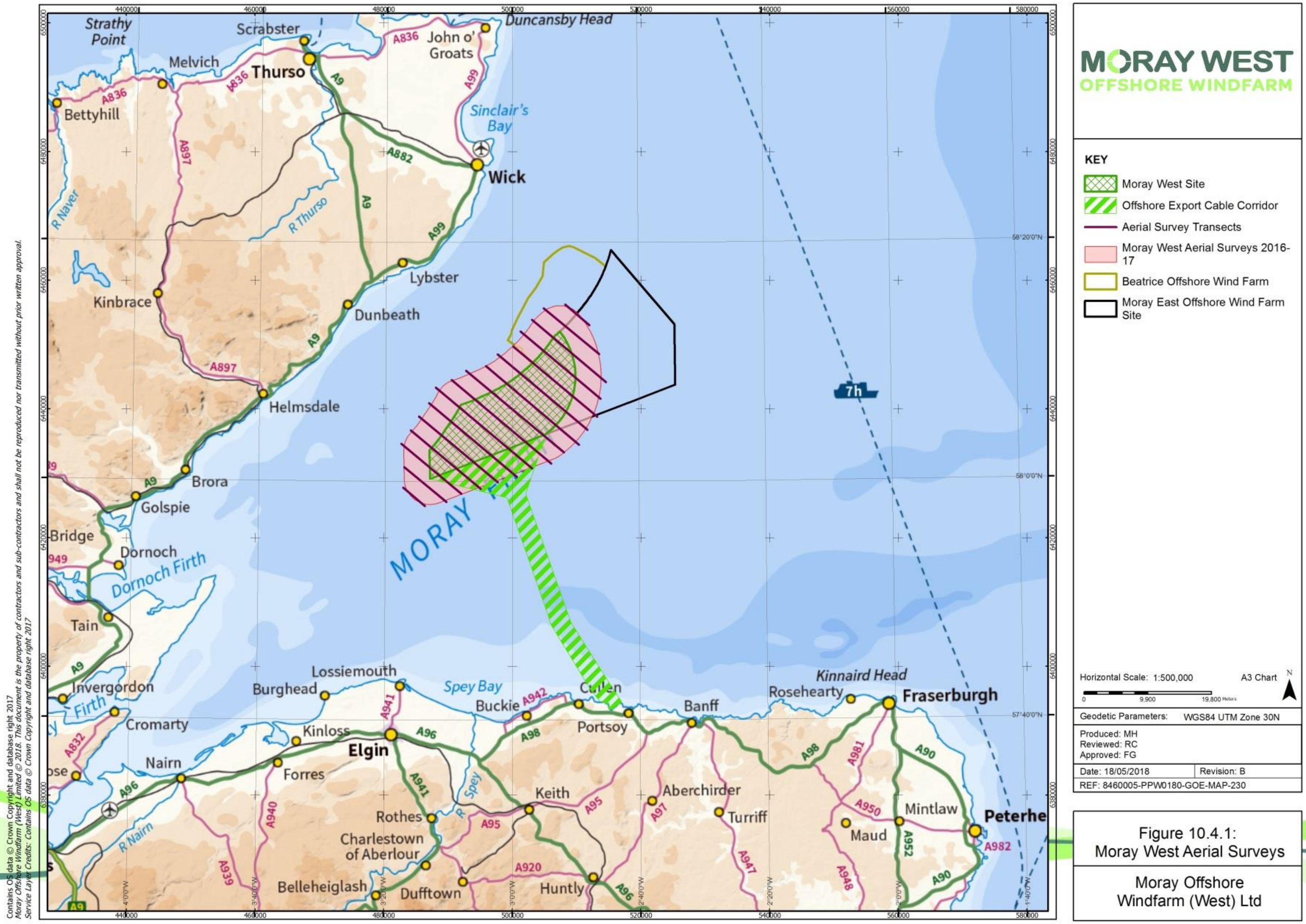

Figure 10.4.1: Study Areas Defined to Characterise the Ornithological Baseline for the Development

Site Specific Digital Aerial Survey

10.4.1.3 Contemporary digital aerial site-specific surveys to inform the assessment of the Development commenced in April 2016 and were completed in March 2017. These recent data obtained over a 12-month period are considered the primary dataset to inform the EIA of the Development. It is recognised that a single year of data may incompletely capture the inter-annual variability in seabird presence and abundance at or around the Moray West Site. The process initiated to inform this impact assessment therefore follows that the single year of site-specific surveys is combined with the extensive existing datasets that are available to robustly characterise the baseline for the purposes of impact assessment.

10.4.1.4 A series of DAS strip transects were flown monthly from April 2016 to March 2017 over the Moray West Site plus a 4 km buffer area. The survey methodology was designed to provide information suitable to support an EIA and Habitats Regulations Assessment ("HRA") of the potential effects of a large offshore wind farm, for which an accurate assessment of abundance and distribution of seabirds is required.

10.4.1.5 Aerial surveys involved transects placed 2.5 km apart within the Wind Farm plus a 4 km buffer Figure 10.4.1 using a transect-based survey design in which strip transects are placed approximately perpendicular to the depth contours along the coast. Such a design ensures that each transect samples a similar range of habitats (primarily relating to water depth) and reduces the difference in bird abundance estimates for each transect.

10.4.1.6 Surveys were undertaken using an aircraft equipped with four HiDef Gen II cameras with sensors set to a resolution of 2 centimetres ("cm") Ground Sample Distance ("GSD"). Each camera sampled a strip of 125 m width, separated from the next camera by ~25m, thus providing a combined sampled width of 500 m within a 575 m overall strip. The surveys covered the Moray West Site plus a 4 km buffer representing an area of 1,230 km^2. Analyses were conducted utilising data from two of the four cameras representing 10% coverage of this area.

10.4.1.7 Full details of the survey methodology and the means by which seabird population estimates and densities were derived are given in Volume 4 - Technical Appendix 10.1: Ornithology Technical Report.

Additional Moray Firth Seabird Data

10.4.1.8 There is an extensive amount of ornithology data available for the Moray Firth, as highlighted in the Moray West Offshore Wind Farm Scoping Report (May 2016) and further detailed in the Moray East ES 2012 (August, 2012). These data include one breeding season of digital aerial survey data across the Moray West Site and surrounding area in 2011 and one in 2009. Two boat-based survey datasets, each covering part of the Moray West Site were collected between 2009 and 2012, and a further two aerial surveys during 2014 and 2015 covering large areas of the Moray Firth and overlapping with the Moray West Site or a 4 km buffer of this region. Data additional to that presented in the Moray East ES (2012) has been gathered through great black-backed gull and herring gull tagging (project managed and co-funded by Moray East) as well as through regional strategic monitoring undertaken by Marine Scotland Science (MSS).

10.4.1.9 Volume 4 – Technical Appendix 10.1: Ornithology Technical Report and its Annex 10.1A highlight the extensive amount of ornithology data avaialbe for the Moray Firth. The data used in Appendix 10.1 and Annex 10.1A to provide full baseline characterisation of the Moray West Site and Offshore Export Cable Corridor are:

- Moray East boat-based surveys – Data collected during 28 boat-based surveys between April 2010 and March 2012 covering Moray East Site plus a 4 km buffer;
- BOWL boat-based surveys – Data collected during boat-based surveys of the Beatrice Offshore Wind Farm plus a 4 km buffer between October 2009 and September 2011; and

- BOWL pre-construction aerial surveys – Data collected during aerial surveys of the area between the East Caithness Cliffs SPA and the Beatrice offshore wind farm plus a 10 km buffer between May and August 2015.

10.4.1.10 These data provide information on the densities of key seabird species in addition to data on flight heights, with both surveys overlapping to some extent with the ZoI for the Development (Volume 4: Technical Appendix 10.1 – Annex 10.1A).

10.4.1.11 Further data is available for the Moray Firth from aerial surveys:

- Moray East aerial surveys – Data collected during six aerial surveys between May and July 2011 covering a wide strip from the East Caithness Cliffs and North Caithness Cliffs SPAs to the southern coast of the outer Moray Firth; and
- Zonal Surveys commissioned by The Crown Estate / COWRIE – comprising aerial surveys of the Moray Firth Zone (Zone 1) including a 4 km buffer.

10.4.1.12 These data provide contextual information on the densities of key bird species.

10.4.1.13 Tracking data are useful to establish connectivity between breeding colonies and the wind farm site and, in turn, the assumptions that are made about apportioning of impacts calculated to arise from wind farm construction and operation back to those colonies. Tracking of herring and great black-backed gulls has been carried out at the East Caithness Cliffs SPA (Archibald *et al.,* 2014).

Seabird Phenology in the Moray Firth

10.4.1.14 During the breeding season foraging birds may travel some distance from their breeding colonies. The information available on the distances that breeding birds will forage depends on the species. Thaxter *et al.* (2012) provide data on recorded foraging ranges for a wide range of species, including the mean-maximum and maximum distances travelled. Typically the mean-maximum foraging range (i.e. the mean of the maximum foraging trips recorded across multiple studies and therefore a precautionary approach) has been used as a criterion for establishing whether there is likely to be connectivity (and hence risk of an impact) between an SPA breeding colony and the Moray West Site. In some cases site-specific information is available from GPS/satellite tracking studies, for example, the Future of the Atlantic Marine Environment (FAME) / Seabird Tracking and Research (STAR) initiatives.

10.4.1.15 For the identification of SPAs relevant to the Development, mean-maximum foraging ranges (± 1 SD) as reported by Thaxter *et al.,* (2012) have been used to determine potential connectivity with the Moray West Site and/or Offshore Export Cable Corridor, unless specific relevant tracking data are available (where the latter is deemed to have priority).

10.4.1.16 During the non-breeding period, birds from colonies further afield may also be present within Moray West Site, although there is uncertainty regarding how many individuals from each of the colonies will be affected by the Development. Details of how potential effects are apportioned across colonies from within the region are given in the supporting documents associated with the RIAA (Technical Appendix 4.2: Phenology and Apportioning).

10.4.2 Current Baseline

Designated sites

10.4.2.1 Designated sites located within close proximity to the Moray West Site and therefore most likely to be potentially affected by activities associated with the Development, are described here and discussed in full in Volume 4 – Technical Appendix 10.1: Ornithology Technical Report.

10.4.2.2 There is only one designated site that potentially directly overlaps with the Development area, the Moray Firth pSPA, which is located along the Offshore Export Cable Corridor.

10.4.2.3 In addition, the potential for birds from breeding colonies to interact offshore with the Moray West Offshore Wind Farm has been identified based on foraging distances including the following sites:

- North Caithness Cliffs SPA;
- East Caithness Cliffs SPA;
- Copinsay SPA;
- Fair Isle SPA;
- Forth Islands SPA;
- Hoy SPA;
- North Rona and Sula Sgeir SPA;
- Troup, Pennan and Lions Heads SPA; and
- Buchan Ness to Collieston Coast SPA.

10.4.2.4 The rationale for the identification of bird species potentially affected are described in Volume 4 – Technical Appendix 10.1: Ornithology Technical Report.

Identification of Valued Ornithological Receptors

10.4.2.5 The species that are considered to be Valued Ornithological Receptors for this assessment are identified in the individual species accounts below. The main premise behind the identification of a Valued Ornithological Receptor is where the numbers present at the Moray West Site plus a 4 km buffer, were greater than 1% of the regional population in any season. In general, it therefore follows that any effects on species occurring in numbers of less than 1% of the relevant regional population will not be significant. This assumption is not however, deemed to be definitive across all species, with expert judgement also applied to identify species where fewer than 1% of the regional population may be important (e.g. species whose populations are not accurately quantified by traditional survey methods) and therefore ensure that a robust and precautionary suite of Valued Ornithological Receptors is identified for further assessment.

10.4.2.6 The next stage of the assessment involves the determination of the importance or value of each Valued Ornithological Receptor taking into account conservation status and the importance of populations estimated within the study area (see Volume 4 – Technical Appendix 10.1: Ornithology Technical Report). These criteria were informed by ecological impact assessment guidance (CIEEM, 2010).

10.4.2.7 Volume 4 – Technical Appendix 10.1: Ornithology Technical Report presents a range of populations at various geographical scales which were used to identify the importance of populations estimated in the Moray West plus 4 km buffer area. Thresholds for international importance have been sourced from Wetlands International (2017), Mitchell *et al.,* (2004), del Hoyo *et al.,* (1996) or Birdlife International (2017) with national population thresholds derived from Musgrove *et al.*, (2013), Furness (2015) or Burton *et al.,* (2013).

10.4.2.8 Regional populations were either calculated based on the population predicted to have connectivity with the Moray West Site using population data from JNCC's Seabird Monitoring Programme (SMP) database[2] or sourced from Furness (2015) which non-breeding season populations for seabirds in UK waters using BDMPS. BDMPS combines both a spatial scale and a population scale within which the number and origin of the birds present in a particular season are defined.

[2] ttp://jncc.defra.gov.uk/smp/Default.aspx

Species Accounts

10.4.2.9 The following species accounts summarise information on the identified Valued Ornithological Receptors recorded within the Moray West Site plus a 4 km buffer area between April 2016 and March 2017 and a summary of each species' conservation status. Full details for each species are provided in Volume 4 – Technical Appendix 10.1: Ornithology Technical Report.

10.4.2.10 Baseline survey data of key seabird species (gannet, kittiwake, puffin, guillemot, razorbill, herring gull and great black-backed gull) were subject to additional modelling work through the MRsea package (Scott-Hayward *et al.,* 2012) for which the process is described in Volume 4 - Technical Appendix 10.1 - Annex 10.1A. This additional modelling was carried out specifically for the application of the DSS which was used specifically to determine density values to inform the impact asserssment for key species sensitive to collision risk and displacement. Further information on the DSS approach is provided in Volume 4 – Technical Appendix 10.1 – Annex 10.1A.

Scaup

10.4.2.11 As an occasional breeder in the UK scaup is listed on Schedule 1 (Part 1) of the Wildlife and Countryside Act 1981 (as amended). Scaup is not however listed under Annex I of the EU Birds Directive (2009/147/EEC). Scaup is currently red-listed on the UK Birds of Conservation Concern as a result of a non-breeding population decline over 25 years and the longer term (Eaton *et al.,* 2015).

10.4.2.12 An estimated 5,200 individuals winter in Britain (Musgrove *et al.,* 2013) where it is widespread around the coast although numbers are relatively small except in a few locations where significant concentrations are consistently present. Their diet consists predominantly of molluscs and in particular blue mussels (*Mytilus edulis*) obtained in waters less than four metres in depth (Cabot, 2009).

10.4.2.13 Although absent from the Moray West Site, the Offshore Export Cable Corridor passes through the Moray Firth pSPA of which scaup is a qualifying feature. An area of relatively low scaup density in the Moray Firth is likely to coincide with the area overlapped by the Offshore Export Cable Corridor.

10.4.2.14 Although impacts from the OfTI components of the Development are unlikely, applying the precautionary principle, scaup is considered for further assessment in this chapter and HRA in respect to the Offshore Export Cable Corridor only.

Eider

10.4.2.15 Eider is currently amber-listed on the UK Birds of Conservation Concern because of its threatened European conservation status (Eaton *et al.,* 2015). Eider is not however listed under Annex I of the EU Birds Directive (2009/147/EEC) or Schedule 1 (Part 1) of the Wildlife and Countryside Act 1981 (as amended).

10.4.2.16 Eider is the commonest breeding species of seaduck in the UK, with a mainly sedentary breeding population of around 27,000 pairs (Musgrove *et al.,* 2013). The British wintering population is estimated at 60,000 individuals (Musgrove *et al.,* 2013) and the 1% threshold for national importance is 550 birds (Frost *et al.,* 2017). Eiders are an inshore species, usually found within 10 km of the coast. Their diet consists predominantly of blue mussels, as well as sea urchins, starfish and other marine invertebrates (Forrester *et al.,* 2007).

10.4.2.17 Eider was recorded in one of the aerial surveys undertaken across the Moray West Site plus 4 km buffer. Furthermore, the Offshore Export Cable Corridor passes through an area of the Moray Firth pSPA with moderate to low densities of eider in winter.

10.4.2.18 The population of eider recorded during aerial surveys did not exceed 1% of the species' regional migratory BDMPS population in the northern North Sea. Therefore it is considered unlikely that significant effects will occur on eider in the Moray West Site.

10.4.2.19 The Offshore Export Cable Corridor passes through the Moray Firth pSPA where eider are likely to be present. Eider is therefore identified as a Valued Ornithological Receptor and considered to be of international conservation value.

10.4.2.20 Although effects from the OfTI components of the Development are unlikely, applying the precautionary principle, eider is considered for further assessment in the EIA and HRA in respect to the Offshore Export Cable Corridor only.

Long-Tailed Duck

10.4.2.21 As a potential breeder in the UK, long-tailed duck it is listed on Schedule 1 (Part 1) of the Wildlife and Countryside Act 1981 (as amended). Long-tailed duck is not however listed under Annex I of the EU Birds Directive (2009/147/EEC) although long-tailed duck is currently red-listed on the UK Birds of Conservation Concern as a result of its threatened global status (Eaton *et al.,* 2015).

10.4.2.22 The UK population is estimated at 11,000 individuals with the 1% threshold for national importance being 110 birds. Long-tailed duck distribution is concentrated around Orkney and the Moray Firth between November and May (Stone *et al.,* 1995). Their diet consists predominantly of molluscs and crustaceans obtained by diving to at least 5–15 metres in depth (Cabot, 2009).

10.4.2.23 Long-tailed duck was not recorded on aerial surveys of the Moray West Site plus 4 km buffer. However, it is a qualifying feature of the Moray Firth pSPA which the Offshore Export Cable Corridor passes through. An area of relatively low long-tailed duck density in the Moray Firth is likely to coincide with the area overlapped by the Offshore Export Cable Corridor. Long- tailed duck is therefore identified as a Valued Ornithological Receptor and considered to be of international conservation value.

10.4.2.24 Although effects from the OfTI components of the Development are unlikely, applying the precautionary principle, long-tailed duck is considered for further assessment in the EIA and HRA in respect to the Offshore Export Cable Corridor only.

Common Scoter

10.4.2.25 As a rare breeder in the UK common scoter is listed on Schedule 1 (Part 1) of the Wildlife and Countryside Act 1981 (as amended). Common scoter is not however listed under Annex I of the EU Birds Directive (2009/147/EEC) but is currently red-listed on the UK Birds of Conservation Concern as a result of declines in breeding status and meeting the amber list criteria for its localised non-breeding distribution (Eaton *et al.,* 2015).

10.4.2.26 The majority of the UK wintering population of common scoter is concentrated in a few large flocks off the mouths of major estuaries around the UK coast. A review of numbers for the UK and survey work at key sites suggested that the number of wintering common scoter is likely to be in the region of 100,000 birds (Musgrove *et al.,* 2011).

10.4.2.27 Common scoter was not recorded on aerial surveys of the Moray West Site plus 4 km buffer. However, it is a qualifying feature of the Moray Firth pSPA which the Offshore Export Cable Corridor passes through. An area of relatively low common scoter density in the Moray Firth is likely to coincide with the area overlapped by the Offshore Export Cable Corridor. Common scoter is therefore identified as a Valued Ornithological Receptor and considered to be of international conservation value.

10.4.2.28 Although effects from the OfTI components of the Development are unlikely, applying the precautionary principle, common scoter is considered for further assessment in the EIA and HRA in respect to the Offshore Export Cable Corridor only.

Velvet Scoter

10.4.2.29 As a potential breeder in the UK velvet scoter is listed on Schedule 1 (Part 1) of the Wildlife and Countryside Act 1981 (as amended). Velvet scoter is not however listed under Annex I of the EU Birds Directive (2009/147/EEC) but is currently red-listed on the UK Birds of Conservation Concern as a result of its globally threatened status and meeting the amber list criteria for its localised non-breeding distribution (Eaton *et al.,* 2015).

10.4.2.30 Approximately 2,500 individuals winter in the UK (Musgrove *et al.,* 2013) where they are widespread around the UK coast with the majority in eastern mainland Scotland, particularly the Moray Firth, as well as Orkney.

10.4.2.31 Velvet scoter was not recorded on aerial surveys of the Moray West Site plus 4 km buffer. However, it is a qualifying feature of the Moray Firth pSPA which the Offshore Export Cable Corridor passes through. An area of relatively low velvet scoter density in the Moray Firth is likely to coincide with the area overlapped by the Offshore Export Cable Corridor (SNH, 2016). Velvet scoter is therefore identified as a Valued Ornithological Receptor and considered to be of international conservation value.

10.4.2.32 Although effects of the OfTI components of the Development are unlikely, applying the precautionary principle, velvet scoter is considered for further assessment in the EIA and HRA in respect to the Offshore Export Cable Corridor only.

Goldeneye

10.4.2.33 Goldeneye is currently amber-listed on the UK Birds of Conservation Concern as a result of its localised breeding distribution (Eaton *et al.,* 2015). Goldeneye is not however listed under Annex I of the EU Birds Directive (2009/147/EEC) or Schedule 1 (Part 1) of the Wildlife and Countryside Act 1981 (as amended).

10.4.2.34 Goldeneye is widely distributed in the non-breeding season on both freshwater and marine sites in the UK with an estimated population of 27,000 individuals (Musgrove *et al.,* 2013). The UK distribution is largely concentrated in the north — on or around the east coast of Scotland, notably the Moray Firth, as well as around Orkney (SNH, 2016).

10.4.2.35 Goldeneye was not recorded on aerial surveys of the Moray West Site plus 4 km buffer. However, it is a qualifying feature of the Moray Firth pSPA which the Offshore Export Cable Corridor passes through. An area of relatively low goldeneye density in the Moray Firth is likely to coincide with the area overlapped by the Offshore Export Cable Corridor (SNH, 2016). Goldeneye is therefore identified as a Valued Ornithological Receptor and considered to be of international conservation value.

10.4.2.36 Although effects from the OfTI components of the Development are unlikely, applying the precautionary principle, goldeneye is considered for further assessment in the EIA and HRA in respect to the Offshore Export Cable Corridor only.

Red-breasted Merganser

10.4.2.37 Red-breasted merganser is currently green-listed on the UK Birds of Conservation Concern (Eaton *et al.,* 2015). Red-breasted merganser is not listed under Annex I of the EU Birds Directive (2009/147/EEC) or Schedule 1 (Part 1) of the Wildlife and Countryside Act 1981 (as amended).

10.4.2.38 Approximately 2,600 pairs breed in the UK, mainly in north and west Scotland (Forrester *et al.,* 2007), with 9,000 individuals wintering (Musgrove *et al.,* 2013). It is widely distributed at low density around the coastal waters of the UK in the non-breeding season (Stone *et al.,* 2016) with concentrations close inshore (SNH, 2016).

10.4.2.39 Red-breasted merganser was not recorded on aerial surveys of the Moray West Site plus 4 km buffer. However, it is a qualifying feature of the Moray Firth pSPA which the Offshore Export Cable Corridor passes through. An area of relatively low red-breasted merganser density in the

Moray Firth is likely to coincide with the area overlapped by the Offshore Export Cable Corridor (SNH, 2016). Red-breasted merganser is therefore identified as a Valued Ornithological Receptor and considered to be of international conservation value.

10.4.2.40 Although effects from the OfTI components of the Development are unlikely, applying the precautionary principle, red-breasted merganser is considered for further assessment in the EIA and HRA in respect to the Offshore Export Cable Corridor only.

Red-throated Diver

10.4.2.41 Red-throated diver is listed on Annex I of the EU Birds Directive (2009/147/EEC) and Schedule 1 of the Wildlife and Countryside Act. Red-throated diver is also currently green-listed on the UK Birds of Conservation Concern list (Eaton *et al.,* 2015).

10.4.2.42 An estimated 1,300 pairs of red-throated diver breed in Britain, with the majority of pairs found in the north and west of Scotland (Musgrove *et al.,* 2013; Balmer *et al.,* 2013). The wintering population around Britain has been estimated at 17,000 individuals (O'Brien *et al.,* 2008). Wintering red-throated divers show a preference for sheltered shallow waters and sandy bays along North Sea coasts with significant concentrations in the north on the Solway on the west coast and the Forth/Tay and the Moray Firth on the east (SNH, 2016). Numbers may however fluctuate widely in response to weather and other factors affecting the supply of prey species such as sandeels, crustaceans and small fish (Lack, 1986).

10.4.2.43 Red-throated diver was not recorded on aerial surveys of the Moray West Site plus 4 km buffer. However, it is a qualifying feature of the Moray Firth pSPA which the Offshore Export Cable Corridor passes through. An area of relatively moderate to low red-throated diver density in the Moray Firth area is likely to coincide with the area overlapped by the Offshore Export Cable Corridor (SNH, 2016). Red-throated diver is therefore identified as a Valued Ornithological Receptor and considered to be of international conservation value.

10.4.2.44 Although effects from the OfTI components of the Development are unlikely, applying the precautionary principle, red-throated diver is considered for further assessment in the EIA and HRA in respect to the Offshore Export Cable Corridor only.

Great Northern Diver

10.4.2.45 Great northern diver is listed under Annex I of the EU Birds Directive (2009/147/EEC) and Schedule 1 (Part 1) of the Wildlife and Countryside Act 1981 (as amended). Great northern diver is also currently amber-listed on the UK Birds of Conservation Concern because of its threatened European conservation status and the international importance of the UK winter population (Eaton *et al.,* 2015).

10.4.2.46 Approximately 2,600 individuals winter in the UK (Musgrove *et al.,* 2013) when its distribution shifts southward from their subarctic breeding grounds to include inshore UK waters. It is widely distributed with the majority of UK birds concentrated in north and west Scotland, particularly off Orkney, Shetland and the Outer Hebrides (Natural England, 2012).

10.4.2.47 Great northern diver was recorded in one of the aerial surveys undertaken across the Moray West Site plus 4 km buffer. The Offshore Export Cable Corridor also passes through the Moray Firth pSPA where great northern diver are likely to be present. Great northern diver is therefore identified as a Valued Ornithological Receptor and considered to be of international conservation value.

10.4.2.48 Although effects from the OfTI components of the Development are unlikely, applying the precautionary principle, great northern diver is considered for further assessment in the EIA and HRA in respect to the Offshore Export Cable Corridor only.

Fulmar

10.4.2.49 Fulmar is currently amber-listed on the UK Birds of Conservation Concern because of its threatened European conservation status and its localised breeding distribution (Eaton *et al.,* 2015). Fulmar is not however listed under Annex I of the EU Birds Directive (2009/147/EEC) or Schedule 1 of the Wildlife and Countryside Act 1981 (as amended).

10.4.2.50 Fulmar numbers and distribution around the UK have increased considerably since the mid-19th century (Pennington *et al.,* 2004). The species is one of the most common seabirds in Britain, with an estimated breeding population of 499,081 pairs (Mitchell *et al.,* 2004), although since Seabird 2000 when the UK breeding population was last estimated, the population is predicted to have decreased by 31% (JNCC, 2016). The largest breeding colonies are located off the north and west coasts of Scotland with birds often present at these colonies outside of the breeding season.

10.4.2.51 Fulmars were recorded in all twelve of the aerial surveys undertaken across the Moray West Site plus 4 km buffer. There are two periods of higher population estimates (May to August and November to March) separated by two periods of relatively low population estimates (April and September to October).

10.4.2.52 The population estimates of fulmar in the Moray West Site plus 4 km buffer in the breeding season for April, May, July and August exceed 1% of the regional population (peaking at 1,042 individuals in August). The 1% values of the national and international populations for fulmar are not surpassed in any month.

10.4.2.53 In surveys undertaken in the post-breeding season (September to October), a peak population estimate of 127 birds occurred in September 2016. This population does not exceed 1% of the post-breeding BDMPS population for fulmar. Similarly, for surveys undertaken in the pre-breeding season (December to March), the peak population of 2,336 birds that occurred in December was also not of regional importance.

10.4.2.54 Based on the presence of an important population, fulmar is identified as a Valued Ornithological Receptor and considered for further assessment in the EIA as a species with regional importance and international conservation value.

10.4.2.55 The mean-maximum foraging range of fulmar (400 ± 245.8 km; Thaxter *et al.,* 2012) from a number of SPA breeding colonies overlaps with the Moray West Site plus 4 km buffer. Based on the potential SPA connectivity and the inclusion of fulmar in the Moray East HRA, fulmar is included in the Moray West Offshore Wind Farm HRA.

Gannet

10.4.2.56 Gannet is currently amber-listed on the UK Birds of Conservation Concern because of its localised breeding distribution and the international importance of the breeding population (Eaton *et al.,* 2015). Gannet is not however listed under Annex I of the EU Birds Directive (2009/147/EEC) or Schedule 1 of the Wildlife and Countryside Act 1981 (as amended).

10.4.2.57 Gannet distribution is widespread around the UK with concentrations around key colonies during the breeding season, i.e. St. Kilda, Ailsa Craig, Grassholm, Bass Rock, Ortec and south-west Ireland (Stone *et al.,* 1995). The UK and Scottish breeding populations have seen a long-term increase (JNCC, 2016) with an estimated 220,000 nests in the UK (Musgrove *et al.,* 2013).

10.4.2.58 Gannet were recorded in 11 of the aerial surveys undertaken across the Moray West Site plus 4 km buffer with a peak in abundance in September corresponding with the post-fledging period.

10.4.2.59 The population estimates of gannet in the Moray West Site plus 4 km buffer in the breeding season (April to September) exceed the 1% threshold of the regional population (1,681 individuals) in September only when an estimated 2,827 birds were present. For the Moray West Site analysed through MRSea, 336 gannet were estimated to be present in September.

10.4.2.60 Outside of September, breeding season populations of gannet were comparatively low with next highest estimate being of 238 birds in June 2016. The 1% values of the national and international populations for gannet are not surpassed in any month.

10.4.2.61 In aerial surveys undertaken in the post-breeding season as defined for gannet (October to November) a peak population of 439 birds was estimated during October 2016. This population does not exceed the 1% threshold of the post-breeding BDMPS population for gannet (4,562 individuals). Similarly, during surveys undertaken in the pre-breeding season (December to March) the peak population of 144 birds that occurred in February was also not of regional importance (1% of 2,484 individuals).

10.4.2.62 Based on the presence of an important population, gannet is identified as a Valued Ornithological Receptor and considered for further assessment in the EIA as a species with regional importance and international conservation value.

10.4.2.63 The mean-maximum foraging range of gannet (Thaxter *et al*., 2012) from a number of SPA breeding colonies overlap with the Moray West Site plus 4 km buffer. Based on the potential SPA connectivity and the inclusion of gannet in the Moray East HRA, it is included in the Moray West Offshore Wind Farm HRA.

Shag

10.4.2.64 Shag is currently red-listed on the UK Birds of Conservation Concern as a result of its breeding population decline (Eaton *et al.,* 2015). The subspecies of shag present in the UK, *Phalacrocorax aristolelis aristotelis*, is not however listed under Annex I of the EU Birds Directive (2009/147/EEC) or Schedule 1 (Part 1) of the Wildlife and Countryside Act 1981 (as amended).

10.4.2.65 Approximately 27,000 pairs breed and 110,000 individuals winter in the UK (Musgrove *et al.,* 2013) where they are widely distributed in coastal water around the western and northern coasts of the UK (Stone *et al.,* 1995). The greatest abundance is in the north and west of Scotland in particular the Moray Firth and the Firth of Forth (SNH, 2016).

10.4.2.66 Shag was not recorded on aerial surveys of the Moray West Site plus 4 km buffer. However, it is a qualifying feature of the Moray Firth pSPA through which the Offshore Export Cable Corridor passes. An area of relatively low shag density in the Moray Firth is likely to coincide with the area overlapped by the Offshore Export Cable Corridor in the non-breeding season (SNH, 2016). Shag is therefore identified as a Valued Ornithological Receptor and considered to be of international conservation value.

10.4.2.67 Although effects from the OfTI components of the Development are unlikely, applying the precautionary principle, shag is considered for further assessment in the EIA and HRA in respect to the Offshore Export Cable Corridor only.

Slavonian Grebe

10.4.2.68 Slavonian grebe is listed under Annex I of the EU Birds Directive (2009/147/EEC) and Schedule 1 (Part 1) of the Wildlife and Countryside Act 1981 (as amended). Slavonian grebe is also currently red-listed on the UK Birds of Conservation Concern as a result of its threatened global status and declining breeding population (Eaton *et al.,* 2015).

10.4.2.69 Approximately 30 pairs breed and 1,100 individuals winter in the UK, the latter being widely distributed round the entire UK coastline with particular concentrations in Scotland in the Firth of Forth, the Moray Firth, the Northern Isles, north-west Scotland including the Outer Hebrides and Kintyre (SNH, 2016).

10.4.2.70 Slavonian grebe was not recorded on aerial surveys of the Moray West Site plus 4 km buffer. However, it is a qualifying feature of the Moray Firth pSPA which the Offshore Export Cable Corridor passes through. An area of relatively low Slavonian grebe density in the Moray Firth is likely to coincide with the area overlapped by the Offshore Export Cable Corridor (SNH, 2016).

Slavonian grebe is therefore identified as a Valued Ornithological Receptor and considered to be of international conservation value.

10.4.2.71 Although effects from the OfTI components of the Development are unlikely, applying the precautionary principle, Slavonian grebe is considered for further assessment in the EIA and HRA in respect to the Offshore Export Cable Corridor only.

Arctic Skua

10.4.2.72 Arctic skua is currently red-listed on the UK Birds of Conservation Concern (Eaton *et al.,* 2015) due to its significant recent decline with the UK breeding population showing declines of 37% between 1985/88 and 1998/2002 and 64% between 1998/2002 and 2015 (JNCC, 2016). Arctic skua is not however listed under Annex I of the EU Birds Directive (2009/147/EEC) or Schedule 1 of the Wildlife and Countryside Act 1981 (as amended).

10.4.2.73 Arctic skua is a passage migrant in spring and autumn in the North Sea, and a scarce UK breeding species, restricted to Shetland, Orkney, north Scotland and the Western Isles (Forrester *et al.,* 2007). Seabird 2000 estimated the Scottish breeding population at 2,136 pairs (Mitchell *et al.,* 2004).

10.4.2.74 Arctic skua were recorded in three of the aerial surveys undertaken across the Moray West Site plus 4 km buffer with peak abundance occurring in August (population estimate of 45 individuals). In the post-breeding season the peak count was 23 birds in September. The breeding season peak population estimate exceeds 1% of the regional population size but the post-breeding estimate does not exceed 1% of any population size.

10.4.2.75 Although Arctic skuas were recorded in relatively low numbers in the digital aerial surveys of Moray West Offshore Wind Farm, birds migrating through the Project may originate from SPA colonies further north. In addition, the abundance estimate of 45 birds in August 2016 is potentially of regional importance. Arctic skua is therefore included as a Valued Ornithological Receptor of regional value and international importance.

10.4.2.76 A strategic assessment (WWT, 2014) provides an overall estimate of collision risk that Scottish offshore wind farms may present to birds on migration. The report concludes that birds on migration through Scottish waters are not considered to be at risk of significant levels of additional mortality as a result of collisions with Scottish offshore wind farms. Therefore Arctic skua, although likely to be present at the Moray West Site on migration, is not assessed for any impacts, notably collision risk.

Puffin

10.4.2.77 Puffin is currently red-listed on the UK Birds of Conservation Concern (Eaton *et al.,* 2015). Puffin is not however listed under Annex I of the EU Birds Directive (2009/147/EEC) or Schedule 1 of the Wildlife and Countryside Act 1981 (as amended).

10.4.2.78 Puffins are one of the most abundant seabird species in Britain, breeding in coastal colonies. Seabird 2000 recorded 579,500 pairs at breeding colonies around Britain (Mitchell *et al.,* 2004). Lesser sandeel is the commonest prey item for puffins, but they also eat sprat, herring and a wide range of young gadoid fish (Harris, 1984). During the breeding season puffin are aggregated around their colonies. During post-breeding, however, the birds disperse towards the north-western North Sea before spreading out more widely throughout the winter months; this has been sent to encompass the whole of the North Atlantic (Harris *et al*., 2010; Jessopp *et al*., 2013)).

10.4.2.79 Puffin were recorded in six of the aerial surveys undertaken across Moray West Offshore Wind Farm array plus a 4 km buffer with peak abundance occurring in August. Two seasons are defined for puffin, a breeding season from April to August and a non-breeding season from August to March. The peak population recorded in the breeding season occurred in August 2016 when a population of 3,042 birds was estimated. This surpasses 1% of the regional population for puffin (1,196 birds).

10.4.2.80 In surveys undertaken in the non-breeding season, puffins were recorded in September and October only with an estimated peak population estimate of 1,335 birds in September 2016. This population does not exceed 1% of the regional non-breeding BDMPS population for puffin (2,320 individuals). The 1% thresholds of the national and international populations for puffin are not surpassed in any month.

10.4.2.81 Based on the presence of an important population, puffin is identified as a Valued Ornithological Receptor and considered for further assessment in the EIA and HRA as a species with regional importance and international conservation value.

Razorbill

10.4.2.82 Razorbill is currently amber-listed on the UK Birds of Conservation Concern (Eaton *et al.,* 2015). Razorbill is not however listed under Annex I of the EU Birds Directive (2009/147/EEC) or Schedule 1 of the Wildlife and Countryside Act 1981 (as amended).

10.4.2.83 Razorbill is one of the most common seabirds in Britain, breeding in large colonies with other seabirds on suitable coastal cliffs. Seabird 2000 recorded 164,557 individuals at breeding colonies around Britain (Mitchell *et al.,* 2004).

10.4.2.84 Razorbill were recorded in 11 of the aerial surveys undertaken across the Moray West Site plus 4 km buffer with peak abundance occurring in September followed by a secondary peak in March.

10.4.2.85 The population estimates of razorbill in the Moray West Site plus 4 km buffer in the breeding season (April – August) exceeded the 1% threshold for the national population (2,600 individuals) in both July and August when populations of 5,246 and 5,852 were estimated respectively.

10.4.2.86 In the non-breeding season (November – December), no populations of importance were recorded. During pre-breeding (January – March) a population of regional importance occurred in March 2017 when 6,036 were estimated to be present (1% = 5,919).

10.4.2.87 In the post-breeding season (September – October), a population of national importance was present in September. This large peak in abundance represented a population of 18,391 razorbill which compares to the 1% of the national population of 11,988.

10.4.2.88 Based on the presence of an important population, razorbill is identified as a Valued Ornithological Receptor and considered for further assessment in the EIA and HRA as a species with national importance and international conservation value.

Guillemot

10.4.2.89 Guillemot is currently amber-listed on the UK Birds of Conservation Concern (Eaton *et al.,* 2015). Guillemot is not however listed under Annex I of the EU Birds Directive (2009/147/EEC) or Schedule 1 of the Wildlife and Countryside Act 1981 (as amended).

10.4.2.90 Guillemot is one of the most abundant seabird species in Britain, breeding in large colonies on suitable coastal cliff habitat. Seabird 2000 recorded 1,322,830 individuals at breeding colonies in Britain (Mitchell *et al.,* 2004).

10.4.2.91 Guillemot were recorded in all 12 of the aerial surveys undertaken across the Moray West Site plus 4 km buffer with peak abundance occurring in September.

10.4.2.92 The population estimates of guillemot in the Moray West Site plus 4 km buffer in the breeding season (April – July) exceeded the 1% threshold for the national population (19,000 individuals) in both May and June when populations of 23,382 and 31,172, were estimated respectively. The population recorded in July (17,976) is deemed to be of regional importance.

10.4.2.93 In the non-breeding season (August – March), populations of national importance occurred in both August and September when significant peaks occurred of 54,732 and 106,810 individuals respectively (1% = 27,565).

10.4.2.94 Based on the presence of an important population, guillemot is identified as a Valued Ornithological Receptor and considered for further assessment in the EIA and HRA as a species of international importance and international conservation value.

Kittiwake

10.4.2.95 Kittiwake is currently red-listed on the UK Birds of Conservation Concern (Eaton *et al.,* 2015). The species is not however listed under Annex I of the EU Birds Directive (2009/147/EEC) or Schedule 1 of the Wildlife and Countryside Act 1981 (as amended).

10.4.2.96 Kittiwake is one of the commonest seabirds in the UK, breeding in large colonies on coastal cliff habitat. Seabird 2000 recorded 366,835 pairs in the UK, with the largest numbers on the east coast (Mitchell *et al.,* 2004). The nearest large colony to Moray West is at East Caithness Cliffs. Kittiwakes mostly prey on small fish such as sandeels as well as fishery discards (Forrester *et al.,* 2007).

10.4.2.97 Between April and July, kittiwakes are dispersed widely around the coast of Britain, with relatively high densities around the coast of Scotland where the main breeding colonies are located (Stone *et al.,* 1995).

10.4.2.98 From August to October, kittiwakes begin to disperse across the North Sea, although the predominant distribution still reflects the location of breeding colonies. From November to March, birds are dispersed over much larger areas of the North Sea, and in the southern parts, numbers peak during this period. This reflects the kittiwake's preference for pelagic habitats in winter.

10.4.2.99 Kittiwake is listed as a qualifying interest species in the breeding season for 20 SPAs and three pSPAs on the UK east coast. These SPAs are designated for 256,160 breeding pairs representing nearly 70% of the national breeding population as recorded during Seabird 2000 (Mitchell *et al.,* 2004). The Moray West Site plus 4 km buffer lies within the mean-maximum foraging range of five SPAs at which kittiwake is a qualifying feature (Copinsay, East Caithness Cliffs, Hoy, North Caithness Cliffs and Troup, Pennan and Lion's Heads SPAs). East Caithness Cliffs (19.9 km) and North Caithness Cliffs (41.6 km) are in closest proximity to the Moray West Site.

10.4.2.100 Kittiwake were recorded in all 12 of the aerial surveys undertaken across the Moray West Site plus 4 km buffer with a peak in abundance in June corresponding with the breeding season.

10.4.2.101 Population estimates derived from aerial survey data during all breeding months (April – August) surpass the 1% of the regional population (393 birds) with the exception of April. The population estimates calculated for June 2016 (8,978 birds) exceed the 1% threshold for national importance (7,600 birds).

10.4.2.102 Populations estimated during the post-breeding season (September to December) did not surpass 1% d of the post-breeding regional BDMPS population for kittiwake (8,299 individuals). However, the abundance of kittiwake was still relatively high in September (5,100 individuals). Populations estimated during the surveys undertaken in the pre-breeding season (January to March) also did not surpass 1% of the regional population (6,278 individuals) with the peak population occurring in the March survey (2,433 birds).

10.4.2.103 The population estimates of kittiwake in the Moray West Site plus 4 km buffer in the breeding season for the months of June and August exceed the 1% threshold of the regional population and surpass the 1% thresholds of the national populations in June.

10.4.2.104 Kittiwake is therefore identified as a Valued Ornithological Receptor and considered for further assessment in the EIA and HRA as a species of national importance and international conservation value.

Herring Gull

10.4.2.105 Herring gull is not listed under Annex I of the EU Birds Directive (2009/147/EEC) or Schedule 1 of the Wildlife and Countryside Act 1981 (as amended). The species is currently red-listed on the UK Birds of Conservation Concern (Eaton *et al.,* 2015).

10.4.2.106 Herring gulls are resident, common and widespread, breeding in colonies in coastal and inland locations. Seabird 2000 recorded 142,942 pairs in Britain (Mitchell *et al.,* 2004). There is a general movement southwards in winter months (Forrester *et al.,* 2007) with the UK wintering population estimated at over 740,000 individuals (Burton *et al.,* 2012). The UK winter population is comprised of UK breeding birds (*Larus argentatus argenteus*) plus a substantial influx from Scandinavia (*L. a.. argentatus*) (Coulson *et al*., 1984). Herring gulls exploit a wide range of food sources, including scraps and offal from trawlers, as well as on land at refuse dumps and farm land (Forrester *et al.,* 2007).

10.4.2.107 Herring gull were recorded in seven of the aerial surveys undertaken across the Moray West Site plus 4 km buffer with peak abundance occurring in June.

10.4.2.108 The peak population of herring gull estimated during aerial surveys exceeded the 1% of the regional population in June and August. The peak population estimate does not exceed the relevant 1% thresholds of the international or national populations in any month.

10.4.2.109 The mean-maximum foraging range of herring gull (Thaxter *et al.,* 2012) means that there is potential for interaction between birds from three SPAs and the Moray West Site. Tracking of herring gulls at East Caithness Cliffs however was carried out in 2014 through funding from Moray Offshore Windfarm (East) Ltd (Moray East) and Beatrice Offshore Wind Farm (Archibald *et al.,* 2014). A total of 10 herring gulls were tagged, with data being obtained from seven of these. Data from the tags found that all birds remained in coastal waters with evidence of no offshore foraging and no overlap of flights with the Moray West Site plus 4 km buffer.

10.4.2.110 Herring gull is therefore identified as a Valued Ornithological Receptor and considered for further assessment in the EIA as a species with a regional importance and international conservation value. Herring gull has also been assessed within the HRA, although as detailed above, evidence for connectivity between Moray West Offshore Wind Farm and SPA colonies is weak.

Great Black-Backed Gull

10.4.2.111 Great black-backed gull is not listed under Annex I of the EU Birds Directive (2009/147/EEC) or Schedule 1 of the Wildlife and Countryside Act 1981 (as amended). The species is currently amber-listed on the UK Birds of Conservation Concern (Eaton *et al.,* 2015).

10.4.2.112 Great black-backed gull is a common resident species in the UK, occurring in coastal areas. Seabird 2000 recorded 17,394 pairs in Britain, with the largest numbers recorded on western coasts (Mitchell *et al.,* 2004). Great black-backed gulls are omniValued Ornithological Receptorous, foraging at sea, on estuaries and beaches, and less commonly at rubbish dumps (Forrester *et al.,* 2007).

10.4.2.113 Great black-backed gull were recorded in 10 of the aerial surveys undertaken across the Moray West Site plus 4 km buffer with peak abundance occurring in September followed by a secondary peak in February.

10.4.2.114 The peak population of great black-backed gull estimated during aerial surveys exceeded 1% of the regional population in the breeding season in June, July and August. The peak population estimate in September exceeded both the regional and national 1% thresholds.

10.4.2.115 Tracking of great black-backed gulls at the East Caithness Cliffs SPA was carried out in 2014 through funding from Moray East and Beatrice Offshore Wind Farm (Archibald *et al.,* 2014). A total of 11 great black-backed gulls were tagged, with data being obtained from all individuals. All birds remained in coastal waters with evidence of no offshore foraging and no flights inside any of the Wind Farms in the Moray Firth. Based on the maximum foraging range of great black-backed gull (Thaxter *et al*., 2012) and tracking showing that birds are restricted to coastal waters (Archibald *et al.,* 2014) there is no potential for interaction between birds from SPAs and the Moray West Offshore Wind Farm in the breeding season.

10.4.2.116 Based on the presence of an important population, great black-backed gull is identified as a Valued Ornithological Receptor and considered for further assessment in the EIA as a species of regional and national importance (breeding and non-breeding respectively) and international conservation value. Great black-backed gull has also been assessed within the HRA, although as detailed above, evidence for connectivity between Moray West Offshore Wind Farm and SPA colonies is weak.

10.4.3 Future Baseline

10.4.3.1 The Environmental Impact Assessment Regulations (Scotland) 2017 requires that a "description of the relevant aspects of the current state of the environment (the "baseline scenario") and an outline of the likely evolution thereof without implementation of the development as far as natural changes from the baseline scenario can be assessed with reasonable effort on the basis of the availability of relevant information and scientific knowledge" .

10.4.3.2 In the event that the Moray West Offshore Wind Farm does not come forward, an assessment of the future baseline conditions has been carried out and is described within this EIA Report.

10.4.3.3 A projection of the likely evolution of the baseline for species relevant to the Moray West Site and Offshore Export Cable Corridor is best assessed from the latest population trends. These, are published by JNCC, as part of the Seabird Monitoring Programme (SMP) (JNCC, 2017b), as annual updates on seabird population trends at a range of spatial scales. A summary of these trends are presented in Appendix 10.1: Ornithology Technical Report (in Table 1-2).

10.5 Assessment Methodology

10.5.1.1 The Offshore Ornithology EIA has followed the general approach to the assessment as set out in Chapter 5: Environmental Impact Assessment Methodology. However, the criteria presented has been adapted in order to implement a specific methodology for offshore ornithology. The general principle of determining impact significance from levels of sensitivity of the receptors and magnitude of effect is consistent with Impact Assessment Guidelines and ES Review Criteria, from the Institute of Environmental Management and Assessment (IEMA, 2004).

10.5.1.2 In addition, the Offshore Ornithology EIA has considered relevant legislation as detailed in Section 10.2. Also considered in this section are methodologies specific to certain impacts that may affect those Valued Ornithological Receptors identified in Section 10.4.2.

10.5.2 Impact Identified as Requiring Assessment

10.5.2.1 Table 10.5.1 below lists all potential impacts on ornithology identified as requiring consideration as part of the assessment. This list of impacts is based on expert judgement, reflects responses provided by statutory consultees and other stakeholders in the Moray West Offshore Wind Farm and OfTI Scoping Opinions and takes into account further comments received as part of ongoing consultation activities.

Table 10.5.1: Impacts on Ornithology Requiring Assessment		
Potential Impact	**Nature of Impact (direct or indirect)**	**Inter-Relationships with Other EIA Topics / Receptors**
Impacts During Construction		
Disturbance / displacement	Direct	N/A
Indirect effects (prey species and habitat loss)	Indirect	Chapter 8: Benthic and Interidal Ecology Chapter 9: Fish and Shellfish Ecology
Effects of pollution	Direct and indirect	Chapter 6: Physical Processes and Water Quality
Impacts during Operation		
Displacement	Direct	N/A
Collision Risk	Direct	N/A
Barrier effects	Direct	N/A
Attraction to lit structures and associated disorientation	Direct	Chapter 12: Shipping and Navigation Chapter 13: Aviation and MOD Chapter 14: SLVIA
Indirect effects (prey species and habitat loss)	Indirect	Chapter 9: Fish and Shellfish Ecology
Effects of pollution	Direct and indirect	Chapter 6: Physical Processes and Water Quality
Impacts During Decommissioning		
Disturbance / displacement	Direct	N/A
Indirect effects (prey species and habitat loss)	Indirect	Chapter 9: Fish and Shellfish Ecology
Effects of pollution	Direct and indirect	Chapter 6: Physical Processes and Water Quality

<u>Disturbance</u>

10.5.2.2 During construction there is the potential for the presence of vessels and construction works to disturb birds present in the Moray West Site or along the Offshore Export Cable Corridor. This can deter birds from using suitable or preferred habitat.

10.5.2.3 Different species show differing sensitivities to disturbance. Assessment of birds’ sensitivity to disturbance will be based upon: the number of each bird species within Moray West Site, the estimated proportion of the colony–population, their estimated sensitivities to vessel presence (Wade *et al.,* 2016), whether their distribution over the wider area is localised or widespread, their reliance on specific habitat types, and any published information on habituation.

10.5.2.4 Short-listing of species to be included in the disturbance assessment is based on those known to be vulnerable to disturbance impacts (based on Wade *et al.,* 2016; Bradbury *et al.,* 2014) and where the population of the species observed at the Moray West Site plus 4 km buffer is considered to be of importance (when compared against a relevant population scale thresholds - regional, national or international).

Displacement and Barrier Effects

10.5.2.5 Displacement may affect bird populations by affecting site usage which may be for foraging, resting or moulting purposes. As a result of displacement an individual bird may experience a decrease in fitness, due to the effect of re-locating to alternative foraging grounds and/or changes to energy budgets due to the increased energy expenditure when avoiding a wind farm. These impacts, in turn, may have indirect effects on birds in areas that may be some distance from the wind farm including reduced energy acquisition as a result of increased competition at other foraging sites which can result in further reductions in fitness affecting reproductive success. However, due to limited empirical evidence quantifying the likely energetic consequences of displacement, the advice of the Statutory Nature Conservation Bodies (SNCBs) is to consider displacement impacts in terms of direct mortality on bird populations (JNCC *et al.,* 2017).

10.5.2.6 Recent advice published by UK SNCBs (JNCC *et al.,* 2017) suggests that in addition to the defined vulnerability of seabirds, habitat use flexibility can, in-combination with other factors including expert opinion, be used to propose an appropriate rate of mortality that occurs as a result of displacement.

10.5.2.7 Short-listing of species for displacement analysis is based on those known to be vulnerable to displacement impacts (based on Wade *et al.,* 2016; Bradbury *et al.,* 2014) and where the population of the species observed at the Moray West Site plus 4 km buffer is considered to be of importance (when compared against a relevant population scale thresholds - regional, national or international).

10.5.2.8 Barrier effects may arise when birds incur extra energetic costs as a result of avoiding a wind farm. Species passing through an area infrequently, such as birds traversing the sites as part of a longer biannual migration flight, would incur much less impact than a species breeding near the development that needed to avoid it on a daily basis as part of its foraging routine. Effects upon birds simply passing through an area will be negligible (although possibly contributing to cumulative effects where other barriers exist on a migration route), whereas those making frequent flights across the sites may do so to the detriment of their body condition, which may affect adult survival or reproductive success.

10.5.2.9 Short–listing species for barrier effect considerations will be based upon: the number of each species recorded on the Moray West Site plus 4 km buffer, the likelihood of locally breeding individuals foraging on the site (based on empirical tracking data and mean of the maximum foraging ranges, from BirdLife and the review by Thaxter *et al.*, 2012) and the frequency of foraging flights made by each species (from Masden, 2010).

Collision

10.5.2.10 Birds can collide with turbine rotor blades, which is almost certain to result in direct mortality. Most studies have found evidence of only low levels of bird mortality associated with operational onshore wind farms, as birds are able to take avoiding action (Drewitt and Langston, 2006; Skov *et al*., 2018), although evidence from offshore wind farms is limited. The actual risk of collision depends on a number of factors including the location of a wind farm, the bird species using the area, weather and visibility conditions, and the size and design of the wind farm, including the number and size of turbines and the use, or otherwise, of lighting (e.g., Kerlinger and Curry, 2002).

10.5.2.11 The effect of collision rates on a population is influenced by various characteristics, notably its size, density, recruitment rate (additions to the population through reproduction and immigration) and mortality rate (the natural rate of losses due to death and emigration). In general, the effect of an individual lost from the population will be greater for species that occur at low density, are relatively long-lived and reproduce at a low rate with most seabird species falling into this category. Conversely, the effect will often be reduced for shorter-lived species with higher reproductive rates found at high densities, including some smaller gull species. Species that habitually fly at night or during low light conditions at dawn and dusk may also be at increased risk from collisions, however, both eider and scoter have been shown to detect and avoid offshore turbines at night in both the Netherlands (Winkelman, 1995) and at offshore towers at Tuno Knob in Denmark (Tulp *et al*., 1999).

10.5.2.12 Short-listing of species for collision risk considerations is based upon the vulnerability to the impact (Wade *et al.,* 2016) and the importance of the population recorded at the Moray West Site (Volume 4 – Technical Appendix 10.1).

Pollution

10.5.2.13 During construction, support vessels and machinery present will contain a fuel supply and lubricants which, in the event of an incident such as a collision, may be released into the surrounding sea. During the operation phase, each turbine will undergo a routine service every year. As part of this process, hydraulic fluids, gearbox oils and lubricants will be replaced and solid consumables such as filters will be disposed of.

10.5.2.14 Although likelihood and risks are low, seabirds utilising the environment in the vicinity of a pollution incident may be vulnerable to either direct mortality from oil coverage preventing flight for example, or indirectly via a reduction in ability to forage.

Indirect Effects

10.5.2.15 The physical presence of foundation and potential scour protection, as well as potential changes in commercial fishing activities may impact upon the availability of prey species. Indirect effects from the presence of foundations include potential changes to the wave climate, creation of hard substrate around turbine foundations and inter-array / export cables, increases in sedimentation in the water column and noise and vibration from operational turbines. The potential reduction in fishing activity within the vicinity of turbines could have a positive benefit on prey stocks as could the aggregation of fish and shellfish around the introduced hard substrates.

Attraction to Lit Structures

10.5.2.16 Birds are often attracted to structures such as oil rigs during the hours of darkness, as they may provide opportunities for extended feeding periods, shelter and resting places or navigation aids for migrating birds. Any benefits of lighting, however, may be outweighed by increased risks of collision with gas flares, or in the case of turbines, rotating blades. Turbines are not likely to be extensively lit, compared to oil rigs for example, and so any benefits relating to increased provision of foraging opportunities during hours of darkness are likely to be negligible.

10.5.2.17 The complexity of this issue arises in the fact that disturbance effects of lighting may derive from changes in orientation, disorientation and attraction or repulsion from the altered light environment, which in turn may affect foraging, migration and communication (Longcore and Rich, 2004). Birds may collide with each other or a structure, or become exhausted as a result. Conversely, for unlit turbines at night or during foggy conditions, it is possible that the risk of collision may be greater because moving rotors may not be detectable (Trapp, 1998).

10.5.3 Scoped Out Impacts

10.5.3.1 In accordance with the scoping reports produced in 2016 and 2017 (Moray West, 2016 & Moray West 2017) and in line with the scoping opinions received from MS-LOT in August 2016 and August 2017, no potential impacts have been scoped out of the assessment.

10.5.4 Assessment of Potential Effects

10.5.4.1 The criteria for determining the significance of effects is a two stage process that involves defining the sensitivity of the receptors and the magnitude of the impacts. This section describes the criteria applied in this chapter to assign values to the sensitivity of receptors and the magnitude of potential impacts. The terms used to define sensitivity and magnitude are based on those used in the IEMA methodology, which is described in further detail in Chapter 5: Environmental Impact Assessment Methodology. These criteria have been adapted in order to implement a specific methodology for offshore ornithology. The general principle of determining impact significance from levels of sensitivity of the receptors and magnitude of effect is however consistent with IEMA (2004). In this respect, the methodology used also follows the approach outlined by CIEEM (2010).

Displacement Analysis

Overview

10.5.4.2 The presence of wind turbines has the potential to directly disturb and displace birds from within and around Moray West Offshore Wind Farm. As displacement effectively leads to exclusion from areas of suitable habitat, it can be regarded as being similar to habitat loss in its effect on birds, although it may be more spatially extensive. This indirect habitat loss would reduce the area available for feeding, loafing and moulting for seabird species that may occur at the Moray West Site. In addition there is the potential for seabird species to be affected by disturbance impacts resulting from construction, operation and maintenance and decommissioning activities along the Offshore Export Cable Corridor.

10.5.4.3 Seabird species vary in their reactions to the presence of operational infrastructure (e.g. wind turbines, substations and met mast) and to the maintenance activities that are associated with it (particularly ship and helicopter traffic). Wade *et al*. (2016) presents a scoring system for such disturbance factors, which is used widely in offshore wind farm EIAs.

10.5.4.4 Following recently published joint SNCB interim guidance JNCC *et al*. (2017), displacement impacts for each relevant species are presented using a wide range of potential displacement and mortality rates. These have been presented as separate matrix tables, one for each of the seasons being assessed as applicable (e.g. 'breeding', 'post-breeding', 'non-breeding' and 'pre-breeding') in Volume 4 – Technical Appendix 10.3: Ornithology Displacement. The matrices and assessments presented in this chapter take into consideration three species-specific factors: (i) intensity of displacement within a given area (i.e. what proportion of the population is displaced); (ii) spatial extent – to what distance from turbines any individuals within the population will be displaced; and (iii) seasonality – what magnitude of impact there will be within a population (taken as percentage mortality), based on the species' particular sensitivity during a particular stage in the life cycle.

10.5.4.5 It is recognised that for many species, limited information is available to predict the magnitude of displacement or, should it occur, its resultant effects on populations. The biological consequences of such displacement and any resultant population-level effects will depend on the importance of the area from which birds are displaced and the capacity of alternative habitats to support these displaced birds. Migratory species are unlikely to find the area particularly important unless it is recognised as an important staging area, whereas impacts may be more acutely felt if a loss of prime foraging habitat for a breeding colony results. For most species there has been little evidence of total or near-total displacement from constructed offshore wind farms (e.g. Krijgsveld *et al.,* 2011). For some species, such as auks, the reported levels of displacement have been variable.

10.5.4.6 The period of time and constancy that individuals within a population may be subject to displacement impacts is uncertain. It is likely that the impacts will be felt at greatest intensity during the first year of exposure, before there is any opportunity for habituation. Mortality is likely to be greatest in this year while in subsequent years it is possible that birds may become habituated to a certain extent, thereby reducing mortality rates. However, if the population has a large number of non-breeding 'floaters' then mortality rates may stay at similar levels for a number of years until this pool is used up.

10.5.4.7 If this is the case then absolute mortality may be lower in subsequent years because the population reaches equilibrium as the result of previous loss of habitat available for foraging. In the long-term the impact is potentially more likely to result in a decrease in productivity rather than an additive annual mortality that has been predicted here, and so these predicted values of annual mortality should not be summed to make total mortality across the lifespan of the Development.

10.5.4.8 Disturbance by operating wind turbines can exclude birds from suitable breeding, roosting, and feeding habitats around a larger area than otherwise would occur through direct habitat loss (Exo *et al.,* 2003; Petersen *et al.,* 2006; Maclean *et al*., 2009). Although some species show little avoidance, others such as divers, auks and pelagic birds may not fly or forage within hundreds of metres of the turbines (Kerlinger and Curry, 2002).

10.5.4.9 Comparatively, some gull species, cormorant and terns have generally shown little avoidance to wind farms and for instance were seen regularly foraging within the Egmond aan Zee offshore wind farm (Krijgsveld *et al*., 2010; 2011). Post-construction surveys at Ormonde Offshore Wind Farm in the north-east Irish Sea inferred an 'attractive' effect of the turbines on kittiwake as abundance was significantly higher compared to control areas (CMACS, 2014). Displacement effects are therefore likely to be minimal on these species.

10.5.4.10 A study at Tuno Knob, in Denmark, reported effects on nocturnal flights of eiders out to 1,500 m from turbines (Tulp *et al*., 1999). Conversely, other studies at operational wind farms have not observed significant effects on the abundance or distribution of local seabirds (Leopold *et al*., 2010; Barrow Offshore Wind Ltd., 2009). With the exception of red-throated diver, monitoring at Kentish Flats also reported no avoidance behaviour (Percival, 2009; 2010). It has been postulated that other natural environmental variables were the driver for any observed effects, as well as the influence of fishing vessels on some species (particularly gulls) (e.g. Leopold *et al.,* 2011).

10.5.4.11 In general, migrants appear to be more obviously displaced than local resident birds, likely due to the lack of habituation of birds passing briefly through the area (Petersen *et al*., 2004; Petersen, 2005). Habituation is likely to occur for some species once turbines are operational and human activity is reduced. A study conducted at Blyth Harbour in Northumberland showed that eiders and other birds did habituate to the turbines so that impacts were not considered significant (Lowther, 2000). Seaducks initially avoided the Horns Rev Offshore Wind Farm, but later assembled between turbines, possibly after successful recruitment of benthic prey (Petersen and Fox, 2007).

Species for Consideration

10.5.4.12 Volume 4 – Technical Appendix 10.3: Analysis of Displacement Impacts on Seabirds presents information to inform the assessments presented in this chapter relating to the significance of displacement impacts. These analyses have been informed by recent guidance published jointly by the UK SNCBs (JNCC *et al.,* 2017).

10.5.4.13 The full process applied to identify species that may be impacted by displacement effects is documented in the Ornithology Technical Report (Volume 4 – Technical Appendix 10.1).

10.5.4.14 The following species were identified for inclusion in the displacement assessment for potential displacement impacts associated with the Moray West Offshore Wind Farm:

- Fulmar;
- Kittiwake;
- Puffin;
- Razorbill; and
- Guillemot.

10.5.4.15 In addition, potential disturbance and displacement impacts associated with the Offshore Export Cable Corridor have been considered for nine Valued Ornithological Receptors: scaup, eider, long-tailed duck, common scoter, velvet scoter, goldeneye, red-breasted merganser, red-throated diver, and great northern diver.

Spatial Scales

10.5.4.16 JNCC *et al.* (2017) interim guidance recommends that for the species of highest sensitivity (divers and sea ducks), the Moray West Site plus 4 km buffer should be used when assessing displacement, whereas a 2 km buffer should be used for all other species. In both cases JNCC *et al.* (2017) recommended that no gradient of impact of displacement level should be applied to the buffer zone, as there is not sufficient evidence to underpin any such gradient application on a species-by-species basis. This is a precautionary approach that doesn’t represent the reality that some degree of gradient will occur in respect to how close individual birds will approach a source of disturbance influenced by, for example, past exposure to the event (habituation), need to feed chicks and ability to forage as successfully elsewhere.

10.5.4.17 For all species included in the displacement analysis for impacts associated with the Moray West Offshore Wind Farm, a 2 km buffer around the Moray West Site is used with no gradient of impact of displacement level applied to the buffer zone. Species deemed particularly sensitive to displacement, such as divers and seaduck did not qualify as Valued Ornithological Receptors in this assessment for the Moray West Site due to either being absent or recorded in only very small numbers (during site-specific aerial surveys (Volume 4 – Technical Appendix 10.1: Ornithology Technical Report). Red-throated diver and common scoter did however qualify as Valued Ornithological Receptors for consideration in relation to construction phase disturbance impacts arising from the Offshore Export Cable Corridor.

10.5.4.18 Significant degrees of precaution are built into the assessment of displacement effects. The JNCC *et al.* (2017) interim guidance underpins the process followed. The assessment applies the mean peak number of birds recorded within the Moray West Site (plus an appropriate buffer) during appropriate seasons defined for each Valued Ornithological Receptor. Populations (for guillemot, razorbill, puffin and kittiwake) used in the assessment of displacement have been derived through a ‘decision support system’ process by which the single year of data collected for Moray West is compared against overlapping data from surveys of Beatrice Offshore wind Farm and the MORL EDA (now Moray East Offshore Wind Farm) (Volume 4 – Technical Appendix 10.1 - Annex 10.1A). Mean peak population estimates for fulmar have been taken directly from the outputs of the single year of digital aerial survey for Moray West (Volume 4 – Technical Appendix 10.1: Ornithology Technical Report).

10.5.4.19 The mean peak number (i.e. the mean of the highest population estimates within a particular season) is considered sufficiently precautionary for the realistic worst-case. It is considered likely that displacement responses by seabirds are highly likely to decline the further distant from the disturbance source. A notable example of this was recorded for red-throated divers at Kentish Flats Offshore Wind Farm (Percival, 2010). However, in general, species specific information is lacking on geographically defined displacement rates and therefore on a precautionary basis a consistent displacement rate is applied through the Moray West Site plus buffer. This therefore means that assessments of displacement effects are associated with a significant degree of in-built precaution.

Displacement Rates

10.5.4.20 The potential impact of displacement will vary depending on the season. Breeding seabirds are 'central place foragers', with the need to optimise their time spent away from the nest and energy expended in foraging. The range at which they can forage away from the nest site becomes constrained by distance from their nesting site, unlike birds that are not actively breeding, irrespective of season that can forage more widely. Consequently, any displacement during the breeding season of breeding adults from foraging areas is predicted to have a greater magnitude of impact than at other times as birds may struggle to meet their energy requirements.

10.5.4.21 JNCC *et al. (*2017) indicates that SNCBs intend to use 'Disturbance Susceptibility' scores from Bradbury *et al*. (2014) (which have in fact been updated by Wade *et al.* (2016)) as a general guide to the appropriate displacement levels to apply for a species. JNCC *et al.* (2017) suggests that displacement rates of 90-100% should be used for species with a high vulnerability, 30-70% should be used for species with a moderate vulnerability and 10% should be used for species with a low vulnerability. Since the publication of JNCC *et al.* (2017) further advice from SNH has been provided on the appropriate species specific rates that should be applied to impact assessments (e.g. SNH advice to scoping opinions for Forth and Tay wind farms). In addition to these recommended rates, attempts have been made in this EIA Report below to summarise available published evidence on displacement and provide alternative suggested displacement rates if considered appropriate.

10.5.4.22 Although concentrating on birds in flight, the study of the operational Egmond aan Zee wind farm by Krijgsveld *et al.* (2011) represents one of the most in-depth studies to date on determining the effect of the presence of operational turbines on birds. Based on radar and panorama scans, macro-avoidance rates (i.e. birds avoiding the wind farm as a whole) were assessed for the majority of species groups present, and this behaviour is likely to be indicative of displacement risks. Gulls were the main species present, and although in the cases of auks and divers too few observations were available to obtain a reliable macro-avoidance rate, from flight paths it was evident that their avoidance behaviour was similar to that of gannets and scoters, rather than that of gulls.

10.5.4.23 Construction period records from the Lincs offshore wind farm showed that at least 769 birds (198 observations) including large gulls, kittiwake and terns used turbine bases and monopiles to rest on. On several occasions gulls were clearly associated with the jack-up barge, the guard vessels and with the construction vessel while piling was in progress (RPS, 2012). Similarly, Vanermen *et al.* (2013) in their study of Belgian offshore wind farms, birds (mainly gulls) were attracted to physical structures e.g. turbines, as roost locations and did not show any signs of displacement. Construction disturbance to these species is therefore considered likely to be minimal.

<u>Fulmar</u>

10.5.4.24 Fulmar is considered to have a very low vulnerability to displacement from offshore wind farms, being assigned a score of 1 (out of 5) by Wade *et al.* (2016). JNCC *et al.* (2017) suggests that a 10% displacement rate would be assumed for species such as fulmar.

10.5.4.25 There was no significant effect on the abundance of fulmar at the Thortonbank offshore wind farm between the pre-construction and operational phases (Vanerman *et al.,* 2017). Leopold *et al.* (2011) was unable to draw conclusive results at Egmond aan Zee due to low numbers of birds although Krijgsveld *et al.* (2011), using data collected at the same project, identified fulmar as a lower sensitivity species with a displacement rate of 28%. Barton *et al*. (2009) noted "highly significant" declines in the abundance of fulmar at the Arklow Bank wind farm although declines appear to have occurred across the study area.

10.5.4.26 Available published evidence for fulmar is limited and while a displacement rate of 10% is considered appropriate, the results at a range of 10-30% are presented.

Auks

10.5.4.27 Guillemot and razorbill are considered to have a high vulnerability to displacement from offshore wind farms, being assigned a score of 4 (out of 5) by Wade *et al.* (2016). Puffin is assigned a score of 3 and considered to be moderately vulnerable to displacement. JNCC *et al.* (2017) suggests that a 30-100% displacement rate range would be assumed for species with moderate or high vulnerability.

10.5.4.28 Krijgsveld *et al.* (2011) identified auks as higher sensitivity species to displacement calculating a macro-avoidance rate of 68% however, only relatively close to turbines (within 500 m). Dierschke and Garthe (2006) present evidence that also suggests guillemot and razorbill have a relatively high sensitivity to displacement from offshore wind farms. Danish studies at Horns Rev, whilst showing considerable variability, also suggest this, noting total absence from the wind farm footprint following construction (Petersen *et al.,* 2006).

10.5.4.29 Studies undertaken at Dutch wind farms have reported displacement effects of less than 50% (Leopold *et al.,* 2011). Leopold *et al.* (2010) found that at Egmond aan Zee, auks enter the wind farm area by swimming, and both species regularly foraged within the site. However, a number of more recent studies have not shown a similar level of impact. Arklow Bank Offshore Wind Farm did not find any significant difference in the number of guillemots present pre- and post-construction with an increase in the abundance of razorbill suggesting no impact due to the presence of turbines (Barton *et al.*, 2009). Post construction monitoring at North Hoyle Offshore Wind Farm indicated an increase of up to 55% in the number of guillemots present compared to before the wind farm was constructed (nPower, 2008).

10.5.4.30 The abundance of razorbill at the Robin Rigg offshore wind farm was not significantly affected by the development phase of the wind farm, although densities of razorbill on the sea did increase within the wind farm area between the pre-construction and operational phases (Nelson *et al.,* 2014). The spatial abundance of guillemot changed between time periods, but it did not appear to be linked with the presence of the wind farm. The abundance of guillemot at the Thortonbank offshore wind farm was shown to have decreased once the wind farm was operational (69% in the wind farm plus 500 m buffer area) with these decreases significant within the wind farm plus 500 m buffer area. Although decreases were also noted in the buffer area (500 m to 3 km) these were not statistically significant. The abundance of razorbill decreased within the wind farm area but increased in the surrounding buffer. When these two areas were combined there was no apparent effect on the abundance of razorbill due to the presence of the wind farm (Vanerman *et al*., 2017). Similar results were found at the Alpha Ventus offshore wind farm with the abundance of guillemot statistically significantly lower after the construction of the wind farm (Mendel *et al*., 2014). At Blighbank offshore wind farm both guillemot and razorbill appeared to avoid the wind farm area with decreases of 75% and 67%, respectively however, decreases were lower (and not significant) in the buffer area (49 and 32%, respectively) (Vanerman *et al*., 2016).

10.5.4.31 It is important to note that some of the high displacement rates reported in the studies summarised here apply to the wind farm alone whereas the displacement analyses for this Development calculate the number birds displaced from the Moray West Site plus a 2 km buffer. A number of studies found no significant effect on the number of birds present in buffer areas around wind farms and therefore the likely displacement rate is not considered to be at the upper end of the range considered.

10.5.4.32 Monitoring studies have often recorded auks inside of wind farm areas and on the basis of the above information, a highlighted displacement rate of 50% for guillemots based on the conclusions of Vanerman *et al*., (2016; 2017) and Nelson *et al.,* (2014), in particular. This is presented in addition to a 60% rate advised on all auk species for Forth and Tay projects by Marine Scotland (e.g. Scoping Opinion for Seagreen Offshore Wind Farm, 2017).

10.5.4.33 Based on the studies summarised above, razorbill appears to have a lower vulnerability to displacement impacts than guillemot, especially when considering the results obtained at Thortonbank (Vanerman *et al.,* 2017), Blighbank (Vanerman *et al*., 2016) and Robin Rigg (Nelson *et al.,* 2014) which show lower displacement rates than those calculated for guillemot. As such, a displacement rate of 40% is considered appropriate for razorbill. This is presented in addition to a 60% rate advised on all auk species for Forth and Tay projects by Marine Scotland (e.g. Scoping Opinion for Seagreen Offshore Wind Farm, 2017).

10.5.4.34 There have been few studies which have included puffin as a separate species to assess displacement rates, with the majority combining all auks together. For assessment purposes, a displacement value of 50% from the Moray West Site plus 2 km buffer during the breeding and non-breeding seasons is considered appropriate for puffin, based on the rationale described for razorbill, but with an added degree of precaution due to a lower level of empirical evidence. This is again presented in addition to a 60% rate advised on all auk species for Forth and Tay projects by Marine Scotland (e.g. Scoping Opinion for Seagreen Offshore Wind Farm, 2017).

Kittiwake

10.5.4.35 There was no impact on the distribution of gulls (including kittiwake) arising from the construction of the Egmond aan Zee Offshore Wind Farm (Leopold *et al.*, 2011). At Robin Rigg, the number of kittiwakes on the sea decreased within the Robin Rigg offshore wind farm during the construction phase, although this reduction was not statistically significant (Walls *et al.,* 2013a, 2013b). During operation, modelled kittiwake abundance across the Robin Rigg study area was largest within and immediately east and west of the Robin Rigg offshore wind farm, providing clear evidence that kittiwakes sitting on the sea had not been displaced from the Robin Rigg offshore wind farm during operation. However, results from Alpha Ventus indicated that kittiwakes were displaced (Mendel *et al*., 2014).

10.5.4.36 A 30% rate has been advised for kittiwake for Forth and Tay projects by Marine Scotland (e.g. Scoping Opinion for Seagreen Offshore Wind Farm, 2017) and this is taken as being a precautionary rate for this Development.

Mortality Rates

10.5.4.37 There are no directly appropriate studies of the effects of displacement on mortality of seabirds. It is however reasonable to consider the assumption that 100% of displaced birds will die as overly precautionary. It follows that the density of birds within areas to which birds are displaced will increase as a result of the relocation of the displaced birds to where others may already be occupying. There is the possibility that there will be additional mortality experienced by these birds due to increased resource competition and that this “additional mortality” will be a function of density, i.e. the mortality rate increases as density increases.

10.5.4.38 There is little or no evidence on what the extent of mortality may be, although a typical ceiling of under 10% is often applied by advisers. The following rates advised by Marine Scotland (e.g. Scoping Opinion for Seagreen Offshore Wind Farm, 2017) have been followed for the purposes of this assessment:

- Guillemot and razorbill: 1%
- Puffin and kittiwake: 2%

10.5.4.39 Fulmar have extensive foraging ranges during the breeding season (*Thaxter et al.,* 2012) providing the species with sufficient alternative foraging opportunities. A mortality rate of 1% is therefore considered appropriate in the breeding season.

10.5.4.40 The mortality rate varies between species, with actual assigned values dependent on that species' known behaviour (e.g. habitat and foraging flexibility as defined in Wade *et al*., 2016). These rates are considered suitably precautionary for EIA requirements, although the matrices presented show rates of up to 100% for both displacement and mortality as recommended in interim guidance (JNCC *et al.,* 2017).

Population Consequences of Displacement / Barrier Effects

10.5.4.41 Searle *et al.* (2014) developed a model ('CEH displacement model') to estimate the population consequences of displacement/barrier effects from proposed offshore wind energy developments for key species of seabirds breeding at SPAs in proximity to proposed Forth/Tay offshore wind farm developments. For each of five species (gannet, puffin, razorbill, guillemot and kittiwake), bird densities were estimated from filtered GPS tracking data using a Binomial Generalized Additive Model (GAM). The GAMs provided an estimate of the predicted bird density for each species-by-SPA combination, which was then used to select daily foraging locations for each bird in the simulation. Impacts of displacement on population size were considered operating via two main processes: reduced survival of offspring during the breeding season, and reduced body mass of adults leading to lower survival in the following winter.

10.5.4.42 The CEH displacement model assumed a 60% displacement rate for auk species and gannet, and 40% for kittiwake. It provided outputs for two types of assumed prey distribution in the absence of direct empirical data:

- A 'homogeneous' (even) distribution of prey across the region.
- A heterogeneous (variable) prey distribution derived from bird GPS tracking data.

10.5.4.43 These represent two extreme scenarios, from which the modelled outputs encompasses the range of possible displacement / barrier effects.

10.5.4.44 Though Searle *et al.* (2014) were unable to undertake a full quantitative assessment of uncertainty, qualitatively the indications were that the uncertainty in the magnitude of the wind farm effect is likely to be large. Many parameters used in the CEH displacement model were unknown, poorly estimated or estimated away from the study area. It was therefore recommended that the outputs from the modelling should be "interpreted with considerable caution". An important step towards reducing the uncertainty of the outputs would be parameterisation of the model with local data, in particular prey distribution, behaviour of seabirds in response to wind farms (including habituation) and influence of adult body mass change on subsequent survival.

10.5.4.45 The CEH displacement model's outputs addressed the cumulative development scenario of all four Forth and Tay wind farms (Alpha, Bravo, Neart na Gaoithe and Inch Cape) in combination as well as each individual wind farm in isolation (provided for all species, excepting gannet). Whilst the output of the CEH displacement model does not provide for quantification of displacement/barrier effect at Moray West, the findings of this study does provide the current assessment with some context as to the scale of possible displacement / barrier effects upon a species alongside the mortality estimates of the SNCB displacement guidance (2017).

At-Sea Turnover of Breeding Seabirds

10.5.4.46 Searle *et al.* (2015) reviewed the 'turnover' of individual seabirds at sea during the breeding season and assessed how this may lead population estimates derived from boat or aerial surveys to underestimate the total number of birds that use an area during the course of the breeding season. In this context, turnover was defined as the total number of birds that will use a particular area of sea at any point during the breeding season, divided by the number of birds that will be present in that area at a particular snapshot in time.

10.5.4.47 Searle *et al.* (2015) estimated turnover using modelled foraging densities of the Forth-Tay area derived from GPS tracking data (as generated by Searle *et al.,* 2014 for the CEH displacement model) to simulate the daily foraging locations of individual birds on individual days throughout the breeding season. By assuming that birds rest at their foraging locations, and fly in a straight line between the colony and foraging location, these simulations were used to evaluate the locations that are associated with foraging, commuting and resting at sea. Empirical data on the daily activity budget of birds was used for simulating the number of birds that would be seen performing each behaviour (foraging, commuting, resting at sea) within each wind farm footprint during a "snapshot" survey of the entire footprint area. This enabled for four species (kittiwake, guillemot, razorbill and puffin) in the Forth-Tay region, a direct estimate of turnover to be quantified for site fidelity at a range of spatial scales and levels (i.e. none to complete).

10.5.4.48 What this Marine Scotland commissioned study has not enabled is the provision of specific estimates of turnover at a given location until further data on both the level and spatial scale of site fidelity of these species become available. The findings therefore provide a guide to describing how the level of turnover changes with site fidelity behaviours and patterns, and with the spatial scale of wind farm footprints. Quantifying the fate of birds that lie within the development footprint is a related but separate task that was outside of the study's remit.

10.5.4.49 In general however, it can be supposed that the higher the turnover the less often any individual is likely to be using the Site, and therefore the lower the impact to any one individual. So, by not assessing turnover, and assuming the mean peak represents birds dependent on the Site, the assessment is highly likely to be conservative.

Collision Risk Analysis

10.5.4.50 Collision Risk Modelling (CRM) has been undertaken to quantify the potential risk of additional mortality through collisions with operational turbines above the current baseline for each species. The most frequently used collision risk model in the UK is commonly referred to as 'the Band model'. This model was originally devised in 1995 and has since been subject to a number of iterations, most recently to facilitate application in the offshore environment (Band, 2011), to allow for the use of flight height distribution data and to include a methodology for considering birds on migration (Band, 2012).

10.5.4.51 Masden (2015) presents an update to Band (2012) which further develops the application of the Band model using a simulation modelling approach to incorporate variability and uncertainty. The update provides for an improved understanding of uncertainty by randomly sampling parameter values from distributions for each parameter, deriving average collision risk estimates with associated measures of variability. However, it has recently come to light, through advice from SNH and MSS, that further amendment of Masden (2015) to update the collision risk model is required before they advise its use. These amendments are however expected to be included as part of ongoing work that aims to produce an improved stochastic collision risk model later in 2018. As a result, Masden (2015) has not been used to calculate collision risk estimates for Moray West Offshore Wind Farm.

10.5.4.52 The Band (2012) model incorporates two approaches to calculating the risk of collision referred to as the 'Basic' and 'Extended' versions of the model. A key difference between these versions is the extent to which they account for the flight height distributions of seabirds (Band, 2012). The distribution of seabird flights above the sea is generally strongly skewed towards lower altitudes. As stated by Band (2012) there are three consequences of a skewed flight height distribution:

- "the proportion of birds flying at risk height decreases as the height of the rotor is increased;
- more birds miss the rotor, where flights lie close to the bottom of the circle presented by the rotor; and
- the collision risk, for birds passing through the lower parts of a rotor, is less than the average collision risk for the whole rotor."

10.5.4.53 The Basic model assumes a uniform distribution of flights across the rotor with a consistent risk of collision across the whole rotor swept area. The Extended model of Band (2012) takes into account the distribution of birds in addition to the differential risk across the rotor swept area. It should be noted that the use of the basic model is precautionary as it does not take into account the variability in risk of collision that occurs across a rotor swept area, with the risk of collision decreasing as the distance from the hub of the turbine increases. If this were to be taken into account (as when using Option 3 – see below) it is likely that collision risk estimates would be lower as the vertical distribution of birds flying above the water is skewed towards lower heights (i.e. those associated with a lower risk of collision within a rotor swept area).

10.5.4.54 Both the Basic and Extended models of Band (2012) allow for the use of two 'Options' termed Options 1-4. Options 1 and 2 use the Basic model with Options 3 and 4 utilising the Extended model. The difference between the two Options under each model is linked to the use of flight height data. Options 2 and 3 use generic data from Johnston *et al.* (2014) whereas Options 1 and 4 use data derived from site-specific surveys.

10.5.4.55 The Band (2012) CRM requires monthly densities of each species assessed to be provided. Volume 4 – Technical Appendix 10.1 - Annex 10.1A presents the process by which appropriate densities have been selected to inform the CRM. In order to express the uncertainty associated with the collision risk estimates used in the assessment, modelling has been conducted incorporating upper and lower confidence intervals associated with both species densities and flight height distributions.

10.5.4.56 The flight height data collected as part of site-specific digital aerial surveys of the Moray West Site plus 4 km buffer have been thoroughly reviewed and are concluded to be of limited use in collision risk modelling. For the majority of species the number of records falls below a usable sample size in order to derive any degree of confidence in the estimate (i.e. considerably below 100 records for most species). In addition, flight height estimates have tended to fall considerably outside of the confidence limits associated with generic flight height information (Johnston *et al.*, 2014) with no valid ecological reason as to why this should occur. Further to this, the majority of records in the dataset have associated wide confidence intervals and there are a significant number of records that are assigned a negative flight height. It was therefore agreed with SNH and MSS that the data was unsuitable to inform the CRM in the assessment of Moray West Offshore Wind Farm (see Table 10.3.1).

10.5.4.57 There exists a considerable amount of flight height data that were collected during boat-based surveys conducted to support the application for the Moray East Offshore Wind Farm. Surveys were conducted between April 2010 and March 2012 using standard survey methodologies (Camphuysen *et al*., 2004).

10.5.4.58 A proportion of the survey area overlaps with the Moray West Site (see Volume 4 – Technical Appendix 10.1 - Annex 10.1A). A full description of the surveys conducted is presented in the Moray East ES 2012. These data have been applied to Option 1 of the Moray West Offshore Wind Farm Band (2012) CRM. However, the flight height bands used to collect flight height data during these surveys do not correspond with the turbine models used in collision risk modelling for the Moray West Offshore Wind Farm. Therefore, although results using Option 1 are presented in Volume 4 – Technical Appendix 10.2: Collision Risk Modelling they are not used for assessment purposes as they are considered to greatly over-estimate the likely collision risk at the Moray West Site.

10.5.4.59 Collision risk estimates calculated using Options 2 and 3 of the Band (2012) model which make use of aggregated flight height data contained in Johnston *et al.* (2014) are therefore used to inform the assessments presented.

10.5.4.60 The proportion collision height (PCH) calculated for each species are presented in Volume 4 – Technical Appendix 10.2: Collision Risk Modelling.

10.5.4.61 The maximum design scenario for collision risk when using the Basic model of Band (2012) was the development scenario comprising 85 x Model 2 turbines whereas for the Extended model the worst case scenario was the development scenario comprising 85 x Model 1 turbines. The parameters for both turbine scenarios are as defined in Chapter 4: Development Description and detailed in Volume 4 – Technical Appendix 10.2: Collision Risk Modelling. This includes a lower tip height clearance of 35 m above HAT for all WTG models.

Collision Risk to Regularly Occurring Seabirds

10.5.4.62 Collision risk modelling was conducted for four regularly occurring seabird species at the Moray West Site with these species selected using the criteria applied in Volume 4 – Technical Appendix 10.1 Ornithology Technical Report:

- Gannet;
- Kittiwake;
- Herring gull; and
- Great black-backed gull.

10.5.4.63 CRM for these species has been conducted using the Band (2012) CRM, as agreed with SNH and MSS. Bird biometric parameters for each of these species is presented in Volume 4 – Technical Appendix 10.2: Collision Risk Modelling.

10.5.4.64 The avoidance rates applied for each species are also presented in Appendix10.2: Collision Risk Modelling. The rates applied are in general, taken from Cook *et al*. (2014) which presents avoidance rates for all four species included in the modelling for the Moray West Offshore Wind Farm. Cook *et al.* (2014) recommended avoidance rates for use with the Basic model for all four species and with the Extended model for herring gull and great black-backed gull. Cook *et al*. (2014) were unable to recommend an avoidance rate for use in the Extended model for gannet and kittiwake and as such a 'default' 98% avoidance rate is applied in the modelling conducted for this Development.

10.5.4.65 In a joint response, UK SNCBs supported the recommended avoidance rates of Cook *et al.* (2014) with the exception of kittiwake (JNCC *et al.,* 2014). The SNCBs did not agree with the application of avoidance rates calculated for the 'small gull' category used in Cook *et al.* (2014) to kittiwake and recommended that the avoidance rate calculated for the 'all gull' category should be applied instead. Collision risk modelling for this Development is presented at a range of avoidance rates; it is however therefore focussed on the avoidance rates presented in Table 10.5.2 taking into account the recommendations in JNCC *et al.* (2014).

Table 10.5.2: Avoidance Rates Applied in Collision Risk Modelling for Regularly Occurring Seabirds

Band (2012) model	Gannet	Kittiwake	Herring gull	Great black-backed gull
Basic	98.9 (±0.2)	98.9 / 99.2 (±0.2)	99.5 (±0.1)	99.5 (±0.1)
Extended	98.0	98.0	99.0 (±0.2)	98.9 (±0.2)

10.5.4.66 Outputs from the collision risk modelling undertaken for the four regularly occurring seabird species are presented in Volume 4 – Technical Appendix 10.2: Collision Risk Modelling.

Collision Risk to Regularly Migratory Seabirds and Waterbirds

10.5.4.67 It was advised by Marine Scotland in their Scoping Opinion for the Moray West Offshore Wind Farm that for non-seabird migratory interests on the 'long-list', information presented in Marine Scotland's strategic collision risk assessment can be utilised[3]. No additional work was deemed to be required in this regard, including with respect to wintering wildfowl interests of the Moray Firth pSPA. The strategic assessment (WWT, 2014) provides an overall estimate of collision risk that Scottish offshore wind farms may present to birds on migration.

10.5.4.68 The report concludes that birds on migration through Scottish waters are not considered to be at risk of significant levels of additional mortality, due to collisions with Scottish offshore wind farms. Possible exceptions are large gulls, cormorant and common tern. Marine Scotland concluded that there is sufficient "flex" in the report to indicate that any potential impacts from Moray West lie well within the level of strategic collision risk that has been advised for migratory (non-seabird) interests. Since the time of the report, a number of design envelopes for consented schemes have been substantially refined reducing the levels of predicted collision risk. No collision risk modelling has therefore been undertaken for species occurring only on migration at the Moray West Site.

Assumptions and Precaution in Collision Risk Modelling Parameters

10.5.4.69 To quantify bird collision risk, collision risk models (CRM) such as 'the Band model' (Band 2012) used in the current assessment, use technical specifications of the turbines, bird morphological and behavioural parameters together with site-specific bird data e.g. densities. Models are often finally corrected to take account of behavioural responses of birds to the presence of wind farms and the turbines within, by multiplying the model's outcome with a correction factor that takes into account, among other things, avoidance (action taken by a bird, when close to an operational wind farm, which prevents collision), termed the "avoidance rate".

10.5.4.70 It is acknowledged that there is considerable uncertainty surrounding the estimates provided by collision risk models, including that from the Band model (Masden 2015, Skov *et al.* 2018). Any model is only as good as its assumptions and the parameter values used. As more data become available, for example, through radar or tracking studies, we should seek to refine the models in order to more accurately account for bird movement and behaviour.

10.5.4.71 In addition to the uncertainty associated with the collision risk models, it is frequently the case that projects when constructed do not reflect the maximum design scenario assessed. In many cases, the as-built scenario will represent a significantly lower impact resulting from collisions than that assessed as the maximum design scenario for the purpose of obtaining a consent. When these reductions in predicted collision mortality due to design changes are summed across wind farms as is required for cumulative impact assessment (CIA), the reduction in mortality can become substantial.

10.5.4.72 The recent publication of the ORJIP Bird Collision Avoidance (BCA) study (Skov *et al.* 2018) provides important and enhanced input for some of the required data used in the Band model, including species-specific data on flight speeds, empirical evidence on nocturnal activity and the best available empirical information to account for avoidance behaviour in seabirds which can be readily applied in CRM. This section considers these existing opportunities to refine the CRM in order to more accurately account for bird movement and behaviour. Moreover MacArthur Green's (2017) calculated update of collision mortality to reflect actual wind farm designs, has highlighted the ornithological 'headroom' that exists - the difference between the two

[3] http://www.gov.scot/Resource/0046/00461026.pdf

estimates. This additional existing opportunity to update CRM parameters by means of reviewing consented and as-built scenarios, is given further consideration in Section 10.8.4.

Bird flight speed

10.5.4.73 The ORJIP BCA study has generated the most extensive dataset of observations of seabird behaviour in and around an operational offshore wind farm that is currently available. This includes species-specific data on flight speed that can inform the estimation of more realistic flux of birds. The Band model makes use of bird speed twice: firstly in order to estimate the flux rate of birds through the wind farm and; secondly to estimate the probability of a bird colliding with a turbine rotor (Skov *et al.,* 2018). Band CRM assumes flight speeds through the wind farm as linear flight patterns. However, the empirical flight speeds obtained by Skov *et al.* (2018) and other studies clearly indicate that seabirds typically perform non-linear movements within a wind farm. Moreover bird flight speeds are highly variable (Thaxter *et al.,* 2011) depending on environmental factors, notably wind direction. The duration of a long convoluted track is also different than the duration of a straight track.

10.5.4.74 At present, flight speed data for use in CRM relies on published data (Pennycuick 1997; Alerstram *et al.,* 2007) based on very small sample sizes ranging from 32 (northern gannet) down to two (black-legged kittiwake). On the other hand, the laser rangefinder track data recorded by Skov *et al.* (2018) at Thanet Offshore Wind Farm, off the Kent coast, offer species-specific empirical data on flight speeds from large numbers of individuals, albeit in non-adverse weather conditions. As such, those data are a valuable source of information on more realistic mean flight speeds and associated variability in offshore wind farms necessary for improving estimates of the flux of birds for the species in question.

10.5.4.75 Table 10.5.3 provides a comparison between the species-specific mean flight speeds often used in CRM and those recorded by Skov *et al.,* (2018). For the former, the total track time for the two radar recordings of kittiwake was 660 seconds. Furthermore, the flight speed data for all four gull species (kittiwake, lesser black-backed gull, great black-backed gull and herring gull) was restricted to radar recordings from migration flight which are expected to be birds flying at an airspeed close to that associated with maximum lift-drag ratio (Alerstram *et al.* 2007). This would imply that the very small sample sizes of flight speed data used at present in CRM are not necessarily behaviourally representative of bird flight at sea. Indeed the flight speeds recorded by Skov *et al.* (2018) were markedly lower than the generic speeds typically recommended in guidance (Alerstam *et al.,* 2007).

Table 10.5.3: Species-Specific Mean Flight Speeds (m/s) Often Used in CRM, and those Measured from Single Rangefinder Segments Recorded at Thanet (SD is shown in brackets)

Species	Flight Speed Commonly Used (no. of tracks)	Flight Speed Estimated by the Study
Gannet	14.9* (n=32)	13.33 (4.24) [n=683]
Kittiwake	13.1** (n=2)	8.71 (3.16) [n= 287]
Lesser black-backed gull	13.1** (n=11)	9.80 (3.63)*** [n=790]
Great black-backed gull	13.7** (n=4)	
Herring gull	12.8** (n=18)	

* Pennycuick (1997)
**Alerstram *et al.* (2007)
***Estimated with data for all large gulls combined

10.5.4.76 Against this background, the flight speeds from Skov *et al.* (2018) are therefore the best available evidence to inform the collision risk assessment of Moray West as presented in Volume 4 – Technical Appendix 10.2: Collision Risk Modelling. Collision risk estimates calculated using flight speeds from Alerstam *et al.* (2007) or Pennycuick (1987) are however also presented in Volume 4 – Technical Appendix B of Appendix 10.2: Collision Risk Modelling.

Avoidance rates

10.5.4.77 Species specific generic avoidance rates currently used are often based on mortality rates observed at onshore wind farms with no consideration of actual avoidance behaviour. The ORJIP BCA study, 2014 – 2017 (Skov *et al.,* 2018), was designed to improve the evidence base for seabird avoidance behaviour and collisions around offshore wind farms. This study generated the most extensive dataset of observations of seabird behaviour in and around an operational offshore wind farm (Thanet Offshore Wind Farm, off the Kent coast) that is currently available. A bird monitoring system was developed for the study, that allowed detecting and tracking bird movements at the species level in and around an operational offshore wind farm. Bird behaviour was monitored by the study at Thanet Offshore Wind Farm, deploying a multiple sensor monitoring system partly operated by experienced seabird observers (laser rangefinders and radar equipment), and partly automated through the collection of video evidence, with a focus on five target species: gannet, kittiwake and three species of large gulls (lesser black-backed gull, herring gull, great black-backed gull).

10.5.4.78 The study by Skov *et al.* (2018) concluded that bird avoidance behaviour is likely to lead to a greater reduction in estimated collision rates than current correction factors (avoidance rates) applied to CRM assume. The differences between avoidance rates and empirical avoidance rates as quantified by Skov *et al.* (2018), are mainly driven by the fact that the former have been developed from land-based studies using the Band CRM to fit the observed number of collisions from carcass surveys while assuming flight speeds through the wind farm as linear flight patterns. For the purposes of this EIA Report, the Skov *et al.* (2018) empirical avoidance rates are considered the best available empirical information to account for avoidance behaviour. This provides a compelling basis for using higher avoidance rates, for these species, than are currently advised for use in collision risk assessment in the UK. Those rates should be closer to those indicated by the EARs derived in this study.

10.5.4.79 The empirical avoidance rates quantified by Skov *et al.* (2018) are considered applicable in the basic and extended version of the Band model (Band 2012). Thus, provided that empirically derived input parameters on flight speed in offshore wind farms and flight height outside offshore wind farms are applied, Skov *et al.* (2018) advise that the empirical avoidance rates can be readily used in the Band model. The empirical avoidance rates are provided below with standard deviation below calculated so as to reflect both variability and uncertainty.

- Gannet: 0.999 ± 0.003 SD
- Kittiwake: 0.998 ± 0.006 SD
- Herring gull: 0.999 ± 0.005 SD
- Great black-backed gull: 0.996 ± 0.011 SD
- Lesser black-backed gull: 0.998 ± 0.006 SD
- All large gulls: 0.998 ± 0.007 SD

10.5.4.80 The SNCBs are however currently assessing how the empirically estimated avoidance rates estimated as by Skov *et al.* (2018) should (or should not) be fed into a Band (2012) basic, and/or Band (2012) extended, model. In the absence from this review of recommendations by the SNCBs to date, the CRM of Volume 4 – Technical Appendix 10.2: Collision Risk Modelling is conducted using the avoidance rates presented in Table 1.3, taking into account the recommendations in both Cook *et al.* (2014) and JNCC *et al.* (2014).

Nocturnal flight activity

10.5.4.81 There is considerable uncertainty about levels of bird flight activity by night and in consequence the nocturnal activity factors to be used in collision risk modelling. Studies had only managed to capture very small sample sizes (Desholm 2005) prior to the study of Skov *et al.* (2018). The thermal video data collected by Skov *et al.* (2018) at Thanet Offshore Wind Farm provide an unprecedented body of evidence on nocturnal flight activity by seabirds in an offshore wind farm, indicating very low activity during dark hours throughout the annual cycle. Based on the thermal videos processed, there is an indication that nocturnal flight activity may only constitute a negligible proportion (i.e. < 5%) of total flight activity of the species study (kittiwake, lesser black-backed gull, great black-backed gull and herring gull).

10.5.4.82 Volume 4 – Technical Appendix 10.2: Collision Risk Modelling considers Skov *et al. (*2018) findings on the levels of bird flight activity by night in the context of other recent studies and the advice from Marine Scotland and SNH on the nocturnal activity factors to be used in collision risk modelling. Against this background, Annex C of Appendix 10.2: Collision Risk Modelling (Volume 4) presents an analysis of the potential change in collision risk estimates as a result of updating the nocturnal activity factors used in collision risk modelling at previously consented projects.

10.5.5 Impact Assessment Criteria

10.5.5.1 To determine the significance of an impact, a sequence of criteria are evaluated against each species and each impact:

(1) Receptor sensitivity – based on a combination of the conservation value of the species, the vulnerability of the species to each particular impact, and the recoverability of a species' population after being subject to a particular impact;

(2) Magnitude of impact – based on a combination of spatial extent (and therefore number of birds that may be affected), duration, frequency and reversibility in relation to reference populations (e.g. regional, national); and

(3) Significance – based on a combination of receptor sensitivity and magnitude to determine which effects on which species may be considered significant in EIA terms.

10.5.5.2 These three steps are described in sequence in the following sections.

Sensitivity Criteria

10.5.5.3 With regard to offshore ornithology, the overall sensitivity rating (negligible to very high) is based on a combination of conservation value, vulnerability and recoverability.

10.5.5.4 The value / importance of each receptor is based on standard guidelines by CIEEM (2010) which places the conservation value of receptors within a geographical frame of reference (e.g. international, national, regional). This is based on standard guidance and available information, and the distribution and status of the ecological features being considered (e.g. qualifying interest of a nearby SPA).

10.5.5.5 Evaluation of the ornithological assemblage identified by the baseline studies has been assessed in relation to its conservation value over a full range of geographical scales as recommended by CIEEM (2010) and listed in Table 10.5.4. This has been used to determine each species' sensitivity in a regional, national or international context.

10.5.5.6 The value/importance of each receptor has been defined in Volume 4 – Technical Appendix 10.1: Ornithology Technical Report and is summarised in Table 10.5.5.

10.5.5.7 For each impact considered (e.g. disturbance, displacement collision risk and indirect effects), species' sensitivity also takes into consideration how vulnerable a species is to that impact, for example how flexible the species is in its habitat use or susceptibility to disturbance, based on classification by Wade *et al.* (2016). Where species or impacts are not covered by Wade *et al.* (2016) other key literary sources on the impacts of offshore wind developments on birds are referred to (i.e. Langston, 2010; Maclean *et al.,* 2009; Garthe & Hüppop, 2004). In general, species are determined to be of low, medium or high vulnerability, based on their particular characteristics or requirements, relative to other seabird species.

10.5.5.8 The assessment of ornithological recoverability considers the ability of species' populations to return to their former status once background conditions return (i.e. when the effects of a particular impact cease, e.g. upon completion of the construction phase, or as birds habituate to an impact). It is thus important to evaluate the nature of the impact in terms of the duration required for recoverability, which is a factor of a species' natural productivity rate and background population trend in the absence of the impact.

10.5.5.9 Species with the potential to produce many young per year are considered to be able to recover more rapidly and hence to be at less risk than species that produce fewer young per year. This was determined using information on clutch size (average clutch size and maximum clutch size) and age at first breeding (as per Williams *et al.,* 1995 and Robinson, 2017). Species such as fulmar, gannet and guillemot that lay only one egg each year and do not breed until they are several years old, have the lowest recoverability. Conversely seaduck have large clutches and usually commence breeding at two or three years of age and so recoverability would be higher.

10.5.5.10 The second factor for recoverability is a species' population status (e.g. stable, declining) of for example, a regional breeding population, or during winter months for a national or flyway population.

10.5.5.11 Regional breeding status has been determined by comparing the trend in the populations of breeding colonies within mean maximum foraging range of Moray West Offshore Wind Farm, between the Seabird 2000 survey results in Mitchell *et al*. (2004) and the most recent counts produced in JNCC's SMP database (JNCC 2017b). Status of migratory/wintering populations has been determined at a broader national scale for each species, based on trends presented by JNCC (http://jncc.defra.gov.uk/page-1419).

10.5.5.12 Using these trends, the recoverability of a population can be determined. It was considered that a significantly increasing population (>25% increase) has a high recoverability, with a stable population (<25% change) rated medium, and a declining population (>25% decrease) rated as having a low recoverability (excluding differences in reproductive rate). In exceptional circumstances where the species' population would be at risk of extinction, there may be no ability for recovery.

10.5.5.13 Evaluation of the sensitivity of a species can therefore be assessed in relation to its conservation value over a range of geographical scales, its vulnerability to a particular impact, and recoverability based on population status and reproduction rate. Combined, this information can be used to determine each species' overall sensitivity to a particular impact using the definitions in Table 10.5.5. A summary of the overall sensitivity of the ornithological receptors considered with for the Development is presented in Table 10.5.5. The sensitivities of the ornithological receptors and the location of individual impacts of the Development with respect to the abundance and distribution of species, as established in the baseline environment, have been used together with expert judgement to select Valued Ornithological Receptors for assessment for all individual impacts to be considered in this chapter.

10.5.5.14 Table 10.5.6 presents a summary of Valued Ornithological Receptors selected for assessment for all individual impacts considered in this chapter. Whether a species is to be considered for an individual impact will be made on expert judgement when considering a combination of:

- Abundance of birds in the Moray West Site plus 4 km buffer is of a magnitude considered meaningful to consider an impact on the population;
- Species vulnerability to the impact; and
- Species use of the Moray West Site plus 4 km buffer and / or the Offshore Export Cable Corridor e.g. for foraging, passage through on migration.

Table 10.5.4: Definition of Terms Relating to the Overall Sensitivity of Ornithological Receptors

Sensitivity	Definition
Negligible	Valued Ornithological Receptor is not vulnerable to the impact considered regardless of value/importance. Valued Ornithological Receptors of Local value with low vulnerability and medium to high recoverability.
Low	Valued Ornithological Receptors of Local value with moderate to high vulnerability and low recoverability. Valued Ornithological Receptors of Regional value with low vulnerability and medium to high recoverability. Valued Ornithological Receptors of National or International value with low vulnerability and high recoverability.
Medium	Valued Ornithological Receptors of Local value with high vulnerability and no ability for recovery. Valued Ornithological Receptors of Regional value with moderate to high vulnerability and low recoverability. Valued Ornithological Receptors of National or International value with moderate vulnerability and medium recoverability.
High	Valued Ornithological Receptors of Regional value with high vulnerability and no ability for recovery. Valued Ornithological Receptors of National or International value with high vulnerability and low recoverability.
Very High	Valued Ornithological Receptors of National or International value with very high vulnerability and no ability for recovery.

Table 10.5.5: Information Used to Determine Overall Impact Sensitivity of Valued Ornithological Receptors, Based on Indications of Conservation Value, Vulnerability and Recoverability

Species	Conservation Value [c] (rationale)	Vulnerability (applicable across all phases of Moray West) [d]				Factors Potentially Influencing Recoverability					
		Collision Risk	Displacement / Barrier Effects: Structures	Disturbance / Displacement : Vessels	Indirect Effects (prey species and habitat loss)	Clutch Size and Year of 1st Breeding [e]	Mean-Maximum Foraging Range (±1 SD) (km) [f]	Regional Breeding Population (individuals)	Regional Trend (1986 - 2011)[k]	National Trend (2000-16) [g]	Overall Recoverability
Scaup	International (SPA)	Low	High	High	High	8-11 eggs / 2 years	n/a	n/a	n/a	n/a	High
Eider	International (SPA)	Low	Moderate	Moderate	Low	4- 6 eggs / 3 years	n/a	n/a	n/a	n/a	High
Long-tailed duck	International (SPA)	Low	High	High	High	6-9 eggs / n/a	n/a	n/a	n/a	n/a	High
Common scoter	International (SPA)	Low	Very high	Very high	High	6-8 eggs / 2 years	n/a	n/a	n/a	n/a	High
Velvet scoter	International (SPA)	Low	Very high	Very high	Moderate	8-9 eggs / n/a	n/a	n/a	n/a	n/a	High
Goldeneye	International (SPA)	Low	High	High	High	8-11 eggs / 2 years	n/a	n/a	n/a	n/a	High
Red-breasted merganser	International (SPA)	Low	Moderate	Moderate	High	8-10 eggs / n/a	n/a	n/a	n/a	n/a	High
Red-throated diver	International (SPA)	Moderate	Very high	Very high	High	2 eggs / 3 years	n/a	n/a	n/a	n/a	Medium

Table 10.5.5: Information Used to Determine Overall Impact Sensitivity of Valued Ornithological Receptors, Based on Indications of Conservation Value, Vulnerability and Recoverability

Species	Conservation Value [c] (rationale)	Vulnerability (applicable across all phases of Moray West) [d]				Factors Potentially Influencing Recoverability					
		Collision Risk	Displacement / Barrier Effects: Structures	Disturbance / Displacement : Vessels	Indirect Effects (prey species and habitat loss)	Clutch Size and Year of 1st Breeding [e]	Mean-Maximum Foraging Range (±1 SD) (km) [f]	Regional Breeding Population (individuals)	Regional Trend (1986 - 2011) [k]	National Trend (2000-16) [g]	Overall Recoverability
Great northern diver	International (SPA)	Moderate	Very high	Very high	Moderate	2 eggs / 6 years	n/a	n/a	n/a	n/a	Low
Fulmar	International (SPA)	Very low	Very low	Very low	Very low	1 egg / 9 years	400 (± 245.8)	42,686	7	- 31%	Low
Gannet	International (SPA)	High	High	Very low	Very low	1 egg / 5 years	229.4 (± 124.3)	168,144	+33	+ 34% [i]	High
Shag	International (SPA)	Moderate	High	High	Moderate	3 eggs / 4 years	n/a	1,098	-47	-34%	Low
Slavonian grebe	International (SPA)	Low	Moderate	Moderate	High	4-5 eggs / n/a	n/a	n/a	n/a	n/a	Medium
Arctic skua	International (Migratory species)	High	Very low	Very low	Low	2 eggs / 4 years	62.5 (± 17.7)	428	-74	- 64%	Low
Puffin	International (SPA)	Very low	Moderate	Moderate	Moderate	1 egg / 5 years	105.4 (± 46.0)	199,600	+13	n/a	Low
Razorbill	International (SPA)	Very low	High	Moderate	Moderate	1 egg / 4 years	48.5 (± 35.0)	107,711	+13	+ 32%	Medium

Table 10.5.5: Information Used to Determine Overall Impact Sensitivity of Valued Ornithological Receptors, Based on Indications of Conservation Value, Vulnerability and Recoverability

Species	Conservation Value [c] (rationale)	Vulnerability (applicable across all phases of Moray West) [d]				Factors Potentially Influencing Recoverability					
		Collision Risk	Displacement / Barrier Effects: Structures	Disturbance / Displacement : Vessels	Indirect Effects (prey species and habitat loss)	Clutch Size and Year of 1st Breeding [e]	Mean-Maximum Foraging Range (±1 SD) (km) [f]	Regional Breeding Population (individuals)	Regional Trend (1986 - 2011) [k]	National Trend (2000-16) [g]	Overall Recoverability
Guillemot	International (SPA / non-breeding population importance)	Very low	High	Moderate	Moderate	1 egg / 5 years	84.2 (± 50.1)	998,623	-24	+ 5%	Medium
Kittiwake	International (SPA)	High	Low	Low	Low	2 eggs / 4 years	60 (± 23.3)	39,360	-66%	- 44%	Low
Herring gull	International (SPA)	Very high	Low	Low	Very low	3 eggs / 4 years	61.1 (± 44)	11,667	-58%	n/a	Low
Great black-backed gull	International (SPA)	Very high	Low	Very low	Very low	2-3 eggs / 4 years	40 [a]	266	-53%	- 11%	Low

Table 10.5.5: Information Used to Determine Overall Impact Sensitivity of Valued Ornithological Receptors, Based on Indications of Conservation Value, Vulnerability and Recoverability

Species	Conservation Value [c] (rationale)	Vulnerability (applicable across all phases of Moray West) [d]				Factors Potentially Influencing Recoverability					
		Collision Risk	Displacement / Barrier Effects: Structures	Disturbance / Displacement : Vessels	Indirect Effects (prey species and habitat loss)	Clutch Size and Year of 1st Breeding [e]	Mean-Maximum Foraging Range (±1 SD) (km) [f]	Regional Breeding Population (individuals)	Regional Trend (1986 - 2011)[k]	National Trend (2000-16) [g]	Overall Recoverability

a maximum foraging range from Ratcliffe *et al.* (2000);
b maximum foraging range from seabird.wikispaces.com;
c SPA = qualifying feature of an SPA either within foraging range during the breeding season or on migratory route;
d taken from Wade *et al*. (2016), Bradbury *et al*. (2014), Langston (2010) or Maclean *et al*. (2009);
e taken from Robinson (2017);
f taken from Thaxter *et al.* (2012) unless otherwise stated;
g taken from JNCC (2016);
h Habitat/prey interactions is termed habitat flexibility by Wade *et al*. (2016).
I Change between censuses in 2003-04 and colonies surveyed in 2013-14 and 2015
J Taken from Langston (2010)
K Scottish trend from SNH (2012) or for gannet, razorbill and puffin: Mitchell *et al.* (2001). Razorbill has however shown somewhat of a decline since 2000.

Table 10.5.6: **Summary of Valued Ornithological Receptors Selected for Assessment for All Individual Impacts Considered in this Chapter**

Species	Conservation Value[a] (rationale)	Construction / Decommissioning			Operation					
		Disturbance / Displacement (vessels activity / construction activity)	Indirect Effects (prey species and habitat loss)	Pollution	Displacement and Barrier Effects	Indirect Effects (prey or habitat availability)	Collision	Lighting	Disturbance (maintenance activities)	Pollution
Scaup	International (SPA)	✓	✓	✓	×	×	×	×	✓	✓
Eider	International (SPA)	✓	✓	✓	×	×	×	×	✓	✓
Long-tailed duck	International (SPA)	✓	✓	✓	×	×	×	×	✓	✓
Common scoter	International (SPA)	✓	✓	✓	×	×	×	×	✓	✓
Velvet scoter	International (SPA)	✓	✓	✓	×	×	×	×	✓	✓
Goldeneye	International (SPA)	✓	✓	✓	×	×	×	×	✓	✓
Red-breasted merganser	International (SPA)	✓	✓	✓	×	×	×	×	✓	✓
Red-throated diver	International (SPA)	✓	✓	✓	×	×	×	×	✓	✓
Great northern diver	International (SPA)	✓	✓	✓	×	×	×	×	✓	✓

Table 10.5.6: Summary of Valued Ornithological Receptors Selected for Assessment for All Individual Impacts Considered in this Chapter

Species	Conservation Value[a] (rationale)	Construction / Decommissioning			Operation					
		Disturbance / Displacement (vessels activity / construction activity)	Indirect Effects (prey species and habitat loss)	Pollution	Displacement and Barrier Effects	Indirect Effects (prey or habitat availability)	Collision	Lighting	Disturbance (maintenance activities)	Pollution
Fulmar	International (SPA)	✗	✓	✓	✓	✓	✗	✓	✓	✓
Gannet	International (SPA)	✗	✓	✓	✗	✓	✓	✓	✓	✓
Shag	International (SPA)	✓	✓	✓	✗	✗	✗	✗	✓	✓
Slavonian grebe	International (SPA)	✓	✓	✓	✗	✗	✗	✗	✓	✓
Arctic skua	International (Migratory species)	✗	✗	✗	✗	✗	✗	✓	✗	✗
Puffin	International (SPA)	✓	✓	✓	✓	✓	✗	✓	✓	✓
Razorbill	International (SPA)	✓	✓	✓	✓	✓	✗	✓	✓	✓
Guillemot	International (SPA / non-breeding population importance)	✓	✓	✓	✓	✓	✗	✓	✓	✓

Table 10.5.6: Summary of Valued Ornithological Receptors Selected for Assessment for All Individual Impacts Considered in this Chapter

Species	**Conservation Value[a] (rationale)**	**Construction / Decommissioning**			**Operation**					
		Disturbance / Displacement (vessels activity / construction activity)	**Indirect Effects (prey species and habitat loss)**	**Pollution**	**Displacement and Barrier Effects**	**Indirect Effects (prey or habitat availability)**	**Collision**	**Lighting**	**Disturbance (maintenance activities)**	**Pollution**
Kittiwake	International (SPA)	×	✓	✓	✓	✓	✓	✓	×	✓
Herring gull	International (SPA)	×	✓	✓	×	✓	✓	✓	×	✓
Great black-backed gull	International (SPA)	×	✓	✓	×	✓	✓	✓	×	✓
a	SPA = qualifying feature of an SPA either within foraging range during the breeding season or on migratory route									

Impact Magnitude

10.5.5.15 Impact magnitude is the degree of change predicted to occur to the sensitive receptor and, for the purposes of this assessment, is largely based on the CIEEM (2010) guidance. This guidance offers a standardised ecological impact assessment approach, which has been tailored for this assessment using expert judgement. The factors taken into account when determining the magnitude of the impact are:

- Spatial extent;
- Duration of the impact (long (more than five years), medium (greater than one year and less than five years) or short term (less than one year));
- Frequency (whether the receptor is subject to the effect once, intermittently or continuously); and
- Reversibility (recovery from) of the effect upon cessation of the impact.

10.5.5.16 These factors are combined to determine the scale of the change from baseline conditions ('no change' to 'high'), in relation to the conservation status of a particular feature (in this case a species' population size). The criteria for defining magnitude in this chapter are outlined in Table 10.5.7 below.

Table 10.5.7: Definition of Impact Magnitude

Magnitude of Impact	**Description**
High	The proposal would affect the conservation status of the Valued Ornithological Receptor with loss of ecological functionality. Recovery expected to be long term (e.g. 10 years) or irreversible following cessation of activity.
Moderate	The Valued Ornithological Receptors conservation status would not be affected, but the impact is likely to be significant in terms of ecological objectives or populations. Impact will occur repeatedly or continuously over a moderate period of time or at moderate intensity for short periods of time. Recovery expected to be medium term (e.g. 5 years) following cessation of activity.
Low	Minor shift away from baseline but the impact is of limited temporal or physical extent. Low frequency impact occurring occasionally or intermittently and at low intensity. Recovery expected to be short-term (e.g. less than 1 year) following cessation of activity.
Negligible	Very slight change from baseline conditions. Impact is highly localised and short term resulting in very slight / imperceptible changes to site characteristics / Valued Ornithological Receptors population. Very slight change from baseline condition. Any recovery expected to be rapid following cessation of activity.
No change	No change from baseline conditions.

Significance Criteria

10.5.5.17 The significance of the effect on offshore ornithology is determined by correlating the magnitude of the impact and the sensitivity of the Valued Ornithological Receptor. The particular method employed for this assessment is presented in Table 10.5.8. Where a range of significance of effect is presented in Table 10.5.8, the final assessment for each effect is based upon expert judgement.

10.5.5.1 In general, any impact with a significance of moderate or greater is considered 'significant' in EIA terms. Where further mitigation is not possible a residual significant effect may remain.

Table 10.5.8: Significance of Effect					
Sensitivity of Receptor	**Magnitude of Impact**				
	No change	**Negligible**	**Low**	**Moderate**	**High**
Negligible	Negligible	Negligible	Negligible or Minor	Negligible or Minor	Minor
Low	Negligible	Negligible or Minor	Negligible or Minor	Minor	Minor or Moderate
Medium	Negligible	Negligible or Minor	Minor	Moderate	Moderate or Major
High	Negligible	Minor	Minor or Moderate	Moderate or Major	Major
Very High	Negligible	Minor	Moderate or Major	Major	Major

10.5.6 Data Limitations

10.5.6.1 It was proposed as part of scoping the EIA for the offshore wind farm, that, given the availability of extensive existing bird data for the Moray Firth and the adjacent Moray East and Beatrice Offshore Wind Farm Sites, one year (12 months) of additional data collected from aerial surveys (carried out between April 2016 and March 2017) would be sufficient to inform the ornithology impact assessment. This approach, although agreed with MSLOT, MSS and SNH, was subject to the approval of the baseline characterisation for the Moray West Site, in particular information for the Moray West Site on inter-annual variation.

10.5.6.2 In addition to characterising the ornithological baseline for purpose of the assessment it has also been necessary to provide further information to reduce the uncertainty associated with having only one year of data. The process developed to reduce this uncertainty is described in Volume 4 – Technical Appendix 10.1 - Annex 10.1A and incorporated into the assessments for all relevant species.

10.6 Design Envelope Parameters

10.6.1 Realistic Worst Case

10.6.1.1 As identified in Chapter 4 Development Description, Moray West is considering a range of potential construction methods and design options for the Development. The Design Envelope presented in Chapter 4 presents the range (minimum and maximum) of design parameters for each of the options under consideration e.g. substructure type or turbine model.

10.6.1.2 In order to determine potential impacts of the various options it is necessary to define the 'realistic worst case scenario'. The realistic worst case scenario represents, for any given receptor and potential impact on that receptor, various options in the Design Envelope that would result in the greatest potential for change to the receptor in question.

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

10.6.1.4 Table 10.6.1 presents the realistic worst case scenario for potential impacts on offshore ornithology during construction, operational and maintenance and decommissioning phases of the Development and provides justification as to why the options and design parameters identified are considered to be the realistic worst case scenario.

Table 10.6.1: Design Envelope Parameters Relevant to the Offshore Ornithology Impact Assessment		
Potential Impact	**Realistic Worst Case Scenario**	**Justification**
Construction		
Disturbance / displacement	**Vessels:** Total number of vessels = 25 based on at any one time, comprising of installation, support, transport and cable lay vessels, tugs and barges. Total number of return trips = 46 return trips per week during installation (WTGs, OSPs and substructures) and five return trips per week for transport vessels. Duration of construction period = 36 months Maximum spatial WCS for piling = 85 monopiles with maximum 5,000 kj hammer energy for five months. **Underwater noise:** • The maximum anticipated hammer energy for monopile installation is 5,000 kJ. • Maximum number of monopiles installed in one day is three. This is based on a two vessel piling campaign (concurrent piling). • Maximum duration of piling (based on pin piles with 3,000 kJ hammer energy) is nine months. • The spatial WCS is 85 x monopiles at 5,000kJ hammer energy over five months. • The temporal WCS is 85 x 4 pin piled jacket structures (340 pin piles) at 3,000kJ hammer energy over nine months. • Seabed preparation and cable installation activities (plough or jet trencher).	**Vessels:** Maximum design scenario provides for the greatest number of potential vessels associated with the construction phase and hence the highest likelihood of potential disturbance/displacement to bird species, as a result of multiple activities taking place over an 36 month offshore construction period. Maximum design scenario also reflects season and location with respect to a species abundance and vulnerability to an impact in the zone of influence i.e. seasonality distribution is considered as part of the sensitivity rating. **Underwater noise:** The installation of monopiles with the highest maximum hammer energy will result in the highest overall levels of underwater noise, resulting in the largest impact footprint for each piling operation. Maximum Design Scenario provides for the greatest disturbance/displacement effects to bird species due to construction activities (magnitude and duration). Maximum magnitude of piling provides for the maximum increase in background noise levels generated over the largest area. Maximum diameter of pile and maximum number of simultaneous piling events provides for the maximum construction activity generated. Maximum separation distance provides the maximum spatial extent of construction activity impact (construction activity footprint area). Maximum piling duration provides for the maximum duration of disturbance / displacement to bird species.
Indirect effects (prey species and habitat loss)	The maximum adverse design scenario for the Benthic and Intertidal habitats is presented in Chapter 7: Benthic & Intertidal Ecology.	Any impacts to Valued Ornithological Receptors are dependent on the significance of impacts on fish and shellfish ecology and benthic habitats,

Table 10.6.1: Design Envelope Parameters Relevant to the Offshore Ornithology Impact Assessment		
Potential Impact	**Realistic Worst Case Scenario**	**Justification**
	The maximum adverse design scenario for the fish and shellfish ecology assessment is presented in Chapter9: Fish & Shellfish Ecology.	therefore the maximum adverse scenarios for those receptors are those considered for prey related impacts on marine mammals.
Effects of pollution	Synthetic compound, heavy metal and hydrocarbon contamination may be released accidentally as a result of offshore infrastructure installation and the presence of various construction vessels during the construction period (see disturbance impacts above - comprising of installation, support, transport and cable lay vessels, tugs, cranes and barges). Water-based drilling muds associated with drilling to install foundations and HDD may also be required. Grout may be required to secure joints between offshore structures. There may also be potential contamination of intertidal habitats resulting from machinery use and vehicle movement.	These parameters are considered to represent the maximum adverse scenario with regards to release of contaminants during construction.
Operation		
Disturbance	Approximately 150-200 return trips per year (O&M vessels). If O&M activity is coordinated entirely from an onshore base, this would mean small crew vessels sailing to and from the Moray West Site on a daily basis from shore. If the SOV option is preferred, the majority of small crew vessels would be operated on a daily basis from a single SOV, although further support vessels are also still likely to transit to and from shore each day. OSPs would require one visit a week maximum.	Option provides for the largest possible source of direct and indirect (prey species) disturbance from noise, vessel movements and other maintenance related activity over the longest time period. A number of vessel visits to each turbine and OSP would be required each year to allow for scheduled and unscheduled maintenance.
Displacement and barrier effects	Operation of maximum number of turbines (up to 85 WTGs), within the total area of the Moray West Site (225 km^2), with a minimum spacing 1,200 m downwind and 1,050 m crosswind. Operation of associated transmission infrastructure (up to two OSPs)	Provides for the maximum amount (spatial extent) of habitat loss due to physical displacement effects. For sensitive species, the wind farm as a whole will be avoided, whereas for others only individual turbines will be avoided while within the wind farm. Edge-weighted layout will potentially maximise area of sea rendered unavailable to birds.

Table 10.6.1: Design Envelope Parameters Relevant to the Offshore Ornithology Impact Assessment		
Potential Impact	**Realistic Worst Case Scenario**	**Justification**
Collision Risk	**CRM Assessment:** Operation of maximum number of turbines (up to 85 WTGs). Maximum rotor swept area for 85 Model 2 WTGs based on rotor diameter of 195 m, hub height = 132.5 m and lowest rotor tip height of 35 m above the Highest Astronomical Tide (HAT). Other specific parameters are presented in 10.2: CRM Technical Appendix (Volume 4). Assessment also assumes grid distribution of the positioning of the foundations within the Moray West Site (225 km^2), with a minimum spacing 1,200 m downwind and 1,050 m crosswind. Detailed results from this additional CRM are presented in 10.2: CRM Technical Appendix (Volume 4).	Greatest rotor swept area plus parameters that maximise collision risk and therefore mortality rates for all species as the surface area available for collision increases. This is the turbine layout with the largest combined rotor swept area and collision probability, the latter at its highest when turbines are at maximum rotor speed and at the lowest tip height.
Attraction to lit structures and associated disorientation	Medium intensity (2000 candela), flashing (morse code 'W') red lights located on the turbine hubs of the peripheral turbines in the layout. These lights may be visible from the coast. The intensity of these lights would reduce to low intensity (200 candela) during suitable visibility conditions. Low intensity lighting for navigation purposes also fixed to the turbines (transition pieces).	Provides the maximum number of structures in the wind farm, with maximum intensity and extent of red and white light sources to increase likelihood that birds will be attracted to structures and become disoriented or more susceptible to collision risk. Red and white lighting, which has been shown to be more disorienting for migrating birds.
Indirect effects (prey species and habitat loss)	The maximum adverse design scenario for the Benthic and Intertidal habitats is presented in Chapter 7: Benthic & Intertidal Ecology. The maximum adverse design scenario for the fish and shellfish ecology assessment is presented in Chapter 9: Fish & Shellfish Ecology.	Any impacts to Valued Ornithological Receptors are dependent on the significance of impacts on fish and shellfish ecology and benthic habitats, therefore the maximum adverse scenarios for those receptors are those considered for prey related impacts on marine mammals.
Effects of pollution	Synthetic compound, heavy metal and hydrocarbon contamination resulting from up to 85 turbines and two OSPs. Accidental pollution may also result from O&M vessels (i.e. up to 200 round trips to port by operational and maintenance vessels including supply/crew vessels and jack-up vessels).	Parameters that create the greatest use of fuel usage, chemicals and hazardous waste offshore in the project area at any one time, that have the potential to spill into the marine environment. The release of contaminants may directly affect birds or indirectly via their prey. Maximum vessel traffic movements will be associated with greatest turbine numbers (and associated infrastructure) and will cause highest risk of a pollution incident.

Table 10.6.1: Design Envelope Parameters Relevant to the Offshore Ornithology Impact Assessment		
Potential Impact	**Realistic Worst Case Scenario**	**Justification**
	A typical turbine is anticipated to require grease, synthetic or hydraulic oil, and other operating compounds or materials such as liquid nitrogen, silicone oil and gas. The OSP is expected to require chemicals and other operating compounds such as diesel, water, coolants, oil, batteries and fire suppressant material.	
Decommissioning		
Impacts from decommissioning are expected to be similar to those listed above for construction, if project infrastructure is removed from the seabed at the end of the development's operational life. If it is deemed closer to the time of decommissioning that removal of certain parts of the development (e.g. cables) would have a greater environmental impact than leaving in-situ, it may be preferable to leave those parts in-situ. In this case, the impacts would be similar to those described for the operational phase.		

10.6.2 Embedded Measures

10.6.2.1 As part of the project design process, a number of designed-in measures have been proposed to reduce the potential for impacts on offshore birds (Table 10.6.2). As there is a commitment to implementing these measures, they are considered inherently part of the design of Moray West and have therefore been considered in the assessment presented in Section 10.7 below (i.e. the determination of magnitude and therefore significance assumes implementation of these measures). These measures are considered standard industry practice for this type of development.

Table 10.1.2: Embedded Measures Adopted as part of Moray West Offshore Wind Farm

Measures Adopted as Part of Moray West	Justification
An appropriate Environmental Management Plan (EMP) will be produced and followed to cover the construction, operation and maintenance phases of the Development. An appropriate Marine Pollution and Contingency Plan (MPCP) will be produced and followed to cover the construction, operation and maintenance phases of the Development. This will include planning for accidental spills, address all potential contaminant releases and include pollution event response protocols.	Measures will be adopted to ensure that the potential for release of pollutants from construction, operation and maintenance, and decommissioning plant is minimised. In this manner, accidental release of contaminants from rigs and supply/service vessels will be strictly controlled, thus providing protection for birds and their prey species across all phases of the wind farm development.
A vessel management plan (VMP) will be developed which will determine vessel routing to and from construction areas and ports to avoid areas of high risk. This will also include codes of conduct for vessel behaviour and for vessel operators including advice to operators to not deliberately approach aggregations of seabirds. This plan will be informed by emerging information from the monitoring at Moray East and Beatrice.	The VMP will minimize disturbance of seabird species and allow the identification of standard routes.
Installation of appropriate lighting on wind farm structures.	Lighting of wind turbines will meet minimum requirements, namely as set out in the International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) Recommendation O-117 on ‘The Marking of Offshore Wind Farms’ for navigation lighting and by the Civil Aviation Authority in the Air Navigation Orders (CAP 393 and guidance in CAP 764). In keeping with the minimum legal requirements, this will minimise the risks of migrating birds becoming attracted to, or disorientated by turbines at night or in poor weather.
A minimum wind turbine hub-height of 35 m (above HAT) will be used for Moray West. This provides for a lower blade tip height clearance of 35m LAT.	This hub-height is considered appropriately conservative so as to minimise the risk of bird collisions.

10.7 Assessment of Potential Effects

10.7.1 Potential Construction Effects

10.7.1.1 The potential impacts arising from the construction of the Development on offshore ornithology are described below. These impacts have been assessed against the maximum design parameters listed in Table 10.6.2. A assessment of the significance of the effect of these impacts on offshore ornithology receptors has also been provided.

Disturbance / Displacement Impacts

10.7.1.2 Disturbance during the construction of a wind farm (visual presence, vessel activity and underwater noise) may displace birds from an area of sea, effectively amounting to habitat loss during the period of disturbance (Drewitt and Langston, 2006). Disturbance caused by construction activities may directly displace birds from foraging or loafing areas thus potentially affecting breeding productivity or survival rates of an individual or population. However, on several occasions during the construction of Lincs Offshore Wind Farm, gulls were clearly associated with the jack-up barge, the guard vessels and with the construction vessel while piling was in progress (RPS, 2012). Disturbance caused by construction activities either within the Moray West Site or along the Offshore Export Cable Corridor are considered to represent the maximum design scenario for relevant species as it is these areas that will be disproportionately affected by the presence of vessels and/or underwater noise.

10.7.1.3 Although the port of origin for vessels has not yet been selected, any vessel movements are likely to occur along well-defined vessel routes, especially in areas closer to shore that may be occupied by sensitive species such as divers or seaduck. There are predicted to be up to 25 vessels present at any one time (the majority within the Moray West Site and up to six along the Offshore Export Cable Corridor) during the construction phase of the Development. There will also be up to 51 vessel return trips per week. Construction will occur over 36 months.

10.7.1.4 It should be noted, however, that the predicted scale of impact will be a considerable over-estimate given that vessels, irrespective of origin port, will be required to follow existing shipping routes where possible. These areas are not likely to support notable densities of species sensitive to disturbance. Similarly, any helicopter movements to the Moray West Site will do so over areas already frequently transited by helicopters supporting the operations associated with the Beatrice Oil Field and other aircraft and vessels.

10.7.1.5 Disturbance associated with vessel movements is of limited duration and also represents a transient impact as vessels / helicopters will move through an area quickly. Impacts are therefore spatially and temporally restricted and are considered unlikely to affect the breeding productivity or survival rates of an individual or population. It is therefore considered that additional vessel and helicopter movements to and from the Moray West Site or Offshore Export Cable Corridor will be indiscernible from baseline levels, whereas the relatively constant presence of vessels in these areas will represent an impact of larger magnitude.

10.7.1.6 For each Valued Ornithological Receptor, the increase in vibration and noise disturbance associated with human construction activities has been evaluated. This involves initially assessing the potential for displacement of mean peak densities within a particular extent around the disturbance source (e.g. piling activities) within the Moray West Site. With respect to the Offshore Export Cable Corridor, in the absence of Site specific survey data along the corridor (as outlined in the OfTI Scoping Report (Moray West, 2017)) a qualitative review of the overlap with core aggregations of Valued Ornithological Receptors (i.e. those detailed in SNH, 2016) has been undertaken.

10.7.1.7 In general, it is considered that effects are likely to last only for the duration of the construction activities, and therefore are predicted to be direct, but temporary, reversible and short-term in nature for a specific event. Although construction is expected to occur over a maximum duration of a 36 months (Table 10.6.1), piling activities will only occur for a maximum duration of nine months during the overall construction period. The largest impacts are likely to be intensive pile-driving activities which may cause extensive, intermittent noise and vibrations. Although effects of underwater noise associated with pile-driving activity are well known on cetaceans and fish (Madsen *et al*., 2006), very little is known about the effects on seabirds.

10.7.1.8 The U.S. Department of the Interior (2004) concluded that noise from seismic studies might only impact those species that spend large quantities of time underwater. Bird species most likely to be vulnerable to underwater sound are those that forage by diving after fish or shellfish, and include auks, divers and seaduck. Gull and tern species feed at the surface only and are considered the least vulnerable.

10.7.1.9 Fulmar, gulls and skuas are opportunistic scavengers that will forage within tens of metres of moving machinery, including vessels, and where feeding opportunities are recognised, close to humans when confident from experience to do so. On that basis together with consideration of their vulnerability to underwater noise, species therefore considered for this impact are all seaduck species, divers, shag, Slavonian grebe, guillemot, razorbill and puffin.

10.7.1.10 As detailed earlier, buffers taken forward to assessment of displacement impacts for the Moray West Site include a 2 km buffer.

Seaducks

<u>*Magnitude of impact*</u>

10.7.1.11 Six species of wintering seaduck are associated with the Moray Firth pSPA (scaup, eider, long-tailed duck, common scoter, velvet scoter, goldeneye and red-breasted merganser). None of these species were recorded in notable numbers during the aerial surveys undertaken across the Moray West Site plus a 4 km buffer area and as such, only disturbance and displacement impacts associated with construction activities along the Offshore Export Cable Corridor are considered.

10.7.1.12 In order to estimate the magnitude of impact associated with installation of the offshore export cable circuits, survey data (SNH, 2016) has been reviewed to determine the extent of any overlap of the Offshore Export Cable Corridor with aggregations of these species. Distribution of these species has been informed through aerial surveys of the Moray Firth from 2001/2 – 2006/7 supplemented by shore-based count surveys.

10.7.1.13 Scaup occurred in small concentrations, usually of less than 50 birds, widely dispersed along both margins of the Firth, and close inshore. The largest flocks were in the Inner Moray Firth and off the coast of Nairn (SNH, 2016). There is no apparent overlap of the Offshore Export Cable Corridor with observations of this species.

10.7.1.14 Eiders were recorded during all surveys that informed the pSPA site selection process and were mainly observed along the south coast of the Moray Firth. They were usually recorded close inshore, in very shallow water, along the whole of this coast, from Buckie to Nairn. While the Offshore Export Cable Corridor passes through areas where eider are known to occur, these areas hold relatively low densities (1-4 birds per km^2) compared to areas further west near Lossiemouth (>8 birds per km^2).

10.7.1.15 Long-tailed duck were abundant and widely dispersed throughout the whole of the SNH survey area and, in contrast to other species, in water up to 40 m deep. They were recorded most frequently in Spey Bay and along the south coast of the Moray Firth and, least frequently, in the Dornoch Firth. Long-tailed duck distribution is similar to that of eider but in even lower densities in the vicinity of the Offshore Export Cable Corridor (<2 birds per km^2).

10.7.1.16 Common and velvet scoter were less widely distributed than other seaduck in the Moray Firth. They were generally concentrated close inshore between Burghead and Nairn, around the mouth of the inner Dornoch Firth, in Spey Bay and on the Riff Bank. There is no apparent overlap of the Offshore Export Cable Corridor with observations of these species.

10.7.1.17 Goldeneye were one of the least abundant waterfowl on the coast during the surveys that informed the pSPA site selection. Goldeneye were mainly distributed either in the most southerly and shallow parts of the Inverness Firth, in the Dornoch Firth or occasionally on the southern shore in the Culbin/ Findhorn area. There is no apparent overlap of the Offshore Export Cable Corridor with observations of this species.

10.7.1.18 Red-breasted mergansers occurred at a number of localities along the southern shore and in the inner firth, but a large aggregation was present only in the Beauly Firth. There is no apparent overlap of the Offshore Export Cable Corridor with observations of this species.

10.7.1.19 Considering the observations on seaduck distribution noted above, no significant aggregations would be exposed to disturbance. It is considered that any disturbance would not affect foraging resources and that there would therefore be no detectable consequences of the impact. Overall the impact is predicted to be of local spatial extent, medium term duration, intermittent and with high reversibility. It is predicted that the impact will affect the receptor directly. As few birds will be affected, the impact magnitude is therefore considered to be of **no change**.

Sensitivity of receptors

10.7.1.20 Seaduck are considered to be vulnerable to disturbance from vessel traffic and certain species (common and velvet scoters) are identified as those most sensitive to disturbance (Wade *et al.,* 2016). Common scoters are known to aggregate in areas that have little shipping activity with the number of birds declining steeply with an increase in the level of shipping traffic (Kaiser *et al.,* 2002). The sensitivity to disturbance as defined by Wade *et al.* (2016) is based on the work by Kaiser *et al.* (2002), in particular the observations that common scoter flushed from a 35 m vessel at distances of 1,000-2,000 m for large flocks (26 observations) and <1000 m for smaller flocks (23 observations). Similar observations were also recorded by Schwemmer *et al.* (2011) with boats flushing birds over 1,000 m distance.

10.7.1.21 The seaduck species assessed, are deemed to be of moderate – very high vulnerability, high recoverability and international value. The sensitivity of these receptors is therefore considered to be **medium or high**.

Significance of the effect

10.7.1.22 Overall, the sensitivity of the receptors are considered to be medium or high while the impact magnitude is deemed to be of no change. The effect will therefore be of **negligible significance**, which is not significant in EIA terms.

Red-throated and Great Northern Divers

Magnitude of impact

10.7.1.23 The distribution of both species of diver is treated in a merged fashion in SNH (2016) although red-throated divers were noted more widely and were the commonest diver throughout the Moray Firth. The distribution of red-throated diver together with great northern diver was taken to be the predominant influence on the site boundary in all but the north of the pSPA.

10.7.1.24 Key aggregations of divers in the Moray Firth occur in Dornoch Firth and along the coast east of Lossiemouth. The latter aggregation is in relative close proximity to the Offshore Export Cable Corridor (<10 km), although densities in the proximity of the Offshore Export Cable Corridor are relatively low (<1 bird per km^2).

10.7.1.25 The impact is predicted to be of local spatial extent, medium term duration, intermittent and with high reversibility. It is predicted that the impact will affect the receptor directly although a very small of individuals would be affected representing a small fraction of the regional population. The impact magnitude is therefore considered to be **low**.

Sensitivity of receptors

10.7.1.26 Red-throated and great northern divers are considered to be species with very high vulnerability to disturbance by flushing on approach by a vessel and the distance of displacement may be substantial (Ruddock and Whitfield, 2007).

10.7.1.27 Red-throated diver is deemed to be of very high vulnerability, medium recoverability and international value. The sensitivity of the receptor is therefore, considered to be **high**.

10.7.1.28 Great northern diver is deemed to be of very high vulnerability, low recoverability and international value. The sensitivity of the receptor is therefore, considered to be **high**.

Significance of the effect

10.7.1.29 Overall, the sensitivity of the receptors is considered to be high and the impact magnitude is deemed to be low. The effect will, therefore, be of **minor adverse significance**, which is not significant in EIA terms.

Shag

Magnitude of impact

10.7.1.30 Two distinct non-breeding distributions of shag exist in the pSPA. Of most relevance the non-breeding distribution on the Moray coast (SNH, 2016). This area is in the vicinity of the Landfall Area, immediately west of Portsoy. The non-breeding aggregation of 3,179 birds was the largest identified around the coast of Great Britain during the ESAS survey programme and, with 19.4 birds/km^2, was also the second-most dense concentration. The densest concentration was that near Portsoy (57.9 birds per km^2) but was only the fourth largest identified with 1,967 birds present on average.

10.7.1.31 The impact is predicted to be of local spatial extent, medium term duration, intermittent and with high reversibility. It is predicted that the impact will affect the receptor directly. Although there is potential for relatively high concentrations of shag in the vicinity of the Landfall Area, given the short term, temporary, intermittent etc., nature of the activities, the magnitude of the impact is considered to be **low**.

Sensitivity of receptors

10.7.1.32 Shag is considered to be a species with high vulnerability to disturbance (Wade *et al*., 2016), of low recoverability and international value. The sensitivity of the receptor is therefore, considered to be **high**.

Significance of the effect

10.7.1.33 Overall, the sensitivity of the receptor is considered to be high and the impact magnitude is deemed to be low. The effect will, therefore, be of **minor adverse significance**, which is not significant in EIA terms.

Slavonian Grebe

Magnitude of impact

10.7.1.34 Through shore-based count surveys, Slavonian grebes were found to be widely distributed around the Moray Firth coasts. This did however, involve a low number of individuals with a mean-peak of 43 birds occurring (SNH, 2016). Very few individuals were recorded east of Lossiemouth and none in the vicinity of the Offshore Export Cable Corridor. For the purposes of the assessment, it is assumed that there is no apparent overlap of the Offshore Export Cable Corridor with Slavonian grebe occurrence.

10.7.1.35 The impact is therefore predicted to be of **no change** in magnitude.

Sensitivity of receptor

10.7.1.36 Slavonian grebe is considered to be a species with moderate vulnerability to disturbance (Wade *et al*., 2016) and is to have medium recoverability and international value. The sensitivity of the receptor is therefore, considered to be **medium**.

Significance of the effect

10.7.1.37 Overall, the sensitivity of the receptor is considered to be medium and the impact magnitude is deemed to be of no change. The effect will, therefore, be of **negligible significance**, which is not significant in EIA terms.

Guillemot

Magnitude of impact

10.7.1.38 The true population level effects of construction disturbance on guillemots are currently unclear; during construction surveys at Lynn and Inner Dowsing there appeared to be no significant patterns of change in guillemot abundance between the wind farm and control sites (ECON, 2012). Leopold *et al.* (2010) could not find any statistically significant changes to auk abundance at Egmond aan Zee due to disturbance, though the sample size was low.

10.7.1.39 Wade *et al*. (2016) report that auks may be disturbed by boats at several hundreds of metres distance although survey vessels have often approached to less than ten metres before eliciting an evasion response.

10.7.1.40 Like the other auks, it is considered that the extent of any disturbance due to construction activities is unlikely to extend to 2 km from source. Cable installation may also disturb birds although this is generally considered to be of lower magnitude than disturbance during installation of the offshore wind farm foundations and WTGs.

10.7.1.41 The peak population estimate within the Moray West Site plus 2 km buffer occurred during the post-breeding period (September) with a notable peak also occurring in August 2016. Birds may be particularly vulnerable at the end of the breeding period if they are undergoing moult and attending young that have restricted mobility. A mean peak breeding population of 24,426 birds was calculated in the breeding season for use in the assessment of disturbance / displacement through the decision support process (Volume 4 – Technical Appendix 10.1 - Annex 10.1A). This is equivalent to around 1.29% of the national breeding population (1,900,000 individuals) or 2.44% of the regional breeding population (998,623 individuals).

10.7.1.42 A mean peak non-breeding (October – March) population of 8,217 birds has been calculated in addition to a mean peak post-breeding population of 38,174 (Volume 4 – Technical Appendix 10.1- Annex 10.1A). It has been advised by SNH that these seasons are assessed against the same non-breeding population of 1,617,306 individuals as defined as the regional BDMPS by Furness (2015). The substantial peak in the post-breeding season at the Moray West Site accounts for 2.36% of this regional reference population. The national non-breeding population is defined at 2,756,526 individuals, with the non-breeding estimate for the Moray West Site accounting for 1.38%.

10.7.1.43 It is considered that extensive disturbance of the guillemot population within the Moray West Site plus 2 km buffer is unlikely, with any disturbance localised within an area around the source (e.g. turbine installation or cable laying). Numbers affected will depend on the overlap of such activity with food resources at any particular time.

10.7.1.44 The impact is predicted to be of local spatial extent, medium term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The impact magnitude is therefore considered to be **low** at a national population scale.

Sensitivity of receptor

10.7.1.45 Guillemot is considered to be a Valued Ornithological Receptor of international conservation value within the context of the Moray West Offshore Wind Farm. The species is considered to be of moderate vulnerability to displacement (Wade *et al*., 2016), and may be particularly sensitive during the post-breeding period during moult and when attending young at sea.

10.7.1.46 There has been an increase in national populations over the last decade (+5%), although the Scottish population is relatively stable or possibly slightly in decline[4]. In addition, guillemot lays a single egg and is a late first breeder (Table 10.5.5). Guillemot is therefore considered to have a medium recoverability potential. Given that guillemot is deemed to be of moderate vulnerability, medium recoverability and international value, the sensitivity of the receptor is considered to be **medium**.

Significance of the effect

10.7.1.47 Overall, the sensitivity of the receptor is considered to be medium and the impact magnitude is deemed to be low. The effect will, therefore, be of **minor adverse significance,** which is not significant in EIA terms.

Razorbill

Magnitude of impact

10.7.1.48 Effects of construction disturbance on razorbill are currently unclear; however, during construction surveys at Lynn and Inner Dowsing there appeared to be no significant patterns of change in razorbill abundance between the wind farm and control sites (ECON, 2012).

10.7.1.49 Similar to guillemot, it is considered that the extent of any disturbance due to construction activities is unlikely to extend to 2 km from source. Cable installation may also disturb birds although this is generally considered to be of lower magnitude than foundation or WTG installation for example.

10.7.1.50 The peak population estimate within the Moray West Site plus 2 km buffer occurred during the post-breeding period (September) with smaller peaks also occurring in July and August 2016. A mean peak breeding population of 2,808 birds was calculated for use in the assessment of disturbance / displacement through the decision support process (Volume 4 – Technical Appendix 10.1 - Annex 10.1A). This is equivalent to around 1.08% of the national breeding population (260,000 individuals) or 2.6% of the regional breeding population (107,711 individuals). The post-breeding peak of 3,544 birds is equivalent to around 0.30 % of the national population (1,198,788 individuals) or 0.59% of the regional population (591,874 individuals).

[4] http://jncc.defra.gov.uk/page-2898

10.7.1.51 A mean peak non-breeding (November - December) population of 184 birds does not approach a threshold of regional importance. In the defined pre-breeding season for razorbill (January – March) a mean peak population defined in Volume 4 - Technical Appenix 10.1 - Annex 10.1A is of 3,585 individuals. This accounts to 0.6% of the regional population.

10.7.1.52 It is considered that extensive disturbance of the razorbill population within the Moray West Site plus 2 km buffer is unlikely, with any disturbance localised within an area around the source (e.g. turbine installation or cable laying). Numbers affected will depend on the overlap of such activity with food resources at any particular time.

10.7.1.53 The impact is predicted to be of local spatial extent, medium term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The impact magnitude is therefore considered to be **low** at a national population scale.

Sensitivity of receptor

10.7.1.54 Razorbill is considered to be a Valued Ornithological Receptor of international conservation value within the context of the Moray West Offshore Wind Farm. The species is considered to be of moderate vulnerability to displacement (Wade *et al.,* 2016), and may be particularly sensitive during the post-breeding period during moult and when attending young at sea.

10.7.1.55 There has been an increase in national populations over the last decade (+21%), although the Scottish population is relatively stable[5]. In addition, razorbill lays a single egg and is a late first breeder (Table 10.5.5), so is therefore considered to have a medium recoverability potential. Given that razorbill is deemed to be of moderate vulnerability, medium recoverability and international value, the sensitivity of the receptor is therefore considered to be **medium**.

Significance of the effect

10.7.1.56 Overall, the sensitivity of the receptor is considered to be medium and the impact magnitude is deemed to be moderate. The effect will therefore be of **minor adverse significance** which is not significant in EIA terms.

Puffin

Magnitude of impact

10.7.1.57 JNCC *et al*. (2017) recommend the use of a 2 km displacement buffer for auks. However, considering the limited spatial relevance of construction disturbance with construction slowly moving out across the project, it is considered very unlikely that all puffin will be displaced within the Moray West Site plus 2 km buffer, even if construction activity is concurrent at two locations. Puffin, in common with other auk species, may continue to forage beyond a 1 km buffer from temporary construction activities but may still be located within the Moray West Site since construction activities will take place only within a small area of the site at any time.

10.7.1.58 Puffin were recorded in six of the aerial surveys undertaken across the Moray West Site with peak abundance occurring in August (breeding season). A mean peak breeding population of 1,115 birds was calculated in the Moray West Site for use in the assessment of disturbance / displacement through the decision support process (Volume 4 – Technical Appendix 10.1 - Annex 10.1A). This is equivalent to around 0.10% of the national breeding population (1,160,000 individuals) or 0.93% of the regional breeding population (119,600 individuals). The post-breeding estimate of 3,996 birds is equivalent to around 0.74 % of the national population (536,514 individuals) or 1.7% of the regional population (231,957 individuals).

[5] http://jncc.defra.gov.uk/page-2899

10.7.1.59 It is considered that extensive disturbance of the puffin population within the Moray West Site plus 2 km buffer is unlikely, with any disturbance localised within an area around the source (e.g. turbine installation or cable laying). Numbers affected will depend on the overlap of such activity with food resources at any particular time.

10.7.1.60 The impact is predicted to be of local spatial extent, medium term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The impact magnitude is therefore considered to be **low** at a regional population scale.

Sensitivity of receptor

10.7.1.61 Puffin is considered to be a Valued Ornithological Receptor of international conservation value within the context of the Moray West Offshore Wind Farm. The species is considered to be of moderate vulnerability to displacement (Wade *et al.,* 2016), and may be particularly sensitive during the post-breeding period during moult and when attending young at sea.

10.7.1.62 There has been an increase in national populations over the last decade (+19%), with a likely increase also occurring in Scotland. Puffin lays a single egg and is a late first breeder (Table 10.5.5) so is therefore considered to have a medium recoverability potential. Given puffin is deemed to be of moderate vulnerability, medium recoverability and international value, the sensitivity of the receptor is considered to be **medium**.

Significance of the effect

10.7.1.63 Overall, the sensitivity of the receptor is considered to be medium and the impact magnitude is deemed to be low. The effect will therefore be of **minor adverse significance** which is not significant in EIA terms.

Summary of Disturbance/Displacement due to Construction Activities

10.7.1.64 A summary of the impact of disturbance / displacement due to construction activity on each Valued Ornithological Receptor is presented in Table 10.7.1 below. Effect significance ranges from negligible to moderate adverse.

Table 10.7.1: Summary of Impacts of Construction Disturbance / Displacement due to Construction Activity on Each Valued Ornithological Receptor

Valued Ornithological Receptor	Sensitivity	Impact Magnitude	Effect Significance
Scaup	High	No change	Negligible
Eider	Medium	No change	Negligible
Long-tailed duck	High	No change	Negligible
Common scoter	High	No change	Negligible
Velvet scoter	High	No change	Negligible
Goldeneye	High	No change	Negligible
Red-breasted merganser	Medium	No change	Negligible
Red-throated diver	High	Low	Minor adverse
Great northern diver	High	Low	Minor adverse
Shag	High	Low	Minor adverse
Slavonian grebe	Medium	Negligible	Negligible
Guillemot	Medium	Low	Minor adverse

Table 10.7.1: Summary of Impacts of Construction Disturbance / Displacement due to Construction Activity on Each Valued Ornithological Receptor			
Valued Ornithological Receptor	**Sensitivity**	**Impact Magnitude**	**Effect Significance**
Razorbill	Medium	Low	Minor adverse
Puffin	Medium	Low	Minor adverse

Indirect Effects (Prey Species and Habitat Loss)

10.7.1.65 The indirect impacts on seabird prey resource and habitats are detailed in Chapter 7: Benthic Ecology and Chapter 8: Fish and Shellfish Ecology. Principal impacts on these resources and habitats are likely to be as a result of construction noise and physical disturbance experienced during foundation, particularly piling activities, and cable installation.

10.7.1.66 Detailed assessments of the following potential construction impacts have been undertaken in Chapter 7: Benthic and Intertidal Ecology and Chapter 8: Fish and Shellfish Ecology for key seabird prey species (including cod, sprat, herring, mackerel and sandeel species):

- Temporary habitat loss/disturbance from construction operations including foundation installation and cable laying operations;
- Increased suspended sediment concentrations as a result of foundation installation, cable installation and seabed preparation resulting in potential effects on fish and shellfish receptors;
- Sediment deposition as a result of foundation installation, cable installation and seabed preparation resulting in potential effects on fish and shellfish receptors; and
- Underwater noise as a result of foundation installation (i.e., piling) and other construction activities (e.g., cable installation) resulting in potential effects on fish and shellfish receptors

10.7.1.67 An assessment of the significance of indirect effects on sensitive receptors (i.e. those resulting from the influence of construction activities on prey species) has been made on the basis of knowledge of the prey species targeted by each species, as well as their level of inflexibility of habitat use (Garthe and Hüppop, 2004; Wade *et al*., 2016). The results of these analyses were evaluated against the indirect impacts on seabird prey resource and habitats as detailed in Chapter 7: Benthic and Interidal Ecology and Chapter 8: Fish and Shellfish Ecology, prior information from operational wind farms and specific information from surveys at the Moray West Site.

10.7.1.68 Direct habitat loss may result in removal or fragmentation of foraging or loafing habitat for particular species. For offshore wind farm developments, this long-term habitat loss is generally relatively small, amounting to the area lost to turbine bases and associated infrastructure; typically <1% of the total development footprint (Drewitt and Langston, 2006), although short-term habitat loss associated with construction processes (see Table 10.6.1) may be larger.

10.7.1.69 The Valued Ornithological Receptors of all seaduck, divers, Slavonian grebe, shag, all auks, fulmar, gannet, kittiwake, herring gull and great black-backed gull, are included in the assessment of habitat loss in the construction phase.

Seaducks

Magnitude of impact

10.7.1.70 Seaduck species qualified as a Valued Ornithological Receptor in this assessment for the Offshore Export Cable Corridor only. The installation of the export cable circuits will occur over a maximum duration of 6 months within the 36 months construction period. Numbers of seaduck affected will depend on the overlap of such activity with food resources at any particular time, although as demonstrated previously in the assessment of construction period disturbance, the overlap of the Offshore Export Cable Corridor with aggregations of all seaduck is limited. Overall the impact is predicted to be of local spatial extent, of short to medium term duration, intermittent and with high reversibility. It is predicted that the impact will affect the receptor directly. The impact magnitude is therefore considered to be of **no change.**

Sensitivity of receptor

10.7.1.71 Seaduck species such as common scoter show limited flexibility in feeding habitats, being dependent on shallow feeding grounds with shellfish banks (Furness *et al*., 2012; Wade *et al.,* 2016). In consequence, they are more likely to be adversely impacted by loss of habitat if construction activities take place within areas that they would otherwise use for foraging.

10.7.1.72 Seaduck species are deemed to be of high or very high vulnerability, medium recoverability and international value. The sensitivity of the receptors is therefore, considered to be **high**.

Significance of the effect

10.7.1.73 Overall, the sensitivity of the receptors is considered to be high and the impact magnitude is deemed to be no change. The effect will therefore be of **negligible significance**, which is not significant in EIA terms.

Red-throated and Great Northern Divers

Magnitude of impact

10.7.1.74 Red-throated and great northern divers qualified as Valued Ornithological Receptors in this assessment for the Offshore Export Cable Corridor only. As noted in in the assessment presented above for seaducks, the nature of cable laying activities (highly localised, limited vessel movement, low noise levels and limited spatial extent of impact) reduces the likelihood for impacts on divers.

10.7.1.75 Export cable installation will be highly localised as cable laying vessels are slow moving during the installation of cables which will occur over a maximum duration of six months during the 36 month construction period.

10.7.1.76 Numbers of divers affected will depend on the overlap of such activity with food resources at any particular time. Moreover in addition to the above mentioned spatial and temporal parameters of the cable installation, the findings of Chapter 9: Fish and Shellfish Ecology are considered which state that the relevant significance of effects of construction impacts on prey species is no greater than minor.

10.7.1.77 Overall the impact is predicted to be of local spatial extent, short - medium term duration, intermittent and with high reversibility. It is predicted that the impact will affect the receptor directly although a small number of individuals may be affected representing a proportion of the regional population. The impact magnitude is therefore, considered to be of **low**.

Sensitivity of the receptor

10.7.1.78 Herring and sprat are amongst the most frequently recorded prey species of red-throated divers (Cramp & Simmons 1977 - 1994), although this species is considered to be an opportunistic feeder, taking a rather broad range of fish species (Guse *et al*., 2009). The species however shows limited flexibility in feeding habitats, being dependent on shallow feeding grounds with shellfish banks (Furness *et al*., 2012; Wade *et al*., 2016). In consequence, the species is amongst those more likely to be adversely impacted by loss of habitat if construction activities take place within areas that they would otherwise use for foraging.

10.7.1.79 Red-throated and great northern divers are deemed to be of very high vulnerability, medium or low recoverability and international value. The sensitivity of the receptors is therefore considered to be **high.**

Significance of the effect

10.7.1.80 Overall, the sensitivity of the receptor is considered to be high and the impact magnitude is deemed to be low. The effect will, therefore, be of **minor adverse significance**, which is not significant in EIA terms.

Auks

10.7.1.81 The auks (puffin, razorbill and guillemot) foraging behaviour and prey species are similar and therefore for the purposes of this assessment are considered together.

Magnitude of impact

10.7.1.82 Based on respective densities of guillemot, razorbill and puffin in comparison with the wider Moray Firth area, survey results suggests that the Moray West Site is of importance in at least a regional context during breeding and post-breeding period (Volume 4 – Technical Appendix 10.1: Ornithology Technical Report).

10.7.1.83 Auks may preferentially forage for sandeels, but they also obtain wide-ranging mobile prey species during this period. Whilst there may be intermittent displacement of prey from a region around the Moray West Site, there is no indication that the overall availability of prey for auk species will be reduced. It is expected that for those periods when auk peak abundance and construction activities coincide that auk species will redistribute themselves in relation to the availability of prey abundance.

10.7.1.84 The impact is predicted to be of local to regional spatial extent, short to medium term duration (six months along the Offshore Export Cable Corridor and 36 months in the Moray West Site), continuous and medium to high reversibility (temporary loss from cable installation and piling activity). The duration of piling activity is nine months while the findings of Chapter 9: Fish and Shellfish Ecology state that the relevant significance of effects of construction impacts on prey species is no greater than minor. It is therefore predicted that the impact will affect the receptor both directly and indirectly. The impact magnitude is therefore, considered to be **low** at regional or national population scales.

Sensitivity of the receptor

10.7.1.85 Auks feed mainly on sandeels, sprat and herring and typically forage offshore with inshore feeding less common. Guillemot, razorbill and puffin were all classified as being of moderate vulnerability to habitat/prey interactions and therefore likely habitat loss by Wade *et al.* (2016).

10.7.1.86 All species are considered to be of international conservation value. When considering the above factors, it is determined that the sensitivity of auks species is considered to be **medium**.

Significance of the effect

10.7.1.87 Overall, the sensitivity of the receptors is considered to be medium and the impact magnitude is deemed to be low. The effect will therefore be of **minor adverse significance**, which is not significant in EIA terms.

Kittiwake

Magnitude of impact

10.7.1.88 The significance of effects on kittiwake prey resource and habitats from construction impacts, as detailed in Chapter 7: Benthic Ecology and Chapter 9: Fish and Shellfish Ecology are assessed at most as minor adverse, which is not significant in EIA terms.

10.7.1.89 The impact on kittiwake is therefore predicted to be of local to regional spatial extent, short to medium term duration (six months along the Offshore Export Cable Corridor and 36 months in the Moray West Site), continuous and medium to high reversibility (temporary loss from cable installation). It is predicted that the impact will affect the receptor both directly and indirectly. Kittiwakes feed on mobile prey species such as herring and sandeels and are generally restricted to prey species available within the top metre of the sea surface (Coulson, 2011) , and therefore the impact magnitude of habitat loss is considered to be **low** at a national population scale.

Sensitivity of the receptor

10.7.1.90 The vulnerability of bird species to changes in habitat or abundance and distribution of prey depends on their foraging flexibility, in particular their specific habitat and dietary requirements. Wade *et al*. (2016) consider that kittiwake is of low sensitivity as birds forage across the continental shelf within the 200 m depth contour, and are extremely pelagic, particularly in winter months. This has been shown in recent studies by Fredericksen *et al.* (2012) for example, where birds range widely across the North Sea and Atlantic. Langston (2010) also rated the species as being of low vulnerability to habitat and prey interactions.

10.7.1.91 Kittiwake is an ornithological receptor of international conservation value within the context of the Moray West Offshore Wind Farm and has low recoverability potential due to regional and national declines. The sensitivity of the receptor to this impact is therefore considered to be **low to medium.**

Significance of the effect

10.7.1.92 Overall, the sensitivity of kittiwake is considered to be low to medium and the magnitude is deemed to be low. The effect will therefore be of **minor adverse significance** on the regional population, which is not significant in EIA terms.

All Other Ornithological Receptors

Magnitude of impact

10.7.1.93 The magnitude of change in habitat or abundance and distribution of prey will be negligible compared to overall foraging range for each species. The impact is predicted to be of local to regional spatial extent, short to medium term duration (six months along the Offshore Export Cable Corridor and 36 months in the Moray West Site), continuous and of medium to high reversibility. It is predicted that the impact will affect each receptor directly and indirectly. For all other ornithological receptors the impact magnitude is therefore considered to be **negligible**.

Sensitivity of the receptor

10.7.1.94 For other ornithological receptors, the vulnerability to habitat/prey interactions was considered by Wade *et al.* (2016) (where it is termed habitat flexibility in this reference) as being very low for fulmar, gannet, herring gull and great black-backed gull. Conservation value is generally international for all species, while in terms of recoverability it ranges from low (gull species, fulmar, shag) to medium (Slavonian grebe) to high (gannet).

10.7.1.95 The sensitivity of the receptors is therefore, considered to be at most **medium**.

Significance of the effect

10.7.1.96 Overall, the sensitivity of these receptors will be medium at most and the impact magnitude is deemed to be negligible. The effect will therefore be of **negligible or minor adverse significance**, which is not significant in EIA terms.

Summary of Indirect Effects During the Construction Phase

10.7.1.97 A summary of the indirect impacted by impacts of habitat loss the during construction phases on each Valued Ornithological Receptor is presented in Table 10.7.2. Effect significance ranges from negligible to minor adverse with no effects considered to be significant in EIA terms.

Table 10.7.2: Summary of Indirect Effects in the Construction Phase on each Valued Ornithological Receptor

Valued Ornithological Receptor	Sensitivity	Impact Magnitude	Effect Significance
Scaup	High	No change	Negligible
Eider	High	No change	Negligible
Long-tailed duck	High	No change	Negligible
Common scoter	High	No change	Negligible
Velvet scoter	High	No change	Negligible
Goldeneye	High	No change	Negligible
Red-breasted merganser	High	No change	Negligible
Red-throated diver	High	Low	Minor adverse
Great northern diver	High	Low	Minor adverse
Fulmar	Low - medium	Negligible	Negligible
Gannet	Low - medium	Negligible	Negligible
Shag	Low - medium	Negligible	Negligible
Slavonian grebe	Low - medium	Negligible	Negligible
Guillemot	Medium	Low	Minor adverse
Razorbill	Medium	Low	Minor adverse
Puffin	Medium	Low	Minor adverse
Kittiwake	Low - medium	Low	Minor adverse
Herring gull	Low - medium	Negligible	Negligible
Great black-backed gull	Low - medium	Negligible	Negligible

Pollution Effects

10.7.1.98 During construction, support vessels and machinery present will contain a fuel supply and lubricants which, in the event of an incident such as a collision, may be released into the surrounding sea. A maximum design scenario has identified oil, synthetic compounds, heavy metal and hydrocarbon contamination resulting from offshore infrastructure installation, and a maximum of 25 construction vessels present at any one time within the Development area for the duration of the construction phase (36 months).

10.7.1.99 The best available information indicates that the most frequently recorded spills from vessels offshore is associated with upsets in the bilge treatment systems and the losses are usually small. This type of partial inventory loss is likely to result in tens of litres being lost to the environment which is not considered to be significant at any level.

10.7.1.100 The worst-case spill from a single tank rupture in the large installation vessels would release diesel into the marine environment. This scenario is considered, however, to be very unlikely, particularly when mitigation measures are included, and so the assessment will take this low likelihood of occurrence into account when reaching levels of significance.

10.7.1.101 Any spill or leak within the offshore regions of the Development area would likely be immediately diluted and rapidly dispersed through natural process e.g. tidal current and waves. The historical frequency of pollution events in the southern North Sea is low considering the density of existing marine traffic in the area. In addition, a number of embedded measures outlined in Table 10.1.2: Embedded Measures Adopted as part of Moray West Offshore Wind Farm (e.g. the EMP and MPCP) will significantly reduce the likelihood of an incident occurring in the Development area that would result in accidental pollution.

10.7.1.102 A quantitative oil vulnerability index of seabird species to surface pollution in the North Sea was developed by Williams *et al*. (1995), based on four factors. These factors were: (a) the proportion which was oiled of each species found dead (or moribund) on the shoreline, and the proportion of time spent on the surface of the sea by that species; (b) the size of the biogeographic population of the species affected; (c) the potential rate of recovery following a reduction in numbers for each species; and (d) the reliance on the marine environment by each species.

10.7.1.103 Although populations of some species may have changed since the date of this study, it is still considered to reflect the relative vulnerability of each species to a pollution incident, and so is used for most Valued Ornithological Receptors considered here.

10.7.1.104 This assessment is considering the impact of pollution which may affect species' survival rates or foraging activity in the Development area and therefore is of minimal importance to species briefly transiting the Moray West Site while on migration. In the absence of a pathway for effect for migrant seabirds, the Valued Ornithological Receptors considered for this potential impact focus on those species using the Moray West Site plus a 4 km buffer area and the Offshore Export Cable Corridor i.e. all seaduck, divers, Slavonian grebe, shag, fulmar, gannet, puffin, razorbill, guillemot, kittiwake, herring gull and great black-backed gull.

All Ornithological Receptors

Magnitude of impact

10.7.1.105 The magnitude of any incident resulting in pollution is difficult to determine due to the unpredictability of such events, as well as the influence of seasonality and conditions. In the example case of guillemot, the highest estimated peaks occur in the post-breeding season. If the mean peak guillemot population within the Moray West Site plus 2 km buffer (derived through the decision support tree process; Volume 4 – Technical Appendix 10.1- Annex 10.1A) were affected due to an incident, this would result in the redistribution and/or direct mortality of up to 112,934 birds, which represents 6.98% and 4.10% of the regional and national non-breeding populations respectively. A smaller peak was predicted in the breeding season (28,092 birds), which represents 2.81% and 1.47% of the regional and national breeding populations respectively.

10.7.1.106 In the event that an incident does occur, with implementation of the embedded pollution prevention measures outlined in Table 10.1.2: Embedded Measures Adopted as part of Moray West Offshore Wind Farm i.e. EMP and MPCP complete mortality of a species within the equivalent extent of the Moray West Site plus 2 km buffer is considered very unlikely to occur.

A major incident that may impact any species at a population level is therefore considered very unlikely.

10.7.1.107 Given the limited size of potential pollution incidents (based on the volumes of any chemicals carried by one vessel) and the designed-in measures, the impact is therefore predicted to be of local spatial extent, short term duration, intermittent and high reversibility within the context of the regional populations. It is predicted that the impact will affect the receptor both directly and indirectly. The impact magnitude is therefore, considered to be **negligible** for all species.

Sensitivity of the receptors

10.7.1.108 The vulnerability of species to accidental spills and pollution incidents depends on their habitat flexibility in addition to their foraging behaviour and dietary requirements.

10.7.1.109 Williams *et al*. (1995) considered the vulnerability of North Sea seabirds to surface pollutants. An index was derived made up of the following four factors: (a) the proportion which was oiled of each species found dead (or moribund) on the shoreline and proportion of time spent on the surface of the sea by that species: (b) the size of the biogeographical population of the species: (c) the potential rate of recovery following a reduction in numbers for each species; (d) the reliance on the marine environment by each species.

10.7.1.110 For surface feeders (as in fulmar and all gulls) direct mortality is considered to be of lower likelihood than for other species, with these species likely to be able to forage widely to find alternative resources. In their assessment of seabird vulnerability to surface pollutants, fulmar was found to be of low vulnerability and therefore low sensitivity, ranking it 28th out of 37 seabird species. As surface feeders the sensitivity of herring gull and great black-backed gull is also considered to be **low**.

10.7.1.111 Diving species that spend long periods of time on the sea surface (particularly during moult periods as in auks) are more likely to be affected. Guillemot survival rates on Skomer were negatively affected by the occurrence of major oil spills on their wintering grounds (JNCC, 2013). Williams *et al.* (1995) ranked the species as being medium to high vulnerability and therefore sensitivity, coming 14th out of 37 seabird species. Due to their foraging habits, seaduck species such as common scoter, scaup, and long-tailed duck were also assessed by Williams *et al.* (1995) and were ranked as relatively less vulnerable than other species, while diver species were considered highly vulnerable. As all receptors are of international value, the level of vulnerability derived from Williams *et al.* (1995) is taken to directly transfer to their sensitivity.

10.7.1.112 Gannet are diving species and highly reliant on the marine environment and so are considered to be relatively vulnerable to pollution incidents by Williams *et al*. (1995), being ranked 13th and 22nd out of 37 seabird species. Gannet is therefore considered to be of **medium** sensitivity.

Significance of the effect

10.7.1.113 Based on an impact of whose magnitude for all receptors is negligible, irrespective of the sensitivity of the receptor, a negligible effect on the regional population is predicted which is not significant in EIA terms.

Summary of Accidental Pollution Events

10.7.1.114 A summary of pollution impacts on each Valued Ornithological Receptor is presented in Table 10.7.3. Impacts of negligible significance are predicted for all Valued Ornithological Receptors.

Table 10.7.3: Summary of Impacts of Construction Pollution on each Valued Ornithological Receptor

Valued Ornithological Receptor	Sensitivity	Impact Magnitude	Effect Significance
Scaup	Low	Negligible	Negligible

Table 10.7.3: Summary of Impacts of Construction Pollution on each Valued Ornithological Receptor			
Valued Ornithological Receptor	**Sensitivity**	**Impact Magnitude**	**Effect Significance**
Eider	Low	Negligible	Negligible
Long-tailed duck	Low	Negligible	Negligible
Common scoter	Medium	Negligible	Negligible
Velvet scoter	Medium	Negligible	Negligible
Goldeneye	Low	Negligible	Negligible
Red-breasted merganser	Medium	Negligible	Negligible
Red-throated diver	High	Negligible	Negligible
Great northern diver	High	Negligible	Negligible
Fulmar	Low	Negligible	Negligible
Gannet	Medium	Negligible	Negligible
Shag	High	Negligible	Negligible
Slavonian grebe	Medium	Negligible	Negligible
Guillemot	Medium to high	Negligible	Negligible
Razorbill	Medium to high	Negligible	Negligible
Puffin	Medium to high	Negligible	Negligible
Kittiwake	Low	Negligible	Negligible
Herring gull	Low	Negligible	Negligible
Great black-backed gull	Low	Negligible	Negligible

10.7.2 Potential Operational Effects

10.7.2.1 The potential impacts arising from the operation and maintenance of the Development on offshore ornithology are described below. These impacts have been assessed against the maximum design parameters listed in Table 10.6.2. A assessment of the significance of the effect of these impacts on offshore ornithology receptors has also been provided.

<u>Disturbance</u>

10.7.2.2 Disturbance to birds due to the presence of operational offshore wind farms is considered to be of a lower intensity than during the construction/decommissioning phases, and limited to maintenance activities as well as vessel and helicopter trips to and from the site service operations vessel (SOV), and also post-construction monitoring survey activity. The maximum design scenario for the Development considered for operation and maintenance disturbance is outlined in Table 10.6.1.

10.7.2.3 In many cases operation and maintenance disturbance may be indistinguishable from displacement, as birds of particular species may be susceptible to both impacts. A bird that has already been displaced from the wind farm may not be affected by operation and maintenance disturbance. Conversely, operation and maintenance disturbance may exacerbate the impact of displacement if it occurs in an area where birds have been displaced to (e.g. supply vessels en route to and from the Moray West Site). As it is not straightforward to predict the long-term displacement reactions of birds to turbines, the impacts of operation and maintenance disturbance have been considered in isolation. An assessment of displacement impacts follows this section.

10.7.2.4 The operation and maintenance of the Development is likely to be managed on site using an SOV (with the use of crew transfer vessels and other support vessels if necessary). Regular maintenance of turbines will occur throughout the year. Periodic inspection of the cable will be undertaken by remotely operated vehicles and/or geophysical survey to check that cables have not been exposed due to seabed movements, in which case remedial burial work or other cable protection methods will be required.

All Ornithological Receptors

Magnitude of impact

10.7.2.5 It is expected that there will be daily boat movements within the Moray West Site during operation and maintenance. Operational vessels are likely to be much less intrusive to seabird species than those associated with construction activities. Impacts are therefore likely to be of a lower magnitude than disturbance during construction, with birds likely to be affected in a smaller radius around the area of activity, compared to activities during construction such as foundation and WTG installation for example.

10.7.2.6 The ultimate consequence of disturbance may be increased mortality to an extent similar to (although likely more restricted in spatial extent) displacement impacts (see following section) with birds during the breeding season more likely to be susceptible to such impacts. As such, the impact is predicted to be of local spatial extent, long term duration, and intermittent and low to medium reversibility within the context of any international, national or regional population. It is predicted that the impact will affect the receptor directly. If it is assumed that the magnitude of loss is similar to identified displacement impacts (Table 10.7.5) although reduced in spatial scale it is considered to be **negligible or no change** for all species.

Sensitivity of the receptors

10.7.2.7 The overall sensitivity of receptors is considered to be of the same levels as those relating to disturbance during construction. Although scientific evidence on the effects of wind farm maintenance activities is lacking, there is no reason to suggest that any receptor will react differently to operation and maintenance activity as opposed to construction phase activity.

Significance of the effect

10.7.2.8 An impact of negligible magnitude on low to medium sensitivity receptors will produce an effect of negligible or minor adverse significance on regional populations for all receptors, which is considered to be not significant in EIA terms.

Summary of Disturbance Impacts During O&M

10.7.2.9 A summary of operation and maintenance disturbance impacts on each Valued Ornithological Receptor is presented in Table 10.7.4. Effect significance ranges from negligible or minor adverse to minor adverse with no effects considered to be significant in EIA terms.

Table 10.7.4: Summary of Impacts of Disturbance in the Operational Phase on Each Valued Ornithological Receptor

Valued Ornithological Receptor	Sensitivity	Impact Magnitude	Effect Significance
Scaup	High	No change	Negligible
Eider	Medium	No change	Negligible

Table 10.7.4: Summary of Impacts of Disturbance in the Operational Phase on Each Valued Ornithological Receptor			
Valued Ornithological Receptor	**Sensitivity**	**Impact Magnitude**	**Effect Significance**
Long-tailed duck	High	No change	Negligible
Common scoter	High	No change	Negligible
Velvet scoter	High	No change	Negligible
Goldeneye	High	No change	Negligible
Red-breasted merganser	Medium	No change	Negligible
Red-throated diver	High	Negligible	Minor adverse
Great northern diver	High	Negligible	Minor adverse
Shag	High	Negligible	Minor adverse
Slavonian grebe	Medium	Negligible	Negligible
Guillemot	Medium	Negligible	Negligible or minor adverse
Razorbill	Medium	Negligible	Negligible or minor adverse
Puffin	Medium	Negligible	Negligible or minor adverse

<u>Displacement and Barrier Effects</u>

10.7.2.10 Within this assessment of operational displacement, Valued Ornithological Receptors considered are fulmar, guillemot, razorbill, puffin and kittiwake. Full displacement matrices for each biological season are presented in Volume 4 – Technical Appendix 10.3: Analysis of Displacement Impacts on Seabirds. The buffer taken forward to the impact assessment of all Valued Ornithological Receptors is 2 km as recommended by JNCC *et al.* (2017).

Fulmar

<u>Magnitude of impact</u>

10.7.2.11 Fulmar has undergone one of the most dramatic expansions in range and population of any UK breeding seabird in recent years (Brown and Grice, 2005; Forrester *et al.,* 2007). Fulmars feed on a wide diversity of food including planktonic crustacean, cephalopods and small fish (Cramp and Perrins, 1977).

10.7.2.12 Fulmar have an extensive foraging range with the Moray West Site representing a small fraction of the available foraging area, as defined by the mean-maximum foraging range of 400 km from their breeding colonies (Thaxter *et al*., 2012). They are a highly pelagic seabird and foraging trips can last up to 30 hours (Furness and Todd, 1984).

10.7.2.13 The displacement rate considered appropriate for fulmar is 10% across all seasons. The mortality rate considered appropriate for fulmar is 1% in all seasons (see Volume 4 – Technical Appendix 10.3: Analysis of Displacement Impacts on Seabirds).

Breeding season

10.7.2.14 The mean peak fulmar population estimate calculated for the Moray West Site plus 2 km buffer during the breeding season (April to August) was 581 birds. Based on a mortality rate of 1% (due to the large foraging range of the species providing sufficient alternative foraging opportunities) and a displacement rate range of 10%, one individual may be lost as a result of displacement (Table 1.6 of Technical Appendix 10.3: Ornithology Displacement (Volume 4)).

10.7.2.15 This predicted level of mortality represents less than a 0.1% increase in the background mortality of the regional breeding population. The true impact is however further reduced by considering population structure. The regional breeding population defined for fulmar is composed of breeding adults only whereas in reality there are likely to be immature and non-breeding birds present in the Moray Firth during the breeding season. The impact of displacement on fulmar during the breeding season is predicted to be of regional spatial extent, long term duration, continuous and of low to medium reversibility. It is predicted that the impact will affect the receptor directly. Considering the low level of predicted mortality of fulmar, the impact magnitude is therefore considered to be **negligible**.

Post-breeding season

10.7.2.16 During the post-breeding season (September to October) the mean peak population estimate calculated for the Moray West Site plus 2 km buffer was 68 birds. Based on a displacement rate of 10% and a mortality rate of 1%, no fulmar mortality is predicted (Table 1.7 in Volume 4 - Technical Appendix 10.3: Ornithology Displacement).

10.7.2.17 The impact of displacement on fulmar during the post-breeding season is therefore considered to represent **no change** in magnitude.

Non-breeding season

10.7.2.18 During the non-breeding season (November) the population estimate calculated for the Moray West Site plus 2 km buffer was 1,223 individual fulmar. Based on a displacement rate of 10% and a mortality rate of 1%, 1 individual may be lost as a result of displacement. This predicted level of mortality does not surpass 1% of baseline mortality of the regional non-breeding population (1% of baseline mortality = 364 individuals) (Table 1.8 in Volume 4 – Technical Appendix 10.3: Ornithology Displacement).

10.7.2.19 The impact of displacement on fulmar during the non-breeding season is predicted to be of regional spatial extent, long term duration, continuous and of high reversibility involving only a small number of individual birds representing a limited proportion of the regional population. It is predicted that the impact will affect the receptor directly. As there is a very low level of predicted fulmar mortality, the impact magnitude is therefore, considered to be **negligible**.

Pre-breeding season

10.7.2.20 The mean peak population estimate of fulmar calculated for the Moray West Site plus a 2 km buffer in the pre-breeding season (December to March) was 1,630 birds. Based on a displacement rate of 10% and a mortality rate of 1%, two individuals may be lost as a result of displacement. This predicted level of mortality does not surpass 1% of baseline mortality of the regional pre-breeding population (1% of baseline mortality = 613 individuals) (Table 1.9 in Volume 4 – Technical Appendix 10.3: Ornithology Displacement).

10.7.2.21 The impact of displacement on fulmar during the pre-breeding season is predicted to be of regional spatial extent, long term duration, continuous and of high reversibility involving only a small number of individual birds representing a limited proportion of the regional population. It is predicted that the impact will affect the receptor directly. As there is a very low level of predicted fulmar mortality, the impact magnitude is therefore, considered to be **negligible**.

Sensitivity of the receptor

10.7.2.22 Fulmar is considered to be of international conservation value as a result of the Moray West Site being in mean maximum foraging range of multiple SPA colonies that support this species as a qualifying feature. With a regional and national population trend likely to be relatively stable, but with low productivity rate, the species' recoverability is considered to be low. Behaviourally, fulmar was considered to be of very low vulnerability to displacement by Wade *et al*. (2016). In summary, fulmar is deemed to be of very low vulnerability, low recoverability and international value. The sensitivity of the Valued Ornithological Receptor is therefore, considered to be **low**.

Significance of the effect

10.7.2.23 Overall, the sensitivity of the receptor is considered to be medium and the impact magnitude is deemed to be no change to negligible. The effect will therefore be of **negligible significance**, which is not significant in EIA terms.

Puffin

Magnitude of impact

10.7.2.24 The displacement rate considered appropriate for puffin is 50 - 60% across all seasons while the mortality rate considered appropriate is 2%.

Breeding season

10.7.2.25 The mean peak puffin population estimate calculated for the Moray West Site plus 2 km buffer during the breeding season (April) was 1,115 birds (Volume 4 – Technical Appendix 10.1 - Annex 10.1A). Based on a displacement rate of 50 and 60% combined with a mortality rate of 2% during the breeding season, between 11 and 13 puffins may be lost as a result of displacement.

10.7.2.26 Assessed against the defined puffin regional breeding population (119,600 birds) the predicted mortality from breeding season displacement does not surpass the 1% baseline mortality figure (Table 1.10 in Volume 4 – Technical Appendix 10.3: Ornithology Displacement).

10.7.2.27 During the breeding season not all puffins attending colonies and adjacent waters are breeding adults. Puffins do not usually breed until they are five years old (Cramp and Perrins 1977 - 1994) and unlike gannets and gulls it is not possible to separate adults from immature birds during site-specific observations offshore. However, data from other studies indicate that during the breeding period at least 35% of all puffins present may be non-breeding or immature birds and therefore not part of the SPA breeding adult population (Harris and Wanless, 2011).

10.7.2.28 This is potentially an underestimate of actual proportions of non-breeders further offshore at the Moray West Site. Votier *et al*. (2008) observed that immature and non-breeding guillemots from Skomer Island, Wales spread out further than breeding adults and it is likely that this pattern is replicated by puffins. Boat-based surveys in the North Sea by Camphuysen (2005) found that most foraging was concentrated around the major colonies, and that within 20 km of land, 99% of puffins were adults in breeding plumage. In contrast, further offshore, many puffins still had traces of winter plumage, suggesting that they were non-breeders that spent less time ashore. A higher proportion of non-breeders are therefore likely to occur further offshore. It is considered likely that a notable proportion of puffins recorded in the breeding season are immature individuals. In addition, a further proportion is likely to be non-breeding adult birds. Therefore, mortality predicted during the breeding season is considered likely to result in considerably less than nine adult birds from the regional breeding population.

10.7.2.29 The impact of displacement on puffin during the breeding season is predicted to be of regional spatial extent, long term duration, continuous and of high reversibility. It is predicted that the impact will affect the receptor directly. Considering the low level of predicted mortality which does not surpass a 1% change in baseline mortality, the impact magnitude is therefore, considered to be **low**.

Post-breeding season

10.7.2.30 During the post-breeding season (September to October) the mean peak puffin population estimate as provided in Volume 4 – Technical Appendix 10.1 - Annex 10.1A was 3,996 birds in the Moray West Site plus 2 km buffer.

10.7.2.31 Based on a 50-60% displacement rate and 2% mortality rate, it is predicted that 40-48 birds will be lost as a result of displacement. From a regional breeding population of 119,600 individuals this level of mortality does not surpass 1% of baseline mortality (baseline mortality = 11,242 individuals) (Table 1.11 in Volume 4 – Technical Appendix 10.3: Ornithology Displacement).

10.7.2.32 The impact of displacement on puffin during the post-breeding season is predicted to be of local spatial extent, long term duration, continuous and of low to medium reversibility. It is predicted that the impact will affect the receptor directly. The impact magnitude is therefore, considered to be **low**.

Non-breeding season

10.7.2.33 During the non-breeding season (October to March) the mean peak puffin population estimate provided in Volume 4 – Technical Appendix 10.1 - Annex 10.1A was 12 birds in the Moray West Site plus 2 km buffer.

10.7.2.34 Based on a 50-60% displacement rate and 2% mortality rate, it is predicted that less than one bird will be lost as a result of displacement (Table 1.12 in Volume 4 – Technical Appendix 10.3: Ornithology Displacement).

10.7.2.35 The impact of displacement on puffin during the non-breeding season is predicted to be of local spatial extent, long term duration, continuous and of low to medium reversibility. It is predicted that the impact will affect the receptor directly. The impact magnitude is therefore, considered to be of **no change**.

Sensitivity of the receptor

10.7.2.36 Puffin is considered to be of international conservation value and the Moray West Site is within the mean maximum foraging range of SPA colonies that include this species as a qualifying feature. With a regional and national population trend likely to be relatively stable, but with low productivity rate, the species' recoverability is considered to be low. Behaviourally, puffin was considered to be of moderate vulnerability to displacement by Wade *et al.* (2016). In summary, puffin is deemed to be of moderate vulnerability, low recoverability and international value. The sensitivity of the Valued Ornithological Receptor is therefore, considered to be **medium**.

Significance of the effect

10.7.2.37 Overall, the sensitivity of the receptor is considered to be medium and the impact magnitude is deemed to be no change to low depending on the season assessed. The effect will, therefore, be no greater than **minor adverse significance**, which is not significant in EIA terms.

Razorbill

Magnitude of impact

10.7.2.38 The displacement rate considered appropriate for razorbill is 40 - 60% across all seasons while the mortality rate considered appropriate is 1%.

10.7.2.39 Searle *et al.* (2014) explored the population effects of displacement from proposed wind energy developments, including the razorbill feature of Forth Islands SPA. The analysis investigated change in adult survival and, breeding success, with results for razorbill showing a relatively high degree of certainty. No combinations of impact scenarios indicated a notable decline for razorbill (all individual wind farms produced declines of adult survival of less than 0.12%).

Breeding season

10.7.2.40 The mean peak razorbill population estimate calculated for the Moray West Site plus 2 km buffer during the breeding season (April to August) was 2,808 birds (Volume 4 – Technical Appendix 10.1 - Annex 10.1A). Based on a displacement rate of 40 - 60% and a mortality rate of 1% during the breeding season, between 11 and 17 razorbills may be lost as a result of displacement (Table 1.13 in Volume 4 – Technical Appendix 10.3: Ornithology Displacement).

10.7.2.41 Assessed against the defined razorbill regional breeding population (107,711 birds) the predicted mortality from breeding season displacement does not surpass 1% of baseline mortality (Table 1.13 in Volume 4 – Technical Appendix 10.3: Ornithology Displacement).

10.7.2.42 The impact of displacement on razorbill during the breeding season is predicted to be of regional spatial extent, long term duration, continuous and of high reversibility. It is predicted that the impact will affect the receptor directly. The impact magnitude is therefore, considered to be **low.**

Post-breeding season

10.7.2.43 During the post-breeding season (September to October) the mean peak razorbill population estimate provided in Volume 4 – Technical Appendix 10.1 - Annex 10.1A was 3,544 birds in the Moray West Site plus 2 km buffer.

10.7.2.44 Based on a 40-60% displacement rate and 1% mortality rate, it is predicted that 14 – 21 birds will be lost as a result of displacement. From a regional BDMPS post-breeding population of 591,874 individuals this level of mortality does not surpass 1% of baseline mortality (Table 1.14 in Volume 4 – Technical Appendix 10.3: Ornithology Displacement).

10.7.2.45 The impact of displacement on razorbill during the post-breeding season is predicted to be of local spatial extent, long term duration, continuous and of low to medium reversibility. It is predicted that the impact will affect the receptor directly. The impact magnitude is therefore, considered to be **low**.

Non-breeding season

10.7.2.46 During the non-breeding season (November to December) the mean peak razorbill population estimate provided in Volume 4 – Technical Appendix 10.1 - Annex 10.1A was 184 birds in the Moray West Site plus 2 km buffer.

10.7.2.47 Based on a 40-60% displacement rate and 1% mortality rate, it is predicted that one bird will be lost as a result of displacement (Table 1.15 in Volume 4 – Technical Appendix 10.3: Ornithology Displacement).

10.7.2.48 The impact of displacement on razorbill during the non-breeding season is predicted to be of local spatial extent, long term duration, continuous and of low to medium reversibility. It is predicted that the impact will affect the receptor directly. The impact magnitude is therefore, considered to be negligible.

Pre-breeding season

10.7.2.49 During the pre-breeding season (January to March) the mean peak razorbill population estimate provided in Volume 4 – Technical Appendix 10.1- Annex 10.1A was 3,585 birds in the Moray West Site plus 2 km buffer.

10.7.2.50 Based on a 40-60% displacement rate and 1% mortality rate, it is predicted that 14 - 22 birds will be lost as a result of displacement (Table 1.12 in Volume 4 – Technical Appendix 10.3: Ornithology Displacement).

10.7.2.51 Assessed against the defined razorbill regional pre-breeding population (591,874 birds) the predicted mortality from breeding season displacement does not surpass 1% of baseline mortality (Table 1.16 in Volume 4 – Technical Appendix 10.3: Ornithology Displacement).

10.7.2.52 The impact of displacement on razorbill during the pre-breeding season is predicted to be of local spatial extent, long term duration, continuous and of low to medium reversibility. It is predicted that the impact will affect the receptor directly. The impact magnitude is therefore, considered to be **low**.

Sensitivity of the receptor

10.7.2.53 Razorbill is considered to be of international conservation value; Moray West Site lies within the mean maximum foraging range of SPA colonies that include this species as a qualifying feature. With a regional and national population trend likely to be relatively stable, but with low productivity rate, the species' recoverability is considered to be medium. Behaviourally, razorbill was considered to be of high vulnerability to displacement by Wade *et al.* (2016), although the results of Searle *et al*. (2014) suggest that this rating may be somewhat precautionary. In summary, razorbill is deemed to be of high vulnerability, medium recoverability and international value. The sensitivity of the Valued Ornithological Receptor is therefore, considered to be **medium**.

Significance of the effect

10.7.2.54 Overall, the sensitivity of the receptor is considered to be medium and the impact magnitude is deemed to be negligible – low depending on the season assessed. The effect will therefore be no greater than **minor adverse significance**, which is not significant in EIA terms

Guillemot

Magnitude of impact

10.7.2.55 The displacement rate considered appropriate for guillemot is 50 - 60% across all seasons while the mortality rate considered appropriate is 1%.

10.7.2.56 Searle *et al.* (2014) explored the population effects of displacement from proposed wind energy developments, including the guillemot feature of the Forth Islands SPA and Fowlsheugh SPA. The model suggested that population level impact on common guillemot breeding success at colonies in the Forth Islands SPA and other nearby SPAs would be less than a reduction of 1% in all cases and all modelled scenarios, even as a cumulative impact of all proposed new offshore wind farms close to the colonies (Inch Cape, Neart na Gaoithe and Seagreen Alpha and Bravo). The model suggested that population level impact on common guillemot adult survival would be less than a 0.5% reduction in survival.

10.7.2.57 The work suggests that displacement / barrier effect of offshore wind farms within the main foraging area of breeding guillemots could have an impact on productivity and adult body condition. However, impacts of the scale assessed were considered to be below levels that would give rise to concern regarding the conservation status of these guillemot populations. Consideration of the species ecology suggested that displacement of nonbreeding guillemots is unlikely to affect the survival rates of displaced birds under most circumstances, but that an impact could occur if prey fish abundance was reduced to unusually low levels such that food shortage caused increased mortality. In that situation, loss of foraging habitat due to displacement could marginally increase mortality in combination with the impact caused by food shortage (Searle *et al.,* 2014).

Breeding season

10.7.2.58 The mean peak guillemot population estimate calculated for the Moray West Site plus 2 km buffer during the breeding season (April to July) was 24,426 birds (Volume 4 – Technical Appendix 10.1 - Annex 10.1A). Based on a displacement rate of 50 - 60% and a mortality rate of 1% during the breeding season, between 122 and 147 guillemots may be lost as a result of displacement (Table 1.17 in Volume 4 – Technical Appendix 10.3: Ornithology Displacement).

10.7.2.59 Assessed against the defined guillemot regional breeding population (998,623 birds) the predicted mortality from breeding season displacement does not surpass the 1% baseline mortality figure (Table 1.17 in Volume 4 – Technical Appendix 10.3: Ornithology Displacement).

10.7.2.60 The impact of displacement on guillemot during the breeding season is predicted to be of regional spatial extent, long term duration, continuous and of high reversibility. It is predicted that the impact will affect the receptor directly. The impact magnitude is therefore considered to be **low**.

Post-breeding season

10.7.2.61 During the post-breeding season (September to October) the mean peak guillemot population estimate provided in Volume 4 – Technical Appendix 10.1 - Annex 10.1A was 38,174 birds in the Moray West array area plus 2 km buffer.

10.7.2.62 Based on a 50-60% displacement rate and 1% mortality rate, it is predicted that 191 – 229 birds will be lost as a result of displacement. From a regional BDMPS non-breeding population of 1,617,306 individuals this level of mortality does not surpass the 1% baseline mortality figure (Table 1.18 in Volume 4 – Technical Appendix 10.3: Ornithology Displacement). The 1% value of the regional population is 987 birds based on a mortality rate of 6.1% (baseline mortality is therefore 98,656 individuals).

10.7.2.63 The impact of displacement on guillemot during the post-breeding season is predicted to be of local spatial extent, long term duration, continuous and of low to medium reversibility. It is predicted that the impact will affect the receptor directly. The impact magnitude is therefore considered to be **low**.

Non-breeding season

10.7.2.64 During the non-breeding season (November - March) the mean peak guillemot population estimate provided in Volume 4 – Technical Appendix 10.1 - Annex 10.1A was 8,217 birds in the Moray West Site plus 2 km buffer.

10.7.2.65 Based on a 50-60% displacement rate and 1% mortality rate, it is predicted that 41 - 49 birds will be lost as a result of displacement (Table 1.19 in Volume 4 – Technical Appendix 10.3: Ornithology Displacement). From a regional BDMPS non-breeding population of 1,617,306 individuals this level of mortality does not surpass 1% of baseline mortality (Table 1.19 in Volume 4 – Technical Appendix 10.3: Ornithology Displacement).

10.7.2.66 The impact of displacement on razorbill during the non-breeding season is predicted to be of local spatial extent, long term duration, continuous and of low to medium reversibility. It is predicted that the impact will affect the receptor directly. The impact magnitude is therefore, considered to be of **negligible**.

Sensitivity of the receptor

10.7.2.67 Guillemot is considered to be of international conservation value and the Moray West Site lies within the mean maximum foraging range of SPA colonies that include this species as a qualifying feature. With a regional and national population trend likely to be relatively stable, but with low productivity rate, the species' recoverability is considered to be medium. Behaviourally, guillemot was considered to be of high vulnerability to displacement by Wade *et al*. (2016). In summary, guillemot is deemed to be of high vulnerability, medium recoverability and international value. The sensitivity of the Valued Ornithological Receptor is therefore, considered to be **medium**.

Significance of the effect

10.7.2.68 Overall, the sensitivity of the receptor is considered to be medium and the impact magnitude is deemed to be negligible – low depending on the season assessed. The effect will, therefore, be of **minor adverse significance** which is not significant in EIA terms.

Kittiwake

Magnitude of impact

10.7.2.69 The displacement rate considered appropriate for kittiwake is 30% across all seasons while the mortality rate considered appropriate is 2%.

10.7.2.70 Searle *et al*. (2014) modelled the consequences for breeding success and survival of a barrier effect and displacement of breeding kittiwakes at SPA colonies on the east coast of Scotland by proposed offshore wind farms that may be constructed within their colony-specific foraging areas. Simulations suggested that a decline in adult kittiwake survival of more than 0.5% might be possible for kittiwakes at Forth Island SPA and Fowlsheugh SPA but not for kittiwakes at St Abbs Head to Fast Castle SPA or Buchan Ness to Collieston Coast SPA. Results for impact on breeding success were similar, suggesting that a relatively small impact was possible.

Breeding season

10.7.2.71 The mean peak kittiwake population estimate selected for the Moray West Site plus 2 km buffer during the breeding season (April to August) was 6,902 birds (Volume 4 – Technical Appendix 10.1 - Annex 10.1A). Based on a displacement rate of 30% and a mortality rate of 2% during the breeding season, 41 kittiwakes are predicted to be lost as a result of displacement (Table 1.20 in Volume 4 – Technical Appendix 10.3: Ornithology Displacement).

10.7.2.72 Assessed against the defined kittiwake regional breeding population (39,360 birds) the predicted mortality from breeding season displacement does not surpass 1% of baseline mortality (Table 1.20 in Volume 4 – Technical Appendix 10.3: Ornithology Displacement). The 1% value is based on the regional population is 57 birds based on a mortality rate of 14.61% (baseline mortality therefore 5,747).

10.7.2.73 A certain proportion of the kittiwake population observed at the Moray West Site in the breeding season will not be breeding adult birds. RIAA Technical Appendix 4.2 (Phenology and Apportioning) provides information on the proportion of first year birds observed from aerial surveys and boat-based surveys, and the likely age structure of the kittiwake population. It is therefore considered that adults will comprise up to 91.5-97.4% of the individuals observed at the Moray West Site. However, this range is considered to be precautionary due to the following:

- Neither value accounts for adults in the population not breeding in a given year – this could account for a further reduction of c5-10% (Coulson 2011, Marine Scotland 2017a,b);
- A smaller proportion of first year birds are likely to be present in natal waters with a much greater proportion of older age classes of immature birds showing affinity with natal waters; and
- Immature birds are not likely to be evenly distributed within the North Sea and will show aggregations near to foraging resources. If the area within which the Moray West Offshore Wind Farm lies is seen to be notable for kittiwake foraging, immatures may be present in large numbers.

10.7.2.74 The information presented in RIAA Technical Appendix 4.2: Phenology and Apportioning, is relevant to the conclusions made in this EIA Report and suggests the proportion of adult kittiwake at the Moray West Site will be somewhat lower than 91.5-97.4%.

10.7.2.75 The impact of displacement on kittiwake during the breeding season is predicted to be of regional spatial extent, long term duration, continuous and of high reversibility. It is predicted that the impact will affect the receptor directly. The impact magnitude is therefore considered to be **low**.

Post-breeding season

10.7.2.76 During the post-breeding season (September to December) the mean peak kittiwake population estimate provided in Volume 4 – Technical Appendix 10.1 - Annex 10.1A was 1,470 birds in the Moray West Site plus 2 km buffer.

10.7.2.77 Based on a 30% displacement rate and 2% mortality rate, it is predicted that nine birds will be lost as a result of displacement. From a regional BDMPS non-breeding population of 829,937 individuals this level of mortality does not surpass 1% of baseline mortality (Table 1.21 in Volume 4 – Technical Appendix 10.3: Ornithology Displacement).

10.7.2.78 The impact of displacement on kittiwake during the post-breeding season is predicted to be of local spatial extent, long term duration, continuous and of low to medium reversibility. It is predicted that the impact will affect the receptor directly. The predicted mortality in the post-breeding season is low, especially when compared to the substantial regional population (and so representing a very small change in baseline mortality). The impact magnitude is therefore, considered to be **negligible**.

Pre-breeding season

10.7.2.79 During the pre-breeding season (January - March) the mean peak kittiwake population estimate provided in Volume 4 – Technical Appendix 10.1 - Annex 10.1A was 1,074 birds in the Moray West Site plus 2 km buffer.

10.7.2.80 Based on a 30% displacement rate and 2% mortality rate, it is predicted that six birds will be lost as a result of displacement (Table 1.22 in Volume 4 – Technical Appendix 10.3: Ornithology Displacement). From a regional BDMPS non-breeding population of 1,617,306 individuals this level of mortality does not surpass 1% of baseline mortality (Table 1.22 in Volume 4 – Technical Appendix 10.3: Ornithology Displacement).

10.7.2.81 The impact of displacement on kittiwake during the pre-breeding season is predicted to be of local spatial extent, long term duration, continuous and of low to medium reversibility. It is predicted that the impact will affect the receptor directly. The predicted mortality in the pre-breeding season is less than 10 birds which is insignificant, especially when compared to the substantial regional population and so representing a very small change in baseline mortality). The impact magnitude is therefore, considered to be **negligible**.

Sensitivity of the receptor

10.7.2.82 Kittiwake is considered to be of international conservation value and the Moray West Site lies within the mean maximum foraging range of SPA colonies that include this species as a qualifying feature. With regional and national population trends indicating declines, with low productivity rate, the species' recoverability is considered to be low. Behaviourally, kittiwake was considered to be of low vulnerability to displacement by Wade *et al*. (2016). In summary, kittiwake is deemed to be of low vulnerability, low recoverability and international value. The sensitivity of the Valued Ornithological Receptor is therefore, considered to be **medium**.

Significance of the effect

10.7.2.83 Overall, the sensitivity of the receptor is considered to be medium and the impact magnitude is deemed to be negligible – low depending on the season assessed. The effect will, therefore, be at most **minor adverse significance** which is not significant in EIA terms.

Summary of operational displacement and barrier effects

10.7.2.84 A summary of displacement impacts on each Valued Ornithological Receptor is presented in Table 10.7.5. All effects predicted are minor adverse or below which are not significant in EIA terms.

Table 10.7.5: Summary of Impacts of Operational Displacement and Barrier Effects on Each Valued Ornithological Receptor			
Valued Ornithological Receptor	**Sensitivity**	**Impact Magnitude**	**Effect Significance**
Fulmar	Medium	Negligible	Negligible
Puffin	Medium	Low	Minor adverse
Razorbill	Medium	Low	Minor adverse
Guillemot	Medium	Low	Minor adverse
Kittiwake	Medium	Low	Minor adverse

Collision Risk

Overview of Approach

10.7.2.85 Although it is evident that there are a number of areas of uncertainty relative to estimating collision risk at offshore wind farms (e.g. natural variability in bird populations, assumptions made in relation to the geometry of turbines and bird shape, etc.), a quantitative impact assessment is considered to be the most appropriate approach to inform assessment. This assessment is informed by the site-specific density data with the output being the estimated annual additional mortality for each Valued Ornithological Receptor deemed sensitive to collision risk.

10.7.2.86 The Basic Band model (Volume 4 - Technical Appendix 10.2: Collision Risk Modelling) assumes a uniform distribution of ‘at-risk’ flights between lowest and highest levels of the rotors, thereby likely overestimating risk for species that predominantly fly at lower heights (e.g. gulls).

10.7.2.87 The Extended Band model uses modelled flight height distributions to allow comparison of the impact of varying the height of wind turbines, and to account for the fact that collision risk is not distributed evenly within the rotor swept area. Full details of the CRM protocol followed for the assessment of Valued Ornithological Receptors at the Moray West Site is presented in Volume 4 - Technical Appendix 10.2: Collision Risk Modelling.

10.7.2.88 The predicted annual mortality estimates for each Valued Ornithological Receptor are presented below, with the model type (Band Options 1, 2 or 3) also detailed. A seasonal breakdown of predicted collisions for each species is presented in Table 10.7.6. This includes outputs informed by the seabird flight speeds given by Skov *et al*. (2018). Annual collision risks by flight speed data sourced from Alerstam *et al.,* (2007) or Pennycuick (1987) are also presented.

10.7.2.89 Collision risk estimates have also been calculated using the upper and lower confidence metrics associated with flight height data and avoidance rate (where possible), which are fully detailed in Volume 4 - Technical Appendix 10.2: Collision Risk Modelling. Within the following species sections consideration has been given to the range of collision risk estimates calculated incorporating the variability of metrics (where available). It is however considered that the collision risk estimates calculated using the mean estimate (density data and avoidance rate) or maximum likelihood value (flight height data) are those on which any assessment should be based.

Table 10.7.6: Seasonal Breakdown of Collision Risk Mortality using the Maximum Design Scenario Turbine Layout and Parameters[a] Representing the Mean Estimate (density data)[b]

Species	Band Model Option	Avoidance Rate (%)	Annual Mortality rate at Appropriate Avoidance Rate[c,d]	Number of Collisions			
				Breeding Season Mortality	Post-Breeding Season Mortality	Non-Breeding Season Mortality	Pre-Breeding Season Mortality
Gannet	2	98.9	12 (13)	10	2		1
	3	98.0	6 (7)	5	1		0
Kittiwake	2	98.9	109 (144)	79	24		7
	3	98	56 (60)	40	12		3
Herring gull	2	99.5	13 (15)	12		1	
	3	98.9	11 (12)	10		1	
Great black-backed gull	2	99.5	9 (11)	4		5	
	3	98.9	10 (11)	4		6	

a Maximum design scenario turbine layout and parameters based on 85 x Model 2 turbines. Parameters on blade pitch, air gap and rotational speed are presented in Volume 4 - Technical Appendix 10.2.

b The grey cells denote where no mortality estimates were calculated due to inappropriate model type for the data available and/or a season (1) in which a species has no population that interacts with Moray West Offshore Wind Farm, or (2) not defined for the species considered.

c All mortality estimates presented are rounded to a whole number (i.e. whole bird). Mortality estimates have been summated across seasons using the actual value, the resultant decimal value only then rounded to a whole number. The latter rounded value may differ to the less accurate summation of whole numbers presented for each season.

d All collision outputs used within this EIA Report are informed by seabird flight speeds taken from Skov *et al.* (2018). Alternative annual collision risk values using either Alerstam *et al.,* (2007) or Pennycuick (1987) are presented parentheses. For a full breakdown of these figures please refer to Volume 4 - Technical Appendix 10.2: Seabird Collision risk modelling (Appendix B).

Gannet

Magnitude of impact

10.7.2.90 An annual mortality rate of 12 collisions/annum is predicted for gannet using Band Option 2 at an avoidance rate of 98.9% and 6 collisions/annum when using Band Option 3 at a 98.0% avoidance rate (Table 10.7.7).

10.7.2.91 The variability associated with the collision risk estimates has also been considered in relation to flight height data and avoidance rate. Volume 4 - Technical Appendix 10.2: Collision Risk Modelling presents the variability associated with each of these aspects of CRM. The greatest degree of variability in the collision risk estimates for gannet is however caused by the flight height data applied.

Table 10.7.7: Gannet Seasonal Collision Risk Results Expressed as Change in Regional Population Baseline Mortality Based on Collision Risk Estimates Calculated Using the Mean Estimate

CRM Option (Avoidance rate)	Season	Collision Mortality	Baseline Mortality of Regional Population (individuals/annum)	Increase in Baseline Mortality (%)
Band Option 2 (98.9%)	Breeding	10	13,620	0.07
	Post-breeding	2	36,960	<0.01
	Pre-breeding	1	20,119	<0.01
	Total	12	-	-
Band Option 3 (98%)	Breeding	5	13,620	0.04
	Post-breeding	1	36,960	<0.01
	Pre-breeding	0	20,119	<0.01
	Total	6	-	-

Breeding season

10.7.2.92 The breeding season for gannet accounts for approximately 82% of annual collisions. When using Option 2 at a 98.9% avoidance rate (10 collisions) this represents a 0.07% change in baseline mortality of the regional breeding population. When using Option 3 at a 98.0% avoidance rate (5 collisions) this represents a 0.04% increase in baseline mortality.

10.7.2.93 The degree of variability associated with avoidance rates used in collision risk modelling for gannet is considered to represent a negligible change in resulting collision risk estimates in terms of the effect on the regional breeding population (see monthly collision risk values presented in Tables 1.12 and 1.13 in Volume 4 - Technical Appendix 10.2: Collision Risk Modelling). When investigating variability in flight height data, a 1% threshold of baseline mortality for the regional breeding population of gannet is not surpassed when an upper confidence limit is applied.

10.7.2.94 The impact is predicted to be of regional spatial extent, long term duration, continuous, low to medium reversibility with a very slight change from baseline conditions (due to a small number of collisions). It is predicted that the impact will affect the receptor directly. The impact magnitude is therefore, considered to be **low**.

Post-breeding season

10.7.2.95 The post-breeding season for gannet accounts for approximately 12% of annual collisions. When using Option 2 at a 98.9% avoidance rate (two collisions) this represents less than a 0.01% change in baseline mortality of the regional post-breeding population. When using Option 3 at a 98.0% avoidance rate (one collision) this also represents less than a 0.01% increase in baseline mortality.

10.7.2.96 The degree of variability associated with the flight height data and avoidance rates used in collision risk modelling for gannet is considered to represent a negligible change in resulting collision risk estimates in terms of the effect on the regional post-breeding population (see monthly collision risk values presented in Tables 1.12 and 1.13 in Volume 4 - Technical Appendix 10.2: Collision Risk Modelling).

10.7.2.97 The impact is predicted to be of regional spatial extent, long term duration, continuous, low to medium reversibility with a very slight change from baseline conditions (due to a small number of collisions). It is predicted that the impact will affect the receptor directly. The impact magnitude is therefore, considered to be **negligible**.

Pre-breeding season

10.7.2.98 The pre-breeding season for gannet accounts for a very small proportion of annual collisions. When using Option 2 at a 98.9% avoidance rate (one collision) this represents a less than a 0.01% change in baseline mortality of the regional post-breeding population.

10.7.2.99 The degree of variability associated with the density data, flight height data and avoidance rates used in collision risk modelling for gannet is considered to represent a negligible change in resulting collision risk estimates in terms of the effect on the regional pre-breeding population (see monthly collision risk values presented in Tables 1.12 and 1.13 in Volume 4 - Technical Appendix 10.2: Collision Risk Modelling).

10.7.2.100 The impact is predicted to be of regional spatial extent, long term duration, continuous, low to medium reversibility with a very slight change from baseline conditions (due to a small number of collisions). It is predicted that the impact will affect the receptor directly. The impact magnitude is therefore, considered to be **negligible**.

Sensitivity of the receptor

10.7.2.101 As a qualifying feature of regional SPAs, gannet is afforded international conservation value. It was ranked high in terms of vulnerability to collisions by Wade *et al*. (2016) although moderate vulnerability by Langston (2010). High vulnerability is considered appropriate within this assessment.

10.7.2.102 Gannet is deemed to be of high vulnerability, high recoverability and international value. The sensitivity of the receptor is therefore, considered to be **high**.

Significance of the effect

10.7.2.103 Overall, the sensitivity of the receptor is considered to be high and the impact magnitude is deemed to be negligible - low. The effect will, therefore, be of **negligible to minor adverse significance**, which is not significant in EIA terms.

Kittiwake

Magnitude of impact

10.7.2.104 An annual mortality of 109 collisions/annum is predicted for kittiwake using Band Option 2 at an avoidance rate of 98.9%, with 56 collisions/annum when using Band Option 3 at a 98.0% avoidance rate (Table 10.7.8).

Table 10.7.8: Kittiwake Seasonal Collision Risk Results Expressed as Change in Regional Population baseline Mortality Based on Collision Risk Estimates Calculated using the Mean Estimate				
CRM Option (Avoidance rate)	**Season**	**Collision Mortality**	**Baseline Mortality of Regional Population (individuals/annum)**	**Increase in Baseline Mortality (%)**
Band Option 2 (98.9%)	Breeding	79	5,747	1.37
	Post-breeding	24	121,171	0.02
	Pre-breeding	7	91,661	0.01
	Total	109	-	-
Band Option 3 (98%)	Breeding	40	5,747	0.70
	Post-breeding	12	121,171	0.01
	Pre-breeding	3	91,661	<0.01
	Total	56	-	-

Breeding season

10.7.2.105 The breeding season for kittiwake accounts for approximately 72% of annual collisions. When using Option 2 at a 98.9% avoidance rate (79 collisions) this represents a 1.37% increase baseline mortality of the regional breeding population. However, should a higher rate of avoidance be applied, for example the 99.2% recommended by Cook *et al.* (2014), collision estimates would equate to 57 collisions at Option 2, which represents a 1.00% change in baseline mortality. When using Option 3 at a 98.0% avoidance rate (40 collisions) this represents a 0.70% increase in baseline mortality.

10.7.2.106 With respect to the collision risk results for the breeding season, the degree of variability associated with the flight height data and avoidance rates used in the modelling for kittiwake is considered to represent a negligible change in terms of the effect on the regional population (see Volume 4 - Technical Appendix 10.2: Collision Risk Modelling).

10.7.2.107 The impact is predicted to be of regional spatial extent, long term duration, continuous, low to medium reversibility with a notable change from baseline conditions. It is predicted that the impact will affect the receptor directly. Considering that only the most precautionary Band model option and avoidance rate leads to estimated collision mortality that equates to over a 1% change in baseline mortality, the impact magnitude is therefore, considered to be **low**.

Post-breeding season

10.7.2.108 The post-breeding season for kittiwake accounts for approximately 22% of annual collisions. When using Option 2 at a 98.9% avoidance rate (24 collisions) this represents a 0.02% change in baseline mortality of the regional post-breeding population. When using Option 3 at a 98.0% avoidance rate (12 collisions) this represents a 0.01% increase in baseline mortality.

10.7.2.109 With respect to the collision risk results for the post-breeding season, the degree of variability associated with the flight height data and avoidance rates used in the modelling for kittiwake is considered to represent a negligible change in terms of the effect on the regional population (see monthly collision risk values presented in Tables 1.15 and 1.16 in Volume 4 - Technical Appendix 10.2: Collision Risk Modelling).

10.7.2.110 The impact is predicted to be of regional spatial extent, long term duration, continuous, low to medium reversibility with a very slight change from baseline conditions (due to a relatively small number of collisions). It is predicted that the impact will affect the receptor directly. The impact magnitude is therefore, considered to be **low**.

Pre-breeding season

10.7.2.111 The pre-breeding season for kittiwake accounts for approximately 6% of annual collisions. When using Option 2 at a 98.9% avoidance rate (seven collisions) this represents a 0.01% change in baseline mortality of the regional post-breeding population.

10.7.2.112 With respect to the collision risk results for the pre-breeding season, the degree of variability associated with the flight height data and avoidance rates used in the modelling for kittiwake is considered to represent a negligible change in terms of the effect on the regional population (see monthly collision risk values presented in Tables 1.159 and 1.16 in Volume 4 - Technical Appendix 10.2: Collision Risk Modelling).

10.7.2.113 The impact is predicted to be of regional spatial extent, long term duration, continuous, low to medium reversibility with a very slight change from baseline conditions (due to a small number of collisions). It is predicted that the impact will affect the receptor directly. The impact magnitude is therefore, considered to be **negligible**.

Sensitivity of the receptor

10.7.2.114 Kittiwake was rated as having relatively high vulnerability to collision impacts by Wade *et al.* (2016), due to the proportion of flights likely to occur at potential risk height and percentage of time in flight, including at night. From previous studies in Flanders that have recorded mortality rates and collision rates, estimated micro-avoidance rates were, however, high for smaller gulls (Everaert, 2006; 2008; 2011; Everaert *et al.,* 2002; Everaert and Kuijken, 2007). Studies have also shown that rates are consistently above 98% for flights at rotor height (GWFL, 2011). The recently published report for Marine Scotland (Cook *et al.,* 2014) considers that a 99.2% avoidance rate is appropriate for the 'Basic' Band Model.

10.7.2.115 Kittiwake is deemed to be of high vulnerability, low recoverability and international value. The sensitivity of the receptor is therefore, considered to be **high**.

Significance of the effect

10.7.2.116 Overall, the sensitivity of the receptor is considered to be high and the impact magnitude is deemed to be low (breeding and post-breeding seasons). Consequently, the effect could be either minor or moderate adverse significance. Where an assessment concludes a significance that falls between two categories the EIA methodology states that expert judgement should be used in order to determine the effect significance (Section 10.5.5). The assessment presented in the above sections is based on conservative assumptions, including the use of a breeding regional population that is based only on breeding adult birds (excluding immature and non-breeding adult birds) whereas the predicted collision rate is based on the observed birds at Moray West which will include immature and non-breeding adults.

10.7.2.117 On this basis it is judged that the effect is of **minor adverse significance**, which is not significant in EIA terms.

Herring gull

Magnitude of impact

10.7.2.118 An annual mortality of 13 collisions/annum is predicted for herring gull using Band Option 2 at an avoidance rate of 99.5%, with 11 collisions/annum when using Band Option 3 at a 99.0% avoidance rate (Table 10.7.9).

Table 10.7.9: Herring Gull Seasonal Collision Risk Results Expressed as Change in Regional Population Baseline Mortality Based on Collision Risk Estimates Calculated using the Mean Estimate				
CRM Option (Avoidance rate)	**Season**	**Collision Mortality**	**Baseline Mortality of Regional Population (individuals/annum)**	**Increase in Baseline mortality (%)**
Band Option 2 (99.5%)	Breeding	12	1,937	0.61
	Non-breeding	1	77,441	<0.01
	Total	13	-	-
Band Option 3 (99.0%)	Breeding	10	1,937	0.53
	Non-breeding	1	77,441	<0.01
	Total	11	-	-

Breeding season

10.7.2.119 The breeding season for herring gull accounts for over 90% of annual collisions. When using Option 2 at a 99.5% avoidance rate (12 collisions) this represents a 0.61% change in baseline mortality of the regional breeding population. When using Option 3 at a 99.0% avoidance rate (10 collisions) this represents a 0.53% increase in baseline mortality.

10.7.2.120 With respect to the collision risk results for the pre-breeding season, the degree of variability associated with the flight height data and avoidance rates used in the modelling for herring gull is considered to represent a negligible change in terms of the effect on the regional population.

10.7.2.121 The impact is predicted to be of regional spatial extent, long term duration, continuous, low to medium reversibility with a potential change from baseline conditions. It is predicted that the impact will affect the receptor directly. The impact magnitude is therefore, considered to be **low.**

Non-breeding season

10.7.2.122 The non-breeding season for herring gull accounts for a less than 10% of annual collisions. When using Option 2 at a 99.5% avoidance rate (one collision) this represents less than a 0.01% change in baseline mortality of the regional non-breeding population.

10.7.2.123 With respect to the collision risk results for the non-breeding season, the degree of variability associated with the flight height data and avoidance rates used in the modelling for herring gull is considered to represent a negligible change in terms of the effect on the regional population (see monthly collision risk values presented in Tables 1.18 and 1.19 in Volume 4 - Technical Appendix 10.2: Collision Risk Modelling).

10.7.2.124 The impact is predicted to be of regional spatial extent, long term duration, continuous, low to medium reversibility with a very slight change from baseline conditions (due to a small number of collisions). It is predicted that the impact will affect the receptor directly. The impact magnitude is therefore, considered to be **negligible**.

<u>*Sensitivity of the receptor*</u>

10.7.2.125 Herring gull was rated as being very highly vulnerable to collision impacts by Wade *et al.* (2016), due to the proportion of flights likely to occur at potential risk height and percentage of time in flight, including at night.

10.7.2.126 Herring gull is deemed to be of very high vulnerability, medium recoverability and international value. The sensitivity of the receptor is therefore, considered to be **high**.

Significance of the effect

10.7.2.127 Overall, the sensitivity of the receptor is considered to be high and the impact magnitude is deemed to be low (breeding season). Consequently, the effect could be either minor or moderate adverse significance. Where an assessment concludes a significance that falls between two categories the EIA methodology states that expert judgement should be used in order to determine the significance of the impact. The assessment presented in the above sections is based on conservative assumptions, including the use of a breeding regional population that is based only on breeding adult birds (excluding immature and non-breeding adult birds) whereas the predicted collision rate is based on the observed birds at Moray West which will include immature and non-breeding adults.

10.7.2.128 On this basis it is judged that the effect is of **minor adverse significance**, which is not significant in EIA terms.

Great Black-backed Gull

Magnitude of impact

10.7.2.129 An annual mortality of nine collisions/annum is predicted for great black-backed gull using Band Option 2 at an avoidance rate of 99.5%, with ten collisions/annum when using Band Option 3 at a 98.9% avoidance rate (Table 10.7.10).

Table 10.7.10: Great Black-Backed Gull Seasonal Collision Risk Results Expressed as Change in Regional Population Baseline Mortality Based on Collision Risk Estimates Calculated using the Mean Estimate

CRM Option (Avoidance rate)	Season	Collision Mortality	Baseline Mortality of Regional Population (individuals/annum)	Increase in Baseline Mortality (%)
Band Option 2 (99.5%)	Breeding	4	19	21.46
	Non-breeding	5	6,398	0.08
	Total	9	-	-
Band Option 3 (98.9%)	Breeding	4	19	22.38
	Non-breeding	6	6,398	0.09
	Total	10	-	-

Breeding season

10.7.2.130 The breeding season for great black-backed gull accounts for approximately 43% of annual collisions. When using Option 2 at a 99.5% avoidance rate (four collisions) this represents a 21.46% change in baseline mortality of the regional breeding population. When using Option 3 at a 98.9% avoidance rate (four collisions) this represents a 22.38% increase in baseline mortality. This high level of change is due to the low defined regional breeding population of this species (266 birds). The assessment presented is based on conservative assumptions, including the use of a breeding regional population that is based only on breeding adult birds (excluding immature and non-breeding adult birds) whereas the predicted collision rate is based on the observed birds at the Moray West Site which will include immature and non-breeding adults. Indeed, approximately 70% of breeding season great black-gull collisions occur in the month of August when it is very likely that a significant proportion of individuals present in the region would be either immature or passage birds.

10.7.2.131 The impact is predicted to be of regional spatial extent, long term duration, continuous, low to medium reversibility with a potential change from baseline conditions. It is predicted that the impact will affect the receptor directly. Considering these factors and that a very low level of collision is predicted (4 individuals), the impact magnitude is therefore, considered to be **low.**

Non-breeding season

10.7.2.132 The non-breeding season for great black-backed gull accounts for approximately 57% of annual collisions. When using Option 2 at a 99.5% avoidance rate (five collisions) this represents a 0.08% increase in baseline mortality of the regional non-breeding population.

10.7.2.133 With respect to the collision risk results for the non-breeding season, the degree of variability associated with the flight height data and avoidance rates used in the modelling for great black-backed gull is considered to represent a negligible change in terms of the effect on the regional population (see monthly collision risk values presented in Tables 1.21 and 1.22 in Volume 4 - Technical Appendix 10.2: Collision Risk Modelling).

10.7.2.134 The impact is predicted to be of regional spatial extent, long term duration, continuous, low to medium reversibility with a very slight change from baseline conditions (due to a small number of collisions). It is predicted that the impact will affect the receptor directly. The impact magnitude is therefore, considered to be **negligible.**

Sensitivity of the receptor

10.7.2.135 Great black-backed gull was rated the seabird species most vulnerable to collision impacts by Wade *et al.* (2016), mainly due to the high proportion of flights at potential collision heights, and the percentage of time in flight, including at night.

10.7.2.136 In summary, great black-backed gull is deemed to be of very high vulnerability, medium recoverability and national value. The sensitivity of the receptor is therefore, considered to be **medium.**

Significance of the effect

10.7.2.137 Overall, the sensitivity of the receptor is considered to be medium sensitivity and the impact magnitude is deemed to be negligible – low. The effect will therefore be of **minor adverse significance**, which is not significant in EIA terms.

Summary of Operational Phase Collision Risk

10.7.2.138 A summary of operation phase collision impacts on each Valued Ornithological Receptor is presented in Table 10.7.11 The effects are all predicted to be minor adverse which is not significant in EIA terms.

Table 10.7.11: Summary of Operational Phase Collision Risk

Valued Ornithological Receptor	Sensitivity	Impact Magnitude	Effect Significance
Gannet	High	Low	Minor adverse
Kittiwake	High	Low	Minor adverse
Herring gull	High	Low	Minor adverse
Great black-backed gull	Medium	Low	Minor adverse

Attraction to Lit Structures and Associated Disorientation

10.7.2.139 Some species of birds are often attracted to structures such as oil rigs during the hours of darkness, as they may provide opportunities for extended feeding periods, shelter and resting places or navigation aids for migrating birds. Any benefits of lighting, however, may be outweighed by increased risks of collision with gas flares, or in the case of turbines, rotating blades. Turbines are not likely to be extensively lit, compared to oil rigs for example, and so any benefits relating to increased provision of foraging opportunities during hours of darkness are likely to be negligible.

10.7.2.140 The complexity of this issue arises from the fact that disturbance effects of lighting may derive from changes in orientation, disorientation and attraction or repulsion from the altered light environment, which in turn may affect foraging, migration and communication (Longcore and Rich, 2004). Birds may collide with each other or a structure, or become exhausted as a result. Conversely, for unlit turbines at night it is possible that the risk of collision may be greater because moving rotors may not be detectable (Trapp, 1998).

10.7.2.141 Migrating birds are likely to be particularly susceptible to any adverse effects of lighting. Around two thirds of all bird species migrate during darkness, when collision risk is expected to be higher than during daylight (Hüppop *et al*., 2006).

10.7.2.142 The evidence for this impact is however mixed. ICES (2011) state that birds are somewhat less inclined to avoid turbines at night, but in contrast extended periods of infra-red monitoring at night using a Thermal Animal Detection System (TADS) at Nysted provided unexpected evidence that no movements of birds were detected below 120 m during the hours of darkness, even during periods of heavy seabird migration (Desholm, 2005). Welcker *et al*. (2017) found nocturnal migrants do not have a higher risk of collision with wind energy facilities than do diurnally active species, but rather appear to circumvent collision more effectively.

10.7.2.143 In terms of attraction to lit structures, the worst-case scenario for the Moray West Offshore Wind Farm would involve 85 turbines and the maximum number of ancillary structures. For maximum visibility, each structure would be fitted with lighting requirements for aviation and shipping.

All Ornithological Receptors

Magnitude of impact

10.7.2.144 The species that are likely to be present in largest numbers (kittiwake, gannet and guillemot) are unlikely to be active at night, either returning to colonies or roosting on the sea surface. In addition, auks and gannet have been shown to avoid wind farms to some degree, and it is therefore possible that this will continue at night, although auks have been found in close proximity to lit oil rigs. Fulmars are unlikely to be found in large aggregations and so any impacts would occur on a relatively small proportion of birds within Moray West Offshore Wind Farm at any time. Since gulls are visual foragers that may follow lit trawlers and other vessels, it is unlikely that birds, at least those local to the area, would be disoriented by lit turbines to a significant degree.

10.7.2.145 It is therefore most likely that a significant effect would only occur if large numbers of a migrant species pass through the Moray West Site in a single event, leading to mass disorientation or collisions. Certain migratory species may theoretically all move at night and therefore be at risk, although all of these species are given the lowest ranking for nocturnal activity rate by Wade *et al*. (2016). Precise numbers of birds moving through the site are unknown, but in relation to national or international populations, proportions travelling through the Moray West Site during hours of darkness are likely to be low (see Wade *et al.* (2016) for determination of nocturnal activity rates), particularly as most flights would be below potential collision height. Moreover, there is no evidence from any existing offshore wind farms to suggest mass collision events as a result of the navigational and aviation lighting that is typical for offshore wind farms. As previously referenced, Welcker *et al*. (2017) found nocturnal migrants do not have a higher risk of collision with wind energy facilities than do diurnally active species, but rather appear to circumvent collision more effectively.

10.7.2.146 As such, the impact is therefore predicted to be of local spatial extent, short term duration, intermittent and of low to medium reversibility within the context of any international, national or regional population. It is predicted that the impact will affect the receptor directly. The impact magnitude is therefore considered to be, at most, **low** for all receptors.

Sensitivity of the receptors

10.7.2.147 The attraction to lit structures and therefore any resulting impacts are likely to depend much on each species' presence within the Moray West Site during the hours of darkness, as well as the proportion of flights likely to occur at potential collision height. Based on nocturnal activity rates advocated in Garthe and Hüppop (2004) and King *et al.* (2009), gulls are likely to have moderate levels of nocturnal activity. Garthe and Hüppop (1996) reported that in the southern North Sea, gulls (including kittiwake) frequently forage at fishing vessels during the night. However, Kotzerka *et al*. (2010) reported that kittiwake foraging trips mainly occurred during daylight and birds were mostly inactive during the night, and so risks may be lower for this species despite the proportion of flights at risk heights being higher than for some other species.

10.7.2.148 Gannets have been shown to rarely fly at night, although may do so slightly more during the migratory periods, and their activity rate was rated as low (Wade *et al.,* 2016). A moderate number of flights are likely to be at risk height (Johnston *et al.,* 2014). Fulmar was given a relatively high nocturnal activity rate (4 out of 5) (Wade *et al*., 2016), which is likely to be due to the long duration of foraging trips undertaken by the species. However, very few flights are likely to be at risk height (Wade *et al*., 2016).

10.7.2.149 Auks were attributed a very low nocturnal activity rate score, as were skuas, which is likely to be due to foraging requirements related to visibility rather than smell or obtaining discards, and their relatively short foraging durations. Few flights from these species are likely to be at risk height (Johnston *et al*., 2014, Wade *et al.,* 2016).

10.7.2.150 Based on previously reported conservation status and recoverability levels for each species, in combination with vulnerability, the sensitivity of all receptors is considered to be **low**, with species generally either having low nocturnal activity rates at potential collision height or high conservation status (e.g. guillemot, skuas, kittiwake).

Significance of the effect

10.7.2.151 An impact of low magnitude on low sensitivity receptors during the migratory periods will produce an effect of **negligible or minor adverse significance**, which is considered to be not significant in EIA terms for all receptors. This evaluation is supported by literature evidence detailed above that those species that are most active at night are unlikely to be affected by lit turbines and other structures, whereas those species that may have been sensitive on account of their conservation status or recoverability are unlikely to be present on site at night.

Summary of the Effect of Attraction to Lit Structures During O&M

10.7.2.152 A summary of the effect of attraction to lit structures is provided in Table 10.7.12. The significance of all effects for all Valued Ornithological Receptors is negligible to minor adverse with no impacts considered to be significant in EIA terms.

Table 10.7.12: Summary of the Impact of Lit Structures in the Operational Phase			
Valued Ornithological Receptor	**Sensitivity**	**Impact Magnitude**	**Effect Significance**
Fulmar	Low	Low	Negligible or minor adverse
Gannet	Low	Low	Negligible or minor adverse
Puffin	Low	Low	Negligible or minor adverse
Razorbill	Low	Low	Negligible or minor adverse
Guillemot	Low	Low	Negligible or minor adverse
Kittiwake	Low	Low	Negligible or minor adverse
Herring gull	Low	Low	Negligible or minor adverse
Great black-backed gull	Low	Low	Negligible or minor adverse
Arctic skua	Low	Low	Negligible or minor adverse

Indirect Effects (Prey Species and Habitat Loss)

10.7.2.153 The physical presence of foundations and associated scour protection, as well as potential changes in commercial fishing activities may impact upon the availability of prey species to seabirds.

10.7.2.154 The indirect impacts on seabird prey resource (in particular cod, sprat, herring, mackerel and sandeel) and habitats are detailed in Chapter 8: Fish and Shellfish Ecology and Chapter 7: Benthic and Intertidal Ecology respectively. The potential operation and maintenance phase impacts assessed within these chapters include:

- Long term habitat loss due to presence of turbine foundations and scour/cable protection;
- Underwater noise as a result of operational turbines and maintenance vessel traffic;
- Accidental release of pollutants (e.g. from accidental spillage/leakage);
- Creation of new substrate and habitat (foundations, substructure, scour protection and cable protection);
- Seabed sediment heating from subsea cables; and
- Electromagnetic fields (EMF) emitted by inter-array, OSP interconnectors and offshore export cables.

10.7.2.155 Details of the fish and shellfish ecology assessment are summarised in Table 10.7.13. Evidence, modelling and justifications for these assessments are provided in Chapter 8: Fish and Shellfish Ecology and so justifications for this assessment will not be repeated in this chapter.

10.7.2.156 Potential reduction in fishing activity in the vicinity of turbines could have a positive benefit on prey stocks as could the aggregation of fish and shellfish around the introduced hard substrates, although this is likely to be localised.

10.7.2.157 The Valued Ornithological Receptors fulmar, gannet, puffin, razorbill, guillemot, kittiwake, herring gull and great black-backed gull, are included in the assessment of indirect effects, such as changes in habitat or abundance and distribution of prey in the operation and maintenance phase.

Table 10.7.13: Significance of Effects of Operation and Maintenance Impacts on Benthic and Intertidal Ecology and Fish and Shellfish Ecology (EIA Report Chapters 7 and 8 Respectively).

Potential Impact	Species	Significance of Effect
Long term habitat loss	Sandeel	Minor adverse
	All other fish and shellfish species	Negligible - Minor adverse
Underwater noise	All fish and shellfish species	Negligible - Minor adverse
Accidental release of pollution	All fish and shellfish species	Negligible - Minor adverse
Creation of new substrate and habitat	All fish and shellfish species	Negligible - Minor adverse
Seabed sediment heating from subsea cable	All fish and shellfish species	Negligible - Minor adverse
Electromagnetic fields (EMF)	All fish and shellfish species	Negligible - Minor adverse

All Ornithological Receptors

Magnitude of impact

10.7.2.158 Any changes to the distribution of prey species and habitat during the operation and maintenance phase of the Development for seabirds is likely to be negligible when considering the size of the Moray West Site and Offshore Export Cable Corridor in relation to each species' total foraging range. The assessments in the benthic ecology and fish and shellfish chapters predicted either negligible or minor adverse effects for these impacts (Chapter 7: Benthic and Intertidal Ecology and Chapter 8: Fish and Shellfish Ecology). It is also possible that the attraction of birds to the base of structures to forage may result in a small increase in flight activity around the rotors, and therefore birds may be at a higher risk of collision, which may cancel out any benefits. Though this will depend on the height of birds foraging around turbines. The impact for all Valued Ornithological Receptors therefore is predicted to be of local spatial extent, long term duration, continuous and of high reversibility. It is predicted that the impact will affect the receptor indirectly. The impact magnitude is therefore, considered to be **negligible** on all receptors.

Sensitivity of the receptor

10.7.2.159 As described previously, Wade *et al*. (2016) ranked each seabird species based on habitat flexibility. The vulnerability of the Valued Ornithological Receptors is generally ranked as being very low (Wade *et al.,* 2016).

10.7.2.160 Each Valued Ornithological Receptor is deemed to be of very low vulnerability, low to high recoverability and regional to international value. The sensitivities of the receptors are therefore, considered to be **low**.

Significance of the effect

10.7.2.161 An indirect impact of negligible magnitude on a low sensitivity receptor is predicted to produce a **negligible or minor adverse** effect. The effects on all of these receptors are not significant in EIA terms.

Summary of Indirect Effects (Prey and Habitat Loss) in the Operation and Maintenance Phase

10.7.2.162 A summary of operation and maintenance indirect effects on each Valued Ornithological Receptor is presented in Table 10.7.14. Effect significance ranges from negligible to minor adverse with no effects considered to be significant in EIA terms.

Table 10.7.14: Summary of the Indirect Effects due to Changes in Habitat or Abundance and Distribution of Prey

Valued Ornithological Receptor	Sensitivity	Impact Magnitude	Effect Significance
Fulmar	Low	Negligible	Negligible or minor adverse
Gannet	Low	Negligible	Negligible or minor adverse
Puffin	Low	Negligible	Negligible or minor adverse
Razorbill	Low	Negligible	Negligible or minor adverse
Guillemot	Low	Negligible	Negligible or minor adverse
Kittiwake	Low	Negligible	Negligible or minor adverse
Herring gull	Low	Negligible	Negligible or minor adverse
Great black-backed gull	Low	Negligible	Negligible or minor adverse

Pollution Effects

10.7.2.163 Each WTG will contain components which require lubricants, coolant, diesel fuel and hydraulic oils in order to operate (Table 10.6.1). In addition, the OSPs will also require coolant, diesel fuel and hydraulic oils.

10.7.2.164 During the operation and maintenance phase, each turbine will undergo a routine service every year. As part of this process, hydraulic fluids, gearbox oils and lubricants will be replaced and solid consumables such as filters will be disposed of. These routine maintenance activities will be launched from a Service Operations Vessel (SOV) that will be permanently positioned a at the Moray West Site. There will also be up to three crew transfer vessels (CTVs). The SOV and CTVs will also contain diesel fuels and hydraulic oils.

10.7.2.165 There may also be a requirement for major maintenance activities e.g. replacement of turbine parts, repairs to turbine and OSP foundations and substructures, or repairs to/replacement of damaged to cables. These major maintenance activities are likely to require the use of jack-up vessels or heavy lift construction vessels and any additional support vessels (e.g. tugs and transport vessels). These vessels and associated machinery will also contain a fuel supply and lubricants which, in the event of an incident such as a collision, may be released into the surrounding sea. Details on the potential worst-case spills are presented in Table 10.6.1.

10.7.2.166 Although the likelihood of a pollution incident occurring is very low, seabirds utilising the environment in the vicinity of a pollution incident may be vulnerable to either direct mortality from oil coverage preventing flight for example, or indirectly via a reduction in ability to forage.

10.7.2.167 This assessment considers the impact of pollution which may affect species' survival rates or foraging activity at the Moray West Site and therefore is of minimal importance to species actively migrating when only briefly transiting. In the absence of a pathway for effect for migrant seabirds, the Valued Ornithological Receptors considered for this potential impact are those species using the Moray West Site plus a 4 km buffer and the Offshore Export Cable Corridor i.e. all Valued Ornithological Receptors.

Magnitude of impact

10.7.2.168 The magnitude of the impact is dependent on the nature of the pollution incident but the Strategic Environmental Assessment (SEA) carried out by DECC (2011) recognised that, "renewable energy developments have a generally limited potential for accidental loss of containment of hydrocarbons and chemicals, due to the relatively small inventories contained on the installations (principally hydraulic, gearbox and other lubricating oils, depending on the type of installation)".

10.7.2.169 However, it is expected that there will be daily boat movements within the Moray West Site during operation and maintenance, with up to three CTVs and an SOV on site. In general, maintenance vessels are likely to have lower volumes of potential pollution sources than their construction equivalents, except in the event of turbine replacement. With a lower intensity of activity than during construction, impacts are therefore likely to be of a lower likelihood and magnitude. In addition, EMP / MPCP commitments are part of the mitigation measures adopted as part of design. This will reduce likelihood of event and also reduce the consequence of any spills.

10.7.2.170 Given the likely limited size of potential pollution incidents (based on the volumes of any chemicals carried by one vessel) and the designed-in measures, the impact is therefore predicted to be of local spatial extent, short term duration, intermittent and high reversibility within the context of the regional populations. It is predicted that the impact will affect the receptor both directly and indirectly. The impact magnitude is therefore, considered to be **negligible** for all Valued Ornithological Receptors.

Sensitivity of the receptor

10.7.2.171 The overall level of sensitivity of receptors is considered to be the same as those relating to pollution effects assessed for the construction phase of the Development.

Significance of the effect

10.7.2.172 Based on an impact magnitude for all receptors being negligible irrespective of the sensitivity of the receptor a **negligible effect** on the regional population is predicted which is not significant in EIA terms.

Summary of Accidental Pollution Effects in the Operation and Maintenance Phase

10.7.2.173 A summary of operation and maintenance pollution effects on each Valued Ornithological Receptor is presented in Table 10.7.15. Effect significance for all Valued Ornithological Receptors is negligible with no effects considered to be significant in EIA terms.

Table 10.7.15: Summary of Impacts of Operational Pollution on each Valued Ornithological Receptor

Valued Ornithological Receptor	Sensitivity	Impact Magnitude	Effect Significance
Scaup	Medium	Negligible	Negligible
Eider	Low	Negligible	Negligible
Long-tailed duck	Low	Negligible	Negligible
Common scoter	Medium	Negligible	Negligible
Velvet scoter	Medium	Negligible	Negligible
Goldeneye	Low	Negligible	Negligible
Red-breasted merganser	Medium	Negligible	Negligible
Red-throated diver	High	Negligible	Negligible
Great northern diver	High	Negligible	Negligible
Fulmar	Low	Negligible	Negligible
Gannet	Medium	Negligible	Negligible
Shag	High	Negligible	Negligible
Slavonian grebe	Moderate	Negligible	Negligible
Guillemot	Medium to high	Negligible	Negligible
Razorbill	Medium to high	Negligible	Negligible
Puffin	Medium to high	Negligible	Negligible
Kittiwake	Low	Negligible	Negligible
Herring gull	Low	Negligible	Negligible
Great black-backed gull	Low	Negligible	Negligible

<u>Displacement and Collision Combined</u>

10.7.2.174 As highlighted in the Scoping Opinions for all Forth and Tay Projects (Marine Scotland, 2017), for kittiwake, collision risk and displacement are currently considered to be mutually exclusive impacts, and therefore combining mortality estimates for kittiwake displacement and collision should be considered extremely precautionary.

10.7.2.175 In the breeding season, kittiwake mortality from collision is estimated at 79 birds based on a 98.9% avoidance rate using Option 2. From displacement, mortality is estimated at 41 birds based on 30% displacement and 2% mortality. This results in a combined total of 110 birds, which if taken as appropriate to assess would account for a 1.9% change in baseline mortality of the regional population (39,360 birds). Considering that, firstly, the two impact mechanisms are mutually exclusive and secondly the precaution built in the assessment of both impacts in isolation (avoidance rate and option choice for collision, the potential for exaggeration of the species sensitivity with regards displacement) it is considered unlikely that the magnitude of any combined impacts is any greater than that for collision alone. For these reasons, it is predicted that the significance of any combined collision and displacement effects in the breeding season would not be any greater than **minor**.

10.7.2.176 In the post-breeding season, kittiwake mortality from collision is estimated at 24 birds based on a 98.9% avoidance rate using Option 2. From displacement, mortality is estimated at 9 birds based on 30% displacement and 2% mortality. This results in a combined total of 33 birds, which if taken as appropriate to assess would account for a 0.02% change in baseline mortality of the regional population (829,937 birds). Even without considering the limitations of combining collision and displacement and inherent precaution of the assessments, it is predicted that that significance of the effect would be **negligible**.

10.7.2.177 In the pre-breeding season, kittiwake mortality from collision is estimated at 7 birds based on a 98.9% avoidance rate using Option 2. From displacement, mortality is estimated at 6 birds based on 30% displacement and 2% mortality. This results in a combined total of 13 birds, which if taken as appropriate to assess would account for a 0.01% change in baseline mortality of the regional population (829,937 birds). Even without considering the limitations of combining collision and displacement and inherent precaution of the assessments, it is predicted that that significance of the effect would be **negligible**.

10.7.3 Potential Decommissioning Effects

10.7.3.1 The impacts of the decommissioning the Moray West Offshore Wind Farm have been assessed on birds present in the offshore environment. These impacts are listed in Table 10.6.1 along with the maximum design scenario against which each decommissioning phase impact has been assessed. The turbines and OSPs would be dismantled and removed from the site in a manner similar to that of their installation. Foundations will be removed to an agreed level below the seabed with buried parts remaining in situ. Cables will also be left in-situ. Any section of cable protruding above the surface of the seabed will be removed by cutting the cable at an agreed depth below the seabed.

10.7.3.2 The approach to decommissioning is described in the draft Decommissioning Programme which has be prepared in line with the requirements of the Energy Act 2004.

10.7.3.3 A description of the potential effect on offshore ornithological receptors caused by each identified impact is given below.

<u>Disturbance and Displacement</u>

10.7.3.4 A degree of temporary disturbance and displacement is likely to occur throughout the decommissioning phase. The magnitude and significance of any effects is likely to be of a similar or identical scale to those presented for the construction phase above. The magnitude and significance for each relevant receptor is presented in Table 10.7.16 below. Overall, the long term effect would be to return the Moray West Site to its former state with no long term significant effects on regional or national populations of concern.

Table 10.7.16: Summary of Impacts of Decommissioning Disturbance / Displacement due to Construction Activity on each Valued Ornithological Receptor

Valued Ornithological Receptor	Sensitivity	Impact Magnitude	Effect Significance
Scaup	High	No change	Negligible
Eider	Medium	No change	Negligible
Long-tailed duck	High	No change	Negligible
Common scoter	High	No change	Negligible

Table 10.7.16: Summary of Impacts of Decommissioning Disturbance / Displacement due to Construction Activity on each Valued Ornithological Receptor			
Valued Ornithological Receptor	**Sensitivity**	**Impact Magnitude**	**Effect Significance**
Velvet scoter	High	No change	Negligible
Goldeneye	High	No change	Negligible
Red-breasted merganser	Medium	No change	Negligible
Red-throated diver	High	Low	Minor adverse
Great northern diver	High	Low	Minor adverse
Shag	High	Low	Minor adverse
Slavonian grebe	Medium	Negligible	Negligible
Guillemot	Medium	Low	Minor adverse
Razorbill	Medium	Low	Minor adverse
Puffin	Medium	Low	Minor adverse

Indirect Effects (Prey and Habitat Loss)

10.7.3.5 Indirect impacts will likely be similar or identical to those described for the construction phase e.g. habitat loss, physical disturbance, smothering, underwater noise and accidental pollution affecting prey species. Given all potential effects on key prey species were assessed as, at most, minor and not significant (see Chapter 7: Benthic and Intertidal Ecology and Chapter 8: Fish and Shellfish Ecology) and the low magnitude of indirect effects likely to occur on foraging seabirds, the significance of effects on foraging birds would be minor adverse at worst.

Table 10.7.17: Summary of Indirect Effects in the Decommissioning Phase on each Valued Ornithological Receptor			
Valued Ornithological Receptor	**Sensitivity**	**Impact Magnitude**	**Effect Significance**
Scaup	High	No change	Negligible
Eider	High	No change	Negligible
Long-tailed duck	High	No change	Negligible
Common scoter	High	No change	Negligible
Velvet scoter	High	No change	Negligible
Goldeneye	High	No change	Negligible
Red-breasted merganser	High	No change	Negligible
Red-throated diver	High	Low	Minor adverse
Great northern diver	High	Low	Minor adverse
Fulmar	Low - Medium	Negligible	Negligible
Gannet	Low - Medium	Negligible	Negligible
Shag	Low - Medium	Negligible	Negligible

Table 10.7.17: Summary of Indirect Effects in the Decommissioning Phase on each Valued Ornithological Receptor			
Valued Ornithological Receptor	**Sensitivity**	**Impact Magnitude**	**Effect Significance**
Slavonian grebe	Low - Medium	Negligible	Negligible
Guillemot	Medium	Low	Minor adverse
Razorbill	Medium	Low	Minor adverse
Puffin	Medium	Low	Minor adverse
Kittiwake	Low - Medium	Low	Minor adverse
Herring gull	Low - Medium	Negligible	Negligible
Great black-backed gull	Low - Medium	Negligible	Negligible

<u>Pollution Effects</u>

10.7.3.6 The impacts of pollution during the decommissioning activities are expected to be the same or similar to those identified during construction. A summary of the significance of the effect of potential pollution impact on each Valued Ornithological Receptor is presented in Table 10.7.18.

Table 10.7.18: Summary of Impacts of Decommissioning Pollution on each Valued Ornithological Receptor			
Valued Ornithological Receptor	**Sensitivity**	**Impact Magnitude**	**Effect Significance**
Scaup	Medium	No change	Negligible
Eider	Low	No change	Negligible
Long-tailed duck	Low	No change	Negligible
Common scoter	Medium	No change	Negligible
Velvet scoter	Medium	No change	Negligible
Goldeneye	Low	No change	Negligible
Red-breasted merganser	Medium	No change	Negligible
Red-throated diver	High	No change	Negligible
Great northern diver	High	No change	Negligible
Fulmar	Low	No change	Negligible
Gannet	Medium	No change	Negligible
Shag	High	No change	Negligible
Slavonian grebe	Medium	No change	Negligible
Guillemot	Medium to high	No change	Negligible
Razorbill	Medium to high	No change	Negligible
Puffin	Medium to high	No change	Negligible
Kittiwake	Low	No change	Negligible

Table 10.7.18: Summary of Impacts of Decommissioning Pollution on each Valued Ornithological Receptor			
Valued Ornithological Receptor	**Sensitivity**	**Impact Magnitude**	**Effect Significance**
Herring gull	Low	No change	Negligible
Great black-backed gull	Low	No change	Negligible

10.7.4 Summary of Development Specific Effects

10.7.4.1 A summary of all potential effects of the Development on offshore ornithological receptors is provided in Table 10.7.19 below. This includes all impacts seaward of MHWS for construction, operation and maintenance, and decommissioning phases of the Development. Detailed technical information underpinning the impact assessments presented within this chapter is contained within Volume 4 - Technical Appendix 10.1: Ornithology Technical Report, Technical Appendix 10.3: Ornithology Displacement, Appendix 10.2: Collision Risk Modelling and Appendix 10.1 - Annex 10.1A: Decision Support System Analysis.

Table 10.7.19: Summary Development Specific Effects						
Potential Impact	**Receptor**	**Impact Magnitude**	**Sensitivity**	**Effect Significance**	**Mitigation**	**Residual Significance**
Construction						
Disturbance and displacement	Scaup	No change	High	Negligible	None	N/A
	Eider	No change	Medium	Negligible	None	N/A
	Long-tailed duck	No change	High	Negligible	None	N/A
	Common scoter	No change	High	Negligible	None	N/A
	Velvet scoter	No change	High	Negligible	None	N/A
	Goldeneye	No change	High	Negligible	None	N/A
	Red-breasted merganser	No change	Medium	Negligible	None	N/A
	Red-throated diver	Low	High	Minor adverse	None	N/A
	Great northern diver	Low	High	Minor adverse	None	N/A
	Shag	Low	High	Minor adverse	None	N/A
	Slavonian grebe	Negligible	Medium	Negligible	None	N/A
	Guillemot	Low	Medium	Minor adverse	None	N/A
	Razorbill	Low	Medium	Minor adverse	None	N/A
	Puffin	Low	Medium	Minor adverse	None	N/A
Indirect effects (prey and habitat loss)	Scaup	No change	High	Negligible	None	N/A
	Eider	No change	High	Negligible	None	N/A
	Long-tailed duck	No change	High	Negligible	None	N/A
	Common scoter	No change	High	Negligible	None	N/A

Table 10.7.19: Summary Development Specific Effects						
Potential Impact	**Receptor**	**Impact Magnitude**	**Sensitivity**	**Effect Significance**	**Mitigation**	**Residual Significance**
	Velvet scoter	No change	High	Negligible	None	N/A
	Goldeneye	No change	High	Negligible	None	N/A
	Red-breasted merganser	No change	High	Negligible	None	N/A
	Red-throated diver	Low	High	Minor adverse	None	N/A
	Great northern diver	Low	High	Minor adverse	None	N/A
	Fulmar	Negligible	Low – medium	Negligible	None	N/A
	Gannet	Negligible	Low - medium	Negligible	None	N/A
	Shag	Negligible	Low - medium	Negligible	None	N/A
	Slavonian grebe	Negligible	Low - medium	Negligible	None	N/A
	Guillemot	Low	Medium	Minor adverse	None	N/A
	Razorbill	Low	Medium	Minor adverse	None	N/A
	Puffin	Low	Medium	Minor adverse	None	N/A
	Kittiwake	Low	Low - medium	Negligible	None	N/A
	Herring gull	Negligible	Low - medium	Negligible	None	N/A
	Great black-backed gull	Negligible	Low - medium	Negligible	None	N/A
Pollution effects	Scaup	Negligible	Medium	Negligible	None	N/A
	Eider	Negligible	Low	Negligible	None	N/A
	Long-tailed duck	Negligible	Low	Negligible	None	N/A
	Common scoter	Negligible	Medium	Negligible	None	N/A
	Velvet scoter	Negligible	Medium	Negligible	None	N/A

Table 10.7.19: Summary Development Specific Effects						
Potential Impact	**Receptor**	**Impact Magnitude**	**Sensitivity**	**Effect Significance**	**Mitigation**	**Residual Significance**
	Goldeneye	Negligible	Low	Negligible	None	N/A
	Red-breasted merganser	Negligible	Medium	Negligible	None	N/A
	Red-throated diver	Negligible	High	Negligible	None	N/A
	Great northern diver	Negligible	High	Negligible	None	N/A
	Fulmar	Negligible	Low	Negligible	None	N/A
	Gannet	Negligible	Medium	Negligible	None	N/A
	Shag	Negligible	High	Negligible	None	N/A
	Slavonian grebe	Negligible	Medium	Negligible	None	N/A
	Guillemot	Negligible	Medium to high	Negligible	None	N/A
	Razorbill	Negligible	Medium to high	Negligible	None	N/A
	Puffin	Negligible	Medium to high	Negligible	None	N/A
	Kittiwake	Negligible	Low	Negligible	None	N/A
	Herring gull	Negligible	Low	Negligible	None	N/A
	Great black-backed gull	Negligible	Low	Negligible	None	N/A
Operational						
Displacement / Barrier Effects	Fulmar	Negligible	Medium	Negligible	None	N/A
	Puffin	Low	Medium	Minor adverse	None	N/A
	Razorbill	Low	Medium	Minor adverse	None	N/A
	Guillemot	Low	Medium	Minor adverse	None	N/A

Table 10.7.19: Summary Development Specific Effects						
Potential Impact	**Receptor**	**Impact Magnitude**	**Sensitivity**	**Effect Significance**	**Mitigation**	**Residual Significance**
	Kittiwake	Low	Medium	Minor adverse	None	N/A
Indirect effects (prey and habitat loss)	Fulmar	Negligible	Low	Negligible or minor adverse	None	N/A
	Gannet	Negligible	Low	Negligible or minor adverse	None	N/A
	Puffin	Negligible	Low	Negligible or minor adverse	None	N/A
	Razorbill	Negligible	Low	Negligible or minor adverse	None	N/A
	Guillemot	Negligible	Low	Negligible or minor adverse	None	N/A
	Kittiwake	Negligible	Low	Negligible or minor adverse	None	N/A
	Herring gull	Negligible	Low	Negligible or minor adverse	None	N/A
	Great black-backed gull	Negligible	Low	Negligible or minor adverse	None	N/A
Collision risk	Gannet	Low	Medium	Minor adverse	None	N/A
	Kittiwake	Low	High	Minor adverse	None	N/A
	Herring gull	Low	High	Minor adverse	None	N/A
	Great black-backed gull	Low	High	Minor adverse	None	N/A
	Fulmar	Low	Low	Negligible or minor adverse	None	N/A

Table 10.7.19: Summary Development Specific Effects						
Potential Impact	**Receptor**	**Impact Magnitude**	**Sensitivity**	**Effect Significance**	**Mitigation**	**Residual Significance**
Attraction to lit structures and disorientation	Gannet	Low	Low	Negligible or minor adverse	None	N/A
	Puffin	Low	Low	Negligible or minor adverse	None	N/A
	Razorbill	Low	Low	Negligible or minor adverse	None	N/A
	Guillemot	Low	Low	Negligible or minor adverse	None	N/A
	Kittiwake	Low	Low	Negligible or minor adverse	None	N/A
	Herring gull	Low	Low	Negligible or minor adverse	None	N/A
	Great black-backed gull	Low	Low	Negligible or minor adverse	None	N/A
	Arctic skua	Low	Low	Negligible or minor adverse	None	N/A
Pollution effects	Scaup	Negligible	Medium	Negligible	None	N/A
	Eider	Negligible	Low	Negligible	None	N/A
	Long-tailed duck	Negligible	Low	Negligible	None	N/A
	Common scoter	Negligible	Medium	Negligible	None	N/A
	Velvet scoter	Negligible	Medium	Negligible	None	N/A
	Goldeneye	Negligible	Low	Negligible	None	N/A

Table 10.7.19: Summary Development Specific Effects						
Potential Impact	**Receptor**	**Impact Magnitude**	**Sensitivity**	**Effect Significance**	**Mitigation**	**Residual Significance**
	Red-breasted merganser	Negligible	Medium	Negligible	None	N/A
	Red-throated diver	Negligible	High	Negligible	None	N/A
	Great northern diver	Negligible	High	Negligible	None	N/A
	Fulmar	Negligible	Low	Negligible	None	N/A
	Gannet	Negligible	Medium	Negligible	None	N/A
	Shag	Negligible	High	Negligible	None	N/A
	Slavonian grebe	Negligible	Medium	Negligible	None	N/A
	Guillemot	Negligible	Medium to high	Negligible	None	N/A
	Razorbill	Negligible	Medium to high	Negligible	None	N/A
	Puffin	Negligible	Medium to high	Negligible	None	N/A
	Kittiwake	Negligible	Low	Negligible	None	N/A
	Herring gull	No change	Low	Negligible	None	N/A
	Great black-backed gull	No change	Low	Negligible	None	N/A
Decommissioning						
Disturbance / displacement	Scaup	No change	High	Negligible	None	N/A
	Eider	No change	Medium	Negligible	None	N/A
	Long-tailed duck	No change	High	Negligible	None	N/A
	Common scoter	No change	High	Negligible	None	N/A
	Velvet scoter	No change	High	Negligible	None	N/A

Table 10.7.19: Summary Development Specific Effects						
Potential Impact	**Receptor**	**Impact Magnitude**	**Sensitivity**	**Effect Significance**	**Mitigation**	**Residual Significance**
	Goldeneye	No change	High	Negligible	None	N/A
	Red-breasted merganser	No change	Medium	Negligible	None	N/A
	Red-throated diver	Low	High	Minor adverse	None	N/A
	Great northern diver	Low	High	Minor adverse	None	N/A
	Shag	Low	High	Minor adverse	None	N/A
	Slavonian grebe	Negligible	Medium	Negligible	None	N/A
	Guillemot	Moderate	Medium	Moderate adverse	None	N/A
	Razorbill	Moderate	Medium	Moderate adverse	None	N/A
	Puffin	Low	Medium	Minor adverse	None	N/A
Indirect effects (prey and habitat loss)	Scaup	No change	High	Negligible	None	N/A
	Eider	No change	High	Negligible	None	N/A
	Long-tailed duck	No change	High	Negligible	None	N/A
	Common scoter	No change	High	Negligible	None	N/A
	Velvet scoter	No change	High	Negligible	None	N/A
	Goldeneye	No change	High	Negligible	None	N/A
	Red-breasted merganser	No change	High	Negligible	None	N/A
	Red-throated diver	Low	High	Minor adverse	None	N/A
	Great northern diver	Low	High	Minor adverse	None	N/A
	Fulmar	Negligible	Low - medium	Negligible	None	N/A

Table 10.7.19: Summary Development Specific Effects						
Potential Impact	**Receptor**	**Impact Magnitude**	**Sensitivity**	**Effect Significance**	**Mitigation**	**Residual Significance**
	Gannet	Negligible	Low - medium	Negligible	None	N/A
	Shag	Negligible	Low - medium	Negligible	None	N/A
	Slavonian grebe	Negligible	Low - medium	Negligible	None	N/A
	Guillemot	Low	Medium	Minor adverse	None	N/A
	Razorbill	Low	Medium	Minor adverse	None	N/A
	Puffin	Low	Medium	Minor adverse	None	N/A
	Kittiwake	Low	Low - medium	Negligible	None	N/A
	Herring gull	Negligible	Low – medium	Negligible	None	N/A
	Great black-backed gull	Negligible	Low - medium	Negligible	None	N/A
Pollution effects	Scaup	No change	Medium	Negligible	None	N/A
	Eider	No change	Low	Negligible	None	N/A
	Long-tailed duck	No change	Low	Negligible	None	N/A
	Common scoter	No change	Medium	Negligible	None	N/A
	Velvet scoter	No change	Medium	Negligible	None	N/A
	Goldeneye	No change	Low	Negligible	None	N/A
	Red-breasted merganser	No change	Medium	Negligible	None	N/A
	Red-throated diver	No change	High	Negligible	None	N/A
	Great northern diver	No change	High	Negligible	None	N/A
	Fulmar	No change	Low	Negligible	None	N/A
	Gannet	No change	Medium	Negligible	None	N/A

Table 10.7.19: Summary Development Specific Effects						
Potential Impact	**Receptor**	**Impact Magnitude**	**Sensitivity**	**Effect Significance**	**Mitigation**	**Residual Significance**
	Shag	No change	High	Negligible	None	N/A
	Slavonian grebe	No change	Medium	Negligible	None	N/A
	Guillemot	No change	Medium to high	Negligible	None	N/A
	Razorbill	No change	Medium to high	Negligible	None	N/A
	Puffin	No change	Medium to high	Negligible	None	N/A
	Kittiwake	No change	Low	Negligible	None	N/A
	Herring gull	No change	Low	Negligible	None	N/A
	Great black-backed gull	No change	Low	Negligible	None	N/A

10.8 Assessment of Cumulative Effects

10.8.1 Scope of the Cumulative Assessment

10.8.1.1 Cumulative effects refer to effects upon receptors arising from the development of Moray West Offshore Wind Farm when considered alongside other proposed developments and activities and any other reasonably foreseeable project(s) proposals (Table 10.8.1). In this context the term projects is considered to refer to any project with comparable effects and is not limited to offshore wind projects.

10.8.1.2 Assessment based on method presented in Chapter 5: EIA Methodology and guidance on the assessment of cumulative impacts presented in Section 10.2.

10.8.1.3 For the breeding season, the Cumulative Impact Assessment considers effects from projects within mean maximum foraging range of the colony SPA under consideration. This has been applied for the following assessments. The approach applied to the non-breeding season depends but typically incorporates effects from all projects within the defined BDMPS (Furness, 2015) for each species. BDMPS is defined from the total number of birds present in all UK territorial waters during a defined season allocated into spatially distinct biologically BDMPS units population during that defined season. Typically, Moray West lies within a defined UK North Sea and Channel non-breeding BDMPS. Based on advice provided in the Moray West Offshore Wind Farm Scoping Opinion (2016), the impacts identified as requiring assessment with respect to potential cumulative effects on offshore ornithological receptors include:

- Construction:
  - Disturbance and displacement.
- Operation and maintenance:
  - Displacement; and
  - Collision.

10.8.2 Projects Considered for the Assessment of Cumulative Effects

10.8.2.1 Table 10.8.1 below lists all projects considered as part of the cumulative assessment. Due to the nature of potential cumulative effects on offshore ornithology receptors it is considered only necessary to consider other offshore wind farms for this assessment.

Table 10.8.1: Projects Considered for Cumulative Impact Assessment

Project (offshore wind farm)	Status	Capacity (as built or consented)	Confidence
Moray East	Consented and awarded CfD	950 MW	High[a]
Beatrice	Under construction	588 MW	High[a]
Blyth Demonstrator	Under construction	40 MW	High[a]
Aberdeen European Offshore Wind Deployment Centre	Consented and awarded CfD	92.4 MW	High[a]
Dogger Bank Creyke Beck A	Consented – no CfD	2,400 MW	High[a]
Dogger Bank Creyke Beck B			High[a]
Dogger Bank Teesside A	Consented – no CfD	2,400 MW	High[a]
Dudgeon	Operational	400 MW	High[a]
East Anglia ONE	Under construction	714 MW	High[a]

Table 10.8.1: Projects Considered for Cumulative Impact Assessment			
Project (offshore wind farm)	**Status**	**Capacity (as built or consented)**	**Confidence**
East Anglia Three	Consented – no CfD	1,204 MW	High[a]
Galloper	Under construction	352.8 MW	High[a]
Greater Gabbard	Operational	504 MW	High[a]
Hornsea Project One	Under construction	1,218 MW	High[a]
Hornsea Project Two	Consented and awarded CfD	1,368 MW	High[a]
Humber Gateway	Operational	219 MW	High[a]
Hywind	Operational	30 MW	High[a]
Inch Cape	Consented – no CfD	784 MW consented (No MW specified in 2017 Scoping Report just turbine numbers (up to 72)	High[a]
Kincardine	Consented – no CfD	Up to 50 MW	High[a]
Kentish Flats	Operational	49.5 MW	High[a]
Lincs and LID6	Operational	270 MW	High[a]
London Array	Operational	630 MW	High[a]
Neart na Gaoithe	Consented and awarded CfD	450 MW	High[a]
Race Bank	Under construction	Consented = 580 MW but as built not confirmed	High[a]
Rampion	Under	400.2 MW	High[a]
Seagreen A & B	Consented – no CfD	1050 MW (2017 scoping report specifies 70 -120 tutbines of up to 15 MW but no maximum capacity).	High[a]
Sheringham Shoal	Operational	316.8 MW	High[a]
Sofia (formerly Dogger Bank Teesside B)	See Dogger Bank Teesside A above	-	High[a]
Teesside	Operational	62.1 MW	High[a]
Thanet	Operational	300 MW	High[a]
Triton Knoll	Consented and awarded CfD	855 MW	High[a]
Westermost Rough	Operational	210	High[a]
a Third party project details published in the public domain and confirmed as being 'accurate'.			

10.8.3 Cumulative Construction Effects

10.8.3.1 Any potential cumulative effects on the Valued Ornithological Receptors will only occur if the construction phases of wind farm projects within a particular spatial extent (for example foraging range during breeding season or the Moray Firth / North Sea in winter) are coincidental or sequential, leading to a short- to mid-term impact.

10.8.3.2 Although it is difficult to quantify, numbers of birds cumulative affected during construction are likely to be lower than those predicted in the cumulative displacement assessment relating to the Operation and Maintenance phases of the Development (see Section 10.8.4). This is on the basis that fewer projects relevant to the assessment will be constructed at the same time as this Development. Impacts experienced during construction will also be of shorter duration and temporary in nature.

<u>Disturbance and Displacement</u>

10.8.3.3 In Section 10.7.1 the potential impact of construction activities that may result in direct disturbance or displacement from important foraging and habitat areas of birds, was assessed for all relevant Valued Ornithological Receptors including sea ducks and foraging seabirds.

Magnitude of Impact

10.8.3.4 Moray East is the only project in the Moray Firth identified has having potential for cumulative effects during construction as a result of the construction phases for the two projects (Moray East and Moray West) occurring sequentially. Construction of Moray East is expected to be completed by 2021 (commencing in 2019). Construction works for this Development are due to commence in 2022.

10.8.3.5 Disturbance events during construction activities (including piling of foundations) will disturb and displace birds for the duration of the construction period. As construction activities will be focused at specific locations within the Moray West Site, any impacts resulting from disturbance and displacement from construction activities are considered likely to be short-term, temporary and reversible in nature, lasting only for the duration of construction activity, with birds expected to return to the area once construction activities have ceased. The installation of the offshore components of Moray West Offshore Wind Farm will occur over a maximum duration of 36 months (Table 10.6.1).

10.8.3.6 In Section 10.7.1, the assessment of this impact for Moray West Offshore Wind Farm alone was predicted to be at most of low magnitude for the Valued Ornithological Receptors, on the basis that the extent of disturbance is limited, as construction activities will take place only within a small area of the site at any time (i.e. local spatial extent and intermittent with respect to any one area).

10.8.3.7 The impact is predicted to be of local spatial extent, medium term duration, intermittent and low to medium reversibility. It is predicted that the impact will affect the receptor directly. The impact magnitude is therefore, considered to be at most **low** dependent upon the Valued Ornithological Receptors.

Sensitivity of Receptor

10.8.3.8 The sensitivity of all Valued Ornithological Receptors to cumulative disturbance/displacement due to construction activity is considered to be the same as predicted in Table 10.7.1 when assessing this impact for Moray West Offshore Wind Farm alone.

10.8.3.9 For the receptors assessed, sensitivity ranges from **medium** (auks, Slavonian grebe, eider and red breasted merganser) **to high** (all other sea ducks, shag).

Significance of Effect

10.8.3.10 Overall, the sensitivity of the Valued Ornithological Receptors is considered to be medium or high and the impact magnitude is deemed to be at most low. The effect will, therefore, be at most of **minor adverse** significance, which is not significant in EIA terms.

10.8.4 Cumulative Operational Effects

Disturbance and Displacement

Methodology for Cumulative Effect Assessment - Displacement

10.8.4.1 Predicted displacement effects for the Moray West Offshore Wind Farm alone during the operation and maintenance phase are discussed previously in Section 0. With respect to assessing cumulative displacement effects, information on the number of birds predicted to be affected by displacement for each project considered in this cumulative assessment was obtained from relevant chapters of the Environmental Statements (ESs) for these projects and any associated technical reports and other submitted documents.

10.8.4.2 Recently published interim guidance by JNCC *et al*. (2017) states that displacement impacts for each relevant species should be assessed based on a wide range of potential displacement and mortality rates in a 'matrix'. While some recent ES chapters use this matrix approach, many older projects do not. Instead of discounting data from all projects without a matrix approach, their data has been considered here where possible.

10.8.4.3 For the Moray West Offshore Wind Farm, the mean peak/peak population estimates were calculated for the Moray West Site plus 2 km buffer, through the 'decision support' process described in Volume 4 – Technical Appendix 10.1 - Annex 10.1A. As described previously in the assessment of the Moray West Offshore Wind Farm alone, gulls (e.g. kittiwake) have a low sensitivity to disturbance/displacement, and so any displacement impacts are unlikely to extend further than the wind farm itself, whereas a moderate vulnerability species such as guillemot may show displacement up to a buffer of 1 km. Predicted displacement mortality is not expected to occur on a year on year basis; it is considered more likely to relate to a singular event following which seabirds will respond to by either redistribution or habituation.

10.8.4.4 No species where JNCC *et al.* (2017) recommend a 4 km buffer (divers and scoters) are relevant to this assessment as none of these species have been identified as Valued Ornithological Receptors for the Moray West Site.

10.8.4.5 For the large majority of projects that are now operational, no attempt was made to quantify either the number of birds displaced by the wind farm, or the resultant mortality levels. Instead a qualitative assessment is usually conducted and as such these projects cannot be included as part of the quantitative assessment. For certain other projects, 100% displacement has been assumed, but the resultant mortality rate is not considered and in some (e.g. Beatrice Offshore Wind Farm), the impact on productivity rather than mortality is considered the more appropriate metric. These projects are also excluded from the quantitative assessment.

10.8.4.6 Some applications are still within the planning process at the time of writing. It is therefore considered that the figures provided in such cases have not been finalised. The levels of mortality predicted are therefore subject to change, and so the confidence level in their results is low.

10.8.4.7 Data sources used to determine the potential levels of displacement and mortality from wind farms included in the cumulative effect assessment include population data held in individual wind farm project ESs and Habitats Regulations Appraisal (or Assessment) Reports (HRAs) consisting of population estimates for individual project areas rather than raw survey data. Monthly population estimates have been collated where available. For some projects data is not available for the relevant buffer area and the data has been scaled up or down based on data from other project areas.

10.8.4.8 Upon obtaining mean-peak population estimates for the individual projects the numbers of birds affected through displacement and subsequent mortality has been calculated using the displacement and mortality rates established for the Moray West Offshore Wind Farm.

Fulmar

Magnitude of impact

10.8.4.9 The effect of displacement from the Moray West Offshore Wind Farm alone was assessed as being of no change or negligible magnitude. Fulmar was not assessed of being at risk at either the Moray East (Moray East, 2012) or the Beatrice Offshore Wind Farm (BOWL, 2012) in any season. Fulmar ranges widely in the non-breeding season and have not been considered to be of any risk at additional wind projects in the North Sea. On this basis, it is considered that the magnitude of cumulative displacement on fulmar will be of at worst **negligible** magnitude across all seasons.

Sensitivity of the receptor

10.8.4.10 Fulmar is considered to be of international conservation value as a result of the Moray West Site being in mean maximum foraging range of multiple SPA colonies that include this species as a qualifying feature. With a regional and national population trend likely to be relatively stable, but with low productivity rate, the species recoverability is considered to be low. Behaviourally, fulmar was considered to be of very low vulnerability to displacement by Wade *et al*. (2016). In summary, fulmar is deemed to be of very low vulnerability, low recoverability and international value. The sensitivity of the Valued Ornithological Receptor is therefore, considered to be **low.**

Significance of the effect

10.8.4.11 Overall, the sensitivity of the receptor is considered to be low and the cumulative impact magnitude is deemed to be no change - negligible. The effect will therefore be of **negligible significance**, which is not significant in EIA terms.

Puffin

10.8.4.12 SNH and MSS have advised the application of a post-breeding season for puffin; other projects such as Moray East and Beatrice were assessed prior to this advice and applied a non-breeding season only covering all months outside of the core breeding season. To ensure common currency for this cumulative assessment, no post-breeding season has been assessed and a mean-peak population for the entire non-breeding season (i.e. September – March) has been selected to combine with estimates from other projects considered.

Magnitude of impact

Breeding season

10.8.4.13 Using the same assumptions as for Moray West Offshore Wind Farm alone (50-60% displacement and 2% mortality), the predicted cumulative mortality of puffin displaced from the Moray West Offshore Wind Farm, Beatrice and Moray East offshore wind farms combined in the breeding season is up to 68-81 birds (see Table 10.8.2 which provides figures for the 60% displacement rate).

10.8.4.14 Assessed against the defined puffin regional breeding population (119,600 birds) the predicted mortality from breeding season displacement does not surpass the 1% baseline mortality (1% = 112 birds).

10.8.4.15 The impact of cumulative displacement mortality on puffin during the breeding season is predicted to be of regional spatial extent, long term duration, continuous and of high reversibility. It is predicted that the impact will affect the receptor directly. The impact magnitude is therefore, considered to be **low**.

Non-breeding season

10.8.4.16 Using the same assumptions as for Moray West Offshore Wind Farm alone (50-60% displacement and 2% mortality), the predicted cumulative mortality of puffin displaced from the Moray West Offshore Wind Farm, Beatrice and Moray East offshore wind farms combined in the non-breeding season is 155-186 birds (see Table 10.8.2 which provides figures for the 60% displacement rate).

10.8.4.17 Assessed against the defined puffin regional breeding population (231,937 birds) the predicted mortality from breeding season displacement does not surpass the 1% baseline mortality (1% = 218 birds).

10.8.4.18 The impact of cumulative displacement on puffin during the non-breeding season is predicted to be of local spatial extent, long term duration, continuous and of low to medium reversibility. It is predicted that the impact will affect the receptor directly. The impact magnitude is therefore, considered to be **low**.

Table 10.8.2: Predicted Cumulative Predicted Puffin Mortality as a Result of Displacement Effects

Offshore Wind Farm	Breeding Season (60% displacement, 2% mortality)	Non-Breeding Season (60% displacement, 2% mortality)
Moray West	13	48
Moray East	34	2
Beatrice	34	29
Aberdeen		1
Blyth Demonstration		1
Dogger Bank Creyke Beck A		3
Dogger Bank Creyke Beck B		9
Dogger Bank Teesside A		3
Dudgeon		0
East Anglia ONE		0
East Anglia Three		1
Galloper		0
Greater Gabbard		0
Hornsea Project One		15
Hornsea Project Two		24
Humber Gateway		0
Hywind		0
Inch Cape		32
Kincardine		0
Lincs and LID6		0

Table 10.8.2: Predicted Cumulative Predicted Puffin Mortality as a Result of Displacement Effects		
Offshore Wind Farm	**Breeding Season (60% displacement, 2% mortality)**	**Non-Breeding Season (60% displacement, 2% mortality)**
London Array		0
Neart na Gaoithe		11
Race Bank		0
Seagreen A		0
Seagreen B		0
Sheringham Shoal		0
Sofia (formerly Dogger Bank Teesside B)		4
Teesside		0
Thanet		0
Triton Knoll		1
Westermost Rough		0
Total	81	186

Sensitivity of the receptor

10.8.4.19 Puffin is considered to be of international conservation value as a result of Moray West Offshore Wind Farm being in mean maximum foraging range of SPA colonies that include this species as a qualifying feature. With a regional and national population trend likely to be relatively stable, but with low productivity rate, the species' recoverability is considered to be low. Behaviourally, puffin was considered to be of moderate vulnerability to displacement by Wade *et al*. (2016). In summary, puffin is deemed to be of moderate vulnerability, low recoverability and international value. The sensitivity of the Valued Ornithological Receptor is therefore, considered to be **medium**.

Significance of the effect

10.8.4.20 Overall, the sensitivity of the receptor is considered to be medium and the impact magnitude is deemed to be low depending on the season assessed. The effect will therefore be no greater than **minor adverse** significance, which is not significant in EIA terms.

Razorbill

Magnitude of impact

10.8.4.21 In the breeding season, it is considered that impacts associated with projects in the Moray Firth may act cumulatively with the Moray West Offshore Wind Farm. Although the focus population of birds will be of breeding adults, the population of razorbill that is predicted to be exposed to cumulative displacement impacts in the breeding season will be composed of a proportion immature birds and non-breeding adults too.

10.8.4.22 During non-breeding seasons the population affected by cumulative displacement impacts is predicted to comprise a mixture of adults and immatures from colonies on the east coast of the UK with smaller proportions from colonies further afield during the non-breeding season. In the non-breeding season, it is therefore considered that impacts associated with projects in the in the UK North Sea defined BDMPS area have the potential to act cumulatively with the Moray West Offshore Wind Farm.

Breeding season

10.8.4.23 Using the same assumptions as for the Moray West Offshore Wind Farm alone (the 60% displacement rate recommended by MSS and SNH and 1% mortality) the precautionary predicted cumulative mortality of razorbill due to the displacement predicted to arise from the Moray West Offshore Wind Farm, Beatrice and Moray East offshore wind farms in the breeding season is 37 (Table 10.8.3). When a 40% mortality rate is applied, this would reduce the total to 24 birds. It is however, considered that displacement from an area is unlikely to result in direct mortality on individual birds; instead the impact of displacement will have fitness consequences in terms of productivity and mortality which will vary depending on the age of the birds impacted.

10.8.4.24 Assessed against the defined razorbill regional breeding population (107,711 birds) the predicted cumulative mortality from breeding season displacement does not surpass the 1% baseline mortality (1% = 113 birds). The impact of displacement mortality on guillemot during the breeding season without considering the likely age structure of population affected is predicted to be of regional spatial extent, long term duration, continuous and of high reversibility. It is predicted that the impact magnitude is therefore **low**.

Post-breeding season

10.8.4.25 Based on a 40-60% displacement rate and 1% mortality rate, it is predicted that –139-208 birds will be lost as a result of cumulative displacement in the post-breeding season. From a regional BDMPS post-breeding population of 591,874 individuals this level of mortality does not surpass the 1% baseline mortality (1% = 621 birds).

10.8.4.26 The impact of cumulative displacement on razorbill during the post-breeding season is predicted to be of local spatial extent, long term duration, continuous and of low to medium reversibility. It is predicted that the impact will affect the receptor directly. The impact magnitude is therefore, considered to be **low**.

Non -breeding season

10.8.4.27 Based on a 40-60% displacement rate and 1% mortality rate, it is predicted that 58- 86 birds will be lost as a result of displacement with the Moray West Offshore Wind Farm only contributing a single bird to this total. From a regional BDMPS post-breeding population of 218,622 individuals this level of mortality does not surpass the 1% baseline mortality (1% = 230 birds).

10.8.4.28 The impact of cumulative displacement on razorbill during the non-breeding season is predicted to be of local spatial extent, long term duration, continuous and of low to medium reversibility. It is predicted that the impact will affect the receptor directly. The impact magnitude is therefore, considered to be **low.**

Pre-breeding season

10.8.4.29 Based on a 40-60% displacement rate and 1% mortality rate, it is predicted that 101 - 153 birds will be lost as a result of cumulative displacement in the pre-breeding season with the Moray West Offshore Wind Farm accounting for 14% of the total. Assessed against the defined razorbill regional pre-breeding population (591,874 birds) the predicted mortality from pre-breeding season displacement does not surpass 1% baseline mortality (1% = 621 birds). There are a small number of operational projects situated within the defined non-breeding BDMPS for razorbill that did not assess displacement effects in an appropriate quantitative fashion for inclusion in this assessment (e.g. Kentish Flats). Considering that these projects are not, in general, located in regions of high razorbill abundance and there is sufficient 'headroom' available between the cumulative total predicted in Table 10.8.4 and 1% baseline mortality, it is anticipated that no material changes to the impact magnitude would be considered if these projects were incorporated.

10.8.4.30 The impact of displacement on razorbill during the pre-breeding season is predicted to be of local spatial extent, long term duration, continuous and of low to medium reversibility. It is predicted that the impact will affect the receptor directly. The impact magnitude is therefore, considered to be **low.**

Table 10.8.3: Predicted Razorbill Mortality as a Result of Cumulative Displacement Effects

Offshore Wind Farm	Breeding Season (60% displacement, 1% mortality)	Post-Breeding Season (60% displacement, 1% mortality	Non-Breeding Season (30% displacement, 1% mortality	Pre-Breeding Season (60% displacement, 1% mortality)
Moray West	17	21	1	22
Moray East	15	7	0	1
Beatrice	5	5	3	5
Aberdeen		0	0	0
Blyth Demonstration		0	0	1
Dogger Bank Creyke Beck A		13	10	25
Dogger Bank Creyke Beck B		16	13	31
Dogger Bank Teesside A		3	6	12
Dudgeon		2	4	2
East Anglia ONE		0	1	2
East Anglia Three		5	7	9
Galloper		0	1	2
Greater Gabbard		0	2	1
Hornsea Project One		43	9	11
Hornsea Project Two		25	4	10
Humber Gateway		0	0	0
Hywind		0	0	0
Inch Cape		17	4	0
Kincardine		0	0	0
Lincs and LID6		0	0	0
London Array		0	0	0
Neart na Gaoithe		33	3	0
Race Bank		0	0	0
Seagreen A		0	0	0
Seagreen B		0	0	0
Sheringham Shoal		8	1	0

Table 10.8.3: Predicted Razorbill Mortality as a Result of Cumulative Displacement Effects				
Offshore Wind Farm	**Breeding Season (60% displacement, 1% mortality)**	**Post-Breeding Season (60% displacement, 1% mortality**	**Non-Breeding Season (30% displacement, 1% mortality**	**Pre-Breeding Season (60% displacement, 1% mortality)**
Sofia (formerly Dogger Bank Teesside B)		5	9	18
Teesside		0	0	0
Thanet		0	0	0
Triton Knoll		2	5	1
Westermost Rough		1	1	1
Total	37	208	86	153

Sensitivity of the receptor

10.8.4.31 Razorbill is considered to be of international conservation value as a result of Moray West Offshore Wind Farm being in mean maximum foraging range of SPA colonies that include this species as a qualifying feature. With a regional and national population trend likely to be relatively stable, but with low productivity rate, the species' recoverability is considered to be medium. Behaviourally, razorbill was considered to be of high vulnerability to displacement by Wade *et al.* (2016), although the results of Searle *et al*. (2014) suggest that this rating may be somewhat precautionary. In summary, razorbill is deemed to be of high vulnerability, medium recoverability and international value. The sensitivity of the Valued Ornithological Receptor is therefore, considered to be **medium.**

Significance of the effect

10.8.4.32 Overall, the sensitivity of the receptor is considered to be medium and the impact magnitude is deemed to be low. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

Guillemot

Magnitude of impact

10.8.4.33 In the breeding season, it is considered that impacts associated with other offshore wind farm projects in the Moray Firth may act cumulatively with the Moray West Offshore Wind Farm. The population of guillemot that is predicted to be exposed to cumulative displacement impacts in the breeding season will be composed of a proportion of breeding adults, immature birds and non-breeding adults. It is not known how many immature or non-breeding guillemot are present in the Moray Firth during the breeding season and it is therefore difficult to calculate a population against which impacts can be assessed. In addition, different projects, depending on their proximity to breeding colonies will impact differing proportions of breeding adult, immature or non-breeding adult birds.

10.8.4.34 In the non- breeding season, it is considered that impacts associated with projects in the in the UK North SEA defined BDMPS area have the potential to act cumulatively with Moray West Offshore Wind Farm. Guillemot is a dispersive rather than a migratory species with birds overwintering in sea areas close to their breeding colonies, although immature birds do disperse further than adults (Wernham *et al.*, 2002). Furness (2015) suggests that reasonably high proportions (up to 80%) of immature guillemots from colonies bordering the North Sea remain in the North Sea during winter. At breeding colonies in the UK North Sea the total number of breeding adult birds is 1,175,332 (Furness, 2015). Furness (2015) indicates that the non-breeding component of a guillemot population will represent 43% of the total population. This would mean that there are an additional 869,746 immature birds associated with breeding colonies in the North Sea. It is possible that not all immature birds associated with UK North Sea breeding colonies will be present in the North Sea during the breeding season, although immature birds from elsewhere (breeding colonies in UK western waters and other colonies) may be present. However, it is considered a precautionary assumption to assume that immature birds associated with colonies in the North Sea that are present in the North Sea during the non-breeding season will remain in the North Sea into the following breeding season. This would therefore represent a breeding season immature population of 560,761 birds. Combining these breeding adult and immature populations would provide a North Sea population of 2,045,078 individuals.

10.8.4.35 The use of these population is not appropriate in a cumulative context as the impacts predicted for each project affect different components of the population. Any assessment using this as a discrete population against which impacts would be equally distributed would therefore not capture the complexity of the population structure present in the North Sea, as it ignores the distribution of different age classes. No attempt has therefore been made to compare the predicted impact against this total population.

10.8.4.36 During the non-breeding season the population affected by cumulative displacement impacts is predicted to comprise a mixture of adults and immatures from colonies on the east coast of the UK with smaller proportions from colonies further afield during the non-breeding season. SNH and MSS have advised the application of a post-breeding season for guillemot; other projects such as the Moray East and Beatrice Offshore Wind Farms were assessed prior to this advice and applied a non-breeding season only covering all months outside of the core breeding season. To ensure common currency for this cumulative assessment, no post-breeding season has been assessed and a mean-peak population for the entire non-breeding season (i.e. September – March) has been selected to assess in combination with other projects considered.

Breeding season

10.8.4.37 Using the same assumptions as for Moray West Offshore Wind Farm alone (the 60% displacement rate recommended by MSS and SNH and 1% mortality) the precautionary predicted cumulative mortality of guillemot due to the displacement predicted to arise from the Moray West Offshore Wind Farm, Beatrice and Moray East offshore wind farms in the breeding season is 287 (Table 10.8.4). When a 50% mortality rate is applied, this would reduce the total to 239 birds. It is however considered that displacement from an area is unlikely to result in direct mortality on individual birds; instead the impact of displacement will have fitness consequences in terms of productivity and mortality which will vary depending on the age of the birds impacted.

10.8.4.38 Moray West contributes 51% to the cumulative total impact. Assessed against the defined guillemot regional breeding population (998,623 birds) the predicted mortality from breeding season displacement does not surpass 1% baseline mortality (of 609 birds). The impact of displacement mortality on guillemot during the breeding season without considering the likely age structure of population affected is predicted to be of regional spatial extent, long term duration, continuous and of high reversibility. It is predicted that the impact will affect the receptor directly. The impact magnitude is therefore, considered to be **low**.

Table 10.8.4: Predicted Cumulative Guillemot Mortality as a Result of Displacement Effects

Offshore Wind Farm	Breeding Season (60% displacement, 1% mortality)	Non-Breeding Season (30% displacement, 1% mortality)
Moray West	122	191
Moray East	59	7
Beatrice	82	17
Aberdeen		1
Blyth Demonstration		8
Dogger Bank Creyke Beck A		40
Dogger Bank Creyke Beck B		68
Dogger Bank Teesside A		17
Dudgeon		4
East Anglia ONE		4
East Anglia Three		8
Galloper		4
Greater Gabbard		4
Hornsea Project One		44
Hornsea Project Two		79
Humber Gateway		1
Hywind		0
Inch Cape		19
Kincardine		0
Lincs and LID6		6
London Array		3
Neart na Gaoithe		20
Race Bank		6
Seagreen A		0
Seagreen B		0
Sheringham Shoal		5
Sofia (formerly Dogger Bank Teesside B)		28

Table 10.8.4: Predicted Cumulative Guillemot Mortality as a Result of Displacement Effects		
Offshore Wind Farm	**Breeding Season (60% displacement, 1% mortality)**	**Non-Breeding Season (30% displacement, 1% mortality)**
Teesside		6
Thanet		1
Triton Knoll		5
Westermost Rough		3
Total	287	636

Non-breeding season

10.8.4.39 During the non-breeding season, the precautionary predicted cumulative mortality of guillemot due to the displacement predicted to arise from the Moray West Offshore Wind Farm and other projects considered cumulatively is 636 at 60% displacement (Table 10.8.4) or 527 at 50% displacement. The Moray West Offshore Wind Farm accounts for 36% of the cumulative total, which is heavily influenced by the 'post-breeding' peak of abundance in the month of October. The total of 636 birds represents 0.04% of the regional non-breeding population of 1,617,306 and does not constitute an increase in baseline mortality of greater than 1% (98,656 individuals; 1% threshold = 987). There are a small number of operational projects situated within the defined non-breeding BDMPS for guillemot that did not assess displacement effects in an appropriate quantitative fashion for inclusion in this assessment (e.g. Kentish Flats). Considering that these projects are not, in general, located in regions of high guillemot abundance and there is sufficient 'headroom' available between the cumulative total predicted in Table 10.8.4 and 1% baseline mortality, it is anticipated that no material changes to the impact magnitude would be considered if these projects were incorporated.

10.8.4.40 The impact of displacement mortality on guillemot during the non-breeding season is predicted to be of local spatial extent, long term duration, continuous and of low to medium reversibility. It is predicted that the impact will affect the receptor directly. The impact magnitude is therefore, considered to be **low**.

Sensitivity of the receptor

10.8.4.41 Guillemot is considered to be of international conservation value as a result of Moray West Offshore Wind Farm being within mean maximum foraging range of SPA colonies that include this species as a qualifying feature. With a regional and national population trend likely to be relatively stable, but with low productivity rate, the species' recoverability is considered to be medium. Behaviourally, guillemot was considered to be of high vulnerability to displacement by Wade *et al.* (2016). In summary, razorbill is deemed to be of high vulnerability, medium recoverability and international value. The sensitivity of the Valued Ornithological Receptor is therefore, considered to be **medium**.

Significance of the effect

10.8.4.42 Overall, the sensitivity of the receptor is considered to be medium and the impact magnitude is deemed to be low (for the non-breeding season). The effect will therefore be highest during the post-breeding season when it is assessed as being of **minor adverse** significance.

Kittiwake

Magnitude of impact

10.8.4.43 The effect of displacement from the Moray West Offshore Wind Farm alone was assessed as being of minor magnitude for the breeding season only. Considering that effects in all non-breeding seasons for Moray West alone were considered to be of negligible significance and that for the majority of North Sea wind farms the species was not considered for assessment due to its lack of vulnerability to the effect, only the breeding season is considered in this cumulative assessment.

10.8.4.44 For sites that would be considered cumulatively with Moray West Offshore Wind Farm in the breeding season, kittiwake has not been assessed of being at risk at either the Moray East Offshore Wind Farm (Moray East ES, 2012) or the Beatrice Offshore Wind Farm (BOWL, 2012) in any season. Moray East refer to the potential for 98 birds to be displaced at a 10% displacement rate (and so equating to 294 birds at a rate of 30% as currently advised) (Moray East ES, 2012). Should a 2 % mortality rate be applied this would refer to just 6 birds. Displacement analysis at Beatrice is effectively focussed on the number of birds predicted failing to breed rather than direct mortality. However, BOWL (2012) reports a peak abundance within baseline surveys of 786 birds. Despite, a peak number being an overly precautionary value for use in displacement analysis, this would only equate to a mortality of less than five birds at the currently advocated displacement and mortality rates (30 / 2 %). It is therefore considered that the predictions made for the magnitude of displacement effects in the breeding season from Moray West Offshore Wind Farm alone, would remain unchanged if considered cumulatively with Beatrice or Moray East.

10.8.4.45 The impact of cumulative displacement mortality on kittiwake during the breeding season is predicted to be of regional spatial extent, long term duration, continuous and of high reversibility. It is predicted that the impact will affect the receptor directly. The impact magnitude is therefore, considered to be **low**.

Sensitivity of the receptor

10.8.4.46 Kittiwake is considered to be of international conservation value and the Moray West Site lies within the mean maximum foraging range of SPA colonies that include this species as a qualifying feature. With regional and national population trends indicating declines, with low productivity rate, the species' recoverability is considered to be low. Behaviourally, kittiwake was considered to be of low vulnerability to displacement by Wade *et al*. (2016). In summary, kittiwake is deemed to be of low vulnerability, low recoverability and international value. The sensitivity of the Valued Ornithological Receptor is therefore, considered to be **medium**.

Significance of the effect

10.8.4.47 Overall, the sensitivity of the receptor is considered to be medium and the impact magnitude is deemed to be low. The effect will, therefore, be **minor adverse significance** which is not significant in EIA terms.

Collision Risk

Methodology for Cumulative Effect Assessment – Collision Risk

10.8.4.48 Direct comparison of the collision risks predicted by the wind farms in the wider area is problematic due to the differing assumptions made in the calculations used in the different studies, and the limited amount of species data presented in ES chapters (Maclean *et al.,* 2009). Nevertheless, a combined quantitative assessment of the cumulative impacts posed by the Moray West Offshore Wind Farm in conjunction with other projects has been undertaken, based on the information presented in other projects' supporting documentation available to date. Due to a lack of compatible project information it has not, however, been possible to include a quantitative assessment for each project. All suitable quantitative data from relevant projects are presented in each species assessment below.

10.8.4.49 Cumulative impacts of the Moray West Offshore Wind Farm and other relevant projects during the breeding season have been based on the mean maximum foraging range given for each species (or other information e.g. tracking information). However, it is also important to consider the populations of immature and non-breeding individuals that may be impacted by wind farms considered cumulatively with the Moray West Offshore Wind Farm to which a proportion of collision impacts will be attributable.

10.8.4.50 For the purposes of this assessment, the definition of cumulative effects is the effect of the Moray West Offshore Wind Farm, alongside the effect of other offshore wind farm projects on a single Valued Ornithological Receptor. Although further mortality will occur during the breeding season due to collisions from birds from other colonies with other projects outside of foraging range (e.g. kittiwakes at English North Sea projects), the Moray West Offshore Wind Farm will contribute zero collisions to this as it is outside of foraging range, and so these projects are not considered to require inclusion in a breeding season cumulative assessment.

10.8.4.51 During the non-breeding period, it is assumed that individuals present from each species will originate from a wider range of colonies, with mixing throughout the Moray Firth and North Sea, and so the most appropriate reference populations (e.g. east coast or flyway) have been taken forward to assessment, based on literature evidence available (Furness, 2015). A greater range of projects are included, reflecting the wider movements of birds (i.e. all east coast UK offshore wind farm projects).

Confidence in Collision Risk Data Available from Other Projects

Overview

10.8.4.52 The earliest collision risk assessments of offshore wind farms for Round 1 and 2 projects were generally undertaken by adapting the Band (2000) collision risk model (updated in Band *et al.,* 2007), developed on behalf of Scottish Natural Heritage to quantify mortality rates for birds at onshore wind farms. As flight data are collected in a fundamentally different way in the onshore and offshore environments, the boat survey data collected at these offshore sites required significant reinterpretation to become compatible with the model. This is a potential source of variability in interpretation and results between projects, particularly as a standard method of interpretation was not available at that time.

10.8.4.53 For these projects' models it was also assumed that for birds transiting through turbines at risk height, collision risk was distributed evenly within the rotor swept area (as per Option 1 or 2 of the Band model), which in the majority of cases overestimates the risk for most species which predominantly fly at lower altitudes (including some within the lower rotor swept area). As the probability of colliding with a rotor blade is lower at these lower altitudes, using the mean value instead will invariably overestimate risk, and therefore resultant mortality rates.

10.8.4.54 The most recent projects have run collision risk analyses using the Band model, updated for the offshore environment (Band, 2012; sometimes the draft version Band (2011)). The updates within Band (2012) mean that projects that have used the Band (2012) or Band (2011) models are likely to produce more realistic mortality rates than earlier projects that had to interpret the onshore Band models. This is particularly the case for those that undertook modelling using the Extended Option 3 or 4 variants.

10.8.4.55 In addition to the different models used to estimate collision mortality, different avoidance rates have been selected for impact assessment in different projects. This is the most sensitive parameter in the model, and so leads to a great deal of variability in results. Mortality estimates from other projects have been converted to a common currency in this assessment consistent with those avoidance rates recommended by JNCC *et al.* (2014) and Cook *et al*. (2014).

Consideration of precaution in in-combination assessments

10.8.4.56 Assessments conducted for this EIA use the worst case scenario for collision risk modelling. This involves applying the levels of mortality predicted in the submission documents or consent document for each project. These numbers are the number up on which consent for the Development has been granted. In many cases, these assessments have, however, been conducted long before construction commences and often the more current 'as-built scenario' will consist of fewer, higher capacity turbines that typically result in lower collision risk rates. A process has therefore been developed for this EIA to identify differences in the consented and as-built or current planned turbine scenarios. This process, which is described below allows the worst case scenario assessment to be set into context of the likely lower level of in combination collision risk.

10.8.4.57 In recent years there have also been numerous developments in the understanding of bird behaviour that have changed the way in which certain aspects of collision risk modelling have been conducted. Some of these developments (e.g. species specific avoidance rates) have been incorporated into the in-combination assessment on a common currency basis. However, there are a number of other parameters (e.g. flight speed, nocturnal activity factors) where the evidence base is increasingly suggesting that parameters used in previous collision risk modelling have been overly conservative. It is considered that the evidence base for one of these parameters, nocturnal activity, is sufficiently robust to provide quantitative context on the parameters used in previous modelling within the in-combination assessment presented in this chapter. Specifically, updates are to those projects applying different nocturnal activity factors to those used at many older projects as advised by SNH and Marine Scotland.

10.8.4.58 The elements of precaution identified in this section have not been quantified as part of the main (i.e. worst case) in-combination assessments presented in the species-specific sections in this EIA. Consideration of these aspects of precaution are presented in separate sections (termed "Consideration of precaution within the assessment") where these finding are further discussed as part of the conclusions on adverse effect on integrity for each species.

Consented and as-built scenarios

10.8.4.59 In addition to the observation that different versions of the Band CRM have been used for different projects, it is frequently the case that projects when constructed do not reflect the maximum design scenario assessed. In many cases, the as-built scenario will represent a significantly lower impact than that assessed as the maximum design scenario for the purpose of obtaining a consent.

10.8.4.60 In order to provide an appraisal of this likely over-estimation of the cumulative collision risk totals for each species, a simple analysis has been conducted comparing the turbine scenario used for CRM for projects considered cumulatively with the respective as-built turbine scenario. Table 10.8.5 identifies the assessed, consented and as-built or planned turbine scenarios for each of the projects considered cumulatively in addition to the possible change that may result if CRM was conducted utilising the as-built turbine scenario.

Table 10.8.5: Assessed, Consented and As-Built / Planned Turbine Scenarios for Projects Considered Cumulatively for Collision Risk Impacts

Offshore Wind Farm	Assessed Turbine Scenario	Assessed Capacity (MW)	Consented Capacity (MW)	Consented Number of Turbines	As-Built Scenario / Turbine Scenario Currently Being Considered	As-Built / Currently Planned Capacity	Is there a Difference between the Assessed Turbine Scenario and either the Consented or As-Built/Planned Turbine Scenario (Y/N)	Implications for Cumulative Assessment	Correction Factors Applied to Consideration of Collison Assessment Precaution
Operational									
Dudgeon	168 x 3 MW	504	560	77	67 x 6 MW	402	Yes – consented number of turbines (77) lower than that assessed (168). In addition, constructed number of turbines lower than consented	Reduction of 54% - assessed vs consented number of turbines Potential additional 6% reduction if as built scenario vs assessed scenario taken into account.	Yes – Correction factor from MacArthur Green (2017) applied
Greater Gabbard	140	Unavailable	-	-	140 x 3.6 MW	504	No – assessed scenario consistent with as-built scenario	-	-
Humber Gateway	83 x 3.6 MW	298.8	300	83	73 x 3 MW	219	Yes – as-built number of turbines (73) lower than assessed (83) however capacity of as-built turbines lower than assessed	Reduction of 12% in terms of number of turbines however change in capacity of turbines may influence collision risk estimates.	Yes – Correction factor from MacArthur Green (2017) applied
Kentish Flats Extension	17 x 3 MW	51	-	-	15 x 3.3 MW	49.5	Yes – as-built scenario has fewer turbines than assessed scenario	Reduction of 12% in terms of number of turbines however change in capacity of turbines may influence collision risk estimates.	Yes – Correction factor from MacArthur Green (2017)

Table 10.8.5: Assessed, Consented and As-Built / Planned Turbine Scenarios for Projects Considered Cumulatively for Collision Risk Impacts

Offshore Wind Farm	Assessed Turbine Scenario	Assessed Capacity (MW)	Consented Capacity (MW)	Consented Number of Turbines	As-Built Scenario / Turbine Scenario Currently Being Considered	As-Built / Currently Planned Capacity	Is there a Difference between the Assessed Turbine Scenario and either the Consented or As-Built/Planned Turbine Scenario (Y/N)	Implications for Cumulative Assessment	Correction Factors Applied to Consideration of Collison Assessment Precaution
Lincs	83 x 3 MW	249	250	83	75 x 3.6 MW	270	Yes – as-built scenario has fewer turbines than assessed scenario	Reduction of 10% in terms of number of turbines however change in capacity of turbines may influence collision risk estimates.	Yes – Correction factor from MacArthur Green (2017) applied
London Array	271 x 3 MW	813	1000	341	175 x 3.6 MW	630	Yes – as-built scenario has fewer turbines than assessed scenario	Reduction of 35% in terms of number of turbines however change in capacity of turbines may influence collision risk estimates.	No – correction factor presented in MacArthur Green (2017) is not applicable as it uses different turbine scenarios
Sheringham Shoal	108 x 3 MW	324	316.8	108	88 x 3.6 MW	316.8	Yes – as-built scenario has fewer turbines than assessed scenario	Reduction of 19% in terms of number of turbines however change in capacity of turbines may influence collision risk estimates.	No – collision risk estimates are unavailable for species considered in this RIAA
Teesside	30	Unavailable	100	30	27 x 2.3 MW	62.1	Yes – as-built scenario has fewer turbines than assessed scenario	Reduction of 10% in terms of number of turbines however the assessed turbine capacity is unknown and therefore it is not known if the reduction can be applied.	Yes – Correction factor from MacArthur Green (2017) applied

Table 10.8.5: Assessed, Consented and As-Built / Planned Turbine Scenarios for Projects Considered Cumulatively for Collision Risk Impacts

Offshore Wind Farm	Assessed Turbine Scenario	Assessed Capacity (MW)	Consented Capacity (MW)	Consented Number of Turbines	As-Built Scenario / Turbine Scenario Currently Being Considered	As-Built / Currently Planned Capacity	Is there a Difference between the Assessed Turbine Scenario and either the Consented or As-Built/Planned Turbine Scenario (Y/N)	Implications for Cumulative Assessment	Correction Factors Applied to Consideration of Collison Assessment Precaution
Thanet	60 x 5 MW	300	300	-	100 x 3 MW	300	Yes – as-built scenario has more turbines than assessed scenario	As-built scenario was assessed within the Environmental Statement but was not the maximum design scenario. As this scenario has ultimately been built the collision risk estimates used for Thanet represent the 100 x 3 MW turbine scenario.	Yes – Correction factor from MacArthur Green (2017)
Westermost Rough	50 x 3.6 MW	180	245	80	35 x 6 MW	210	Yes – as-built scenario has fewer turbines than assessed scenario	Reduction of 30% in terms of number of turbines however change in capacity of turbines may influence collision risk estimates.	Yes – Correction factor from MacArthur Green (2017) applied
Under Construction									
Beatrice	277 x 3.6 MW	817.2	750	125	84 x 7 MW	588	Yes – consented number of turbines (125) lower than that assessed (277). In addition, constructed number of turbines lower than consented	Collision risk estimates calculated for Beatrice use the as-built turbine scenario.	No - collision risk estimates calculated for Beatrice use the as-built turbine scenario
Blyth Demonstration Project	15 x 8 MW	120	-	-	5 x 8 MW	40	Yes – as-built scenario has fewer turbines than assessed scenario	Reduction of 67% - assessed vs consented number of turbines.	No – no correction factor presented in

Table 10.8.5: Assessed, Consented and As-Built / Planned Turbine Scenarios for Projects Considered Cumulatively for Collision Risk Impacts									
Offshore Wind Farm	**Assessed Turbine Scenario**	**Assessed Capacity (MW)**	**Consented Capacity (MW)**	**Consented Number of Turbines**	**As-Built Scenario / Turbine Scenario Currently Being Considered**	**As-Built / Currently Planned Capacity**	**Is there a Difference between the Assessed Turbine Scenario and either the Consented or As-Built/Planned Turbine Scenario (Y/N)**	**Implications for Cumulative Assessment**	**Correction Factors Applied to Consideration of Collison Assessment Precaution**
									MacArthur Green (2017)
East Anglia ONE	325 x 3.6 MW	1,170	1,200	240	102 x 7 MW	714	Yes – consented number of turbines (240) lower than that assessed (325). In addition, project has committed to building only 102 turbines but using a different turbine scenario	Reduction of 26% - assessed vs consented number of turbines Potential additional 42% reduction if as built scenario vs assessed scenario taken into account.	No – qualitative discussion only
Galloper	140 x 3.6 MW	504	504	140	56 x 6.3 MW	352.8	Yes – as-built scenario has fewer turbines than assessed scenario	Reduction of 60% in terms of number of turbines however change in capacity of turbines may influence collision risk estimates.	Yes – Correction factor from MacArthur Green (2017) applied
Hornsea Project One	240 x 5 MW	1,200	1,200	-	174 x 7 MW	1,218	Yes – as-built scenario has fewer turbines than assessed scenario	Reduction of 28% in terms of number of turbines however change in capacity of turbines may influence collision risk estimates.	No – qualitative discussion only
Hywind	5 x 6 MW	30	30	-	5 x 6 MW	30	No – assessed scenario consistent with as-built scenario	-	-

Table 10.8.5: Assessed, Consented and As-Built / Planned Turbine Scenarios for Projects Considered Cumulatively for Collision Risk Impacts									
Offshore Wind Farm	**Assessed Turbine Scenario**	**Assessed Capacity (MW)**	**Consented Capacity (MW)**	**Consented Number of Turbines**	**As-Built Scenario / Turbine Scenario Currently Being Considered**	**As-Built / Currently Planned Capacity**	**Is there a Difference between the Assessed Turbine Scenario and either the Consented or As-Built/Planned Turbine Scenario (Y/N)**	**Implications for Cumulative Assessment**	**Correction Factors Applied to Consideration of Collison Assessment Precaution**
Race Bank	206	Unavailable	580	-	91	-	Yes - as-built scenario has fewer turbines than assessed scenario	Reduction of 56% in terms of number of turbines however change in capacity of turbines may influence collision risk estimates.	Yes – Correction factor from MacArthur Green (2017) applied
Rampion	175	700	700	175	116 x 3.45 MW	400.2	Yes – as-built scenario has fewer turbines than assessed/consented scenario	Reduction of 34% in terms of number of turbines however change in capacity of turbines may influence collision risk estimates.	No – qualitative discussion only
Consented and Awarded CfD									
Aberdeen European Offshore Wind Deployment Centre	11 x 7 MW	77	100	-	11 x 8.4 MW	92.4	Yes – same number of turbines, however capacity of turbines higher for as-built scenario	Potential for a minor change in collision risk due to change in turbine scenario.	No – qualitative discussion only
Hornsea Project Two	300 x 5 MW	1,800	1,800	300	92-231	1,368	Yes – planned turbine scenario has fewer turbines than assessed scenario	Reduction of 23-69% in terms of number of turbines however change in capacity of turbines may influence collision risk estimates.	No – qualitative discussion only

Table 10.8.5: Assessed, Consented and As-Built / Planned Turbine Scenarios for Projects Considered Cumulatively for Collision Risk Impacts									
Offshore Wind Farm	**Assessed Turbine Scenario**	**Assessed Capacity (MW)**	**Consented Capacity (MW)**	**Consented Number of Turbines**	**As-Built Scenario / Turbine Scenario Currently Being Considered**	**As-Built / Currently Planned Capacity**	**Is there a Difference between the Assessed Turbine Scenario and either the Consented or As-Built/Planned Turbine Scenario (Y/N)**	**Implications for Cumulative Assessment**	**Correction Factors Applied to Consideration of Collison Assessment Precaution**
Moray East (Consented Telford, Steveson and MacColl wind farms)	339 (139 x 3.6, 100 x 5 and 100 x 5 MW)	1,500	1,116	186[6]	100 x 9.5 MW	950	Yes – consented number of turbines (186) lower than that assessed (339). In addition, planned turbine scenario is lower than consented	Updated collision risk estimates are presented in Appendix 5 of MS-LOT (2017) using a turbine scenario comprising 157 turbines. There is therefore a potential reduction of 36% - assessed vs as-built scenario however change in capacity of turbines may influence collision risk estimates	No – qualitative discussion only
Neart na Gaoithe	128 x 3.6 MW	460.8	450	75	56 x 8 MW	450	Yes – consented number of turbines (75) lower than that assessed (128). In addition, planned turbine scenario is lower than consented	Reduction of 41% - assessed vs consented number of turbines Potential additional 15% reduction if as built scenario vs assessed scenario taken into account.	No – qualitative discussion only
Triton Knoll	288 x 3.6 MW	1,036.8	1,200	288	90 x 9.5 MW	855	Yes – planned turbine scenario has fewer turbines than assessed scenario	Reduction of 69% in terms of number of turbines however change in capacity of turbines may influence collision risk estimates.	No – qualitative discussion only
Consented – No CfD									

[6] Consent is for 186 turbines based 6 MW turbines. With respect to birds worst case within the envelope is 159 turbines for 7-10 MW turbine

Table 10.8.5: Assessed, Consented and As-Built / Planned Turbine Scenarios for Projects Considered Cumulatively for Collision Risk Impacts									
Offshore Wind Farm	**Assessed Turbine Scenario**	**Assessed Capacity (MW)**	**Consented Capacity (MW)**	**Consented Number of Turbines**	**As-Built Scenario / Turbine Scenario Currently Being Considered**	**As-Built / Currently Planned Capacity**	**Is there a Difference between the Assessed Turbine Scenario and either the Consented or As-Built/Planned Turbine Scenario (Y/N)**	**Implications for Cumulative Assessment**	**Correction Factors Applied to Consideration of Collison Assessment Precaution**
Dogger Bank Creyke Beck A and B	400 x 6 MW	2,400	2,400	400	-	-	No	Project was consented in 2015 and it is likely that a larger capacity turbine scenario, resulting in fewer turbines, will be constructed.	-
Dogger Bank Teesside A and Sofia (formerly Dogger Bank Teesside B)	400 x 6 MW	2,400	2,400	400	240-400	Unavailable	No	Project was consented in 2015 and it is likely that a larger capacity turbine scenario, resulting in fewer turbines, will be constructed.	-
East Anglia Three	172 x 7 MW	1,204	-	-	172 x 7 MW	1204	No	-	-
Inch Cape	213	784	-	-	72	Unavailable	Yes – planned turbine scenario has fewer turbines than assessed scenario	Reduction of 66% in terms of number of turbines however change in capacity of turbines may influence collision risk estimates.	No – qualitative discussion only
Kincardine	8 x 6 MW	6 to 8	Up to 50 MW	-	7	Unavailable	Yes - planned turbine scenario has fewer turbines than assessed scenario	Reduction of 13% in terms of number of turbines however change in capacity of turbines may influence collision risk estimates.	No – qualitative discussion only
Methil	1	Unavailable	-	-	2	Unavailable	Yes - planned turbine scenario has more	Increase of 100% in terms of number of turbines however	No – qualitative discussion only

Table 10.8.5: Assessed, Consented and As-Built / Planned Turbine Scenarios for Projects Considered Cumulatively for Collision Risk Impacts									
Offshore Wind Farm	**Assessed Turbine Scenario**	**Assessed Capacity (MW)**	**Consented Capacity (MW)**	**Consented Number of Turbines**	**As-Built Scenario / Turbine Scenario Currently Being Considered**	**As-Built / Currently Planned Capacity**	**Is there a Difference between the Assessed Turbine Scenario and either the Consented or As-Built/Planned Turbine Scenario (Y/N)**	**Implications for Cumulative Assessment**	**Correction Factors Applied to Consideration of Collison Assessment Precaution**
							turbines than assessed scenario	change in capacity of turbines may influence collision risk estimates.	
Seagreen Alpha	75 x 7 MW	525	525		35-60	525	Yes - planned turbine scenario has more turbines than assessed scenario	Reduction of 20-53% in terms of number of turbines however change in capacity of turbines may influence collision risk estimates.	No – qualitative discussion only
Seagreen Bravo	75 x 7 MW	525	525		35-60	525	Yes - planned turbine scenario has more turbines than assessed scenario	Reduction of 20-53% in terms of number of turbines however change in capacity of turbines may influence collision risk estimates.	No – qualitative discussion only

10.8.4.61 Where differences arise between the assessed turbine scenario and the as-built/planned turbine scenario (i.e. those projects for which consideration in the assessment is qualitative) further analysis utilising the correction factors calculated by MacArthur Green (2017), has been applied in order to calculate the likely change in collision risk estimates for a project with this discussed qualitatively in the respective species sections.

10.8.4.62 MacArthur Green (2017) presents an appraisal of the likely 'headroom' that exists in current cumulative collision risk estimates due to assessed turbine scenarios representing a higher collision risk to birds than as-built or planned turbine scenarios. The correction factors have only been applied here if the assessed turbine scenario presented in Table 10.6.1 matches that used by MacArthur Green (2017). The correction factors presented in MacArthur Green (2017) can be applied for ten projects, as given in Table 10.8.6, that are included in Table 10.8.5.

Table 10.8.6: Correction factors from MacArthur Green (2017) Applied to Collision Risk Estimates

Offshore Wind Farm	Correction Factors from MacArthur Green (2017)			
	Gannet	Kittiwake	Herring gull	Great black-backed gull
Dudgeon[7]	0.46			
Galloper	0.43	0.42	0.43	0.41
Humber Gateway	0.50	0.39	0.42	0.45
Kentish Flats Extension	0.80	0.72	0.80	0.80
Lincs	1.01	1.04		
Race Bank	0.53	0.59		
Rampion[7]	0.69			
Sheringham Shoal[7]	0.97			
Teesside	0.68	0.67	0.67	0.68
Westermost Rough	0.83	0.82	0.82	0.83

10.8.4.63 The exercise presented therefore does not account for considerable reductions that are likely to occur in the assessed collision risk estimates calculated for Hornsea Project Two, Neart na Gaoithe, Seagreen Alpha and Seagreen Bravo due to these projects currently planning to deploy turbine scenarios that will meet the consented maximum project capacity but using fewer higher capacity turbines. Reductions in collision risk estimates are also likely for London Array, Beatrice, Blyth Demonstration, East Anglia One and Triton Knoll as these projects are currently planning or operating turbine scenarios that are below the consented maximum capacity for the project. Based on the changes that have occurred between assessment and construction, it is considered highly likely that the eventual as-built turbine scenarios for projects such as Dogger Bank Creyke Beck A&B, Dogger Bank Teesside A, Sofia (formerly Dogger Bank Teesside B) and Inch Cape will also contain fewer higher capacity turbines that will lead to reductions in the collision risk estimates incorporated into the cumulative assessments presented below.

[7] Applicable to gannet only

Nocturnal activity factors

10.8.4.64 Annex C of Volume 4 - Technical Appendix 10.2: Collision Risk Modelling presents an analysis of the potential change in collision risk estimates as a result of updating the nocturnal activity factors used in collision risk modelling at previously consented projects. Collision risk modelling conducted for projects considered in-combination are considered to have most certainly used the nocturnal activity factors from Garthe and Hüppop (2004) and therefore it is necessary to correct the collision risk estimates to account for this over-estimation.

10.8.4.65 The correction factor to apply to the collision risk estimates for each project considered in-combination will depend on the latitude at which a project is located. An analysis has been conducted in Annex C of Volume 4 - Technical Appendix 10.2: Collision Risk Modelling that calculates correction factors for four geographic areas into which each of the projects considered in-combination have been assigned (Table 10.8.7). Two correction factors are presented, a minimum representing the minimum monthly change that can be applied cross all months and the total representing the total change in collision risk estimates in each area using a generic wind farm scenario. The 'total' correction factor may potentially under or over-estimate the collision risk for an individual project and therefore this is applied in the following species sections as guidance only. The application of the 'minimum' correction factor is considered to be precautionary as this represents the minimum change that would occur across all months.

Table 10.8.7: Reductions to Apply to Collision Risk Estimates for Projects in each Geographic Region

Geographic Region	Projects within Region	% Reduction in Collision Risk Estimates
East Anglia and English Channel	East Anglia One East Anglia Three Galloper Greater Gabbard Kentish Flats Extension London Array Rampion Thanet	Gannet = 10.1 Gulls = 9.2
Southern North Sea	Dogger Bank Creyke Beck A & B Dogger Bank Teesside A & B Dudgeon Hornsea Project One Hornsea Project Two Humber Gateway Lincs Race Bank Sheringham Shoal Teesside Triton Knoll Westermost Rough	Gannet = 9.3 Gulls= 8.5
Firth of Forth	Aberdeen (EOWDC) Inch Cape	Gannet = 8.4 Gulls = 7.8

Table 10.8.7: Reductions to Apply to Collision Risk Estimates for Projects in each Geographic Region		
Geographic Region	**Projects within Region**	**% Reduction in Collision Risk Estimates**
	Kincardine[8] Methil Neart na Gaoithe Seagreen Alpha Seagreen Bravo	
Moray Firth	Beatrice Hywind	Gannet = 7.6 Gulls = 7.1

Gannet

10.8.4.66 Table 10.8.10 10.8.10 presents a seasonal breakdown of predicted cumulative collision mortality for gannet.

Magnitude of impact

Breeding season

10.8.4.67 The combined breeding season mortality is estimated to be 110 gannets, of which the Moray West Offshore Wind Farm contributes approximately 9.2% when Option 2 results are applied. The mortality of these additional birds in the breeding season is equal to an increase in baseline mortality of 0.0.81% on the regional breeding population (168,144 individuals) using a baseline mortality rate of 0.081 (Horswill and Robinson, 2015).

10.8.4.68 It is considered likely that a substantial proportion of all birds recorded in the breeding season are immature individuals. In addition, a further proportion are likely to be non-breeding adult birds.

10.8.4.69 The impact of collision on gannet during the breeding season is predicted to be of regional spatial extent, long term duration, continuous and of low to medium reversibility. It is predicted that the impact will affect the receptor directly. As has been illustrated the cumulative collision risk estimate is likely to be a considerable over-estimate for the breeding season due to factors including the age structure of the regional population. On this basis, the impact magnitude is therefore, considered to be **low**.

Post-breeding season

10.8.4.70 In the post-breeding season a total of 485 collisions are estimated to occur with the Moray West Offshore Wind Farm making a small contribution (0.32%) of this total (Table 10.8.10). This level of additional mortality represents a 1.31% increase in baseline mortality (36,960 individuals) of the post-breeding BDMPS population of gannet (456,298 individuals).

10.8.4.71 As an impact that would affect the receptor directly, has a regional spatial extent, is long term in duration, is continuous and of low to medium reversibility, it is predicted that the cumulative collision risk estimate in the post-breeding season would be of low or moderate magnitude. However, there are a number of additional factors that suggest the magnitude of the impact would be lower.

[8] Collision risk modelling for Kincardine used a nocturnal activity factor of 1 for gannet and therefore only the gull correction factor has been applied

Consideration of precaution in the assessment

10.8.4.72 When applying the turbine scenario correction factors calculated by MacArthur Green (2017) (Table 10.8.8), the total in-combination post-breeding season collision risk estimate reduces by 7.3%. In addition, to the reductions in collision risk for the projects included in Table 10.8.5 and paragraph 10.8.4.69, considerable reductions in the number of collisions will occur at the East Anglia One offshore wind farm (which contributes nearly 18% of the total cumulative collision risk), which has committed to reductions in both the total capacity of the wind farm and the number of turbines and the Moray East offshore wind farm (which contributes nearly 10% of the total in-combination collision risk) and projects in the Firth of Forth and Tay (which contribute over 27% of the total in-combination collision risk) which are expected to install a fewer, larger capacity turbines which will likely lead to reductions in the predicted collisions for these projects. Reductions in collision risk are also likely to occur at many other projects at which construction has yet to commence (see Table 10.8.5) with this likely to have a significant effect on the in-combination total predicted for gannet.

Table 10.8.8: Changes to Collision Risk Estimates for Gannet Calculated when Applying the Turbine Scenario Correction Factors from MacArthur Green (2017)

Offshore Wind Farm	Post-Breeding Season		Pre-Breeding Season		Annual	
	No Correction	Corrected	No Correction	Corrected	No Correction	Corrected
Dudgeon	30	14	19	9	49	23
Galloper	24	11	11	5	36	15
Humber Gateway	1	1	0	1	2	1
Kentish Flats Extension	0	0	0	0	0	0
Lincs	1	2	1	2	2	2
Race Bank	6	3	5	2	10	5
Rampion	9	6	2	1	11	8
Sheringham Shoal	2	0	2	0	2	2
Teesside	0	0	0	0	0	0
Westermost Rough	0	0	0	0	0	0
Totals						
Other projects	413		328		851	
Total	485	449	367	347	963	907
% change	7.3		5.5		5.8	

10.8.4.73 Applying the nocturnal activity correction factors presented in Table 10.8.7 the collision risk estimates presented in Table 10.8.10 have been corrected to account for the over-estimation of nocturnal flight activity. When applying the 'minimum' correction factor the number of post-breeding season collisions reduces by 9.1%. It should be noted that this is the minimum by which collision risk estimates would reduce as a result of a change in the nocturnal activity factor used for gannet and that a realistic change would be higher and potentially closer to the collision risk estimates presented in Table 10.8.10 when applying the 'total' correction factor.

Table 10.8.9: Correction to Collision Risk Estimates for Gannet to take Account of the Over-Estimation of Nocturnal Flight Activity					
Season	**Uncorrected Collision Risk Estimate**	**Corrected Collision Risk Estimate**		**Percentage Change**	
		Minimum	**Total**	**Minimum**	**Total**
Post-breeding	485	441	396	9.1	18.3
Pre-breeding	368	336	299	8.6	18.6
Total	963	887	806	7.8	16.3

Summary

10.8.4.74 The impact of collision on gannet during the post-breeding season is predicted to be of regional spatial extent, long term duration, continuous and of low to medium reversibility. It is predicted that the impact will affect the receptor directly. As has been illustrated, the cumulative collision risk estimate presented below is likely to be an over-estimate for the post-breeding season due to factors including the age structure of the regional population, and assessed turbine scenarios that over-estimate results. When these factors are taken into account the impact magnitude is therefore, considered to be **low**.

Pre-breeding season

10.8.4.75 There are estimated to be 367 collisions during the pre-breeding season with the Moray West Offshore Wind Farm contributing a negligible proportion of these collisions (Table 10.8.10). This total represents an increase of 1.83% in the baseline mortality (20,119 individuals) of the pre-breeding BDMPS population of gannet (248,385 individuals).

10.8.4.76 As an impact that would affect the receptor directly, has a regional spatial extent, is long term in duration, is continuous and of low to medium reversibility it is predicted that the cumulative collision risk estimate in the pre-breeding season would be of moderate magnitude. However, there are a number of additional factors that suggest the magnitude of the impact would be lower.

Consideration of precaution in the assessment

10.8.4.77 When applying the turbine scenario correction factors calculated by MacArthur Green (2017) (Table 10.8.8), the total in-combination pre-breeding season collision risk estimate reduces by 5.5%. In addition, there are also likely to be reductions for those projects mentioned in paragraphs 10.8.4.69 and 10.8.4.76 based on the information presented in Table 10.8.5.

10.8.4.78 Applying the nocturnal activity correction factors presented in Table 10.8.7 the collision risk estimates presented in Table 10.8.10 have been corrected to account for the over-estimation of nocturnal flight activity (Table 10.8.9). When applying the ‘minimum’ correction factor the number of pre-breeding season collisions reduces by 8.6%. It should be noted that this is the minimum by which collision risk estimates would reduce as a result of a change in the nocturnal activity factor used for gannet and that a realistic change would be higher and potentially closer to the collision risk estimates presented in Table 10.8.10 when applying the ‘total’ correction factor.

Summary

10.8.4.79 The impact of collision mortality on gannet during the pre-breeding season is predicted to be of regional spatial extent, long term duration, continuous and of low to medium reversibility. It is predicted that the impact will affect the receptor directly. As has been illustrated, the cumulative collision risk estimate presented in Table 10.8.10 is likely to be a considerable over-estimate for the pre-breeding season due to factors including the age structure of the regional population and differences between as-built, consented and assessed turbine scenarios that over-estimate results. When these factors are taken into account the impact magnitude is therefore, considered to be **low**.

10.8.4.80 There are a small number of operational projects situated within the defined non-breeding (i.e. either pre- or post-breeding) BDMPS for gannet that did not assess collision effects in an appropriate quantitative fashion for inclusion in this assessment (e.g. Gunfleet, Lynn and Inner Dowsing). Considering that these projects do not, in general, occur in regions of high gannet abundance and there is significant ‘headroom’ available in the the cumulative total predicted for both seasons compared to 1 % baseline mortality, it is anticipated that no material changes to the impact magnitude would be considered if these projects were incorporated.

Sensitivity of the receptor

10.8.4.81 As a qualifying feature of regional SPAs, gannet is afforded international conservation value. It was ranked high in terms of vulnerability to collisions by Wade *et al*. (2016) although moderate vulnerability by Langston (2010). High vulnerability is considered appropriate within this assessment.

10.8.4.82 Gannet is deemed to be of high vulnerability, high recoverability and international value. The sensitivity of the receptor is therefore, considered to be **medium**.

Significance of the effect

10.8.4.83 Overall, the sensitivity of the receptor is considered to be medium and the impact magnitude is deemed to be low at worst. The effect will therefore be of **minor adverse** significance, which is not significant in EIA terms.

Table 10.8.10: Seasonal Breakdown of Predicted Cumulative Collision Mortality for Gannet

Offshore Wind Farm	Collision Risk Model	Option	Avoidance Rate (%)	Annual Collisions	Breeding	Post-Breeding	Pre-Breeding
Breeding and Non-Breeding Season							
Moray West	Band (2012)	2	98.9	12	10	2	1
Moray East	Band (2012)	1	98.9	96	78	11	7
Beatrice	Band (2012)	1	98.9	42	22	14	5
Non-Breeding Season Only							
Aberdeen Demo	Band (2012)	2	98.9	9		4	0
Blyth Demo	Band *et al.* (2007)	1	98.9	8		1	3
Dogger Bank Creyke Beck A and B	Band (2012)	2	98.9	33		12	9
Dogger Bank Teesside A and Sofia (formerly Dogger Bank Teesside B)	Band (2012)	2	98.9	36		7	11
Dudgeon	Band (2000)	1	98.9	80		30	19
East Anglia One	Band (2012)	2	98.9	178		164	9
East Anglia Three	Band (2012)	1	98.9	56		35	11
Galloper	Band *et al.* (2007)	1	98.9	56		24	11
Greater Gabbard	Band (2000)	1	98.9	28		7	9
Hornsea Project One	Band (2012)	1	98.9	66		22	24
Hornsea Project Two	Band (2012)	2	98.9	27		11	6
Humber Gateway	Not available	1	98.9	4		1	1

Table 10.8.10: Seasonal Breakdown of Predicted Cumulative Collision Mortality for Gannet							
Offshore Wind Farm	**Collision Risk Model**	**Option**	**Avoidance Rate (%)**	**Annual Collisions**	**Breeding**	**Post-Breeding**	**Pre-Breeding**
Hywind	Band (2012)	1	98.9	7		1	2
Inchcape	Band (2012)	1	98.9	365		8	5
Kincardine	Band (2012)	1	98.9	21		1	1
Kentish Flats Extension	Band (2012)	1	98.9	0		0	0
Lincs	Band (2000)	1	98.9	5		1	2
London Array	Band (2000)	1	98.9	6		2	0
Methil	Band (2011/12)	1	98.9	1		0	0
Neart na Gaoithe	Band (2012)	1	98.9	570		24	109
Race Bank	Band (2000)	1	98.9	50		6	4
Rampion	Band (2011)	1	98.9	102		9	2
Seagreen Alpha	Band (2012)	1	98.9	552		18	37
Seagreen Bravo	Band (2012)	1	98.9	364		20	40
Sheringham Shoal	Band (2000)	1	98.9	18		2	0
Teesside	Band (2000)	1	98.9	7		0	0
Thanet	Band (2000)	1	98.9	1		0	0
Triton Knoll	Band (2000)	1	98.9	122		50	40
Westermost Rough	Band *et al.* (2007)	1	98.9	0		0	0
Total				**2,919**	**110**	**485**	**368**

Kittiwake

10.8.4.84 Table 10.8.13 presents a seasonal breakdown of predicted cumulative collision mortality using results from the Basic Band model, for kittiwake.

Magnitude of impact

Breeding season

10.8.4.85 When considering all projects which are within foraging range, the combined breeding season mortality is estimated to be 181 kittiwakes, of which the Moray West Offshore Wind Farm contributes approximately 43%. The mortality of these additional birds in the breeding season is equal to an increase in baseline mortality (5,747 individuals; 1% = 57) of 3.2% on the regional breeding population (39,360 individuals) using a baseline mortality rate of 0.146 (Horswill and Robinson, 2015).

10.8.4.86 As the cumulative collision risk estimate in the breeding season is over 1 % baseline mortality there is potential for the impact magnitude to be considered to be of a moderate level. However, there are a number of additional factors that suggest the magnitude of the impact would be lower.

10.8.4.87 It is considered likely that a proportion of all birds recorded in the breeding season are immature individuals. In addition, a further proportion are likely to be non-breeding adult birds. Analyses undertaken in RIAA Technical Appendix 4.2: Phenology and Apportioning suggests that around 20% of birds at the Moray West Site in the breeding season will be immature birds or breeding adults on 'sabbatical'. The avoidance rate and Band model option applied to the Moray West Offshore Wind Farm and other projects considered cumulatively can be considered to be notably precautionary (Skov *et al.*, 2018). If option 3 at 98% avoidance is applied to Moray West alone, the cumulative total would equate to a change of 1.6% baseline mortality. It is therefore considered that there is a high degree of likelihood that that cumulative breeding total presented here includes an excessive degree of precaution and that it will represent only a minor shift away from baseline conditions for the regional population of kittiwake.

10.8.4.88 On this basis, the impact is predicted to be of regional spatial extent, long term duration, continuous, low to medium reversibility with a notable change from baseline conditions. It is predicted that the impact will affect the receptor directly. The impact magnitude is therefore considered to be **low**.

Post-breeding season

10.8.4.89 In the post-breeding season a total of 1,427 collisions are estimated to occur with the Moray West Offshore Wind Farm contributing a very small proportion of this total (1.7%). This level of additional mortality represents an increase of 1.2% in baseline mortality (121,171 individuals) of the post-breeding BDMPS population of kittiwake (829,937 individuals).

10.8.4.90 As an impact that would affect the receptor directly, has a regional spatial extent, is long term in duration, is continuous and of low to medium reversibility it is predicted that the cumulative collision risk estimate in the post-breeding season would be of low or moderate magnitude. However, there are a number of additional factors that suggest the magnitude of the impact would be at the lower end of this scale.

Consideration of precaution in the assessment

10.8.4.91 When applying the turbine scenario correction factors calculated by MacArthur Green (2017) (Table 10.8.11), the total in-combination post-breeding season collision risk estimate reduces by 2.0%. In addition, to the reductions in collision risk for the projects included in Table 10.8.5 and paragraph 10.8.4.69 considerable reductions in the number of collisions will occur at the East Anglia One offshore wind farm (which contributes over 19% of the total cumulative collision risk), which has committed to reductions in both the total capacity of the wind farm and the number of turbines and the Moray East offshore wind farm (which contributes over 3% of the total in-combination collision risk) and projects in the Firth of Forth and Tay (which contribute over 29% of the total in-combination collision risk) which are expected to install a fewer, larger capacity turbines which will likely lead to reductions in the predicted collisions for these projects. Reductions in collision risk are also likely to occur at many other projects at which construction has yet to commence (see Table 10.8.5), with this likely to have a significant effect on the in-combination total predicted for kittiwake.

Table 10.8.11: Changes to Collision Risk Estimates for Kittiwake Calculated when Applying the Turbine Scenario Correction Factors from MacArthur Green (2017)

Offshore Wind Farm	Post-Breeding Season		Pre-Breeding Season		Annual	
	No Correction	Corrected	No Correction	Corrected	No Correction	Corrected
Galloper	27	11	27	11	54	22
Humber Gateway	2	1	2	1	4	2
Kentish Flats Extension	1	1	1	0	2	1
Lincs	1	1	1	1	2	2
Race Bank	17	10	6	3	22	13
Teesside	13	9	3	2	15	10
Westermost Rough	0	0	0	0	0	0
Totals						
Other projects	1367		1117		2665	
Total	1427	1399	1155	1135	2764	2716
% change	2.0		1.7		1.7	

10.8.4.92 Applying the nocturnal activity correction factors presented in Table 10.8.7, the collision risk estimates presented in Table 10.8.13 have been corrected to account for the over-estimation of nocturnal flight activity (Table 10.8.12). When applying the 'minimum' correction factor the number of post-breeding season collisions reduces by 8.3%. It should be noted that this is the minimum by which collision risk estimates would reduce as a result of a change in the nocturnal activity factor used for kittiwake and that a realistic change would be higher and potentially closer to the collision risk estimates presented in Table 10.8.12 when applying the 'total' correction factor.

Table 10.8.12: Correction to Collision Risk Estimates for Kittiwake to take Account of the Over-Estimation of Nocturnal Flight Activity

Season	Uncorrected Collision Risk Estimate	Corrected Collision Risk Estimate		Percentage Change	
		Minimum	Total	Minimum	Total
Post-breeding	1427	1309	1201	8.3	15.9
Pre-breeding	1155	1060	973	8.2	15.8
Total	2764	2550	2355	7.7	14.8

Summary

10.8.4.93 The impact of collision on kittiwake during the post-breeding season is predicted to be of regional spatial extent, long term duration, continuous and of low to medium reversibility. It is predicted that the impact will affect the receptor directly. As has been illustrated, the cumulative collision risk estimate is likely to be a considerable over-estimate for the post-breeding season due to factors including the age structure of the regional population, differences between as-built, consented and assessed turbine scenarios. When these factors are taken into account the impact magnitude is therefore, considered to be **low.**

Table 10.8.13: Seasonal Breakdown of Predicted Cumulative Collision Mortality for Kittiwake							
Offshore Wind Farm	**Collision Risk Model**	**Option**	**Avoidance Rate (%)**	**Annual Collisions**	**Breeding**	**Post-Breeding**	**Pre-Breeding**
Breeding and Non-Breeding Season							
Moray West	Band (2012)	2	98.9	109	79	24	7
Moray East	Band (2012)	1	98.9	86	73	2	12
Beatrice	Band (2012)	1	98.9	45	30	4	10
Non-Breeding Season Only							
Aberdeen Demo	Band (2012)	2	98.9	19		3	0
Blyth Demo	Band (2011)	1	98.9	5		2	1
Dogger Bank Creyke Beck Projects A and B	Band (2012)	2	98.9	719		107	295
Dogger Bank Teesside Projects A and Sofia (formerly Dogger Bank Teesside B)	Band (2012)	2	98.9	445		79	217
East Anglia One	Band (2012)	2	98.9	581		396	142
East Anglia Three	Band (2012)	1	98.9	106		64	31
Galloper	Band *et al*. (2007)	1	98.9	66		27	27
Greater Gabbard	Band (2000)	1	98.9	28		6	17
Hornsea Project One	Band (2012)	1	98.9	123		43	23
Hornsea Project Two	Band (2012)	1	98.9	27		7	3
Humber Gateway	Not available	1	98.9	7		2	2
Hywind	Band (2012)	1	98.9	18		1	1
Inchcape	Band (2012)	1	98.9	301		224	63

Table 10.8.13: Seasonal Breakdown of Predicted Cumulative Collision Mortality for Kittiwake							
Offshore Wind Farm	**Collision Risk Model**	**Option**	**Avoidance Rate (%)**	**Annual Collisions**	**Breeding**	**Post-Breeding**	**Pre-Breeding**
Kentish Flats Extension	Band (2012)	1	98.9	3		1	1
Kincardine	Band (2012)	2	98.9	19		6	1
Lincs	Band (2000)	1	98.9	3		1	1
London Array	Band (2000)	1	98.9	6		2	3
Methil	Band (2011/12)	1	98.9	1		0	0
Neart na Gaoithe	Band (2012)	1	98.9	93		35	26
Race Bank	Band (2000)	1	98.9	31		17	6
Seagreen Alpha	Band (2012)	1	98.9	371		149	112
Seagreen Bravo	Band (2012)	1	98.9	343		113	85
Teesside	Band (2000)	1	98.9	81		13	3
Thanet	Band (2000)	1	98.9	0		0	0
Triton Knoll	Band (2000)	1	98.9	209		99	67
Westermost Rough	Band *et al*. (2007)	1	98.9	0		0	0
Total				**3,845**	**181**	**1,427**	**1,155**

Pre-breeding season

10.8.4.94 There are estimated to be 1,155 collisions from projects considered cumulatively during the pre-breeding season with the Moray West Offshore Wind Farm contributing less than 1% of these collisions. The total represents a 1.3% increase in the baseline mortality (91,661 individuals) of the pre-breeding BDMPS population of kittiwake (627,816 individuals).

10.8.4.95 As an impact that would affect the receptor directly, has a regional spatial extent, is long term in duration, is continuous and of low to medium reversibility it is predicted that the cumulative collision risk estimate in the pre-breeding season would be of low or moderate magnitude. However, there are a number of additional factors that suggest the magnitude of the impact would be lower.

Consideration of precaution in the assessment

10.8.4.96 When applying the turbine scenario correction factors calculated by MacArthur Green (2017) (Table 10.8.11), the total in-combination pre-breeding season collision risk estimate reduces by 1.7%. In addition, there are also likely to be reductions for those projects mentioned in paragraphs 10.8.4.69 and 10.8.4.91 based on the information presented in Table 10.8.5.

10.8.4.97 Applying the nocturnal activity correction factors presented in Table 10.8.7, the collision risk estimates presented in Table 10.8.13 have been corrected to account for the over-estimation of nocturnal flight activity (Table 10.8.12). When applying the 'minimum' correction factor the number of pre-breeding season collisions reduces by 8.2%. It should be noted that this is the minimum by which collision risk estimates would reduce as a result of a change in the nocturnal activity factor used for kittiwake and that a realistic change would be higher and potentially closer to the collision risk estimates presented in Table 10.8.12 when applying the 'total' correction factor.

Summary

10.8.4.98 The impact of collision on kittiwake during the pre-breeding season is predicted to be of regional spatial extent, long term duration, continuous and of low to medium reversibility. It is predicted that the impact will affect the receptor directly. As has been illustrated the cumulative collision risk estimate presented is likely to be a considerable over-estimate for the pre-breeding season due to factors including the age structure of the regional population, differences between as-built, consented and assessed turbine scenarios. When these factors are taken into account the impact magnitude is therefore, considered to be **low**.

<u>Sensitivity of the receptor</u>

10.8.4.99 Kittiwake was rated as being relatively high vulnerability to collision impacts by Wade *et al.* (2016), due to the proportion of flights likely to occur at potential risk height and percentage of time in flight, including at night. From previous studies in Flanders that have recorded mortality rates and collision rates, estimated micro-avoidance rates were, however, high for smaller gulls (Everaert, 2006; 2008; 2011; Everaert *et al*., 2002; Everaert and Kuijken, 2007). Studies have also shown that rates are consistently above 98% for flights at rotor height (GWFL, 2011).

10.8.4.100 Kittiwake is deemed to be of high vulnerability, low recoverability and international value. The sensitivity of the receptor is therefore, considered to be **high**.

<u>Significance of the effect</u>

10.8.4.101 Overall, the sensitivity of the receptor is considered to be high and the impact magnitude is deemed to be low.

10.8.4.102 On this basis it is judged that the effect is of **minor adverse** significance, which is not significant in EIA terms.

Herring Gull

10.8.4.103 Table 10.8.16 presents a seasonal breakdown of predicted cumulative collision mortality using results from the Extended Band model, where available, for herring gull.

Magnitude of impact

Breeding season

10.8.4.104 When considering all projects which are within foraging range, the combined breeding season mortality is estimated to be 26 herring gulls, of which the Moray West Offshore Wind Farm contributes approximately 45%. The mortality of these additional birds in the breeding season is equal to an increase in baseline mortality (1,937 individuals) of approximately 1.3% on the regional breeding population (11,667 individuals) using a baseline mortality rate of 0.166 (Horswill and Robinson, 2015).

10.8.4.105 As an impact that would affect the receptor directly, has a regional spatial extent, is long term in duration, is continuous and of low to medium reversibility it is predicted that the cumulative collision risk estimate in the breeding season would be of medium magnitude. However, there are a number of additional factors that suggest the magnitude of the impact would be lower.

10.8.4.106 It is considered likely that a substantial proportion of all birds recorded in the breeding season are immature individuals. In addition, a further proportion are likely to be non-breeding adult birds. Site-specific age class data from boat-based surveys conducted for the Moray East Site indicates that at least 15.9% of birds recorded in the breeding season were immature or juvenile birds. Therefore the impact on the regional breeding population is likely to be an overestimate. In addition a proportion of adults every breeding season skip breeding and take a sabbatical from breeding. To include any impacts occurring on any sabbatical birds would seem likely to overestimate the effects to these species/populations (Marine Scotland 2017a, b). Therefore in accordance with Marine Scotland guidance (Marine Scotland 2017a, b), the impacts assigned to sabbaticals should be removed from the assessment. For herring gull the proportion of adults taking a sabbatical is 35% (See RIAA Technical Appendix 4.2: Phenology and Apportioning). It is further noted that tracking work from East Caithness Cliffs in 2014 (Archibald *et al.*, 2014) found that none of the herring gulls fitted with tags foraged within the boundary of the Moray West Site.

10.8.4.107 The impact is predicted to be of regional spatial extent, long term duration, continuous, low to medium reversibility with a potential change from baseline conditions. It is predicted that the impact will affect the receptor directly. The impact magnitude is therefore, considered to be **low.**

Non-breeding season

10.8.4.108 There are estimated to be 318 collisions projects during the non-breeding season with the Moray West Offshore Wind Farm contributing less than 1% of these collisions. The total represents a 0.41% increase in the baseline mortality (77,441 individuals) of the pre-breeding BDMPS population of herring gull (466,511 individuals).

10.8.4.109 As an impact that would affect the receptor directly, has a regional spatial extent, is long term in duration, is continuous and of low to medium reversibility it is predicted that the cumulative collision risk estimate in the pre-breeding season would be of low magnitude. However, there are a number of additional factors that suggest the magnitude of the impact would be lower.

Consideration of precaution in the assessment

10.8.4.110 When applying the turbine scenario correction factors calculated by MacArthur Green (2017) (Table 10.8.14, the total in-combination non-breeding season collision risk estimate reduces by 6.4%. In addition, to the reductions in collision risk for the projects included in Table 10.8.5 and paragraph 10.8.4.69, considerable reductions in the number of collisions will occur at the East Anglia One offshore wind farm (which contributes over 14% of the total cumulative collision risk), which has committed to reductions in both the total capacity of the wind farm and the number of turbines and the Moray East offshore wind farm (which contributes over 16% of the total in-combination collision risk) and projects in the Firth of Forth and Tay (which contribute over 17% of the total in-combination collision risk) which are expected to install a fewer, larger capacity turbines which will likely lead to reductions in the predicted collisions for these projects. Reductions in collision risk are also likely to occur at many other projects at which construction has yet to commence (see Table 10.8.5), with this likely to have a significant effect on the in-combination total predicted for herring gull.

Table 10.8.14: Changes to Collision Risk Estimates for Herring Gull Calculated when Applying the Turbine Scenario Correction Factors from MacArthur Green (2017)

Offshore Wind Farm	Non-Breeding Season		Annual	
	No Correction	Corrected	No Correction	Corrected
Galloper	17	6	17	6
Humber Gateway	1	0	1	0
Kentish Flats Extension	1	1	1	1
Teesside	25	16	25	16
Westermost Rough	0	0	0	0
Totals				
Other projects	274		300	
Total	318	297	344	323
% change	6.4		5.9	

10.8.4.111 Applying the correction factors presented in Table 10.8.7 the collision risk estimates presented in Table 10.8.15 have been corrected to account for the over-estimation of nocturnal flight activity. When applying the 'minimum' correction factor the number of non-breeding season collisions reduces by 6.0%. It should be noted that this is the minimum by which collision risk estimates would reduce as a result of a change in the nocturnal activity factor used for herring gull and that a realistic change would be higher and potentially closer to the collision risk estimates presented in Table 10.8.14 when applying the 'total' correction factor.

Table 10.8.15: Correction to Collision Risk Estimates for Herring Gull to take Account of the Over-Estimation of Nocturnal Flight Activity

Season	Uncorrected Collision Risk Estimate	Corrected Collision Risk Estimate		Percentage Change	
		Minimum	Total	Minimum	Total
Non-breeding	318	299	278	6.0	12.4
Total	344	325	304	5.6	11.5

Table 10.8.16: Seasonal Breakdown of Predicted Cumulative Collision Mortality for Herring Gull						
Offshore Wind Farm	**Collision Risk Model**	**Option**	**Avoidance Rate (%)**	**Annual Collisions**	**Breeding**	**Non-Breeding**
Breeding and Non-Breeding Season						
Moray West	Band (2012)	2	98.9	13	12	1
Moray East	Band (2012)	1	98.9	58	6	51
Beatrice	Band (2012)	1	98.9	69	8	61
Non-Breeding Season Only						
Aberdeen Demo	Band (2012)	2	99.5	5		2
Blyth Demo	Band (2011)	1	99.5	11		6
East Anglia One	Band (2012)	1	99.5	57		49
East Anglia Three	Band (2012)	1	99.5	19		19
Galloper	Band *et al.* (2007)	1	99.5	20		17
Hornsea Project One	Band (2012)	1	99.5	14		13
Humber Gateway	Not available	1	99.5	2		1
Hywind	Band (2012)	1	99.5	8		5
Inchcape	Band (2012)	1	99.5	13		13
Kentish Flats Extension	Band (2012)	1	99.5	2		1
Kincardine	Band (2012)	1	99.5	1		1
Neart na Gaoithe	Band (2012)	1	99.5	32		26
Seagreen Alpha	Band (2012)	1	99.5	19		13
Seagreen Bravo	Band (2012)	1	99.5	12		8
Teesside	Band (2000)	1	99.5	43		25
Thanet	Band (2000)	1	99.5	9		6
Westermost Rough	Band *et al.* (2007)	1	99.5	0		0

Table 10.8.16: Seasonal Breakdown of Predicted Cumulative Collision Mortality for Herring Gull						
Offshore Wind Farm	**Collision Risk Model**	**Option**	**Avoidance Rate (%)**	**Annual Collisions**	**Breeding**	**Non-Breeding**
Total				**406**	**26**	**318**

Sensitivity of the receptor

10.8.4.112 Herring gull was rated as being very highly vulnerable to collision impacts by Wade *et al*. (2016), due to the proportion of flights likely to occur at potential risk height and percentage of time in flight, including at night.

10.8.4.113 Herring gull is deemed to be of very high vulnerability, medium recoverability and international value. The sensitivity of the receptor is therefore, considered to be **high**.

Significance of the effect

10.8.4.114 Overall, the sensitivity of the receptor is considered to be high and the impact magnitude is deemed to be low. Consequently, the effect could be either minor or moderate adverse significance. Where an assessment concludes a significance that falls between two categories the EIA methodology states that expert judgement should be used in order to determine the significance of the impact. The assessment presented in the above sections is based on conservative assumptions, including the use of a breeding regional population that is based only on breeding adult birds (excluding immature and non-breeding adult birds) whereas the predicted collision rate is based on the observed birds at Moray West which will include immature and non-breeding adults.

10.8.4.115 On this basis it is judged that the effect is of **minor adverse** significance, which is not significant in EIA terms.

Great Black-Backed Gull

10.8.4.116 Table 10.8.19 presents a seasonal breakdown of predicted cumulative collision mortality using results from the Extended Band model, where available, for great black-backed gull.

Magnitude of impact

Breeding season

10.8.4.117 When considering all projects which are within foraging range, the combined breeding season mortality is estimated to be 40 great black-backed gulls, of which the Moray West Offshore Wind Farm contributes approximately 10%. The mortality of these additional birds in the breeding season is equal to an increase in baseline mortality (18.6 individuals) of approximately 217% on the regional breeding population (266 individuals) using a baseline mortality rate of 0.07 (Horswill and Robinson, 2015).

10.8.4.118 As an impact that would affect the receptor directly, has a regional spatial extent, is long term in duration, is continuous and of low to medium reversibility it is predicted that the cumulative collision risk estimate in the breeding season would be of moderate magnitude. However, there are a number of additional factors that suggest the magnitude of the impact would be lower.

10.8.4.119 It is considered likely that a substantial proportion of all birds recorded in the breeding season are immature individuals. In addition, a proportion of adults every breeding season skip breeding and take a sabbatical. To include any impacts occurring on any sabbatical birds would seem likely to overestimate the effects to these species/populations (Marine Scotland 2017a, b). Therefore in accordance with Marine Scotland guidance (Marine Scotland 2017a,b), the impacts assigned to sabbaticals should be removed from the assessment. For great black-backed gull the proportion of adults taking a sabbatical is 35% (See RIAA Technical Appendix 4.2: Phenology and Apportioning). It is further noted that tracking work from East Caithness Cliffs in 2014 (Archibald *et al*., 2014) found that none of the great black-backed gulls fitted with tags foraged within the boundary of the Moray West Site.

10.8.4.120 The impact is predicted to be of regional spatial extent, long term duration, continuous, low to medium reversibility with a potential change from baseline conditions. It is predicted that the impact will affect the receptor directly. The impact magnitude is therefore, considered to be **low.**

Non-breeding season

10.8.4.121 There are estimated to be 631 collisions projects during the non-breeding season with the Moray West Offshore Wind Farm contributing less than 1% of these collisions. The total represents a 9.9% increase in the baseline mortality (6,398 individuals) of the pre-breeding BDMPS population of great black-backed gull (91,399 individuals).

10.8.4.122 As an impact that would affect the receptor directly, has a regional spatial extent, is long term in duration, is continuous and of low to medium reversibility it is predicted that the cumulative collision risk estimate in the non-breeding season would be of medium magnitude. However, there are a number of additional factors that suggest the magnitude of the impact would be lower.

Consideration of precaution in the assessment

10.8.4.123 When applying the turbine scenario correction factors calculated by MacArthur Green (2017) (Table 10.8.17) the total in-combination breeding season collision risk estimate reduces by 4.1%. In addition, to the reductions in collision risk for the projects included in Table 10.8.5 and paragraph 10.8.4.69 considerable reductions in the number of collisions will occur at the East Anglia One offshore wind farm (which contributes over 18% of the total cumulative collision risk), which has committed to reductions in both the total capacity of the wind farm and the number of turbines and the Moray East offshore wind farm (which contributes over 5% of the total in-combination collision risk) and projects in the Firth of Forth and Tay (which contribute over 15% of the total in-combination collision risk) which are expected to install a fewer, larger capacity turbines which will likely lead to reductions in the predicted collisions for these projects. Reductions in collision risk are also likely to occur at many other projects at which construction has yet to commence (see Table 10.8.5), with this likely to have a significant effect on the in-combination total predicted for great black-backed gull.

Table 10.8.17: Changes to Collision Risk Estimates for Great Black-Backed Gull Calculated when Applying the Turbine Scenario Correction Factors from MacArthur Green (2017)

Offshore Wind Farm	Non-Breeding Season		Annual	
	No Correction	Corrected	No Correction	Corrected
Galloper	21	9	21	9
Humber Gateway	4	2	4	2
Kentish Flats Extension	0	0	0	0
Teesside	35	24	35	24
Westermost Rough	0	0	0	0
Totals				
Other projects	570		611	
Total	631	605	671	645
% change	4.1		3.8	

10.8.4.124 Applying the correction factors presented in Table 10.8.7 the collision risk estimates presented in Table 10.8.19 have been corrected to account for the over-estimation of nocturnal flight activity . When applying the 'minimum' correction factor the number of breeding season collisions reduces by 8.6%. It should be noted that this is the minimum by which collision risk estimates would reduce as a result of a change in the nocturnal activity factor used for great black-backed gull and that a realistic change would be higher and potentially closer to the collision risk estimates presented in Table 10.8.18 when applying the 'total' correction factor.

Table 10.8.18: Correction to Collision Risk Estimates for Great Black-Backed Gull to take Account of the Over-Estimation of Nocturnal Flight Activity					
Season	**Uncorrected Collision Risk Estimate**	**Corrected Collision Risk Estimate**		**Percentage Change**	
		Minimum	**Total**	**Minimum**	**Total**
Non-breeding	631	576	518	8.6	17.8
Total	671	616	558	8.1	16.8

Summary

10.8.4.125 The impact is predicted to be of regional spatial extent, long term duration, continuous, low to medium reversibility with a slight change from baseline conditions. It is predicted that the impact will affect the receptor directly. The impact magnitude is therefore, considered to be **low.**

Sensitivity of the receptor

10.8.4.126 Great black-backed gull was assessed as the seabird species most vulnerable to collision impacts by Wade *et al.* (2016), mainly due to the high proportion of flights at potential collision heights, and the percentage of time in flight, including at night.

10.8.4.127 In summary, great black-backed gull is deemed to be of very high vulnerability, medium recoverability and national value. The sensitivity of the receptor is therefore, considered to be **medium**.

Significance of the effect

10.8.4.128 Overall, the sensitivity of the receptor is considered to be medium sensitivity and the impact magnitude is deemed to be low. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

Table 10.8.19: Seasonal Breakdown of Predicted Cumulative Collision Mortality for Great Black-Backed Gull						
Offshore Wind Farm	**Collision Risk Model**	**Option**	**Avoidance Rate (%)**	**Annual Collisions**	**Breeding**	**Non-Breeding**
Breeding and Non-Breeding Season						
Moray West	Band (2012)	2	99.5	9	4	5
Moray East	Band (2012)	1	99.5	35	23	12
Beatrice	Band (2012)	1	99.5	45	14	31
Non-Breeding Season Only						
Aberdeen Demo	Band (2012)	2	99.5	3		2
Blyth Demo	Band (2007)	1	99.5	8		5
Dogger Bank Creyke Beck A and B	Band (2012)	2	99.5	33		28
Dogger Bank Teesside A and Sofia (formerly Dogger Bank Teesside B)	Band (2012)	2	99.5	37		29
East Anglia ONE	Band (2012)	2	99.5	124		122
East Anglia Three	Band (2012)	2	99.5	42		37
Galloper	Band (2007)	1	99.5	22		21
Hornsea Project One	Band (2012)	1	99.5	86		71
Hornsea Project Two	Band (2012)	2	99.5	23		18
Humber Gateway	Not available	1	99.5	6		4
Hywind	Band (2012)	1	99.5	5		5
Inchcape	Band (2012)	1	99.5	37		37
Kentish Flats Extension	Band (2007)	1	99.5	0		0
Neart na Gaoithe	Band (2012)	1	99.5	8		7
Seagreen Alpha	Band (2012)	2	99.5	37		31

Table 10.8.19: Seasonal Breakdown of Predicted Cumulative Collision Mortality for Great Black-Backed Gull						
Offshore Wind Farm	**Collision Risk Model**	**Option**	**Avoidance Rate (%)**	**Annual Collisions**	**Breeding**	**Non-Breeding**
Seagreen Bravo	Band (2012)	2	99.5	30		23
Teesside	Band (2000)	1	99.5	44		35
Thanet	Band (2000)	1	99.5	0		0
Triton Knoll	Band (2000)	1	99.5	122		106
Westermost Rough	Band (2007)	1	99.5	0		0
Total				**755**	**40**	**631**

10.9 Conclusion

10.9.1.1 The identified impacts for the Development alone will have no more than a minor adverse effect on most receptors at a regional or national level. On this basis, there is no indication, that the Development alone will have a significant effect on these Valued Ornithological Receptors. When considering the cumulative effects of the Development together with other projects and activities, there are also no more than minor adverse effects predicted.

References

Alerstam, T., Rosén, M., Bäckman, J., Ericson, P.G.P. and Hellgren, O. (2007). Flight speeds among Bird Species: Allometric and Phylogenetic Effects. *PLoS Biology*, 5 (8), 1656-1662.

Archibald., K., Evans, D. and Votier, S. (2014). *East Caithness Cliffs SPA gull Tracking Report 2014*. Environment & Sustainability Institute, University of Exeter.

Band, B. (2011). *Using a collision risk model to assess bird collision risks for offshore wind farms*. The Crown Estate Strategic Ornithological Support Services (SOSS) report SOSS-02. Norfolk, British Trust for Ornithology.

Band, B. (2012). *Using a collision risk model to assess bird collision risks for offshore wind farms*. The Crown Estate Strategic Ornithological Support Services (SOSS) report SOSS-02. Norfolk, British Trust for Ornithology.

Band, W. (2000). *Wind farms and Birds: calculating a theoretical collision risk assuming no avoiding action*. Scottish Natural Heritage Guidance Note.

Band, W., Madders, M., and Whitfield, D.P. (2007). Developing field and analytical methods to assess avian collision risk at wind farms. In: de Lucas, M., Janss, G.F.E. and Ferrer, M. (eds.) Birds *and Wind Farms: Risk Assessment and Mitigation*. Madrid, Quercus. p. 259-275.

Barrow Offshore Wind Ltd. (2009). Post *Construction Monitoring Report for Barrow Offshore Wind Farm*. Barrow Offshore Wind Ltd., Copenhagen.

Beatrice Offshore Wind Farm Limited. (2012). *Ornithological HRA Technical Report*. RPS report to BOWL.

BirdLife International (2017) BirdLife International Species Factsheets. [online] Available at: <http://www.birdlife.org/datazone> [Accessed December 2017].

Bradbury, G., Trinder, M., Furness, B., Banks, A.N., Caldow, R.W.G. and Hume, D. (2014). Mapping Seabird Sensitivity to Offshore Wind Farms. *PLOS ONE*, 12 (1), 1-17.

Burton, N.H.K., Banks, A.N., Calladine, J.R. and Austin, G.E. (2013). The importance of the United Kingdom for wintering gulls: population estimates and conservation requirements. *Bird Study*, 60 (1), 87-101.

Cabot, D. (2009). *Wildfowl*. Harper Collins, London.

Camphuysen, C.J., Fox, T., Leopold, M.F. and Petersen, I.K. (2004). *Towards standardised seabirds at sea census techniques in connection with environmental impact assessments for offshore wind farms in the UK*. A report for COWRIE.

CIEEM (2010). *Guidelines for Ecological Impact Assessment in Britain and Ireland: Marine and Coastal*. Winchester, Institute of Ecology and Environmental Management.

Cook, A.S.C.P., Humphreys, E.M., Masden, E.A. and Burton, N.H.K. (2014). The *avoidance rates of collision between birds and offshore turbines.* Thetford, British Trust for Ornithology.

Coulson, J. (2011). The Kittiwake. Poyser monographs series.

Coulson, J. C., Monaghan, P., Butterfield, J. E. L., Duncan, N., Ensor, K., Shedden, C. and Thomas, C. 1984. Scandinavian Herring Gulls wintering in Britain. *Ornis Scand*. 15, 79-88

Cramp, S. and Perrins, C.M. (1977 - 1994). *Handbook of the birds of Europe, the Middle East and Africa. The birds of the western Palearctic*. Oxford, Oxford University Press.

DECC (2011). *Department of Energy and Climate Change - Offshore Energy Strategic Environmental Assessment: OESEA2 Environmental Report - Future Leasing/Licensing for Offshore Renewable Energy, Offshore Oil and Gas, Hydrocarbon Gas and Carbon Dioxide Storage and Associated Infrastructure*. Department for Energy and Climate Change, February 2011. URN 10D/1024.

del Hoyo, J.; Elliott, A. and Sargatal, J. (1996). *Handbook of the Birds of the World, vol. 3: Hoatzin to Auks*. Barcelona, Lynx Edicions.

Desholm, M. (2005). *TADS investigations of avian collision risk at Nysted Offshore Wind Farm*. Denmark, National Environmental Research Institute.

Dierschke, V. and Garthe, S. (2006). Literature review of offshore wind farms with regards to seabirds. In: Zucco, C., Wende, W., Merck, T., Köchling, I. and Köppel, J. (eds.): *Ecological research on offshore wind farms: international exchange of experiences. Part B: literature review of ecological impacts*. BfN-Skripten 186, 131–198.

Dierschke, V., Garthe, S. and Mendel, B. (2006). *Possible conflicts between offshore wind farms and seabirds in the German sectors of North Sea and Baltic Sea*. In: Köller, J., Köppel, H. and Peters, W. (Eds.): Offshore wind energy. Research on environ mental impacts. Berlin, Springer. p 121-143.

Drewitt, A.L. and Langston, R.H.W. (2006). Assessing the impacts of wind farms on birds. *Ibis*, 148. 29-42.

Eaton, M.A., Aebischer, N.J., Brown, A.F., Hearn, R., Lock, L., Musgrove, A.J., Noble, D., Stroud, D. and Gregory, R.D. (2015). *Birds of Conservation Concern 4: the population status of birds in the United Kingdom, Channel Islands and the Isle of Man*. *British Birds* 108, 708-746.

ECON (2012). *Boat-based ornithological monitoring at the Lynn and Inner Dowsing Wind Farms: Year 3 (2011) post-construction report*. Report for Centrica Renewable Energy Limited.

Everaert, J. (2006). Wind turbines and birds in Flanders: preliminary study results and recommendations. Natuur. *Oriolus*, 69(4), 145-155.

Everaert, J. (2008). *Effecten van windturbines op de fauna in Vlaanderen : onderzoeksresultaten, discussie en aanbevelingen. Effects of wind turbines on fauna in Flanders - Study results, discussions and recommendations*. Rapporten van het Instituut voor Natuur- en Bosonderzoek, 2008(44). Instituut voor Natuur- en Bosonderzoek: Brussel : Belgium.

Everaert, J., Devos, K. and Kuijken, E. (2002). *Windturbines en vogels in Vlaanderen. Voorlopige onderzoeksresultaten en buitenlandse bevindingen*. Report 2002.3, Instituut voor Natuurbehoud,Brussels. Available at http://publicaties.vlaanderen.be/docfolder/12563/Effecten_windturbines_op_de_fauna_Vlaanderen_2008.pdf.

Everaert, J. and Kuijken, E. (2007). *Wind turbines and birds in Flanders (Belgium): Preliminary summary of the mortality research results*. Belgian Research Institute for Nature and Forest.

Exo, K-M., Hüppop, O. and Garthe, S. (2003). *Offshore-Windenergieanlagen und Vogelschutz*. Seevögel 23, 83-95.

Forrester, R.W., Andrews, I.J., McInerny, C.J., Murray, R.D., McGowan, R.Y., Zonfrillo, B., Betts, M.W., Jardine, D.C. and Grundy, D.S. (eds) (2007). *The Birds of Scotland*. Aberlady, The Scottish Ornithologists' Club.

Frederiksen, M. *et al.* (2012). Multicolony tracking reveals the winter distribution of a pelagic seabird on an ocean basin scale. *Diversity Distrib*. 18, 530–542.

Furness, R.W. (2015). Non-*breeding season populations of seabirds in UK waters. Population sizes for Biologically Defined Minimum Population Scales (BDMPS*). Natural England Commissioned Report NECR164.

Furness, R.W., Wade, H.M. and Masden, E.A. (2013). Assessing vulnerability of marine bird populations to offshore wind farms. *Journal of Environmental Management*, 119, 56-66.

Furness, R.W. and Todd, C.M. (1984). Diets and feeding of Fulmars *Fulmarus glacialis* during the breeding season:a comparison between St Kilda and Shetland colonies. *Ibis,* 126 (3), pp. 379-387.

Garthe, S. and Hüppop, O. (2004). Scaling possible adverse effects of marine wind farms on seabirds: developing and applying a vulnerability index. *Journal of Applied Ecology*, 41, 724- 734.

Goodale W. and T. Divoll. (2009). *Birds, Bats and Coastal Wind Farm Development in Maine: A Literature Review*. Report BRI 2009-18. Gorham, Maine, BioDiversity Research Institute.

Guse, N., Garthe, S. & Schirmeister, B. (2009). Diet of red-throated divers *Gavia stellata* reflects the seasonal availability of Atlantic herring Clupea harengus in the southwestern Baltic sea. *Journal of Sea Research,* 62: 268-275.

GWFL (2011). *Galloper Wind Farm Project Environmental Statement - Chapter 11: Offshore Ornithology*.

Harris, M.P., Daunt, F., Newell, M., Phillips, R.A. and Wanless, S. (2010). Wintering areas of adult Atlantic puffins Fratercula arctica from a North Sea colony as revealed by geolocation technology. *Marine Biology*, 157(4), pp.827-836.

Horswill, C. & Robinson R. A. (2015). Review of seabird demographic rates and density dependence. *JNCC Report No. 552.* Joint Nature Conservation Committee, Peterborough

Hüppop, O., Dierschke, J., Exo, K-M., Fredrich, E. and Hill, R. (2006). Bird migration studies and potential collision risk with offshore wind turbines. *Ibis*, 148, 90-109.

ICES (2011). Effects of offshore wind farms on seabirds. p.12-17. *In*: *Report of the Working Group on Seabird Ecology (WGSE)* 1-4 November 2011. Madeira, Portugal. p. 73. CM2011/SSGEF:07. ICES, Copenhagen.

Institute of Environmental Management and Assessment (IEMA) (2004*) Guidelines for Environmental Impact Assessment.*

Jessopp, M.J., Cronin, M., Doyle, T.K., Wilson, M., McQuatters-Gollop, A., Newton, S. and Phillips, R.A. (2013). Transatlantic migration by post-breeding puffins: a strategy to exploit a temporarily abundant food resource?. *Marine biology*, 160(10), pp.2755-2762.

JNCC (2017). Seabird Monitoring Programme database. [Online]. Available at: http://jncc.defra.gov.uk/smp/ (Accessed March 2018).

JNCC (2016). Online species accounts for SPA species. [Online]. Available at http://www.jncc.gov.uk/page-1419 (Accessed March 2018).

JNCC (2014). *Joint Response from the Statutory Nature Conservation Bodies to the Marine Scotland Science Avoidance Rate Review*. Joint Nature Conservation Committee (JNCC), Natural England (NE), Natural Resource Wales (NRW), Northern Ireland Environment Agency (NIEA), Scottish Natural Heritage (SNH).

JNCC (2013). *Seabird Population Trends and Causes of Change: 1986-2015 Report*. [Online]. Available at: http://jncc.defra.gov.uk/page-3201 (Accessed March 2018).

JNCC, Natural Resources Wales, Department of Agriculture, Environment and Rural Affairs/Northern Ireland Environment Agency, Natural England and Scottish Natural Heritage, (2017). *Joint SNCB Interim Displacement Advice Note*. [Online]. Available at: http://jncc.defra.gov.uk/pdf/Joint_SNCB_Interim_Displacement_AdviceNote_2017.pdf (Accessed May 2017).

Johnston, A., Cook, A.S.C.P., Wright, L.J., Humphreys, E.M. and Burton, N.H.K. (2014). Modelling flight heights of marine birds to more accurately assess collision risk with offshore wind turbines. *Journal of Applied Ecology*, 51, 31-41.

Kaiser, M. Elliot, A,. Galanidi, M., Rees, E.I.S., Caldow, R., Stillman, R., Sutherland, W. & Showler, D. (2002). *Predicting the displacement of Common Scoter Melanitta nigra from benthic feeding areas due to offshore windfarms*. Report Cowrie-BEN-03-2002. University of Wales, Bangor.

Kerlinger, P. and Curry, R. (2002). *Desktop Avian Risk Assessment for the Long Island Power Authority Offshore Wind Energy Project*. Prepared for AWS Scientific Inc. and Long Island Power Authority.

King, S., Maclean, I.M.D., Norman, T., and Prior, A. (2009). *Developing Guidance on Ornithological Cumulative Impact Assessment for Offshore Wind Farm Developers*. COWRIE.

Kober. K., Webb. A., Win. I., Lewis. M., O'Brien. S., Wilson. L.J., Reid. J.B. (2010*). An analysis of the numbers and distribution of seabirds within the British Fishery Limit aimed at identifying areas that qualify as possible marine SPAs*. JNCC Report, No. 431.

Kotzerka. J., Garthe. S. and Hatch. S.A. (2010). GPS tracking devices reveal foraging strategies of Black-legged Kittiwakes. *Journal of Ornithology*. 151. 459-467.

Krijgsveld, K.L., Fijn, R.C., Heunks, C.P., van Horssen, W., de Fouw, J., Collier, M.P., Poot, M.J.M., Beuker, D. and Dirksen, S. (2010). *Effect Studies Offshore Wind Farm Egmond aan Zee. Progress report on fluxes and behaviour of flying birds covering 2007 and 2008*. Bureau Waardenburg report 09-023. Bureau Waardenburg, Culemborg.

Krijgsveld, K.L., Fijn, R.C., Japink, M., van Horssen, P.W., Heunks, C., Collier, M.P., Poot, M.J.M., Beuker, D. and Dirksen, S. (2011). *Effect studies Offshore Wind Farm Egmond aan Zee: Final report on fluxes, flight altitudes and behaviour of flying birds*. NoordzeeWind report nr OWEZ_R_231_T1_20111114_fluxandflight, Bureau Waardenburg report nr 10-219.

Lack, P. (Ed) (1986). *The atlas of wintering birds in Britain and Ireland*. T. and A.D. Poyser, Calton.

Langston, R.H.W. (2010). *Offshore wind farms and birds: Round 3 zones, extensions to Round 1 and 2 sites and Scottish Territorial Waters*. RSPB Research Report No. 39.

Leopold, M.F., Dijkman, E.M., Teal, L. and the OWEZ-team (2010). *Local birds in and around the Offshore Wind Farm Egmond aan Zee (OWEZ). NoordzeeWind rapport OWEZ_R_221_T1_20100731_local_birds*. Imares / NoordzeeWind, Wageningen / IJmuiden.

Leopold, M.F., Dukman, E.M., and Teal, L. (2011). *Local Birds in and around the Offshore Wind Farm Egmond aan Zee (OWEZ) (T-0 and T-1, 2002-2010)*. Texel, The Netherlands, Wageningen IMARES.

Longcore, T. and Rich, C. (2004). Ecological light pollution. Frontiers in Ecology and the Environment/Ecological Society of America, 2 (4), 191-198.

MacArthur Green Ltd. (2017). *Estimates of Ornithological Headroom in Offshore Wind Farm Collision Mortality*. Report to Crown Estate.

Maclean, I.M.D., Wright, L.J., Showler, D.A., and Rehfisch, M.M. (2009). A *review of assessment methodologies for offshore wind farms*. British Trust for Ornithology Report, commissioned by COWRIE Ltd.

Marine Scotland (2017). *The Conservation (Natural Habitats, & c.) Regulations 1994. The Offshore Marine Conservation (Natural Habitats, &c.) Regulations, 2007*. Offshore Habitats Regulations Appraisal Screening Opinion on the Moray West Offshore Wind Farm to be Located in the Outer Moray Firth Approximately 22 km South of the Caithness Coastline. October 2017.

Masden, E.A., Haydon, D.T., Fox, A.D. & Furness, R.W. (2010). Barriers to movement: modelling energetic costs of avoiding marine wind farms amongst breeding seabirds. *Marine Pollution Bulletin* 60: 1085-1091.

Masden, E.A. (2015). *Developing an avian collision risk model to incorporate variability and uncertainty*. Environmental Research Institute North Highland College – UHI University of the Highlands and Islands.

Mendel, B., Kotzerka, J., Commerfield, J., Schwemmer, H., Sonntag, N. and Garthe, S. (2014). *Effects of the* alpha ventus *offshore test site on distribution patterns, behaviour and flight heights of seabirds*. Federal Maritime and Hydrographic Agency

Mitchell, P.I., Newton, S.F., Ratcliffe, N. and Dunn, T.E. (2004). *Seabird populations of Britain and Ireland*. Poyser, London.

Moray Offshore Renewables Ltd. (2012) *Environmental Statement: Technical Appendix 4.5A – Ornithology Baseline and Impact Assessment.*

MS-LOT (2017) *Scoping Opinion. Addendum: Ornithology.* [Online]. Available at: http://www.gov.scot/Resource/0052/00521151.pdf (Accessed June 2018).

Musgrove, A.J., Aebicher, N.J., Eaton, M.A., Hearn, R.D., Newson, S.E., Noble, D.G., Parsons, M., Risely, K. and Stroud, D.A. (2013). Population estimates of birds in Great Britain and the United Kingdom. *British Birds*, 106, 64-100.

Nelson, E., Vallejo, G., Canning, S., Kerr, D., Caryl, F., McGregor, R., Rutherford, V. and Lancaster, J. (2015) *Analysis of Marine Ecology Monitoring Plan Data – Robin Rigg Offshore Wind Farm*. [Online]. Available at: http://www.gov.scot/Topics/marine/Licensing/marine/scoping/Robin-Rigg (Accessed March 2018).

nPower Renewables (2008). *North Hoyle Offshore Wind Farm FEPA Monitoring Final Report*.

Pennington M., Osborn K., Harvey P., Riddington R., Okill D., Ellis P. and Heubeck M. (2004). *Birds of Shetland*. Christopher Helm.

Percival, S.M. (2009). *Kentish Flats Offshore Wind Farm: Review of Monitoring of Red Throated Divers 2008-2009*. Ecology Consulting report to Vattenfall.

Percival, S.M. (2010). Kentish Flats Offshore Wind farm: Diver surveys 2009-2010. On behalf of Vattenfall Wind Power.

Petersen, I.K., Christensen, T.K., Kahlert, J., Desholm, M. and Fox, A.D. (2006). *Final results of bird studies at the offshore wind farms at Nysted and Horns Rev, Denmark*. NERI Report Commissioned by Ørsted and Vattenfall A/S 2006. National Environmental Research Institute Ministry of the Environment-Denmark, Denemarken.

Petersen, I.K. and Fox, A.D. (2007). *Changes in bird habitat utilization around the Horns Rev 1 offshore wind farm, with particular emphasis on Common Scoter*. National Environmental Research Institute, p. 36.

Pennycuick, C.J. (1997). Actual and "optimum" flight speeds: field data reassessed. Journal of *Experimental Biology*, 200, 2355-2361.

Robinson, R.A. (2017). *BirdFacts: profiles of birds occurring in Britain and Ireland*. [Online]. Available at: http://www.bto.org/birdfacts (Accessed March 2018)

RPS (2012). *Lincs / LID6 Offshore Wind Farm – Boat-based Ornithological Monitoring: Construction Phase*. Report for CREL.

Ruddock, M. and Whitfield, D.P., (2007). *A Review of Disturbance Distances in Selected Bird Species.* [Online]. Available at: http://www.snh.org.uk/pdfs/strategy/renewables/birdsd.pdf (Accessed March 2013).

Schwemmer, P., Mendel, B., Sonntag, N., Dierschke, V. and Garthe, S. (2011). *Effects of ship traffic on seabirds in offshore waters: implications for marine conservation and spatial planning*. Ecological Applications 21: 1851-1860

Scottish Government. 2011. *Habitats Regulations Appraisal of Draft Plan for Offshore Wind Energy in Scottish Territorial Waters: Pre-Screening Review of the Medium Term Options*. Available at: http://www.gov.scot/Publications/2011/03/04165201/6 (Accessed May 2018).

Scottish Natural Heritage (2012). *Population trends of breeding seabirds colonies in Scottish SPAs*. SNH Report.

Scottish Natural Heritage (2013). *A handbook on environmental impact assessment*. 4th edition.

Scottish Natural Heritage (2016). *Moray Firth Proposed Special Protection Area (pSPA): SPA Site Selction Document: Summary of the scientific case for site selection*.

Scottish Natural Heritage (2017a). *2016-17 Marine bird proposed Special Protection Areas consultation (pSPAs) - consultation closed*. [online] Available at: <https://www.nature.scot/2016-17-marine-bird-proposed-special-protection-areas-consultation-pspas-consultation-closed> [Accessed March 2018].

Scottish Natural Heritage (2017b). Sitelink. [online] Available at: <https://gateway.snh.gov.uk/sitelink/> [Accessed March 2018].

Searle, K.R., Mobbs, D., Butler, A., Bogdanova, M., Freeman, S., Wanless, S. & Daunt, F. (2014). Population Consequences of Displacement from Proposed Offshore Wind Energy Developments for Seabirds Breeding at Scottish SPAs (CR/2012/03). Report to Marine Science Scotland. http://www.gov.scot/Resource/0040/00404982.pdf

Searle, K.R., Butler, A., Mobbs, D., Bogdanova, M., Freeman, S., Wanless, S., Bolton, M., & Daunt, F. (2015). *At-sea turnover of breeding seabirds* (MSQ-0103). Report to Marine Science Scotland. http://www.gov.scot/Publications/2015/06/2797

Skov, H., Heinanen, S., Norman, T., Ward, R.M., Mendez-Roldan, S. & Ellis, I. 2018. *ORJIP Bird Collision and Avoidance Study*. Final report ‑ April 2018. The Carbon Trust. United Kingdom. 247 pp.

Stone, C.J., Webb, A., Barton, C., Ratcliffe, N., Redd, T.C., Tasker, M.L., Camphuysen, C.J. and Pienkowski, M.W. (1995). *An atlas of seabird distribution in north-west European waters*. Joint Nature Conservation Committee and Nederlands Institute voor Onderzoek der Zee, Peterborough.

Thaxter, C.B., Lascelles, B., Sugar, K., Cook, A.S.C.P., Roos, S., Bolton, M., Langton, R.H.W. and Burton, N.H.K. (2012). Seabird foraging ranges as a preliminary tool for identifying candidate Marine Protected Areas. *Biological Conservation* 156; 53-61.

Trapp, J. L. (1998). *Bird kills at towers and other man–made structures: an annotated partial bibliography (1960–1998*). U S Fish and Wildlife Service, Office of Migratory Bird Management,Arlington, Virginia.

Tulp, I., Schekkerman H., Larsen J.K., van der Winden J., van de Haterd R.J.W., van Horssen P., Dirksen S., and Spaans A.L. (1999). *Nocturnal flight activity of sea ducks near the wind farm Tuno Knob in the Kattegat*. IBN-DLO Report No. 99.30.

Vanermen N., Stienen E.W.M., Courtens W., Onkelinx T., Van de walle M. and Verstraete H. (2013). *Bird monitoring at offshore wind farms in the Belgian part of the North Sea - Assessing seabird displacement effects*. Rapporten van het Instituut voor Natuur- en Bosonderzoek 2013 (INBO.R.2013.755887). Instituut voor Natuur- en Bosonderzoek, Brussel.

Vanerman, N., Courtens, W., Van de walle, M., Verstraete, H. and Stienen, E.W.M. (2016). *Seabird monitoring at offshore wind farms in the Belgian part of the North Sea Updated results for the Bligh Bank & first results for the Thorntonbank*. Brussels: Instituut voor Natuur- en Bosonderzoek.

Vanerman, N., Courtens, W., Van de walle, M., Verstraete, H. and Stienen, E.W.M. (2017). *Seabird monitoring at the Thorntonbank offshore wind farm. Updated seabird displacement results & an explorative assessment of large gull behavior inside the wind farm area.* Brussels: Instituut voor Natuur- en Bosonderzoek.

Wade H.M., Masden. E.A., Jackson, A.C. and Furness, R.W. (2016). Incorporating data uncertainty when estimating potential vulnerability of Scottish seabirds to marine renewable energy developments. *Marine Policy*, 70, 108–113.

Welcker, M., Liesenjohann, M., Blew, J., Nehls, G. & Grunkorn, T. (2017). Nocturnal migrants do not incur higher collision risk at wind turbines than diurnally active species. Ibis, 159, 366–373.

Wernham, C.V., Toms, M.P., Marchant, J.H., Clark, J.A., Sirwardena, G.M. and Baillie, S.R. (Eds). (2002). *The Migration Atlas: movement of the birds of Britain and Ireland*. Poyser.

Wetlands International (2017). "Waterbird Population Estimates". Retrieved from wpe.wetlands.org on Friday 12 May 2017

Williams, J.M., Tasker, M.L., Carter, I.C. and Webb, A. (1995). A method of assessing seabird vulnerability to surface pollutants. *Ibis*, 1137, S147-S152.

Winkleman, J.E. (1995). “Bird/wind turbine investigations in Europe.” In Proceedings of National Avian - Wind Power Planning Meeting, Denver, Colorado, July 1994. RESOLVE Inc., Washington, D.C., and LGL Ltd., King City, Ontario. 145 pp.

Wright, L.J., Ross-Smith, V.H., Massimino, D., Dadam, D., Cook, A.S.C.P. and Burton, N.J.K. (2012). *Assessing the risk of offshore wind farm development to migratory birds designated as features of UK Special Protection Areas (and other Annex 1 species)*. The Crown Estate Strategic Ornithological Support Services (SOSS) report SOSS-05. BTO and The Crown Estate. SOSS Website.

MORAY WEST

OFFSHORE WINDFARM

Offshore EIA Report

Moray Offshore Windfarm (West) Limited

Chapter 11 Commercial Fisheries

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Acronyms	
Acronym	**Expanded Term**
AIS	Automatic Identification System
BMM	Brown and May Marine Ltd
Cefas	Centre for Environment, Fisheries and Aquaculture Science
CFP	Common Fisheries Policy
DEFRA	Department for Environment and Rural Affairs
EIA	Environmental Impact Assessment
EU	European Union
FEPA	Food and Environmental Protection Act
FLOWW	Fishing Liaison with Offshore Wind and Wet Renewables Group
ICES	International Council for the Exploration of the Seas
MFIFA	Moray Firth Inshore Fishermen's Association
MS	Marine Scotland
MMO	Marine Management Organisation
NMP	National Marine Plan
NtM	Notice to Mariners
OfT	Offshore Transmission Infrastructure
RIFG	Regional Inshore Fisheries Group
SFF	Scottish Fisherman's Federation
VMS	Vessel Monitoring System

Glossary of Terms	
Term	**Definition**
AIS	The automatic identification system is an automatic tracking system used for collision avoidance on ships and by vessel traffic services.
Creels	Structures generally used for the capture of crabs or lobster with pots baited, usually with fish. Creels are rigged in fleets of between 10 and 50 pots per fleet (in a string) depending on the vessel size and the area to be fished.
Demersal Fish	Fish living on or near the seabed.
ICES Rectangle	An area of approximately 900 nm^2, aligned to 30' latitude by 1° longitude.
Pelagic Fish	Fish living in the mid water.
Mackerel Jigging	A type of fishing lure with a hook moulded onto it. Jigs are intended to create a jerky vertical motion to attract mackerel.
Scallop Dredger	A rigid structure with a chain mail collecting bag, towed on the seabed in order to collect a targeted edible bottom-dwelling species such as scallops.

Glossary of Terms	
Term	**Definition**
VMS	A satellite-based monitoring system which at regular intervals provides data to the fisheries authorities (such as the MMO) on the location, course and speed of vessels.

11 Commercial Fisheries

11.1 Introduction

11.1.1.1 This chapter considers the potential significant effects of the construction, operation and maintenance and decommissioning of the Moray West Offshore Wind Farm and associated Offshore Transmission Infrastructure (OfTI) (defined as "the Development") on commercial fisheries.

11.1.1.2 The specific objectives of this chapter are to:

- Define the legislation, policy and guidance framework that is of relevance to commercial fisheries;
- Detail the consultation activities and responses that are relevant to, and have informed, the assessment of effects on commercial fisheries;
- Describe the commercial fisheries baseline;
- Describe the assessment methodology and significance criteria used in completing the impact assessment;
- Describe the potential effects, including direct, indirect and cumulative effects;
- Describe the mitigation measures proposed to address likely significant effects; and
- Assess the residual effects remaining following the implementation of mitigation.

11.1.1.3 The assessment has been carried out by Brown & May Marine Limited (BMM), who have extensive experience in undertaking research projects, analysis, and stakeholder consultation to inform commercial fisheries and fish ecology baselines and impact assessments related to offshore wind farm installations.

11.1.1.4 This chapter is supported by the following documents:

- EIA Report Volume 4 - Technical Appendix 11.1: Commercial Fisheries Baseline;
- EIA Report Volume 4 – Technical Appendix 11.2: Draft Commercial Fisheries Mitigation Strategy
- EIA Report Volume 2 – Chapter 8: Fish and Shellfish Ecology; and
- EIA Report Volume 2 - Chapter 12: Shipping and Navigation.

11.2 Legislation, Policy and Guidance Framework

11.2.1 Scotland National Marine Plan (NMP)

11.2.1.1 This assessment of the potential impacts on commercial fisheries of the Development has been undertaken with specific reference to the Scottish National Marine Plan (NMP).

11.2.1.2 The Scottish Government has produced a NMP in accordance with National Marine Plan UK policies (Scottish Government, 2015). The plan covers the management of both Scottish inshore waters (out to 12 nm) and offshore waters (12 to 200 nm). It sets out the strategic policies for which management decisions will be made across the main marine sectors, including general policies as well as specific policies for offshore wind and marine renewable energy. Examples of statements within the NMP which address issues related to commercial fisheries are listed in Table 11.2.1.

Table 11.2.1: Scotland's National Marine Plan (NMP)		
NMP Reference	**NMP Guidance**	**Where Addressed in the EIA Report**
4. General Policies, General Planning Principle, GEN 1	GEN 1 General planning principle: There is a presumption in favour of sustainable development and use of the marine environment when consistent with the policies and objectives of this Plan.	Section 11.6.2
4. General Policies, General Planning Principle, GEN 4	GEN 4 Co-existence: Proposals which enable coexistence with other development sectors and activities within the Scottish marine area are encouraged in planning and decision making processes, when consistent with policies and objectives of this Plan	Section 11.6.2
4. General Policies, General Planning Principle, GEN 17.	GEN 17 Fairness: All marine interests will be treated with fairness and in a transparent manner when decisions are being made in the marine environment.	Section 11.6.2
6. Sea Fisheries, Part 1 objectives and marine planning polices, Marine planning policies: Fisheries 1.	Marine plans and decision makers should aim to ensure: Existing fishing opportunities and activities are safeguarded wherever possible Mechanisms for managing conflicts between fishermen and between fishing sector and other users of the marine environment	Section 11.6.2 and Section 11.7
6. Sea Fisheries, Part 1 objectives and marine planning polices, Marine planning policies: Fisheries 2.	The following key factors should be taken into account when deciding on uses of the marine environment and potential impact on fishing: The potential impact (positive and negative) of marine developments on the sustainability of fish and shellfish stocks and resultant fishing opportunities in any given area. The environmental impact on fishing grounds (such as nursery, spawning areas), commercially fisheries species, habitats and species more generally. The potential effect of displacement on: fish stocks; the wider environment; use of fuel; socio-economic costs to fishers and their communities and other marine users.	Section 11.6.2 and Chapter 8: Fish and Shellfish Ecology
6. Sea Fisheries, Part 1 objectives and marine planning polices, Marine planning policies: Fisheries 3.	Where existing fishing opportunities or activity cannot be safeguarded, a Fisheries Management and Mitigation Strategy should be prepared by the proposer of development or use, involving full engagement with local fishing interests (and other interests as appropriate) in the development of the Strategy. All efforts should be made to agree the Strategy with those interests. Those interests should also undertake to engage with the proposer and provide transparent and accurate information and data to help complete the Strategy. The Strategy should be drawn up as part of the discharge of conditions of permissions granted.	Section 11.6.2
Section 6 Sea Fisheries, Part 3 key issues for marine planning, Interactions with other users, paragraphs 6.22 to 6.26.	There are some key emerging issues concerning the interactions between the fishing industry and other interests which should be borne in mind in any proposed marine development and factored into marine planning processes. In respect of Developments these include: Energy developments can displace fishing. The cabling arrays associated with energy and telecoms developments, and other	Section 11.6.2 and Section 11.7 and Chapter 8: Fish and Shellfish Ecology

Table 11.2.1: Scotland's National Marine Plan (NMP)		
NMP Reference	**NMP Guidance**	**Where Addressed in the EIA Report**
	physical infrastructure associated with development, have the potential for short-term displacement of fishing activity during the installation phase. There is also potential for damage to occur to both infrastructure and fishing equipment as a result of interactions, with obvious safety implications. New developments should take into account the intensity of fishing activity in the proposed development area and any likely displacement which the development and associated activity could precipitate, with resultant increased pressure on remaining, often adjacent, fishing grounds. There may be potential for some infrastructure or development areas to act as nursery grounds for fish and, if appropriately protected, these may lead to an increase in fish stocks in the surrounding areas. This possibility should be considered on a case by case basis. Where relevant, Fisheries Liaison with Offshore Wind and Wet renewables (FLOWW) Best Practice Guidance for Offshore Renewables Developments: Recommendations for Fisheries Liaison should be followed.	

11.2.2 Fisheries Controls and Regulations

11.2.2.1 The main bodies regulating fishing activity in the regional study area are the EU through the Common Fisheries Policy (CFP), Marine Scotland through national and regional regulations and the North and East Coast Regional Inshore Fisheries Group (RIFG) (out to six nautical miles (nm)).

11.2.2.2 The CFP was reformed in 2014 with the latest CFP changes placing an emphasis on achieving long-term environmental sustainability. These policy changes included a ban on discarding (phased in to all EU fisheries by 2019) and new mandatory rules on the labelling of fisheries products on sale to consumers. There were also measures implemented to reduce overcapacity, with an obligation to report on the balance between fleet capacity and fishing opportunities and implement plans to address imbalances.

11.2.2.3 It should be noted that the legislation is likely to be reviewed as part of the "Brexit" negotiations being undertaken over two years from March 2017. It is currently unclear what changes, if any, will be implemented under this review. In the meantime, EU regulations, and in particular the CFP, will still be enforced. As a result, it is difficult to predict future fisheries policy changes and the impact of current ongoing negotiations and decision making on the fishing industry.

11.2.2.4 Further detailed information on fisheries controls and regulations is provided in the Commercial Fisheries Baseline (Technical Appendix 11.1, Volume 4).

11.2.3 Relevant Guidance

11.2.3.1 The following guidance documents have been used to inform the assessment of potential effects on commercial fisheries:

- Centre for Environment, Fisheries and Aquaculture Science (Cefas) (2012) Guidelines for data acquisition to support marine environmental assessments of offshore renewable energy projects. Contract report: ME5403, May 2012;
- Cefas, Marine Consents and Environment Unit (MCEU), Department for Environment, Food and Rural Affairs (DEFRA) and Department of Trade and Industry (DTI) (2004) Offshore Wind Farms - Guidance note for Environmental Impact Assessment In respect of FEPA and CPA requirements, Version 2;
- RenewableUK (2013) Cumulative impact assessment guidelines, guiding principles for cumulative impacts assessments in offshore wind farms;
- Sea Fish Industry Authority and UK Fisheries Economic Network (UKFEN) (2012) Best practice guidance for fishing industry financial and economic impact assessments;
- Blyth-Skyrme, R.E. (2010) Options and opportunities for marine fisheries mitigation associated with wind farms. Final report for Collaborative Offshore Wind Research into the Environment contract FISHMITIG09. COWRIE Ltd, London;
- FLOWW Best Practice Guidance for Offshore Renewables Developments: Recommendations for Fisheries Liaison: FLOWW (Fishing Liaison with Offshore Wind and Wet Renewables Group) (2014);
- UK Oil and Gas (2015) Fisheries Liaison Guidelines - Issue 6;
- International Cable Protection Committee (2009) Fishing and Submarine Cables - Working Together. A concise summary of assessment methodology;
- Economic Assessment of Short Term Options for offshore Wind Energy in Scottish Territorial Waters: Costs and Benefits to other Marine Users and Interests (Marine Scotland, 2011);
- Guidance on overlaps with fishing (Subsea Cables UK, 2012) (now incorporated in KIS-ORCA and European Subsea Cables Association web guidance);
- Emergency procedures for fouling gear (Subsea Cables UK, 2015) (now incorporated in KIS-ORCA and European Subsea Cables Association web guidance); and
- SeaPlan. Options for Cooperation between Commercial Fishing and Offshore Wind Energy Industries. A Review of Relevant Tools and Best Practices (2015).

11.3 Consultation

11.3.1 Scoping Opinion Responses

11.3.1.1 Moray West has framed its assessment of potential effects on commercial fisheries through consultation with key stakeholders.

11.3.1.2 Table 11.3.1 details the key issues raised in relation to commercial fisheries in the Moray West Offshore Wind Farm Scoping Opinion (August 2016) and the OfTI Scoping Opinion (August 2017). Other issues/concerns raised during additional consultation activities undertaken as part of the EIA process and how these have been addressed in the preparation of this EIA Report are discussed in Section 11.3.2.

Table 11.3.1: Summary of Consultation Relating to Commercial Fisheries		
Consultee and Date	**Issue Raised**	**Moray West Approach**
Scottish Fishermen's Federation (SFF) - response to the Scoping Consultation Moray West Offshore Wind Farm Scoping Opinion August 2016	SFF expressed concern about a lack of detail of cable parameters, assertion of there being 3 m burial and problem of many cable crossings to be considered.	As described in Section 11.6.2 cables will, where achievable, be buried to a minimum depth of 1 m and where burial is not feasible cable protection measures will be used. The maximum burial depth as stated in Volume 2 - Chapter 4: Description of the Development will be 3 m. Burial to this depth is highly dependent on seabed conditions.
	Referring to seabed disturbance, the SFF requests more information on anchor berms as they believe they are a unique problem to the fishing industry.	Issues associated with seabed obstacles, have taken account of in the impact assessment (Table 11.5.1).
	The EIA should pay close attention to latest ICES advice on development operation during spawning seasons, more attention to squid and scallop spawning and nursery grounds.	The potential impacts of the Development on fish and shellfish populations, including those of commercial importance are described in Volume 2 - Chapter 8: Fish and Shellfish Ecology.
	The table 3.4.3.1 on page 102 needs to be examined particularly the final line "Changes to Fishing Activity" which seems to be claiming Construction and Decommissioning will have no impact, and together with the statement on page 105 that fishing will continue, needs to be substantiated as the SFF remains skeptical of these claims.	The potential impacts of the Development have been assessed for the construction, operation and decommissioning phases (Section 11.7).
	Given that the Smith Bank is a major scallop fishery the SFF would seek clarity on the claim that the suspension of sediment during this development will only have a minor impact on Scallop survival rates.	Potential impacts of the Development on fish and shellfish populations, including those associated with increased suspended sediment concentrations are described in Volume 2 - Chapter 8: Fish and Shellfish Ecology.
	Suggests using UKFIM data	A comprehensive range of datasets have been used to characterise the fisheries baseline (Section 11.4.1). As suggested by SFF, UKFIM data have been reviewed, however, given the low resolution of this data, other sources of data such as VMS and AIS records have instead been used to inform the assessment.

Table 11.3.1: Summary of Consultation Relating to Commercial Fisheries		
Consultee and Date	**Issue Raised**	**Moray West Approach**
Marine Scotland Science (MSS) Moray West Offshore Wind Farm Scoping Opinion August 2016	Section 4.2.1 provides the commercial fisheries baseline characterisation and list potential effects associated with the Western Development Area. Most information have been derived from the MORL ES in 2012. It is advised that more recent data should be used to describe the baseline (5 most recent years' worth of data 2011-2015). This will be possible with MMO landings data by ICES rectangles as listed in Table 4.2-1.	Data used to inform this assessment includes the 5 most recent years of data currently available (2012-2016) (Table 11.4.1).
	Table 4.2-1 listing 'Datasets for the Commercial Fisheries EIA' should expand to cover landings and numbers of active fishing vessels broken down by length classes, by adjacent fishing ports, and ICES rectangle level (see Scottish Sea Fisheries Statistics). Information should be put in context (e.g. percentage share of the national landings etc.) to highlight importance.	Consideration has been given to number vessels and fishing ports, including information on percentage share to highlight importance (EIA Report Volume 4 – Technical Appendix 11.1: Commercial Fisheries Technical Report).
	It should be noted that combined effects from EDA and WDA might not simply be additive. It is stated that "the extent of displacement will be a function of the temporary loss or restricted access to traditional fishing grounds during the construction phase". It should be added that the significance of displacement will also be a function of the available fishing space (availability of target species in sufficient amounts and commercial sizes as well as remaining suitable habitat, e.g. for scallops) over time.	The potential impact on access to fishing grounds and displacement of fishing activity has been considered within the cumulative assessment (Section 11.8).
	Scallop dredge gear modification trials study developed by Bangor University is referenced. However, no statement surrounding plans to undertake the trials are mentioned in the report. The applicants should provide more information about their plans.	A number of embedded mitigation measures have been proposed to minimise impacts to commercial fisheries from the Development (Section 11.6.2). This includes a draft Commercial Fisheries Mitigation Strategy (CFMS) which is presented in Volume 4 – Technical Appendix 11.2.

Table 11.3.1: Summary of Consultation Relating to Commercial Fisheries		
Consultee and Date	**Issue Raised**	**Moray West Approach**
	BERR guidance (2008) reference has been update to FLOWW in 2014. Best Practice Guidance for Offshore Renewables Developments: Recommendations for Fisheries Liaison (FLOWW, 2014). Other best practice guidance documents include: Best Practice Guidance for Fishing Industry Financial and Economic Impact Assessments (Seafish, 2009); Guidance on overlaps with fishing (Subsea Cables UK, 2012); Emergency procedures for fouling gear (Subsea Cables UK, 2015); and SeaPlan. Options for Cooperation between Commercial Fishing and Offshore Wind Energy Industries. A Review of Relevant Tools and Best Practices. 2015	Guidance outlined by MSS has been taken account of in this Chapter (Section 11.2.2.4).
	Section 4.2.7 states that one of the proposed mitigation measures will be the establishment of a Moray Firth Commercial Fisheries Working Group. Rather than plain establishment of the group, mitigation measure should be explicit on the proposed function of the group.	A number of embedded mitigation measures have been proposed to minimise impacts to commercial fisheries from the Development (Section 11.6.2). In addition, a draft CFMS has been included in Volume 4 – Technical Appendix 11.2.
MS-LOT Moray West Offshore Wind Farm Scoping Opinion August 2016	MS-LOT expects any displacement of fishing opportunity to be recognised by the Company. The Company then must resolve any possible potential impacts by early and continued engagement and collaboration with fishing industry representatives. MS-LOT strongly recommends that early engagement with the fishing communities is undertaken and that surveys based upon commercial fishing are also undertaken and data is contained within the ES.	The potential impacts of the Development on commercial fisheries, including potential loss/restricted access to fishing grounds and displacement have been assessed in this Chapter (Section 11.7 and Section 11.8). As described in Section 11.6.2, a draft CFMS has been submitted as part of the Application (Volume 4 - Technical Appendix 11.2). This will be refined and finalised post consent in consultation with fisheries stakeholders. In addition to information gathered through consultation with fisheries stakeholder (Section 11.3.2) a comprehensive range of datasets have been used to characterise the fisheries baseline (Section 11.4.1).
SFF Moray West Offshore Transmission Infrastructure (OfTI) August 2017	In terms of the options for OSP foundations and substructures it is quite clear that the GBS is likely to have the worst impact on fishing during operation and be the most problematic when it comes to decommissioning and SFF would welcome these being ruled out, but the other options will also have negative impacts on the seabed they are installed on.	In respect of seabed disturbance during construction and loss of seabed habitat during operation, the worst case scenario considered includes the use of gravity base foundations (See Volume 2 - Chapter 7: Benthic and Intertidal Ecology).

Table 11.3.1: Summary of Consultation Relating to Commercial Fisheries		
Consultee and Date	**Issue Raised**	**Moray West Approach**
	Regarding the interconnector cables in 2.2.2.3 the SFF preference is burial, and recent studies on protection are clear that protection by rock does not need the same depth as burial, other options must consider the area they are to be used in before deciding which to use. The same comments refer to the export cable.	As outlined in Table 11.6.1 and Section 11.6.2, inter array, inter OSP and export cables will be buried where feasible to a minimum depth of 1 m. Where burial is not possible cable protection will be used. Under the worst case scenario (Table 11.6.1), it is considered that a maximum of 20% of the length of the export cable may require protection. In the case of inter array and inter OSP cables, a maximum of 10% of the cables length may require protection.
	The SFF would take issue with the statement on decommissioning "leaving all in place" as not what is required, for SFF the normal starting point for this discussion is to return the seabed to its original state.	An outline of the decommissioning strategy anticipated for the Development is given in Section 11.7.4.
	The historical baseline for scallops needs to be as long as feasible since the fishery is very cyclical and any given snapshot could miss the peaks of the fishery, which could be anything from 5 – 10 years apart.	Consideration has been given to the latest 10 available years of landings values data (2007 -2016) to take account of the cyclical nature of the scallop fishery (Table 11.4.1).
	The SFF would agree with the chart 7.1.3 listing the impacts to be scoped in, but believe the project is already down playing most of them and needs to give serious consideration to the issue of loss of access and displacement of fishing. The recent Crown Estate report on these phenomena in the Irish Sea shows that fishing still had not resumed 2 years after construction of a windfarm. Embedded mitigation for all these factors is only the start of the story and assessment should also include the effects of construction vessel movements outside the site on the local fishing vessels.	Consideration has been given within this Chapter to the potential impacts of the Development in relation to loss of grounds/access and displacement during all phases of the Development (Table 11.5.1). An assessment of fishing interference in terms of navigational conflict is also given within this Chapter (Table 11.5.1). This takes account of interference associated with construction/operation and decommissioning vessels transits.
	The SFF would expect the project to validate its data baseline with a cross-section of industry, for which the membership of the Commercial Fisheries Working Group would be ideal.	The baseline used to inform this Chapter was presented and discussed with the SFF during a consultation meeting held on 16th February (Table 11.3.2).
	As scallop fishing is a widely dispersed, mobile nomadic activity the cumulative impact of all relevant projects across UK waters needs to be considered.	For assessment of cumulative impacts on the nomadic fleet consideration has been given to relevant projects UK wide (Table 11.8.1).

Table 11.3.1: Summary of Consultation Relating to Commercial Fisheries		
Consultee and Date	**Issue Raised**	**Moray West Approach**
MS-LOT Moray West Offshore Transmission Infrastructure (OfTI) August 2017	The Scottish Minister highlight SFF's consultation response in which it is noted that the shortest and most direct route to landfall is unacceptable to the fishing industry, gravity base structures are likely to result in the worst impact on fishing and decommissioning of assets by leaving them in place is not considered by SFF to be a normal starting point for discussions. Further, SFF's consultation responses references limited data sources being quoted for scallops which should be addressed by Moray West.	Detailed information on design options considered for the Development is given in Volume 2, Chapter 4: Description of the Development. Gravity base foundations have been included within the parameters used to define the worst case scenario in relation to seabed disturbance and permanent loss of seabed (Volume 2 - Chapter 7: Benthic and Intertidal Ecology). Information on the decommissioning strategy is provided in Section 11.7.4.
MS-LOT Moray West Offshore Transmission Infrastructure (OfTI) August 2017	The Scottish Ministers advise Moray West to consider the detail of SFF's response and work with SFF, other relevant stakeholders and the Scottish Ministers to agree measures that reduce the impact to the fishing grounds. The Scottish Ministers note that, where possible, agreeing e.g. the Fisheries Management and Mitigation Plan prior to submitting the application will save time post consent.	Consultation with the fishing industry is ongoing. As described in Section 11.6.2, a draft CFMS has been submitted as part of the Application (Volume 4 - Technical Appendix 11.2). This will be refined and finalised post consent in consultation with fisheries stakeholders.
MS-LOT Moray West Offshore Transmission Infrastructure (OfTI) August 2017	The Scottish Ministers, in consultation with stakeholders, agree with the potential effects highlighted in the Scoping Report and the scoping of the EIA assessment. However, Moray West are required to clarify the potential for the increased suspended sediment in the water column during operation as noted by SFF and the approach noted above in Section 6.4.3. Moray West should note in SFF's response a requirement for appropriate cross referencing between the benthic ecology and fish and shellfish assessments, in consideration of effects on habitats and (it is assumed) commercial fisheries. The Scottish Ministers further request that due consideration is provided to the commentary on scallops and Nephrops contained in SFF's response.	An assessment of the potential impacts of the Development on fish and shellfish species, including those of commercial importance, is provided in Volume 2 - Chapter 8: Fish and Shellfish Ecology, and its outcomes are cross-referenced within this Chapter where relevant.

11.3.2 Additional Consultation

11.3.2.1 In addition to consultation carried out as part of the formal EIA Scoping process, extensive consultation has been undertaken by BMM with fisheries stakeholders to discuss commercial fisheries issues in relation to the Development and inform this assessment. This included:

- Consultation meetings with the Scottish Fishermen's Association (SFF) and the Moray Firth Inshore Fishermen's Association (MFIFA) (Table 11.3.2);
- Consultation by phone with representatives of the Fraserburgh Whitefish Producers Organisation and the North and East Coast RIFG;

- Consultation with non-UK fishing interests potentially active in areas relevant to the Development via email or phone; and
- Direct consultation with a sample of local fishermen.

11.3.2.2 Key issues raised during consultation with fishermen and fishermen organisations include:

- Queries in relation to burial methods to be used for cable installation;
- Concerns in relation to potential interactions between cable protection (particularly mattresses) and fishing gear.
- Concerns in relation to towed gear vessels fishing across the cable and areas of cable that may be protected;
- Concerns in relation to the timing of export cable laying activity, particularly in relation to creeling and mackerel jigging if this coincides with the peak in fishing activity (stated to be June to October);
- Concerns regarding the impact on fish and shellfish populations as a result of noise associate with piling and cable trenching during construction and the vibration of turbines during operation; and
- In respect of scallop dredging, it was noted that analysis of data should be carried out for a 10 year period, as grounds yield high for several years and then drop for a couple of years whilst the population recovers. It was also noted that vessels under-12 m in length do not have operational ranges as wide as those of the nomadic fleet and therefore are more affected by loss of grounds than larger category vessels.

Table 11.3.2: Consultation Meetings with Fishing Associations

Date	Organisation
15/08/2017	Scottish Fishermen's Federation (SFF)
16/08/2017	Moray Firth Inshore Fishermen's Association (MFIFA)
16/02/2018	SFF

11.4 Baseline Conditions

11.4.1 Baseline Characterisation Approach

<u>Study Area</u>

11.4.1.1 The Moray West Site and Offshore Export Cable Corridor are located in International Council for the Exploration of the Sea (ICES) Division IVa (Northern North Sea). Fisheries data are recorded, collated and analysed by ICES rectangles within each division. These rectangles constitute the smallest spatial unit used for the collection and analysis of fisheries statistics and have therefore been used to describe the study area in respect of commercial fisheries.

11.4.1.2 On this basis, the regional study area has been defined as follows (Volume 3a - Figure 11.4.1):

- Rectangles 45E6 and 45E7 - where the Moray West Site is located;
- Rectangle 44E7 - where the majority of the Offshore Export Cable Corridor is located; and
- Adjacent rectangle 44E6 - where a small proportion of the Offshore Export Cable Corridor is located.

11.4.1.3 In the particular case of fleets with wide operational ranges, particularly the demersal trawl and more notably the nomadic scallop fleet, consideration has also been given to larger areas where relevant, to describe the extent of their operational range and their grounds.

Desk Study

11.4.1.4 There is no single data source or model for establishing a commercial fisheries baseline within small, discrete sea areas such as offshore wind farms. Accurate characterisation of a commercial fisheries baseline therefore requires an approach utilising data and information derived from a number of sources.

11.4.1.5 The principal fisheries datasets used to describe the fisheries baseline in the regional study area are outlined in Table 11.4.1.

11.4.1.6 Further detailed information on the sources of data and information used to inform this assessment is provided in the Commercial Fisheries Technical Report (Volume 4 - Technical Appendix 11.1).

Table 11.4.1: Key Sources of Data and Information Used

Data	Description	Source
Fisheries surveillance sightings	• Sightings of fishing vessels recorded by surveillance aircraft and surface vessels. • The data provides information on vessel location, nationality and gear type. • Data were analysed for the period 2012 to 2016.	MMO
Fisheries landings values (£)	• This data provides information on the value of landings by fishing method, vessel category (under 10m, 10-15m, over 15m), species and landing port. • Data include landings of UK vessels (irrespective of landing port) and non-UK vessels landing into UK ports. • Data are provided by ICES rectangle. • Data from 2012 to 2016 were included for analysis to describe the current baseline, as well as data from 2007 to 2016 to describe annual fluctuation in the fisheries.	MMO
VMS data	• Satellite tracking data of vessels of over-15m in length. • Data are cross-referenced with landings and effort data to provide information in a 0.05° by 0.05° grid. • Data are provided for UK vessels only. • Data were analysed for the period 2012-2016.	MMO

11.4.1.7 Note that in addition to these datasets, this Chapter has also been informed by the outputs of the extensive consultation carried out with the fishing industry (Section 11.3), including details on gear specifications, operating practices and location of fishing grounds.

11.4.2 Current Baseline

Overview

11.4.2.1 The majority of fishing activity within the regional study area is by UK vessels. Non-UK vessels have only been recorded in the area on an occasional basis with UK vessels representing over 99% of all the surveillance sightings for the period 2012 to 2016 (Volume 3a - Figure 11.4.2).

11.4.2.2 Fishing activity in the regional study area is principally by creelers targeting lobster and crabs, demersal trawlers targeting Nephrops, squid and whitefish, scallop dredgers targeting king scallops, and Scottish seiners targeting whitefish. In addition, during consultation with fishing interests, jigging for mackerel was also noted as a fishery of relevance in respect of the area of the Development, particularly in a discrete area across the inshore section of the Offshore Export Cable Corridor.

11.4.2.3 Whilst other fishing methods have been identified in the regional study area, as suggested by surveillance sightings data (2012-2016) and landings values (2012-2016), their activity is comparatively very small within the region (Volume 3a - Figure 11.4.3 and Figure 11.4.4).

11.4.2.4 Based on the above, the principal fleets operating in areas relevant to the Development have been identified as follows:

- Creel fleet (crabs and lobster);
- Mackerel jigging;
- Demersal trawl fleet (Nephrops, squid and whitefish);
- Scallop dredging fleet (king scallops); and
- Scottish seine fleet (whitefish).

11.4.2.5 A summary of the commercial fisheries baseline for each of these fleets is given in the following sections. Further detailed fisheries baseline information is provided in the Commercial Fisheries Technical Report (Technical Appendix 11.1, Volume 4).

Creel Fleet

11.4.2.6 Creeling occurs throughout the northern North Sea although the design of creels may vary depending on region and target species. In the regional study area, crabs and lobsters are the main species targeted by this fleet.

11.4.2.7 Surveillance sightings data (2012 -2016) and information gathered through consultation with fisheries stakeholders, indicate that fishing activity by creelers is concentrated in inshore areas close to shore (Volume 3a - Figure 11.4.3, Figure 11.4.6). Analysis of landings data (2012-2016) show highest values for this fleet in rectangle 45E6, with comparatively lower landings recorded in rectangle 44E6 and 44E7 and negligible values in rectangle 45E7 (Volume 3a - Figure 11.4.4 and Figure 11.4.5).

11.4.2.8 Given the location of the fishing grounds and inshore nature of fishing activity by this fleet, interactions between creeling vessels and the Development, for the most part, are expected to be limited to aspects relating to the export cable (Volume 3a - Figure 11.4.6).

11.4.2.9 Vessels engaging in creeling are generally under-10 m in length, with crew members varying from one to three (Volume 4: Technical Appendix 11.2 - Figures 3.9, 3.10 and 3.11) and Volume 3a - Figure 11.4.2 and Figure 11.4.3. They have limited operational range compared to other fishing methods, generally deploying their gear closer to the coast and in areas which are unsuitable for trawling activity. Given the relatively small size of the vessel engaged in this fishery, they are particularly restricted by weather conditions in the winter months.

11.4.2.10 Crab and lobster are targeted all year round. Analysis of landings values data for the period 2007 to 2016, suggest peak landings occur in the summer months (Volume 4: Technical Appendix 11.2 - Figures 3.13, 3.14 and 3.15). Similarly, during consultation with creel fishermen the peak season was noted to run from June to October.

Mackerel Jigging

11.4.2.11 As previously mentioned (paragraph 11.4.2.2), there is a local fishery targeting mackerel by jigging in the southern section of the regional study area. Fishing grounds provided by fishermen during consultation (Volume 3a - Figure 11.4.7), indicate that the fishery concentrates in areas close to shore around the inshore section of the Offshore Export Cable Corridor.

11.4.2.12 Therefore, as noted above in respect of creeling, it is anticipated potential interactions between the Development and this fishery will, for the most part, be limited to aspects relating to the export cable.

Demersal Trawl Fleet

11.4.2.13 Analysis of surveillance sightings and landings values (2012-2016) indicates that fishing activity by demersal trawlers concentrates for the most part in the southern section of the regional study area (rectangles 44E6 and 44E7) (Volume 3a - Figure 11.4.3 and Figure 11.4.4).

11.4.2.14 A large proportion of demersal trawlers operating in this area are over-15 m in length (Volume 4: Technical Appendix 11.2 - Figures 3.9, 3.10 and 3.11). Most of these vessels have wide operational ranges and therefore their fishing opportunities extend beyond the regional study area. Analysis of VMS data (2012 -2016) indicates the presence of extensive demersal trawling grounds offshore of the Moray Firth and all around the Scottish coast. In addition, it shows that within the regional study area, fishing activity appears to concentrate in the southern section of the study area with the Moray West Site recording comparatively lower levels of activity (Volume 3a - Figure 11.4.8 and Figure 11.4.9). It should be recognised, however, that some smaller vessels also operate in the area and their activity is not included in the VMS dataset.

11.4.2.15 As previously mentioned (paragraph 11.4.2.2), demersal trawlers primarily target Nephrops, squid and whitefish. A summary of each fishery is provided below.

Nephrops Fishery

11.4.2.16 Nephrops inhabit muddy substrates and are principally targeted by demersal otter trawlers which can deploy either single or twin rig demersal gears.

11.4.2.17 The highest landings for this species are recorded in the southern section of the regional study area, particularly in rectangle 44E7 and to a lesser extent in rectangle 44E6. Landings values for this species within rectangles 45E7 and 45E6 (where the Moray West Site is located) are significantly lower (Volume 3a - Figure 11.4.5). Consultation carried out with fishermen further corroborates the importance of the southern section of the regional study area to this fishery, with the main fishing grounds depicted by fishermen primarily extending along rectangles 44E7 and 44E6. Therefore for the most part, interactions between vessels targeting Nephrops and the Development are expected to be limited to aspects related to the export cable (Volume 3a - Figure 11.14.10).

11.4.2.18 The number of vessels targeting Nephrops is dependent upon the productivity of the fishery and this fluctuates on an annual basis. Nephrops are targeted all year around, although there are seasonal fluctuations in landings values, with a marked peak recorded during the summer months (June to August) (Volume 4: Technical Appendix 11.2 - Figures 3.13, 3.14 and 3.15). Weather is an important factor in determining the levels of activity in the winter months, particularly for the smaller, local vessels.

Squid Fishery

11.4.2.19 Demersal otter trawlers are able to target squid by reconfiguring their gear for this seasonal fishery. Squid are targeted on rocky or uneven ground. There has been a squid fishery in the Moray Firth since 2004. The importance of this fishery to the demersal trawler fleet has increased since restrictions were imposed on whitefish and Nephrops stocks. A range of vessels have since diversified into this fleet from ports as distant as the west coast, the Orkneys and Shetland.

11.4.2.20 During consultation with the fishing industry it was noted that the annual squid fishery extends for approximately five months (May to October) and is pursued by vessels ranging in size from 10 m to 30 m, with the larger vessels based in Shetland, Peterhead and Fraserburgh. In peak periods up to 30 vessels target squid in the Moray Firth (Commercial Fisheries Technical Report - Technical Appendix 11.1, Volume 4).

11.4.2.21 Analysis of landings values (2012 -2016) indicate that highest squid landings are recorded in ICES rectangle 44E7 (where the majority of the Offshore Export Cable Corridor is located) and to a lesser extent in rectangle 44E6, rectangle 45E7 and rectangle 45E6 (the latter recording significantly lower values) (Volume 3a - Figure 11.4.5). Fishing grounds identified by fishermen during consultation extend over the southern section of the regional study area as well as the Moray West Site and the northern section of the Offshore Export Cable Corridor (Volume 3a - Figure 11.4.11).

Whitefish Fishery

11.4.2.22 The principal whitefish species targeted in the regional study area by the demersal trawl fleet is haddock (Volume 3a - Figure 11.4.5). Other species such as cod and monkfish are also landed from the area, however at considerably lower levels.

11.4.2.23 Whitefish in the area are generally targeted by over-15 m vessels, although some activity by smaller vessels is also understood to occur (Volume 4: Technical Appendix 11.2 - Figures 3.9, 3.10 and 3.11 and Volume 3a - Figure 11.4.4). Analysis of VMS data for the demersal trawl fleet in the regional study area indicates that the fishing activity is highest in the southern section of the study area, including the area of the Offshore Export Cable Corridor, with relatively lower activity recorded within the Moray West Site (Volume 3a - Figure 11.4.8 and Figure 11.4.9). Similarly, landings data indicated that the majority of landings of whitefish species associated with demersal trawling come from the southern section of the regional study area (Volume 4: Technical Appendix 11.2 - Figures 3.5, 3.6 and 3.7).

Scallop Dredging Fleet

11.4.2.24 King scallops are the main species targeted by scallop dredgers, whereby the scallops are raked from the seabed by steel teeth attached along the leading edge of the dredges, which penetrate the seabed to a depth of approximately 20 cm. The vessels used for scallop dredging are either purpose built or converted Dutch beam trawlers. The number of dredges per side can typically vary from three to four on a 10 m boat to up to 14 for the larger class of vessel.

11.4.2.25 In the regional study area, scallop dredging is mainly undertaken by vessels over-15 m in length (Volume 4: Technical Appendix 11.2 - Figures 3.9, 3.10 and 3.11). Analysis of VMS data indicates that the majority of activity by over-15 m vessels concentrates east of the Moray West Site and to a lesser extent in inshore areas to the west. Albeit at relatively lower levels, scallop dredging also takes place within the Moray West Site and across the Offshore Export Cable Corridor (Volume 3a - Figure 11.4.12 and Figure 11.4.13).

11.4.2.26 Larger category scallop vessels are capable of fishing in difficult weather conditions and continuously for several days. These vessels are described as nomadic due to their geographical range, variously targeting grounds around the UK (Volume 3a - Figure 11.4.14, Figure 11.4.15 and Figure 11.4.16). Scallop fishing for the nomadic fleet is generally cyclical with grounds intensively targeted for a period and then left to recover. The main scallop grounds around the UK are on the Scottish east and west coasts, in the Irish Sea and the English Channel. Therefore, the number of these vessels dredging in the regional study area will vary annually, depending upon productivity and access to grounds (SFF 2017, pers.comms, October 2017).

11.4.2.27 It should be recognised that a number of smaller local vessels are also active in the area and activity by these, depending on their size (i.e. if under 15 m), is not included in the VMS dataset. Further, by virtue of their size, they will be more dependent on fishing grounds within the regional study area than the larger nomadic vessels which exploit grounds around the UK.

11.4.2.28 During consultation, scallop grounds were identified over the southern section of the regional study area. These included the inshore section of the Offshore Export Cable Corridor as well as the southern section of the Moray West Site (Volume 3a - Figure 11.4.17). Due to regulations limiting the number of dredges a vessel can deploy within the 12-mile limit (Regulation of Scallop Fishing (Scotland) Order 2017), it is expected that the scallop dredging activity on the inshore grounds overlapping the Offshore Export Cable Corridor is by smaller locally-based vessels. AIS tracks of scallop dredgers recorded in the Moray Firth area, suggest relatively high levels of activity north of the Moray West Site, in addition to discrete areas of relatively high activity in the central area of the Moray West Site and immediately to the south, as well as in areas east and west of the inshore section of the Offshore Export Cable Corridor (Volume 3a - Figure 11.4.18).

11.4.2.29 Scallops are targeted all year round with highest landings generally recorded between May and September (Volume 4: Technical Appendix 11.2 - Figures 3.13, 3.14 and 3.15). Over the last 10 years for which landings data are available (2007 -2016), and in line with the cyclical nature of the fishery, scallop values have fluctuated considerably, with peak landings recorded in 2008 and again in 2013 and 2014 (Volume 4: Technical Appendix 11.2 - Figure 3.12).

<u>Scottish Seine Fleet</u>

11.4.2.30 The highest landings values (2012-2016) within the regional study area for the Scottish seine fleet are recorded in rectangle 45E7 (within which the Moray West Site is located), with the remaining rectangles recording significantly lower values (Volume 3a - Figure 11.4.4). As suggested by surveillance sightings data (2012-2016), however, fishing activity is understood to concentrate in areas north of the Moray West Site and further offshore (Volume 3a- Figure 11.4.3).

11.4.2.31 Haddock is the principal species targeted by this fleet with other whitefish species such as monkfish, cod and whiting accounting for comparatively lower landings values (Volume 3a - Figure 11.4.5, Volume 4: Technical Appendix 11.2 - Figures 3.5, 3.6 and 3.7).

11.4.2.32 The majority of landings values by Scottish seiners are by vessels over-15 m in length (Volume 4: Technical Appendix 11.2 - Figures 3.9, 3.10 and 3.11) and it is understood that the fleet has wide operational ranges, which extend beyond the regional study area.

11.4.3 Future Baseline

11.4.3.1 As discussed in the Section 11.2.2 introduction due to the EU referendum result and the following Brexit negotiations, fisheries policy and international fishing rights in UK waters are under review. As a result, it is currently difficult to predict future fisheries policy changes and the impact on the UK fishing industry.

11.4.3.2 There are multiple aspects of the legislation which may change in the future including licensing, quotas, changes in gear types, fleet numbers and vessel types, changes in fuel costs, restrictions on certain fishing methods or landings of certain species.

11.5 Assessment Methodology

11.5.1 Impacts Identified as Requiring Assessment

11.5.1.1 Table 11.5.1 lists all potential impacts on commercial fisheries identified as requiring consideration as part of the assessment. These impacts are specified in the Cefas and MCEU (2004) Guidelines for offshore wind developments and reflect responses provided by statutory consultees and other stakeholders in the Moray West Offshore Wind Farm and OfTI Scoping Opinions. The assessment also takes into account impact assessment approaches described in the various guidance documents and publications listed in Section 11.2.3 and further comments received as part of ongoing community consultation activities.

Table 11.5.1: Impacts on Commercial Fisheries Requiring Assessment		
Potential Impact	**Nature of Impact (Direct or Indirect)**	**Inter-relationships with Other EIA Topics / Receptors**
Construction and Decommissioning Impacts		
Adverse impacts on commercially exploited fish and shellfish populations	Indirect	Chapter 8: Fish and Shellfish Ecology
Temporary loss or restricted access to traditional fishing grounds	Direct	N/A
Safety issues for fishing vessels	Direct	Chapter 12: Shipping and Navigation
Increased steaming times to fishing grounds	Direct	N/A
Interference with fishing activities (navigational conflict)	Direct	N/A
Displacement of fishing activities into other areas	Direct	N/A
Obstacles on the seabed	Direct	N/A
Operation and Maintenance (O&M) Impacts		
Adverse impacts on commercially exploited fish and shellfish	Indirect	Chapter 8: Fish and Shellfish Ecology
Permanent loss or restricted access to traditional fishing grounds	Direct	N/A
Safety issues for fishing vessels	Direct	Chapter 12: Shipping and Navigation
Increased steaming times to fishing grounds	Direct	N/A
Interference with fishing activities (navigational conflict)	Direct	N/A
Displacement of fishing activities into other areas	Direct	N/A
Obstacles on the seabed	Direct	N/A

11.5.2 Scoped Out Impacts

11.5.2.1 Following the scoping assessment, no potential impacts were scoped out. Each potential impact has therefore been assessed for the fishing activities and fleets identified in the Commercial Fisheries Technical Report (Technical Appendix 11.1, Volume 4).

11.5.3 Scoped Out Receptors

11.5.3.1 In addition to the main fleets described in Section 11.4.2, fishing by other methods has been recorded in the regional study area. However, considering the low levels of activity exhibited by these (Commercial Fisheries Technical Report, Technical Appendix 11.1, Volume 4), they have been scoped out of the impact assessment process (Volume 3a - Figure 11.4.3 and Figure 11.4.4) on the basis that there is limited potential for any effects on these fleets.

11.5.3.2 Similarly, as described in the Commercial Fisheries Technical Report (Technical Appendix 11.1, Volume 4), the regional study area sustains negligible activity by non-UK fleets (Volume 3a - Figure 11.4.2). Therefore, non-UK fleets have been scoped out in the impact assessment process.

11.5.4 Assessment Approach and Criteria

11.5.4.1 An assessment of the potential impacts will be separately applied to the construction, operational and decommissioning phases. For the purposes of the assessment, and in the absence of detailed information on the decommissioning schedules and methodologies, it is considered that the potential effects associated with the decommissioning phases will be of no greater significance than the construction phases.

11.5.4.2 Cumulative impacts relevant to commercial fishing arising from other marine developments are discussed in Section 11.8.

11.5.4.3 Determining the significance of effects is a two-stage process that involves defining the sensitivity of the receptors and the magnitude of the impacts. The general approach to the assessment of significance is detailed in Chapter 5: EIA Methodology (Volume 2). The specific criteria used to describe receptor sensitivity, magnitude and impact significance in respect of commercial fisheries are described in the following sections.

11.5.4.4 It should be noted that sensitivity and magnitude criteria assigned to a fleet are based on professional judgement as there are no pre-defined thresholds for defining these criteria.

<u>Sensitivity Criteria</u>

11.5.4.5 The sensitivity of a fleet may vary with each potential impact, as well as between the construction/decommissioning and operational phases. In each instance, in order to define sensitivity, account is taken of the adaptability, tolerance and recoverability of the fleet to the potential effect as described in Table 11.5.2.

Table 11.5.2: Sensitivity Criteria

Sensitivity	Definition
High	Low adaptability due to limited operational range and ability to deploy only one gear type. Limited tolerance due to dependence upon a single fishing ground. Low recoverability due to inability to mitigate loss of fishing area by operating in alternative areas.
Moderate	Some adaptability due to extent of operational range and / or ability to deploy an alternative gear type. Moderate tolerance due to dependence upon a limited number of fishing grounds. Limited recoverability with some ability to mitigate loss of fishing area by operating in alternative areas.
Low	High adaptability due to extensive operational range and / or ability to deploy a number of gear types. High tolerance due to ability to fish a number of fishing grounds.

Table 11.5.2: Sensitivity Criteria	
Sensitivity	**Definition**
	High recoverability due to ability to mitigate loss of fishing area by operating in range of alternative areas.
Negligible	Category of fishing receptor with an extensive operational range and very high method versatility. Vessels are able to exploit a large number of fisheries.

Magnitude of Effect

11.5.4.6 The magnitude of an effect is considered for each predicted impact on a fleet by fleet basis. In defining the magnitude of a potential impact consideration is given to the spatial extent, duration, and severity of the impact as described in Table 11.5.3.

Table 11.5.3: Magnitude Criteria	
Magnitude	**Definition**
High	The majority of grounds that comprise a significant proportion of landings weights / values for key target species are affected and / or The change to fishing activity is permanent.
Moderate	A moderate proportion of the grounds that comprise a significant proportion of landings weights / values for key target species are affected and / or The effect is temporary but occurs over a relatively long period (i.e. years)
Low	A small proportion of the grounds that comprise significant annual landings weights / values for key target species are affected; and / or The effect is temporary and occurs over a relatively short timescale (i.e. months).
Negligible	Receptor has very little or no history of fishing in the areas under consideration; and / or The change is temporary and recovery is immediate.

Significance Criteria

11.5.4.7 Taking into account the sensitivity of the fleet and the magnitude of the effect the significance of an impact is then assessed as major, moderate, minor or negligible using the significance criteria matrix shown in Table 11.5.4.

11.5.4.8 Impacts which are assessed as of moderate or major significance are considered to be significant in EIA terms and would, where possible, require additional mitigation to reduce the overall significance levels. Impacts assessed as negligible or minor are considered to be not significant in EIA terms.

11.5.4.9 It should be noted that the impacts of offshore wind farm developments upon commercial fishing activities cannot be easily categorised and as a result, the application of significance criteria to the assessment, whilst guided by the significance criteria matrix (Table 11.5.4), is largely qualitative and based upon professional judgement. The matrix improves understanding of how the judgement has been reached from the discussion of each impact considering each fishery and is not prescriptive.

11.5.4.10 In the case of potential impacts associated with safety issues for fishing vessels and seabed obstacles, the use of the matrix in Table 11.5.4 is not considered adequate. Risks associated with these impacts are instead defined on the basis of whether they are acceptable (broadly acceptable or tolerable) or unacceptable (greater than those incurred during the course of normal fishing operations). Impacts within acceptable limits are considered to be not significant in EIA terms, whilst those assessed to be outside acceptable limits are considered to be significant. Further detail on the methods used for assessing safety risks is provided in Chapter 12: Shipping and Navigation (Volume 2).

Table 11.5.4: Significance Criteria

		Magnitude			
		High	**Moderate**	**Low**	**Negligible**
Sensitivity	**High**	Major	Major	Moderate	Minor
	Moderate	Major	Moderate	Minor	Minor
	Low	Moderate	Minor	Minor	Negligible
	Negligible	Minor	Negligible	Negligible	Negligible

11.5.5 Data Limitations

11.5.5.1 The principal limitations of the data used to inform this assessment are highlighted below. Further detailed information on the sources of data and information used, is provided in the Commercial Fisheries Technical Report (Technical Appendix 11.1, Volume 4).

- Surveillance Sightings Data: Fisheries surveillance sightings within the UK Exclusive Economic Zone (EEZ) are recorded by fishery protection aircraft and surface craft as a method of policing fisheries legislation. Fishing vessels of all sizes and nationalities are recorded. Given that surveillance in a given area normally occurs weekly and only during daylight hours, these data cannot be used for quantitative assessments of activity. Therefore, for the purposes of this assessment, surveillance sightings have only been used to provide an indication of the distribution of fishing activity by method and nationality.

- MMO Landings Values Data: This dataset provides information on landings values for all vessel size categories (under-10 m, 10-15 m, over-15 m), nationalities, species and methods. The main limitation of the dataset relates to its spatial resolution. Given that data are collected by ICES rectangle and fishing activity is not uniformly distributed across the area of a rectangle, extrapolations in respect of the value of fishing in discrete sea areas within a given rectangle (i.e. such as those occupied by offshore wind farms) should be made with caution.

- VMS Data: Whilst VMS data provide a comprehensive source of information to describe the distribution and level of fishing within discrete sea areas such as wind farm sites (data provided is provided in a 0.05° by 0.05° grid), the dataset currently available only includes information for vessels in the larger vessel category (over-15 m in length). As such, these data do not incorporate activity by all vessels and therefore are not representative of all fishing activity, particularly in the case of fleets in which a significant number of vessels are in the smaller vessel class (i.e. creelers).

11.5.5.2 Further to the above, it is recognised that the data and information gathered through direct consultation with the fishing industry, whilst it provides a good indication on preferred fishing grounds, operating practices and gear and vessel specifications, may not be totally representative of the levels of activity or the fishing grounds of every single vessel operating in the regional study area.

11.5.6 Assessment Limitations

11.5.6.1 The principal limitation of an assessment of effects upon commercial fishing activities is the potential for a change in the established baseline over time. This may be for a number of reasons, such as fluctuations in landings, changes in legislation and management policies, economic constraints such as fuel costs and crew availability and environmental restrictions such as weather. As a result, the scope of this assessment is limited to the baseline identified.

11.5.6.2 This assessment is based on the best available data and the known operational patterns of the current fleets operating in the study area. Predicting future patterns is currently complex due to a number of aspects, such as Brexit negotiations and the potential impact this can have on the European fleets and foreign fishing rights.

11.5.6.3 Although it is noted that individual vessels may spend more time in certain regional areas such as the Moray Firth, it is not possible within the scope of this assessment to consider an effect on a vessel by vessel basis. This is particularly the case for the king scallop fishery, which with the exception of several smaller and predominately inshore vessels, are largely nomadic vessels targeting grounds around the UK. The assessment therefore focuses on assessing potential effects on the different fleets.

11.5.6.4 There is currently no established model for assessing the economic value of commercial fisheries in discrete sites such as offshore wind farms. National commercial fisheries datasets provide statistics of landings, values and effort for UK licensed fishing vessels of all lengths (and non-UK landings into British ports), however these can only be recorded down to the spatial resolution of an ICES rectangle, which are large areas relative to the wind farm. Whilst additional data and information sources further contribute to describing fishing activities, it is not possible to assign a specific economic value to fisheries. The assessment therefore focuses on measuring the importance of a fishery through levels of activity within an area which are described as low, moderate or high.

11.6 Design Envelope Parameters

11.6.1 Realistic Worst Case Design Scenario

11.6.1.1 As identified in Chapter 4 Development Description (Volume 2), Moray West is considering a range of potential construction methods and design options for the Development. The Design Envelope presented in Chapter 4 (Volume 2) presents the range (minimum and maximum) of design parameters for each of the options under consideration e.g. substructure type or turbine model.

11.6.1.2 In order to determine potential impacts of the various options it is necessary to define the 'realistic worst case scenario'. The realistic worst case scenario represents, for any given receptor and potential impact on that receptor, various options in the Design Envelope that would result in the greatest potential for change to the receptor in question.

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

11.6.1.4 Table 11.6.1 presents the realistic worst case scenario for potential impacts on commercial fisheries during construction, operation and maintenance and decommissioning phases of the Development and provides justification as to why the options and design parameters identified are considered to be the realistic worst case scenario.

Table 11.6.1: Design Envelope Parameters Relevant to the Commercial Fisheries Impact Assessment		
Potential Impact	**Realistic Worst Case Scenario**	**Justification**
Construction		
Adverse impacts on commercially exploited fish and shellfish populations	As defined in Volume 2 - Chapter 8: Fish and Shellfish Ecology.	As described in Volume 2 - Chapter 8: Chapter 8 Fish and Shellfish Ecology.
Temporary loss of restricted access to traditional fishing grounds	Maximum number of safety zones. This would result from the installation of: • Maximum number of WTGs: 85; • Maximum number of OSP: 2; • Maximum length of inter array and inter OSP cables: 275 km and 15 km respectively with up to 10% of the length of inter array and inter OSP cables requiring protection; and • Maximum length of export cables: 130 km (for two cable circuits of 65 km) with up to a maximum of 20% of its length requiring protection. Maximum extent of safety zones: • 500 m safety zones around construction vessels and cable lay vessels; and • 50 m safety zones around partially and completely installed infrastructure prior to commissioning. Presence of sections of unburied cable (i.e. cables awaiting burial or protection). Maximum duration of construction works: 36 months overall construction period with six months for export cable installation.	The maximum duration of construction works, the maximum number and extent of safety zones and the presence of unburied cables would result in the greatest potential temporary loss or restricted access to traditional fishing grounds during the construction phase. Moray West will apply to Scottish Ministers under the Energy Act 2004 to implement standard 500 m safety zones around construction vessels and cable lay vessels and 50 m safety zones around partially and completely installed infrastructure prior to commissioning.

Table 11.6.1: Design Envelope Parameters Relevant to the Commercial Fisheries Impact Assessment		
Potential Impact	**Realistic Worst Case Scenario**	**Justification**
Safety issues for fishing vessels	Maximum Number of WTGs: 85 Maximum Number of OSPs: 2 Maximum length of inter-array and OSP interconnector cables: 275 km and 15 km respectively Maximum length of Offshore Export Cable Corridor cable: 130 km (two cable circuits x 65 km) Maximum number of vessels during construction = 25 based on: • WTGs and substructures (installation periods do not overlap) ○ 2 x installation vessels (Jack-up Vessel (JUV) or Heavy Lift Vessel (HLV)) ○ 2 x support vessels ○ 4 x transport (barges and tugs) • Inter-array and OSP interconnector cables (installation overlaps with installation of export cables): ○ 2 x Cable Lay Vessel (CLV) ○ 2 x Cable Burial Vessel (CBV) ○ 2 x support vessels • Export cables: ○ 2 x CLV ○ 2 x CBV ○ 2 x support • Crew Transfer Vessels (CTVs) and guard vessels (up to five) Maximum vessel movements: • Up to 46 return trips for installation vessels, up to 16 return trips for support vessels and up to five transport vessels per week; and • Cables: number of return trips dependent on final cable lengths.	Installation of the greatest number of WTG and OSPs and the maximum length of cabling as well as the maximum level of construction vessel transits, would result in the greatest safety issues for fishing vessels during construction.
Increased steaming times to fishing grounds	As above for temporary loss or restricted access to traditional fishing grounds.	The maximum duration of construction works and the maximum number and extent of safety zones would result in the greatest potential increases in steaming times to fishing grounds.

Table 11.6.1: Design Envelope Parameters Relevant to the Commercial Fisheries Impact Assessment		
Potential Impact	**Realistic Worst Case Scenario**	**Justification**
Interference with fishing activities (navigational conflict)	Maximum number of vessels during construction = 25 (see safety issues above) Maximum vessel movements: • Up to 46 return trips for installation vessels, up to 16 return trips for support vessels and up to five transport vessels per week; and • Cables: number of return trips dependent on final cable lengths.	The maximum number of construction vessels will result in the greatest risk of interference with fishing gear and vessels.
Displacement of fishing activity into other areas	As above for temporary loss or restricted access to traditional fishing grounds.	The maximum duration of construction works and the maximum number and extent of safety zones would result in the greatest potential loss or restricted access to fishing grounds and associated displacement.
Obstacles on the seabed	Maximum Number of WTGs: 85 Maximum Number of OSPs: 2 Maximum length of inter array and inter OSP cables: 275 km and 15 km respectively. Maximum length of export cable: 130 km (two x cable circuits of 65 km). Potential for objects to be dropped on the seabed by contractors during the construction phase.	The presence of jack up vessels and vessels anchors as well as construction works such as trenching of cables and installation of WTGS and OSPs could potentially result in seabed obstructions, which in turn could cause loss or damage to fishing gear. Installation of the maximum number of turbines, OSPs and length of cables would result in the greatest potential for seabed obstacles to appear. Similarly, objects accidentally dropped during construction activities by contractors could result in seabed obstacles.
Operation and Maintenance		
Adverse impacts on commercially exploited fish and shellfish populations	As defined in Volume 2 - Chapter 8: Chapter 8 Fish and Shellfish Ecology.	As described in Volume 2 - Chapter 8: Chapter 8 Fish and Shellfish Ecology.

Table 11.6.1: Design Envelope Parameters Relevant to the Commercial Fisheries Impact Assessment

Potential Impact	Realistic Worst Case Scenario	Justification
Permanent loss or restricted access to traditional fishing grounds	Presence of WTGs and substructures, OSPs and cables based on: • Maximum number of WTGs: 85; • Maximum number of OSP: 2; • Maximum length of inter array and inter OSP cables: 275 km and 15,000 m; and • Maximum length of export cable: 130 km. Maximum extent of safety zones: • 500 m advisory safety zones around vessels undertaking major maintenance works. Minimum spacing between turbines: 1,200 m downwind x crosswind 1,050 m. Maximum length of cables protected: • Up to 20% of the export cable length: 13 km; • Up to 10% of the inter array cables length: 27 km; and • Up to 10% of the total length of inter OSP cables: 1,500 m. Maximum number of cable crossing: 15 for inter array cables and six for export cables.	Physical presence of offshore wind farm infrastructure and cables would result in the greatest potential permanent loss or restricted access to traditional fishing grounds during the operation phase. The smaller the spacing between turbines the greatest the potential for vessels to have restricted access to the site (particularly in the case of large vessels). The use of cable protection may increase potential exclusion of fishing vessels in discrete areas during operation, particularly in the case of those operating towed gears. Where major maintenance works are required, Moray West will apply to Scottish Ministers for a standard 500 m safety zone around vessels involved in maintenance works.
Safety issues for fishing vessels	Maximum Number of WTGs: 85 Maximum Number of OSPs: 2 Maximum length of inter array and inter OSP cables: 275 km and 15 km respectively Maximum length of export cables: 130 km Export, inter array and inter OSP cables will be buried to a minimum depth of 1 m and protected where burial is not possible Minimum spacing between turbines: 1,200 m downwind x crosswind 1,050 m Maximum number of vessels during operation maintenance: • Up to three crew transfer vessels; • Up to one service operation vessel; and • Up to one jack up for periods of maintenance.	Presence of the greatest number of WTG and OSPs and the maximum length of cabling and associated operation and maintenance vessel transits, would result in the greatest safety issues for fishing vessels. Similarly, the smaller the spacing between turbines the greatest the potential for safety issues to arise.

Table 11.6.1: Design Envelope Parameters Relevant to the Commercial Fisheries Impact Assessment		
Potential Impact	**Realistic Worst Case Scenario**	**Justification**
Increased steaming times to fishing grounds	Presence of WTGs and substructures, OSPs and cables based on: • Maximum number of WTGs: 85; • Maximum number of OSP: 2; • Maximum length of inter array and inter OSP cables: 275 km and 15 km; and • Maximum length of export cable: 130 km. Maximum extent of safety zones: • 500 m advisory safety zones around vessels undertaking major maintenance works. Minimum spacing between turbines: 1,200 m downwind x crosswind 1,050 m.	Physical presence of offshore wind farm infrastructure and cables would result in the greatest potential increases in steaming times to fishing grounds. In addition, the minimum the spacing between turbines the greatest the potential for increased steaming times.
Interference with fishing activities (navigational conflict)	Maximum number of vessels during operation maintenance: • Up to three crew transfer vessels; • Up to one service operation vessel (SOV); and • Up to one jack up for periods of maintenance.	The maximum number of operation and maintenance vessels will result in the greatest risk of interference with fishing gear and vessels.
Displacement of fishing activity into other areas	As above for permanent loss or restricted access to traditional fishing grounds.	Physical presence of offshore wind farm infrastructure and cables would result in the greatest potential loss or restricted access to fishing grounds and associated displacement.
Obstacles on seabed	Potential for objects to be accidentally dropped on the seabed by contractors during the operation phase. Presence of boulders or berms from cable burial or boulder relocation carried out during the construction phase.	This could result in the presence of obstacles on the seabed during the operation phase and associated risk to fishing gear.
Decommissioning		
In the absence of detailed methodologies and schedules, decommissioning works and the implications for commercial fisheries are considered analogous with or likely less than those of the construction phase. Therefore, the worst case parameters defined for the construction phase also apply to decommissioning.		

11.6.2 Embedded Measures

11.6.2.1 Where relevant, mitigation measures are incorporated as part of the development design process to minimise any potential adverse significant effects. These measures are referred to as embedded measures. The measures relevant to commercial fisheries are described below. These reflect current industry best practice and include specific safety measures and draft proposals for development and implementation of a Commercial Fisheries Mitigation Strategy (CFMS).

Safety Measures

- Inter-array cabling, inter OSP cables and offshore export cables will be buried, where possible, to a minimum depth of 1 m to prevent damage to and from fishing gear. Cable protection measures will be applied in areas where burial is not possible e.g. where the cables are required to cross existing cables or in areas of hard ground. Specific protection measures will be determined as part of final detailed design for the cable routes which will be informed by the Cable Burial Risk Assessment (CBRA) (post consent). Cable protection measures are likely to include rock placement, concrete mattresses or grout bags (or combinations of these depending on ground conditions). Specific cable protection measures will be agreed in consultation with fisheries stakeholders (see Commercial Fisheries Mitigation Strategy (CFMS)) below;
- The following advisory safety zones will be applied for by Moray West under the Energy Act 2004:
    - Standard rolling 500 m safety zones around any structure where construction work is underway, as indicated by the presence of a large construction vessel(s);
    - 50 m safety zones around partially (and fully) installed infrastructure during the construction phase where work is not underway. These safety zones will only be in place prior to commissioning of the WTGs; and
    - 500 m safety zones around any structure undergoing major maintenance during the operational phase, defined as work requiring a large construction vessel.
- Appointment of a Fisheries Liaison Officer (FLO) who will be responsible for liaising with local fishermen prior to, during and post construction and to maintain communications during O&M phase of the Development;
- Appointment of Fisheries Industry Representatives (FIR) for key fisheries who will be responsible for liaising with the wider fishing industry. Specific roles and responsibilities of the FIR and how they operate will be defined within the CFMS;
- Navigational Safety Plan (NSP) – this will be submitted to the licensing authority six months prior to commencement of works and will include:
    - Information on navigational safety measures including protocols and procedures for the navigation of vessels (construction and maintenance) to and from the Moray West Site and along the Offshore Export Cable Corridor (i.e. agreement of vessel transit routes in order to minimise, as far as possible, interference with fishing activities and fishing gear);
    - Details on the location and timings for advisory safety zones as listed above;
    - Timely and efficient issue of Notice to Mariners (NtMs), Kingfisher notifications and Radio Navigation warnings advising the fishing community of the position and nature of construction activities and partially installed infrastructure including inter-array, OSP interconnector and export cables and cable crossings; and

    - Identification of refuge/shelter areas for construction vessels to avoid fishing activities and gear.

- Preparation of a Lighting and Marking Plan (LMP) to set out the lighting and marking requirements during the construction and operation of the wind farm and OfTI (for further details please see Chapter 12 Shipping and Navigation). The information will be distributed to fisherman through agreed channels as defined in the CFMS;
- Moray West will advise the United Kingdom Hydrographic Office (UKHO) on the final location of WTGs, OSPs, inter-array cables and export cables for these to be added to appropriate Admiralty Charts; and
- Appropriate liaison would be undertaken with relevant fishing interests for the duration of the Development to ensure that they are informed of development planning, construction, operation, maintenance and decommissioning activities.

<u>Commercial Fisheries Mitigation Strategy (CFMS)</u>

11.6.2.2 An draft CFMS has been developed as part of this assessment in consultation with the SFF and other fisheries stakeholders (Volume 4 – Technical Appendix 11.2). This draft CFMS will form the basis upon which more detailed discussions with the fishing community will be undertaken post consent to agree specific measures to be implemented to minimise potential effects on key fisheries in the area.

11.6.2.3 As described in section 11.6.1, the potential effects on commercial fisheries discussed below (section 11.7) are based on an assessment of the worst case design parameters associated with the Development (as defined by the Design Envelope). Once the final design of the Development has been agreed (post consent), the draft CFMS will be updated, amended where required, and finalised through consultation with local fishing community and other fisheries groups and stakeholders, to ensure that that it fully reflects the final detailed design of the Development.

11.6.2.4 The draft CFMS provides information on the following:

- Measures for facilitating on-going dialogue with the fishing community throughout all phases of the Development;
- Outline measures for managing and mitigating potential effects on key fisheries associated with a loss of, or restriction in access to, traditional fishing grounds during pre-construction, construction, operations and maintenance and decommissioning;
- Outline measures and procedures for minimising interactions (navigation conflict) between wind farm construction and fishing activities;
- Procedures to be implemented in the event of interactions (navigation conflict) between wind farm construction and fishing activities (i.e. claims for lost / and or damaged gear);
- Protocols and procedures for ensuring compliance with standard offshore policies such as the Dropped Objects Policy. These policies prohibit the discarding of objects or materials overboard and require rapid recovery of any accidentally dropped objects; and
- Supplementary industry wide initiatives.

11.7 Assessment of Potential Effects

11.7.1.1 The assessment of potential effects on commercial fisheries described below has been undertaken on a fleet by fleet basis for each stage of the Development (construction, operation and maintenance, and decommissioning) for the following:

- Creel fleet;
- Mackerel jigging;
- Demersal trawl fleet;
- Scallop dredging fleet; and
- Scottish seine net fleet.

11.7.2 Potential Construction Effects

Adverse Impacts on Commercially Exploited Fish and Shellfish Populations

All Fleets

11.7.2.1 As described in Chapter 8: Fish and Shellfish Ecology, there is potential for the construction of the Development to affect fish and shellfish populations. This could in turn indirectly affect the productivity of the fisheries that target them. Key species to commercial fisheries in the regional study area include Nephrops, squid, haddock, mackerel, crab, lobster, and king scallops.

11.7.2.2 The potential effects of the Development on fish and shellfish species, including those of commercial importance, have been assessed in Chapter 8: Fish and Shellfish Ecology, and are not expected to exceed minor significance (for all impacts assessed). The significance of any resulting effects on commercial fisheries is therefore also not expected to exceed **minor** which is **not significant** in EIA terms.

Temporary Loss or Restricted Access to Traditional Fishing Grounds

11.7.2.3 There is potential for activities associated with the construction phase of the Development to result in a temporary loss or restricted access to traditional fishing grounds to commercial fisheries active in the area.

11.7.2.4 The potential temporary loss or restricted access to grounds would be associated with the safety measures implemented during construction as outlined in Section 11.6.2. These include the installation of rolling 500 m safety zones around the active areas of construction / construction vessels within the Moray West Site and along the Offshore Export Cable Corridor and 50 m safety zones around partially or completely installed infrastructure (prior to commissioning).

11.7.2.5 All non-construction associated vessels will be excluded from within the advisory safety zones for the duration of time over which they are present in a certain location (this could range from a number of days to a number of months during the three year construction period depending on the specific construction activities being undertaken). Fishing vessels will still be permitted within parts of the Moray West Site and along sections of the Offshore Export Cable Corridor where safety zones are not in place.

11.7.2.6 Fishermen will also be advised, through NtMs, Kingfisher bulletins and communications from the FLO, of specific locations within the Moray West Site and along the Offshore Export Cable Corridor where sections of unburied cable are present. This includes areas of cable awaiting protection (rock placement or concrete mattresses, or where there are cable crossings) and sections of the cables that may be awaiting burial (i.e. where cables are surface laid). In respect of cables awaiting protection, this is expected to affect approximately 10% of the Moray West Site and 20% of the Offshore Export Cable Corridor. For the purposes of this assessment it is assumed that in such areas fishing will also need to be excluded.

Creel Fleet

11.7.2.7 The creel fleet that operates in the regional study area is comprised of vessels mainly under-10 m in length which primarily target crabs and lobster in nearshore areas (Volume 3a - Figure 11.4.3 and Figure 11.4.4 and Figure 11.4.5). Taking the restricted operational range of the fleet, as well as its limitation in terms of target species, its sensitivity is considered to be **moderate**.

11.7.2.8 Creeling grounds identified through consultation with local stakeholders in the immediate area of the Development are located well inshore of the Moray West Site, however straddle a short nearshore section of the Offshore Export Cable Corridor (Volume 3a - Figure 11.4.6). The potential temporary loss or restricted access to fishing grounds would therefore be a result of safety measures associated with the installation of the export cable and any sections of the cable awaiting burial or protection as outlined above.

11.7.2.9 Any loss of grounds would be short term occurring over the relatively short period of time over which export cables will be installed (six months). Taking this into account together with the location of fishing grounds in respect of the Offshore Export Cable Route (Volume 3a - Figure 11.4.6), and implementation of the embedded mitigation listed in Section 11.6.2 (including the proposals set out in the draft CFMS presented in Volume 4 – Technical Appendix 11.2), the potential impact magnitude is considered to be **low**.

11.7.2.10 Taking the moderate sensitivity of the fleet and the low magnitude of the impact, the significance of the effect associated with temporary loss or restricted access to traditional fishing grounds is considered to be **minor** which is **not significant** in EIA terms.

Mackerel Jigging Fleet

11.7.2.11 Given the small size of the vessels engaged in mackerel jigging (under-10 m), their restricted operational range (Volume 3a - Figure 11.4.7), as well as their limitations in terms of target species, they are considered of **moderate** sensitivity in respect of temporary loss or restricted access to traditional fishing grounds.

11.7.2.12 Mackerel jigging grounds are located inshore of the Moray West Site, however straddle a short nearshore section of the Offshore Export Cable Corridor (Volume 3a - Figure 11.4.7). Any potential loss of fishing grounds to this fishery would therefore be limited to localised areas along the Offshore Export Cable Corridor where relevant safety measures (as listed in Section 11.7.2.4) are in place and to areas where cables are awaiting burial or protection (paragraph 11.7.2.6).

11.7.2.13 The effect would be short term, occurring over the relatively short period of time over which export cables will be installed (six months). Taking this into account together with the relatively small proportion of fishing grounds that could be affected (Volume 3a - Figure 11.4.7), and the embedded mitigation listed in Section 11.6.2, the potential impact magnitude is considered to be **low**.

11.7.2.14 Considering the moderate sensitivity of the fleet and the low magnitude of the impact, the significance of the effect associated with temporary loss or restricted access to traditional mackerel jigging grounds is assessed to be **minor** and **not significant** in EIA terms.

Demersal Trawl Fleet

All Demersal Trawls

11.7.2.15 Demersal trawlers have, accepting quota and market value constraints, a greater degree of target species versatility than for example creel vessels (discussed above) or scallop dredgers. Considering this together with their relatively large operational range (Volume 3a - Figure 11.4.8 and Figure 11.4.9), the sensitivity of the demersal trawl fleet in general is considered to be **low**.

11.7.2.16 The potential loss of grounds to the demersal trawl fleet would be limited to localised areas within the Moray West Site and along the Offshore Export Cable Corridor where safety measures (zones) are in place and to areas where cables may be awaiting burial or protection. The impact would be temporary, with all construction activities associated with the Development occurring over a period of 36 months including six months for installation of the export cable. Taking this into account in the context of the extent of grounds available to the fleet (Volume 3a - Figure 11.4.8 and Figure 11.4.9), the potential impact magnitude is considered to be **low**.

11.7.2.17 Given the low sensitivity of the fleet and low magnitude of the impact, the significance of the effect of temporary loss or restricted access to traditional fishing grounds on the demersal trawl fleet in general is considered to be **minor** and **not significant** in EIA terms.

11.7.2.18 It is recognised that some smaller local vessels will have significantly smaller operational ranges and fishing opportunities than those described for the demersal trawl fishery in general. Consequently, these will be more dependent on fishing grounds in the Moray Firth area. A separate assessment is given below for these vessels broken down by fishery (Nephrops, squid and whitefish).

Nephrops

11.7.2.19 Information provided by fishermen during consultation (Volume 3a - Figure 11.4.10) indicates that with the exception of one very small isolated area, the local Nephrops fishing grounds are located inshore of the area of the Moray West Site. This is further supported by landings values data (Volume 3a - Figure 11.4.5), which suggest that the majority of Nephrops landings come from the two ICES rectangles south of the Moray West Site (rectangles 44E7 and 44E6). Taking the extent of the local grounds relative to the level of overlap with the Development (only relevant to the area of the Offshore Export Cable Corridor) (Volume 3a - Figure 11.4.10) the sensitivity of the Nephrops fishery is considered to be **low**.

11.7.2.20 Any potential loss of grounds would be limited to localised areas around export cable installation works where safety measures (zones) are in place and to sections of cable that may be awaiting burial or protection. In addition, the exclusion from these grounds would be temporary and short term, only occurring over the period of time over which export cables will be installed (six months). The potential magnitude of the impact is therefore considered to be **low**.

11.7.2.21 Taking the low sensitivity of local Nephrops vessels and the low magnitude of the impact, the significance of the effect of temporary loss or restricted access to fishing grounds during construction is considered to **minor** and **not significant** in EIA terms.

Squid

11.7.2.22 With regards to demersal trawling for squid by local vessels, information provided by fishermen during consultation (Volume 3a - Figure 11.4.11) indicates that squid fishing grounds extend over a wide area of the Moray Firth, including the area of the Moray West Site and the northern and southern sections of the Offshore Export Cable Corridor. The majority of squid landings within the study area come from inshore areas (rectangles 44E6 and 44E7). However, it should be noted that, albeit at comparatively lower values, landings of squid are also significant in rectangle 45E7 ,where the eastern section of the Moray West Site is located (Volume 3a - Figure 11.4.5).

11.7.2.23 In this context, it is important to note that the vast majority of landings by demersal trawlers in rectangle 45E7 correspond with vessels that are over-15 m in length. Therefore, for the most part, these vessels would be expected to have the ability to exploit fishing opportunities beyond the regional study area (Volume 4 – Technical Appendix 11.1: Figure 3.10). With this in mind but acknowledging the location of the local grounds relative to the location of the Development (Volume 3a - Figure 11.4.11) the sensitivity of the squid fishery is considered to be **moderate**.

11.7.2.24 Taking the temporary nature of construction activities (up to 36 months in total including six months for export cable installation), the relatively small area lost to fishing at a given time as a result of safety zones (paragraph 11.7.2.4) and areas where cables may be awaiting burial or protection, and the embedded mitigation listed in Section 11.6.2, the impact magnitude is assessed to be **low**. The significance of the effect of temporary loss or restricted access to fishing grounds associated with the construction phase on local squid vessels is therefore considered to be **minor** and **not significant** in EIA terms.

Whitefish

11.7.2.25 In the particular case of demersal trawling for whitefish, as indicated by landings data (2012-2016), the majority of activity occurs inshore of the Moray West Site (Volume 3a - Figure 11.4.4, Figure 11.4.5 and Figures 3.5, 3.6 and 3.7 in Volume 4: Technical Appendix 11.2). It is therefore considered that for the most part, any loss of fishing grounds during construction would be associated with export cable installation works. Considering the extent of the inshore fishing areas available to demersal trawlers, the sensitivity of the local demersal trawlers targeting whitefish is assessed to be **low**.

11.7.2.26 The potential loss of whitefish grounds would be limited to localised areas around export cable installation works where safety measures (zones) are in place and areas where cables may be awaiting burial or protection. In addition, the exclusion from these grounds would be temporary and short term, only occurring over the short period of time during which export cables will be installed (six months). Taking this into account and the embedded mitigation listed in Section 11.6.2, Impact magnitude is considered to be **low**.

11.7.2.27 Taking the low sensitivity of local whitefish vessels and the low magnitude of the impact, the significance of the effect of temporary loss or restricted access to fishing grounds during construction is considered to be **minor** and **not significant** in EIA terms.

Scallop Dredging Fleet

11.7.2.28 Taking the level and distribution of scallop dredging activity recorded within the regional study area and the extent of local scallop grounds provided by fishermen during consultation in respect of the location of the Development (Volume 3a - Figure 11.4.12, Figure 11.4.13, Figure 11.4.17 and Figure 11.4.18) the sensitivity of local (smaller) scallop dredgers is considered to be **moderate**.

11.7.2.29 With regards to the nomadic scallop fleet, considering the extensive and wide ranging distribution of their fishing grounds (Volume 3a - Figure 11.4.14, Figure 11.4.15 and Figure 11.4.16) the sensitivity is considered to be **low**.

11.7.2.30 The loss of fishing grounds to scallop dredgers would be a result of the implementation of safety measures during construction within the Moray West Site and the Offshore Export Cable Corridor (outlined in Section 11.6.2) and of the presence of sections of cables awaiting burial or protection.

11.7.2.31 Considering the small areas potentially lost to fishing at any given time, and the temporary nature of construction works (all construction activities associated with the Development will occur over a period of 36 months including six months for installation of the export cable), the potential magnitude of the impact is considered to be **low**. This is considered to be the case for both local and nomadic vessels. This takes account of the relatively small area of grounds potentially lost and the availability of alternative fishing areas both within the regional study area (for smaller vessels) and UK wide (for nomadic vessels) (Volume 3a - Figure 11.4.12, Figure 11.4.13, Figure 11.4.17, Figure 11.4.18, Figure 11.4.14, Figure 11.4.15 and Figure 11.4.16). In addition, it considers the embedded mitigation listed in Section 11.6.2.

11.7.2.32 Given the moderate sensitivity of the local fleet and the low sensitivity of the nomadic fleet and low impact magnitude, the significance of the effect of temporary loss or restricted access to fishing grounds during construction for the local and nomadic scallop fleets is considered to be **minor** and **not significant** in EIA terms.

Scottish Seine Net Fleet

11.7.2.33 As previously described (paragraphs 11.4.2.30 to 11.4.2.32), Scottish seiners operating in the regional study area are over-15 m in length. They target various whitefish species, particularly haddock, and have wide operational ranges. Their principal area of activity by this fishery in the regionals study area is located north of the Moray West Site (Volume 3a - Figure 11.4.3). Their sensitivity in respect of loss of fishing grounds is therefore considered to be **negligible**.

11.7.2.34 Considering the small extent of exclusion to fishing associated with safety measures which will be implemented during the construction of the Development (paragraph 11.7.2.4) together with the temporary nature of construction activities (up to three years within the Moray West Site and few months for installation of the export cables) potential impact magnitude is considered to be **low**.

11.7.2.35 In light of the negligible sensitivity of the fleet and the low magnitude of the impact, the significance of the effect on the Scottish Seine net fleet will be **negligible** and **not significant** in EIA terms.

<u>Safety Issues for Fishing Vessels</u>

All Fleets

11.7.2.36 During the construction phase there may be potential for safety risks for fishing vessels to arise associated with the presence of partially installed infrastructure, construction vessels and machinery (i.e. collision or snag risk). As described in Section 11.1.1, a number of safety measures will be implemented during the construction phase to minimise potential safety issues for fishing vessels. Safety zones of 500 m will be imposed around active construction works and cable lay vessels, from which all non-construction vessels will be excluded. Safety zones around partially installed infrastructure will also be implemented.

11.7.2.37 All structures will be adequately lit and notified via NtMs, through Kingfisher bulletins as well as by direct liaison and information distribution by the project FLOs and FIRs (see Section 11.1.1). The required notices will also be distributed to make fishermen aware of any seabed levelling or boulder relocation works that may be necessary and of the location of sections of unburied cables.

11.7.2.38 In addition, construction vessel contractors will be obliged to comply with the terms of the NSP plan (Section 11.1.1), in addition to the standard obligations under International Maritime Safety Law, The UK Merchant Shipping Act, SOLAS and COLREGs.

11.7.2.39 With compliance to the above, safety issues for fishing vessels during the construction phase are considered to be **within acceptable limits**.

<u>Increased Steaming Times to Fishing Grounds</u>

Creel Fleet and Mackerel Jigging

11.7.2.40 Creeling and mackerel jigging fishing activity concentrates in nearshore waters and therefore inshore of the Moray West Site (Volume 3a - Figure 11.4.3, Figure 11.4.4, Figure 11.4.6 and Figure 11.4.7). As such, steaming times to fishing grounds would only be affected as a result of export cable installation activities in the discrete small inshore area where creeling/mackerel jigging activity and the Offshore Export Cable Corridor overlap (Volume 3a - Figure 11.4.6). The sensitivity of the fleet is therefore considered to be **low**.

11.7.2.41 Recognising the short term nature of export cable installation activity (up to six months) and the limited spatial extent of any effects associated with safety zones during cable installation (500 m around cable lay vessels), the magnitude of the potential increase in steaming times would be **negligible**.

11.7.2.42 Given the low sensitivity of the creel fleet and the mackerel jigging fishery to increased steaming times and the negligible impact magnitude, the significance of the effect is considered to be **negligible** and **not significant** in EIA terms.

Demersal Trawl, Scallop Dredging Fleet and Scottish Seine Net Fleet

11.7.2.43 The implementation of 500 m safety zones around construction activities and cable lay vessels and advisory 50 m safety zones around partially installed infrastructure during the construction phase could result in some limited, short term increases in steaming distances and times for the demersal trawl, the scallop dredging and the Scottish seine net fleet. Considering the operational ranges of these fleets (i.e. within the Moray Firth area in the case of smaller local vessels and well beyond the regional study area in the case of larger vessels) their sensitivity in respect of increased steaming times is considered to be **low**.

11.7.2.44 Recognising the discrete areas that will be covered by safety zones at any one time and their temporary nature(rolling presence of safety zones (moving from location to location) within the Moray West Site over a three year period and up to six months along the Offshore Export Cable Corridor), the impact magnitude is considered to be **negligible**.

11.7.2.45 Given the low sensitivity of the receptor, and negligible impact magnitude, the significance of the effect of increased steaming times to fishing grounds for the demersal trawl, scallop dredging and Scottish Seine fleets is therefore considered to be **negligible** and **not significant** in EIA terms.

<u>Interference with Fishing Activities (Navigational Conflict)</u>

Creel Fleet

11.7.2.46 There is the potential for transiting construction vessels to interact and cause damage to deployed strings of creels. The most common cause of damage being the unintentional fouling of surface markers or floating heaving lines. Under current UK legislation, there is no obligation on creel fishermen to make the surface markers of their gears visible in all sea states and weather conditions. To do so would require the surface markers to be dhan buoys of sufficient size fitted with lights and radar reflectors as specified under EU regulations for static gears deployed outside member states 12 nm limits. Currently within the 12 nm limit, the majority of UK static gear fishermen appear unwilling to utilise such equipped surface markers.

11.7.2.47 Recognising the more limited adaptability of this fleet to interference given the static nature of the gear used in comparison to towed gear fleets, the sensitivity is considered to be **moderate**.

11.7.2.48 In order to mitigate the risk to construction vessels and creel gear as far as is practically possible, as part of the CFMS (Section 11.1.1 and Volume 4 – Technical Appendix 11.2), liaison and information gathering will be undertaken to obtain the coordinates of static gear deployments. The purpose of this will be to provide the masters of construction vessels with sufficient information to enable them to plan their vessels passage so as to minimise the risks of interactions with static gear. With the above in mind, the potential impact magnitude is considered to be **negligible**.

11.7.2.49 Taking the moderate sensitivity of the creel fleet and the negligible impact magnitude, the significance of the potential effect of interference on the creel fleet is considered to be **minor.** This is **not significant** in EIA terms.

Mackerel Jigging and Demersal Trawl, Scallop Dredging and Scottish Seine Net Fleets

11.7.2.50 In the case of fishing vessels engaged in mackerel jigging and those operating towed gears (namely demersal trawling, scallop dredging and Scottish seiners), it should be noted that under the hierarchy of COLREGS Rule 18, vessels other than those of restricted manoeuvrability (RAMs) or constrained by draft are obliged to keep out of the way of vessels engaged in fishing. Therefore, unless restricted in their manoeuvrability or constrained by draft, construction vessels will be required to pass at safe distances from vessels engaged in fishing operations. With this in mind the sensitivity of vessels targeting mackerel by jigging, demersal trawlers, scallop dredgers and Scottish seiners are considered of **low** sensitivity to interference.

11.7.2.51 The NSP will include protocols and procedures for the transit of construction vessels to and from the Moray West Site and along the Offshore Export Cable Corridor. The NSP will also identify suitable refuge/shelter areas for construction vessels to avoid fishing activity, further minimising the risk of potential interference with fishing activities (Section 11.1.1). Taking these measures into account, the magnitude of the impact is considered to be **negligible**.

11.7.2.52 Taking the low sensitivity of vessels engaged in mackerel jigging, demersal trawling, scallop dredging and seining, and the negligible magnitude of the impact, the significance of the effect of interference with fishing activities is considered to be **negligible** and **not significant** in EIA terms.

<u>Displacement of Fishing Activity into Other Areas</u>

All Fleets

11.7.2.53 The extent of potential displacement of fishing activity into other areas during construction would be a function of the level of temporary loss or restricted access to traditional fishing grounds that each fleet is subject to. As described previously, the effect on key fisheries included in the assessment was assessed to not exceed **minor** significance and therefore is **not significant** in EIA terms.

11.7.2.54 The assessment carried out in respect of temporary loss or restricted access to traditional fishing grounds is therefore considered to also apply in respect of displacement and is summarised in Table 11.7.1.

11.7.2.55 In the context of this assessment, it should be recognised that that given the operational ranges and the extent of the grounds of the fleets of concern, it is possible that skippers might continue fishing within their traditional grounds, rather than exploring new grounds as a result of the limited area and temporary nature of fishing areas lost during construction.

Table 11.7.1: Assessment of Displacement of Fishing Activity into Other Areas during Construction

Receptor	Sensitivity	Impact Magnitude	Significance of Effect
Creel fleet	Moderate	Low	Minor
Mackerel jigging fleet	Moderate	Low	Minor
Demersal trawl fleet (in general)	Low	Low	Minor
Local Nephrops fleet	Low	Low	Minor
Local squid fleet	Moderate	Low	Minor
Local whitefish fleet	Low	Low	Minor
Local scallop fleet	Moderate	Low	Minor
Nomadic scallop fleet	Low	Low	Minor

Table 11.7.1: Assessment of Displacement of Fishing Activity into Other Areas during Construction			
Receptor	**Sensitivity**	**Impact Magnitude**	**Significance of Effect**
Scottish seine fleet	Negligible	Low	Negligible

<u>Obstacles on the Seabed</u>

All Fleets

11.7.2.56 Construction works such as the trenching of cables and installation of the WTGs and OSPs, could potentially produce seabed obstructions which, in turn, could cause loss or damage to fishing gears.

11.7.2.57 In the case of creels, the main risk would be parts of the strings caught fast on obstacles along the Offshore Export Cable Corridor such as berms, that the skipper is unaware of and when attempting to hauling it free, resulted in gear damage or loss.

11.7.2.58 In the case of vessels operating towed gear (namely demersal trawls, scallop dredges and Scottish seiners), seabed obstacles similarly represent a potential cause of damage or loss of fishing gear as well as potential vessel damage due to increased warps loads or warps parting under tension.

11.7.2.59 In the case of mackerel jigging, as there is no contact between the gear used and the seabed, there is no potential for interactions with seabed obstacles to occur.

11.7.2.60 Offshore policy prohibits the discarding of objects or wastes at sea, accidently or otherwise, and requires the reporting and recovery of any accidentally dropped objects. With compliance, the impact of objects dropped from construction vessels would be **within acceptable limits**.

11.7.2.61 It is, however, also recognised that cable burial and bolder clearance activities can result in the presence of boulders or berms which could also constitute a risk to towed fishing gears. In order to mitigate this risk, the appropriate monitoring and distribution of the relevant information to fisherman will be undertaken (Section 11.1.1) with the aim of achieving an impact that is **within acceptable limits.**

11.7.3 Potential Operational Effects

11.7.3.1 The following section outlines the potential effects on commercial fisheries of the operation and maintenance phase of the Development.

<u>Adverse Impacts on Commercially Exploited Fish and Shellfish Populations</u>

All Fleets

11.7.3.2 As described in Chapter 8: Fish and Shellfish Ecology (Volume 2), there is potential for the operation phase of the Development to affect fish and shellfish populations. This could in turn indirectly affect the productivity of the fisheries that target them. Key species to commercial fisheries in the regional study area include Nephrops, squid, haddock, mackerel, crab, lobster, and king scallops.

11.7.3.3 The potential effects of the Development during operation on fish and shellfish species, including those of commercial importance, have been assessed in Chapter 8: Fish and Shellfish Ecology (Volume 2), and are not expected to exceed minor significance (for all impacts assessed). Any resulting in-direct effects on commercial fisheries are therefore also not expected to exceed **minor significance** which is **not significant** in EIA terms.

Permanent Loss or Restricted Access to Traditional Fishing Grounds

Creel Fleet and Mackerel Jigging

11.7.3.4 As discussed for the construction phase, creeling and mackerel jigging activity in the Moray Firth is largely confined to nearshore areas, with negligible activity recorded within the Moray West Site (Volume 3a - Figure 11.4.3, Figure 11.4.6 and Figure 11.4.7). As such, any potential permanent loss or restricted access to traditional fishing grounds in respect of these fleets could only occur as a result of the presence of the export cable rather than the installed infrastructure within the Moray West Site.

11.7.3.5 As outlined in Table 11.6.1, where possible, the export cable will be buried to a depth of least 1 m. Where it is not possible to reach the target cable burial depth, additional cable protection will be required. Under the worst case scenario this would be for up to 20% of the total length of the export cable. In addition, post construction surveys will be undertaken to assess the status of the seabed following cable installation (Section 11.1.1).

11.7.3.6 Following installation of the offshore export cable circuits, and if required, additional cable protection measures, fishing by creelers and vessels engaged in mackerel jigging will be able to resume over the export cable circuits. The sensitivity of these fleets is therefore considered to be **negligible**.

11.7.3.7 Whilst the potential effect would last for the operational life of the export cable, physical exclusion from grounds along the Offshore Export Cable Corridor would only occur in instances where maintenance works and associated 500 m safety zones around maintenance vessels, are required. Considering this in the context of the extent of fishing grounds (Volume 3a - Figure 11.4.6 and Figure 11.4.7), the magnitude of the impact is considered to be **negligible**.

11.7.3.8 Taking into account the negligible sensitivity of the creel fleet and of vessels engaged in mackerel jigging and the negligible impact magnitude, the significance of the effect is considered to be **negligible** and **not significant** in EIA terms.

Demersal Trawl Fleet

11.7.3.9 Existing legislation does not prohibit fishing activity from resuming within operational wind farm sites. Advisory safety zones of 50 m will however be in place around installed infrastructure (including wind turbines and OSPs) and 500 m safety zones around maintenance works. The inter-array and OSP interconnector cables will be buried to at least 1 m depth. Where burial is not possible, cables will be protected using rock placement, concrete mattresses or grout bags (Table 11.6.1). Additional protection is expected to be required for up to 10% of the inter-array and OSP interconnector cables and 20% of the export cables. Therefore, with the exception of 50 m safety zones around infrastructure and 500 m safety zones around maintenance works, the area of the Development will be available for fishing.

11.7.3.10 As identified in the realistic worst case design parameters, the minimum spacing between turbines will be 1,200 m downwind and with a cross wind spacing of 1,050 m (Table 11.6.1). From consultation, the maximum gear spread for local otter trawlers would be circa 92 m (Pers. Comms whitefish and squid fisherman, 2017). It is therefore possible that some demersal trawling could resume once the offshore wind farm is operational.

11.7.3.11 Post construction fish and Nephrops sampling surveys using commercial trawlers in operational wind farms such as Walney 1 & 2, West of Duddon Sands, London Array, Barrow, Ormonde, Galloper and Gunfleet Sands undertaken by BMM demonstrate that it is possible to tow trawl gears between the turbines of operational wind farms. It should, however, be noted that individual skippers may consider it unsafe to fish within the Moray West Site due to the presence of the wind farm infrastructure and this would result in an effective loss of access to grounds within the offshore wind farm for these vessels. This would, however, be on a vessel specific basis rather than applicable to the demersal trawl fleet as a whole, including smaller local squid, Nephrops and whitefish vessels.

11.7.3.12 Given that the demersal trawl fleet (including smaller local vessels targeting Nephrops, squid and whitefish) would regain access to the site during the operational phase, they are considered to be of **low** sensitivity. In the context of this assessment it is important to note that fishing activity by the demersal fleet (in general and in the case of local fisheries) is more intense in the southern section of the study area (Volume 3a - Figure 11.4.8 and Figure 11.4.9 and Figure 11.4.10 and Figure 11.4.11), with comparatively lower levels of activity in the immediate area of the Moray West Site. Therefore for the most part, the loss of grounds would be associated with exclusion around maintenance activities in the area of the offshore export cable circuits.

11.7.3.13 Whilst the effect would last for the operational life of the Development, the loss of fishing area would be very small (i.e. that associated with 50 m advisory safety zones and 500 m around maintenance work).

11.7.3.14 Considering the above in the context of available fishing grounds to the demersal fleet in general (Volume 3a - Figure 11.4.14 and Figure 11.4.15) and those available to smaller local vessels (Volume 3a - Figure 11.4.16, Figure 11.4.17), the magnitude of the impact is considered to be **low**.

11.7.3.15 The sensitivity of the demersal trawl fleet is assessed to be **low** (for the fleet in general as well as for local fisheries) and the magnitude of impact is assessed as **low**. Therefore, the significance of the effect of long term loss / restricted access to traditional fishing ground is **minor** and **not significant** in EIA terms.

Scallop Dredging Fleet

11.7.3.16 In the case of scallop dredging, in addition to the potential loss of fishing area associated with the introduction of 50 m advisory safety zones around infrastructure and 500 m safety zones around major maintenance works, the principal concern would be the risk of interactions with the inter-array and OSP interconnector cables as a consequence of the scallop dredging gear substrate penetration depths with repeated passes.

11.7.3.17 Where additional cable protection is required (e.g. rock placement etc.,) scallop dredge vessels may seek to avoid deploying gear in these locations in order to minimise potential risk of damage to their gear. This could potentially further restrict the total area of the Moray West Site and the Offshore Export Cable Corridor available to the scallop dredging fleet (up to 10% of inter-array and OSP interconnector cables and up to 20% of export cables may need protection).

11.7.3.18 In the case of large nomadic vessels, a further constraint could be the manoeuvrability and minimum turning circles between the turbines within the Moray West Site.

11.7.3.19 The local (smaller) scallop dredges, by virtue of their smaller operational ranges have increased sensitivity to loss of fishing area than nomadic vessels. However, with inter-array, OSP interconnector and the offshore export cable circuits buried to at least 1 m, it is possible that these vessels could resume their activity within the Moray West Site and along the Offshore Export Cable Corridor. Considering the above, their sensitivity is considered to be **moderate**.

11.7.3.20 In the case of nomadic vessels, given the potential risk of interaction with inter-array and OSP interconnector cables as a result of repeat passes and potential constraints associated with manoeuvrability, for the purposes of this assessment, it has been assumed that these vessels will choose not to fish within the Moray West Site. However, given their extensive operational ranges and fishing opportunities, they are considered to be of **low** sensitivity.

11.7.3.21 The areas from which local (smaller) vessels would be excluded would be those associated with 50 m advisory safety zones around infrastructure and 500 m safety zones around maintenance operations and sections of cable protected where fishermen may seek to avoid deploying gear.

Although the impact will occur for the duration of the operational phase of the Development, considering the relatively small area of grounds lost in the context of the fishing grounds available to local scallop dredge vessels in the Moray Firth (Volume 3a - Figure 11.4.12, Figure 11.4.13, Figure 11.4.17 and Figure 11.4.18), potential impact magnitude is considered to be **low**.

11.7.3.22 In this context, it should be noted that as a condition of the Moray East Development consents, trials are to be conducted to evaluate the feasibility of different and modified scallop dredges fishing within an operational wind farm site and the findings of the trials could be carried forward to the Development. As set out in the draft CFMS, where appropriate, key findings from these trails will be taken into account, in the final design of the Moray West Offshore Wind Farm. However, this is highly dependent on necessary information from the trails being available in the timescales required.

11.7.3.23 In the case of nomadic vessels, considering the duration of the impact for the operational phase of the Development and assuming the vessels are excluded from the entire offshore wind farm area, but recognising the limited proportion of their overall fishing grounds that would be affected (Volume 3a - Figure 11.4.14, Figure 11.4.15 and Figure 11.4.16), the magnitude of the impact is considered to be **low**.

11.7.3.24 Although the sensitivity of the local scallop dredge fleet is moderate, the magnitude of any potential impact on this fleet in terms of long term loss / restricted access to traditional fishing grounds is low. Therefore the significance of the effect on the local scallop dredge fleet is **minor** and **not significant** in EIA terms.

11.7.3.25 Similarly, with a low sensitivity and low potential impact magnitude, the significance of the effect of long term loss / restricted access to traditional fishing grounds on the nomadic scallop dredge fleet is also **minor** and **not significant** in EIA terms.

Scottish Seine Fleet

11.7.3.26 Scottish seine netters targeting whitefish species in the regional study area have wide operational ranges and do not appear to be present in any significant levels in the area of the Moray West Site. Their sensitivity in respect of loss of grounds is therefore considered to be **negligible**.

11.7.3.27 The potential loss of grounds would last for the duration of the operational phase. However, considering the small proportion of the fishing grounds for this fleet that the Development represents the potential magnitude of the impact is considered to be **low**.

11.7.3.28 Taking into account the receptor sensitivity and magnitude of effect described above, the significance of the effect of permanent loss or restricted access to traditional fishing grounds on the Scottish seine fleet is considered to be **negligible** and **not significant** in EIA terms.

Safety Issues for Fishing Vessels

All Fleets

11.7.3.29 During the operation phase, there may be potential for safety risks for fishing vessels to arise as a result of the presence of infrastructure associated with the Development and vessels and machinery undertaking maintenance operations (i.e. collision or snag risks).

11.7.3.30 As previously mentioned, the NSP (Section 11.1.1) will also cover the operational phase. In addition, advisory 50 m safety zones around installed infrastructure and 500 m safety zones around major maintenance works will be sought.

11.7.3.31 Inter array, inter OSP and export cables will be buried where feasible to a minimum of 1 m depth and protected where burial is not possible.

11.7.3.32 The experience of the numerous operational offshore wind farms in UK waters suggest that there is no evidence to indicate that the operational Moray West Offshore Wind Farm and associated OfTI, itself will represent a significant safety risk to commercial fishing vessels. An important factor in achieving this will be the role of fishing liaison in ensuring that fishing vessel skippers have the required information to adequately assess the risks of fishing within the operational offshore wind farm.

11.7.3.33 With compliance to the above, it is considered that safety issues for fishing vessels during operation will be kept **within acceptable limits**.

Increased Steaming Times to Fishing Grounds

All Fleets

11.7.3.34 The proposed minimum spacing between turbine rows in the Moray West Site (1,050 m) is wider than many of the fairways, harbour entrances and other restricted passages through which fishing vessel skippers have to navigate their vessels. During the operation phase fishing vessel skippers would therefore have the option to steam throughout the Moray West Site, subject to their own assessment of the conditions at the time. The sensitivity of all fleets is therefore considered to be **negligible**.

11.7.3.35 Any potential impact would last for the operational life of the Development. However, the only aspects that could potentially result in small increases in steaming times would be the implementation of 50 m advisory safety zones around infrastructure and of 500 m safety zones around major maintenance works. Taking the small areas affected by these safety zones, the magnitude of the impact is considered to be **negligible**.

11.7.3.36 Given that the sensitivity of the receptor is negligible and the potential impact magnitude is negligible, the significance of the effect of increased steaming times on all fleets is considered to be **negligible** and **not significant** in EIA terms**.**

Interference with Fishing Activities (Navigational Conflict)

Creel Fleet

11.7.3.37 As described for the construction phase (paragraph 11.7.2.46), recognising the more limited adaptability of the creel fleet to interference given the static nature of the gear used in comparison to towed gear fleets, their sensitivity is considered to be **moderate**.

11.7.3.38 In comparison to the construction phase, the number of operation and maintenance vessel transits will be considerably less and therefore the potential for interference to fishing vessels and damage to creel fishing gears will be markedly reduced. This is also supported by the experience of currently operational sites. The liaison and provision of creel deployment locations to maintenance crew transfer vessel masters described for the construction phase above (paragraph 11.7.2.48) will continue during operation. Taking account of the above the magnitude of the impact is considered **negligible**.

11.7.3.39 On the basis of these factors it is considered that the significance of the effect on the creel fleet during the operational phase will be **minor** and **not significant** in EIA terms.

Mackerel Jigging and Demersal Trawl, Scallop Dredging and Scottish Seine Fleets

11.7.3.40 As previously described for the construction phase (paragraph 11.7.2.50, in the case of fishing vessels engaged in mackerel jigging and those operating towed gears (namely demersal trawling, scallop dredging and Scottish seiners), under the hierarchy of COLREGS Rule 18, there is an obligation for all vessels, other than those of restricted manoeuvrability or constrained by draft, to keep out of the way of vessels engaged in fishing. Therefore, unless restricted in their manoeuvrability or constrained by draft, operation and maintenance vessels are required to pass at safe distances from vessels engaged in fishing operations. The sensitivity of vessels targeting mackerel by jigging, demersal trawlers, scallop dredgers and Scottish seiners are therefore considered of **low** sensitivity to interference.

11.7.3.41 The NSP will include protocols and procedures for the navigation of maintenance and operation vessels to and from the Moray West Site and along the Offshore Export Cable Corridor as well as the identification of refuge/shelter areas for maintenance vessels to avoid fishing activity and therefore minimise as far as possible, interference with fishing activities (Section 11.1.1). With this in mind the magnitude of the impact is considered to be **negligible**.

11.7.3.42 Taking the low sensitivity of vessels engaged in mackerel jigging, demersal trawling, scallop dredging and seining, and the negligible magnitude of the impact, the significance of the effect is considered to be **negligible** and **not significant** in EIA terms.

<u>Displacement of Fishing Activity into other Areas</u>

All Fleets

11.7.3.43 The extent of potential displacement of fishing activity into other areas during operation would be a function of the level of permanent loss or restricted access to traditional fishing grounds that each fleet is subject to. As described above (paragraphs 11.7.3.4 to11.7.3.28) this was assessed to not exceed minor significance for all the fisheries included in the assessment. The assessment carried out in respect of permanent loss or restricted access to traditional fishing grounds is therefore considered to also apply in respect of displacement and is summarised in Table 11.7.2.

11.7.3.44 In the context of this assessment, it should be recognised that given the operational ranges and the extent of the grounds of the fleets of concern, it is possible that skippers might continue fishing within their traditional grounds, rather than exploring new grounds as a result of the limited area of fishing area lost during operation.

Table 11.7.2: Assessment of Displacement of Fishing Activity into Other Areas

Receptor	Sensitivity	Impact Magnitude	Significance of Effect
Creel fleet	Negligible	Negligible	Negligible
Mackerel jigging fleet	Negligible	Negligible	Negligible
Demersal trawl fleet (in general)	Low	Low	Minor
Local Nephrops fleet	Low	Low	Minor
Local squid fleet	Low	Low	Minor
Local whitefish fleet	Low	Low	Minor
Local scallop fleet	Moderate	Low	Minor
Nomadic scallop fleet	Low	Low	Minor
Scottish seine fleet	Negligible	Low	Negligible

<u>Obstacles on the Seabed</u>

All Fleets

11.7.3.45 As discussed above for the construction phase (paragraph 11.7.2.60), contractors will be obliged to mark and recover dropped objects. The same obligations will apply during the operational phase. Furthermore, it is assumed that the measures to mitigate the effects of boulders or berms arising from cable burial or boulder relocation activity will have been completed by the end of the construction phase. As such it is expected that during the operation phase the impact associated with obstacles on the seabed will be **within acceptable limits**.

11.7.4 Potential Decommissioning Effects

11.7.4.1 The following section outlines the potential impact on commercial fisheries during the decommissioning phase of the Development.

11.7.4.2 The scope of decommissioning is assumed to comprise the following:

- Dismantling and removing the WTGs, OSPs and associated substructures and foundations with piled foundations removed just below the seabed; and
- Disconnecting inter-array and OSP interconnector cables (it is currently assumed that cables would be left in place. However, exposed sections e.g. where inter-array cables connected to WTGs will be removed just below the seabed).

11.7.4.3 The potential impacts needing consideration in relation to decommissioning would be the same as outlined above for the construction phase. Given the nature of the works associated with decommissioning (paragraph 11.7.4.2) it is reasonable to assume that the magnitude of the impacts associated with this phase will not be greater than those identified for the construction phase. Assuming that the sensitivities of the receptors at the end of the Development's life are not materially different from those currently assumed, the significance of the effects during decommissioning are not expected to exceed those assessed for the construction phase.

11.7.4.4 It should be noted that individual vessels (particularly towed gear vessels) that had not deemed it safe to fish within the Moray West Site during operation, may benefit from the removal of WTGs and OSP infrastructure during the decommissioning phase.

11.7.4.5 The final details of the decommissioning will be included within the Decommissioning Programme which will be submitted for approval by the Scottish Ministers in line with the requirements of the Energy Act 2004. The decommissioning programme will be reviewed and updated throughout the lifetime of the Development to account for changing best practice.

11.7.5 Summary of Development Specific Effects

11.7.5.1 The assessment carried out in respect of the construction, operation and decommissioning phase of the Development did not identify significant effects (i.e. above minor significance) on commercial fisheries. Mitigation measures other than the embedded measures described in Section 11.1.1 (and incorporated in the assessment) are therefore not considered necessary. A summary of the outcomes of the assessment of effect significance is given in Table 11.7.3 below for the construction, operation and decommissioning phases.

Table 11.7.3: Summary of Development Specific Effects						
Potential Impact	**Receptor**	**Impact Magnitude**	**Sensitivity of Receptor**	**Effect Significance**	**Mitigation (in addition to embedded measures)**	**Residual Significance**
Construction Impacts						
Adverse effects on commercially exploited Fish and Shellfish Populations	All fleets	For full details see Chapter 8: Fish and Shellfish Ecology (Volume 2)		Minor	N/A	N/A
Temporary loss or restricted access to traditional fishing grounds	Creel fleet	Low	Moderate	Minor	N/A	N/A
	Mackerel jigging fleet	Low	Moderate	Minor	N/A	N/A
	Demersal trawl fleet (in general)	Low	Low	Minor	N/A	N/A
	Local Nephrops fleet	Low	Low	Minor	N/A	N/A
	Local squid fleet	Low	Moderate	Minor	N/A	N/A
	Local whitefish fleet	Low	Low	Minor	N/A	N/A
	Local scallop fleet	Low	Moderate	Minor	N/A	N/A
	Nomadic scallop fleet	Low	Low	Minor	N/A	N/A
	Scottish seine fleet	Low	Negligible	Negligible	N/A	N/A
Safety issues for fishing vessels	All fleets	N/A	Within acceptable limits		N/A	N/A
Increased steaming times to fishing grounds	Creel fleet	Negligible	Low	Negligible	N/A	N/A
	Mackerel jigging fleet	Negligible	Low	Negligible	N/A	N/A

Table 11.7.3: Summary of Development Specific Effects						
Potential Impact	**Receptor**	**Impact Magnitude**	**Sensitivity of Receptor**	**Effect Significance**	**Mitigation (in addition to embedded measures)**	**Residual Significance**
	Demersal trawl fleet (including local fleets)	Negligible	Low	Negligible	N/A	N/A
	Scallop dredging fleet (local and nomadic)	Negligible	Low	Negligible	N/A	N/A
	Scottish seine fleet	Negligible	Low	Negligible	N/A	N/A
Interference with fishing activities	Creel fleet	Negligible	Moderate	Minor	N/A	N/A
	Mackerel jigging fleet	Negligible	Low	Negligible	N/A	N/A
	Demersal trawl fleet (including local fleets)	Negligible	Low	Negligible	N/A	N/A
	Scallop dredging fleet (local and nomadic)	Negligible	Low	Negligible	N/A	N/A
	Scottish seine fleet	Negligible	Low	Negligible	N/A	N/A
Displacement of fishing activity into other areas	Creel fleet	Low	Moderate	Minor	N/A	N/A
	Mackerel jigging fleet	Low	Moderate	Minor	N/A	N/A
	Demersal trawl fleet (in general)	Low	Low	Minor	N/A	N/A
	Local Nephrops fleet	Low	Low	Minor	N/A	N/A
	Local squid fleet	Low	Moderate	Minor	N/A	N/A
	Local whitefish fleet	Low	Low	Minor	N/A	N/A
	Local scallop fleet	Low	Moderate	Minor	N/A	N/A
	Nomadic scallop fleet	Low	Low	Minor	N/A	N/A

Table 11.7.3: Summary of Development Specific Effects						
Potential Impact	**Receptor**	**Impact Magnitude**	**Sensitivity of Receptor**	**Effect Significance**	**Mitigation (in addition to embedded measures)**	**Residual Significance**
	Scottish seine fleet	Low	Negligible	Negligible	N/A	N/A
Obstacles on the seabed post construction	All Fleets	N/A		Within acceptable limits	N/A	N/A
Operation and Maintenance						
Adverse effects on commercially exploited Fish and Shellfish Populations	All fleets	For full details see Chapter 8: Fish and shellfish Ecology (Volume 2)		Minor	N/A	N/A
Permanent loss or restricted access to fishing grounds	Creel fleet	Negligible	Negligible	Negligible	N/A	N/A
	Mackerel jigging fleet	Negligible	Negligible	Negligible	N/A	N/A
	Demersal trawl fleet (including local fleets)	Low	Low	Minor	N/A	N/A
	Scallop dredging local fleet	Low	Moderate	Minor	N/A	N/A
	Scallop dredging nomadic fleet	Low	Low	Minor	N/A	N/A
	Scottish seine fleet	Low	Negligible	Negligible	N/A	N/A
Safety issues for fishing vessels	All fleets	N/A		Within acceptable limits	N/A	N/A
Increased steaming times	All fleets	Negligible	Negligible	Negligible	N/A	N/A
Interference with fishing activities	Creel fleet	Negligible	Moderate	Minor	N/A	N/A
	Mackerel jigging fleet	Negligible	Low	Negligible	N/A	N/A

Table 11.7.3: Summary of Development Specific Effects						
Potential Impact	**Receptor**	**Impact Magnitude**	**Sensitivity of Receptor**	**Effect Significance**	**Mitigation (in addition to embedded measures)**	**Residual Significance**
	Demersal trawl fleet (including local fisheries)	Negligible	Low	Negligible	N/A	N/A
	Scallop dredging fleet (including local and nomadic vessels)	Negligible	Low	Negligible	N/A	N/A
	Scottish seine fleet	Negligible	Low	Negligible	N/A	N/A
Displacement of fishing activity into other areas	Creel fleet	Negligible	Negligible	Negligible	N/A	N/A
	Mackerel jigging fleet	Negligible	Negligible	Negligible	N/A	N/A
	Demersal trawl fleet (including local fleets)	Low	Low	Minor	N/A	N/A
	Scallop dredging local fleet	Low	Moderate	Minor	N/A	N/A
	Scallop dredging nomadic fleet	Low	Low	Minor	N/A	N/A
	Scottish seine fleet	Low	Negligible	Negligible	N/A	N/A
Obstacles on the seabed	All fleets	N/A		Within acceptable limits	N/A	N/A
Decommissioning						
Considered to be equal to or less than impacts stated in construction.						

11.8 Assessment of Cumulative Effects

11.8.1 Scope of the Cumulative Assessment

11.8.1.1 The marine developments which could potentially contribute to a cumulative effect on commercial fisheries will vary depending upon the spatial extent of the fishing grounds of the fleet concerned. As such, projects requiring assessment have been identified on a receptor by receptor basis.

11.8.1.2 A summary of the construction timelines for marine developments that to varying degrees will form part of the cumulative assessment in respect of commercial fisheries are outlined in Table 11.8.1. This includes information on the fisheries for which each project has been given consideration in the cumulative assessment.

11.8.1.3 For the purposes of this assessment, and as discussed in Chapter 5: EIA Methodology (Volume 2), projects which were already constructed at the time of the baseline information gathering process are considered to be part of the existing environment and therefore they are not considered in the cumulative assessment.

11.8.1.4 The following potential impacts are taken forward to the cumulative assessment:

- Adverse impacts on commercially exploited fish and shellfish populations;
- Temporary/permanent loss or restricted access to traditional fishing grounds;
- Increased steaming times to fishing grounds;
- Interference with fishing activities; and
- Displacement of fishing activity into other areas.

11.8.1.5 In the case of potential impacts associated with safety issues for fishing vessels, it is assumed that the same obligations will apply to all developments to ensure that safety issues are within acceptable limits. Similarly, all developers will be under the same obligations to ensure objects on the seabed do not represent a hazard to fishing gears and operations. Potential cumulative impacts associated with safety issues and seabed obstacles are therefore not discussed further in the cumulative assessment.

11.8.1.6 In respect of receptors the following have been considered for assessment of cumulative impacts:

- Creel fleet;
- Mackerel jigging fleet;
- Demersal trawl fleet (including local Nephrops, squid and whitefish fisheries); and
- Scallop dredging fleet (including local and nomadic vessels).

11.8.1.7 In the particular case of the Scottish seine fleet, given that its activity in the Moray Firth for the most part is understood to concentrate to the north and offshore of the Moray West Site, the Moray East Offshore Wind Farm (Telford, Stevenson and MacColl) and the Beatrice Offshore Wind Farm (BOWL) it is not considered that there is a potential impact pathway with other projects and therefore, a cumulative assessment in respect of this fleet has not be carried out.

Table 11.8.1: Projects for Cumulative Assessment

General Area	Project	Status	Construction Timeframe	Data Confidence	Receptors for which the Project has been Considered in the Assessment
Moray Firth	Moray East Offshore Wind Farm (Telford, Stevenson and MacColl offshore wind farms)	Consented Up to 1,116 MW and up to 186 turbines across the Moray East Site	Expected to be operational by 2022.	High	All fleets
	Beatrice Offshore Wind Farm (BOWL)	Under construction Up to 84 wind turbines, two OSPs and generate up to 588 MW	To be commissioned and operational in 2019	High	All fleets
	Beatrice Oil Field	Active	Decommissioning due to commence in 2024 for completion in 2027	High	All fleets
	Caithness – Moray Interconnector	Consented HVDV Cable of 1,200 MW capacity. Total length of submarine cable: 113 km	Under construction. Due to be commissioned by the end of 2018	High	All fleets
Forth and Tay and wider Area	Inch Cape Offshore Wind Farm Revised Design	Proposed Up to 784 MW and up to 72 turbines	2020 and 2021	High	Nomadic scallop fleet and demersal trawl fleet in general
	Neart na Gaoithe Offshore Wind Farm-Revised design	Proposed Up to 56 turbines with total capacity of 450 MW	2020 and 2021	High	Nomadic scallop fleet and demersal trawl fleet in general
	Seagreen Phase I Wind Farm	Proposed 70 to 120 turbines of up to 15 MW, with 1 km spacing between turbines.	Construction commencing in 2022 and lasting for up to 36 months	High	Nomadic scallop fleet and demersal trawl fleet in general

Table 11.8.1: Projects for Cumulative Assessment

General Area	Project	Status	Construction Timeframe	Data Confidence	Receptors for which the Project has been Considered in the Assessment
	Aberdeen Offshore Wind Farm	Consented Up to 11 wind turbines, generating up to 8.4 MW each	Construction due to be complete in Sept 2018.	High	Nomadic scallop fleet and demersal trawl fleet in general
	Hywind Demo	Constructed Five wind turbines and is a 30 MW pilot project.	Construction recently completed (end 2017)	High	Nomadic scallop fleet and demersal trawl fleet in general
	Kincardine Floating Offshore Windfarm	Consented A pilot-scale offshore wind farm project utilising floating foundation technology.	May 2018 – June 2020	High	Nomadic scallop fleet and demersal trawl fleet in general
	Forthwind Wind Farm Demonstrator Project – Phase 1	Consented A two turbine project, up to 18MW.	Construction planned for 2018	High	Nomadic scallop fleet and demersal trawl fleet in general
	Forthwind Wind Farm Demonstrator Project – Phase 2	Proposed Up to nine wind turbines with a total capacity of up to 65 MW located in the Firth of Forth.	Constructed by 2019	High	Nomadic scallop fleet and demersal trawl fleet in general
	ORE Catapult Levenmouth	Operational A 7 MW demonstration offshore wind turbine located at the Fife Energy Park off the East Fife coast. Looking at ways in which to drive cost efficiencies in offshore turbines. Operational since March 2014 with current operation proposed until 2019.	Currently operational	High	Nomadic scallop fleet and demersal trawl fleet in general

Table 11.8.1: Projects for Cumulative Assessment					
General Area	**Project**	**Status**	**Construction Timeframe**	**Data Confidence**	**Receptors for which the Project has been Considered in the Assessment**
	Dounreay Trì Floating Wind Demonstration Project	Consented but in administration A commercial demonstration project, comprising two 5 MW wind turbine generators on a semisubmersible platform.	Construction started in March 2017 and commissioning is planned for September 2018.	High	Nomadic scallop fleet and demersal trawl fleet in general
English wind farms	Blyth Offshore Wind Farm	Two WTGs with max capacity 3.8 MW	Operational since 2000	High	Nomadic scallop fleet and demersal trawl fleet in general
	Blyth Offshore Wind Demonstration Project –Array 2	Five WTGs with max. capacity 40 MW	Approved by Scottish Government in October 2013. Currently under construction. Completion was expected by the end of 2017.	High	Nomadic scallop fleet and demersal trawl fleet in general
	Rampion	Under construction 116 wind turbines, 400MW project. Turbines have been installed and the project will be fully operational in 2018.	Under Construction Will be fully operational in 2018.	High	Nomadic scallop fleet

11.8.2 Cumulative Construction Effects

Adverse Impacts on Commercially Exploited Fish and Shellfish Populations

11.8.2.1 As described in Chapter 8: Fish and Shellfish Ecology (Volume 2), there is potential for the construction of the Development cumulatively with other projects to affect fish and shellfish populations. This could in turn indirectly affect the productivity of the fisheries that target them. Key species to commercial fisheries in the regional study area include Nephrops, squid, haddock, mackerel, crab, lobster, and king scallops.

11.8.2.2 The potential cumulative effects of the Development on fish and shellfish species, including those of commercial importance, have been assessed in Chapter 8: Fish and Shellfish Ecology (Volume 2), and are not expected to exceed minor significance (for all impacts assessed). The significance of any resulting cumulative effects on commercial fisheries is therefore also not expected to exceed **minor** which is **not significant** in EIA terms.

Temporary Loss or Restricted Access to Traditional Fishing Grounds

Projects in the Moray Firth

Creel Fleet and Mackerel Jigging

11.8.2.3 As described previously for assessment of the Development alone, the sensitivity of the creel fleet and of vessels engaged in mackerel jigging to temporary loss and restricted access is considered to be **moderate** due to their restricted operational range, reduced availability of fishing grounds and limitations in terms of target species.

11.8.2.4 In addition to the inshore area of the Offshore Export Cable Corridor, the local creeling and jigging grounds (Volume 3a - Figure 11.8.5 and Figure 11.8.6) overlap with or are in close proximity to a small section of the export cable corridor of Moray East offshore wind farm, the Caithness Moray Interconnector and the export cable of the Beatrice Offshore Wind Farm (BOWL). Given that the Moray East offshore wind farm is due to be operational by 2022 and the Caithness Moray Interconnector and BOWL wind farm will be operational by 2019, the potential for an increase in the spatial extent of the effect (where construction is concurrent) is limited. It is however recognised that construction activities at these projects would result in an increase in the overall duration of the effect (i.e. where construction at different projects occurs sequentially). With this in mind but acknowledging the small area of grounds potentially affected and the short term nature of cable installation activity, the impact magnitude is considered to be **low**.

11.8.2.5 The cumulative effect of temporary loss or restricted access to traditional fishing grounds is therefore considered to be **minor** and therefore **not significant** in EIA terms.

Local Demersal Trawl Fisheries

11.8.2.6 The grounds of demersal local trawl fisheries targeting Nephrops and whitefish (Volume 3a - Figure 11.8.7), overlap with the offshore export cable corridors of the BOWL and Moray East offshore wind farms, the Caithness Moray Interconnector and the Moray West Offshore Export Cable Corridor.

11.8.2.7 As described above for the creel and marckerel jigging fisheries, there would be limited potential for construction periods at other Projects in the Moray Firth to coincide with construction at the Development. Therefore, the potential for an increase in the spatial extent of the effect (where construction is concurrent) is limited. It is however recognised that construction activities at these projects would result in an increase in the overall duration of the effect (i.e. where construction at different projects occurs sequentially).

11.8.2.8 With the above I mind but recognising the relatively small area of grounds affected at any one time and short term nature of cable installation activities, the impact magnitude is considered to be **low**.

11.8.2.9 As previously described for the Development alone, the sensitivity of the local Nephrops and whitefish fishery is considered to be **low**.

11.8.2.10 The cumulative effect of temporary loss or restricted access to Nephrops and whitefish fishing grounds is therefore considered to be **minor** and **not significant** in EIA terms.

11.8.2.11 In the case of the local squid fishery, as described for the Development alone, sensitivity is considered to be **moderate**. Local squid fishing grounds overlap with the Moray West Site and sections of the Offshore Export Cable Corridor, the Caithness Moray Interconnector, the Moray East Wind Farm Sites and offshore export cable corridor and the BOWL wind farm export cable corridor (Volume 3a - Figure 11.8.8).

11.8.2.12 Considering the increased potential overall duration of the effects when taking account of construction activities at other projects in the Moray Firth, but recognising the relatively small area of grounds affected at any one time and temporary nature of the impact, the magnitude is considered to be **low**.

11.8.2.13 In light of the above, the cumulative effect of temporary loss or restricted access to fishing grounds on the local squid fishery is considered to be **minor** and therefore **not significant** in EIA terms.

Local Scallop Fleet

11.8.2.14 As described for the Development alone, the sensitivity of the local scallop dredging fleet is considered to be **moderate**.

11.8.2.15 Local fishing grounds defined by fishermen during consultation overlap with the Moray West Site and to a lesser extent the Moray East Site. In addition, they overlap with the export cable routes of the BOWL and Moray East Offshore Wind Farms as well as with the Caithness Moray Interconnector and the Moray West Offshore Export Cable Corridor (Volume 3a - Figure 11.8.9). Analysis of VMS data (2012 -2016) suggests that activity by scallop dredgers in the Moray Firth for the most part concentrates around the area of the Moray East Site and north and east of the site (Volume 3a - Figure 11.8.9 and Figure 11.8.10).

11.8.2.16 As discussed for other fleets above, there would be limited potential for construction periods at other Projects in the Moray Firth to coincide with construction at the Development. There could however be potential for an increase in the duration of the overall impact when considering construction at other projects in the Moray Firth area (i.e. where construction at different projects occurs sequentially). With this in mind but recognising the relatively small area of grounds potentially affected by construction activities at any one time and their temporary nature and, the impact magnitude is considered to be **low**.

11.8.2.17 In light of the above, the cumulative effect of temporary loss or restricted access to fishing grounds is considered to be **minor** and therefore **not significant** in EIA terms.

Moray Firth, Forth and Tay and Wider Area and English Projects

Demersal Trawl Fleet

11.8.2.18 The demersal trawl fleet has a wide operational range and availability of grounds, being able to adapt to target different grounds and species. As described for the Development alone its sensitivity is considered **low**.

11.8.2.19 As discussed for other fleets, there would be limited potential for construction periods at other Projects in the Moray Firth to coincide with construction at the Development. There could however be potential for an increase in the duration of the overall impact when considering construction at other projects in the Moray Firth area (i.e. where construction at different projects occurs sequentially). In the case of projects in the Forth and Tay and wider area, there could be potential for the construction period of the Development to coincide with that of Inch

Cape, Neart na Goithe and Seagreen Phase I. In respect of projects in English waters, they would all be expected to be operational by the time construction starts at the Development.

11.8.2.20 Although there is potential for temporary access restrictions to fishing grounds to extend over a wider geographical spatial or temporal scale, the actual physical restrictions within each project site will still be limited to areas directly affected by the 500 m and 50 m safety zones (and areas around cables that may be awaiting protection or burial). In this context it is important to note that exclusion associated with construction at Inch Cape, Neart na Goithe and Seagreen Phase I, would be very small, as there is limited activity by this fishery within these sites (Volume 3a - Figure 11.8.1 and Figure 11.8.2). Considering this, and the temporary nature of these restrictions, the overall magnitude of the impact is considered to be **low.**

11.8.2.21 Taking into account the low sensitivity of the demersal fleet to cumulative temporary restricted access to traditional fishing grounds, and the low magnitude of the impact, the significance of the effect is considered to be **minor** and **not significant** in EIA terms.

Nomadic Scallop Fleet

11.8.2.22 As described above for the demersal trawl fleet, projects for which the construction period could overlap with construction at the Development include Inch Cape, Neart na Goithe and Seagreen Phase I (Table 11.8.1). Construction at these projects could therefore result in an increase in the overall spatial extent of the effect. In the case of the remaining projects, there could be potential for an increase in the duration of the overall effect (i.e. where construction at different projects occurs sequentially).

11.8.2.23 There is therefore potential for temporary access restrictions to key grounds to extend over a wider geographical spatial or temporal scale, however, the actual physical restrictions within each project site would still be limited to areas directly affected by the 500 m and 50 m safety zones and to areas where cables are awaiting burial or protection. Furthermore, the area occupied by other projects represents a relatively small proportion of the total grounds available to the nomadic fleet around the UK. Considering this and the temporary nature of the effect, the overall impact magnitude is considered to be **low.**

11.8.2.24 As described for assessment of the Development alone, the sensitivity of the nomadic fleet is considered **low**. Taking this and the low magnitude of the impact, the significance of the effect is considered to be **minor** and **not significant** in EIA terms.

Increased Steaming Times to Fishing Grounds

Moray Firth Projects

Creeling Fleet and Mackerel Jigging Fishery

11.8.2.25 Creeling/mackerel jigging occurs in inshore areas of the Moray Firth. Due to the reduced operational range of the small vessels (< 10 m) that make up this fleet/fishery, they are restricted in their ability to relocate to alternative fishing grounds. However, as fishing grounds are located near the shore, steaming times would only be affected as a result of export cable installation in the inshore areas of the offshore export cable corridors for the BOWL and Moray East Offshore Wind Farms and the Caithness Moray Interconnector (Volume 3a - Figure 11.8.5 and Figure 11.8.6). The sensitivity of the creel fleet and the mackerel jigging fishery is therefore considered to be **low**.

11.8.2.26 As discussed previously with respect to temporary loss and restricted access to traditional fishing grounds, given that the Moray Firth projects are due to have completed construction prior to works commencing on the installation of the Moray West Offshore Export Cable the potential for an increase in the spatial extent of the effect (where construction is concurrent) is limited. However, there is potential for a temporal effect as a result on an increase in the duration of the effect due to construction occurring sequentially. Considering this, but also the small area of grounds affected and the short term and sequential nature of cable installation activity, the magnitude of the impact of increased steaming times is considered to be **negligible**.

11.8.2.27 Therefore, the cumulative effect on the creel fleet is considered to be **negligible** and not **significant** in EIA terms.

Local Demersal and Scallop Fleet

11.8.2.28 The implementation of safety zones around construction activities across the Moray Firth projects and advisory safety zones around partially installed infrastructure, could result in limited, short term increases in steaming distances and times to the local demersal trawl fleet (Nephrops, squid and whitefish fisheries) (Volume 3a - Figure 11.8.7 and Figure 11.8.8) as well as the local scallop dredging fleet (Volume 3a - Figure 11.8.9). Considering the operational ranges of these fleets (i.e. within the Moray Firth area), their sensitivity in respect of increased steaming times is considered to be **low**.

11.8.2.29 Given that all three of the main Moray Firth projects (BOWL and Moray East Offshore Wind Farm and Caithness Moray Interconnector) will have completed construction and be operational prior to works commencing on construction of the Moray West Offshore Wind Farm, the potential for an increased spatial extent of effect (where construction is concurrent) is limited. However, there may be potential for an increase in the temporal scale of the effect (where construction is sequential).

11.8.2.30 With the above in mind and taking account of the relatively small extent of the area affected at any given time and temporary nature of the effect, the magnitude of the impact is considered to be **low**. The cumulative effect of increased steaming times to fishing grounds for these fleets is therefore **minor** and **not significant**.

Moray Firth, Forth and Tay and Wider Area and English Projects

Demersal Trawl Fleet and Nomadic Scallop Fleet

11.8.2.31 The implementation of safety zones around construction activities and partially installed infrastructure across other projects in the Moray Firth, projects in the Forth and Tay and wider area and projects in English waters could result in limited, short term increases in steaming distances and times to the demersal trawl fleet in general, as well as the nomadic scallop fleet. Considering the wide operational ranges of these fleets their sensitivity in respect of increased steaming times to fishing grounds is however considered to be **low**.

11.8.2.32 Taking account of the increased spatial extent and/or duration of the impact (whether construction occurs concurrently or sequentially) but recognising its temporary nature and overall small extent, the magnitude of the impact is considered to be **low**. The cumulative effect of increased steaming times to fishing grounds is therefore considered to be **minor** and **not significant** in EIA terms.

Interference with Fishing Activities (Navigational Conflict)

Moray Firth Projects

Creel Fleet

11.8.2.33 There is the potential for transiting vessels from construction activities associated with other projects in the Moray Firth to interact and potentially damage deployed static gears (Volume 3a - Figure 11.8.1). Recognising the more limited adaptability of this fleet to interference given the static nature of the gear used in comparison to towed gear fleets the sensitivity of this fleet is considered to be **moderate**.

11.8.2.34 It is assumed that the other projects in the Moray Firth, would also be required to implement adequate liaison and information gathering to obtain the coordinates of static gear deployments to minimise the risks of interactions with construction vessels. With this in mind the magnitude of the impact would be **negligible**.

11.8.2.35 The cumulative effect associated with interference with fishing activities on the creel fleet during construction is therefore considered to be **minor** and **not significant** in EIA terms.

Mackerel Jigging Fishery and Local Demersal Trawl and Scallop Dredging Fleet

11.8.2.36 In the case of fishing vessels engaged in mackerel jigging and those operating towed gears (namely demersal otter trawlers and scallop dredgers), it should be noted that under the hierarchy of COLREGS Rule 18, vessels other than those of restricted manoeuvrability or constrained by draft are obliged to keep out of the way of vessels engaged in fishing. Therefore, unless restricted in their manoeuvrability or constrained by draft, construction vessels will endeavour to pass at safe distances from vessels engaged in fishing operations. With this in mind the sensitivity of vessels targeting mackerel by jigging, demersal trawlers and scallop dredgers are considered of **low** sensitivity to interference.

11.8.2.37 Provided that in line with the embedded mitigation proposed for the Development (Section 11.6.2), other projects included in the assessment (Table 11.8.1) also implement adequate navigation safety and vessel management plans to avoid fishing activity and mitigate as far as possible, interference with fishing activities, the magnitude of the impact would be **negligible**.

11.8.2.38 Taking the low sensitivity of vessels engaged in mackerel jigging, local demersal trawling and local scallop dredging and the negligible impact magnitude, the effect is considered to be **negligible** and **not significant** in EIA terms.

Moray Firth, Forth and Tay and Wider Area and English Projects

Demersal Trawl Fleet and Nomadic Scallop Fleet

11.8.2.39 Under the hierarchy of COLREGS Rule 18, vessels other than those of restricted manoeuvrability or constrained by draft are obliged to keep out of the way of vessels engaged in fishing. Therefore, unless restricted in their manoeuvrability or constrained by draft, construction vessels will be required to pass at safe distances from vessels engaged in fishing operations. Taking this into account together with the mobile nature of demersal trawl and scallop dredging gear, the sensitivity of the demersal trawl and nomadic scallop fleet is considered to be **low**.

11.8.2.40 Provided that in line with the embedded mitigation proposed for the Development (Section 11.6.2), other projects included in the assessment (Table 11.8.1) also implement adequate navigation safety and vessel management plans to avoid fishing activity and mitigate as far as possible, interference with fishing activities, the magnitude of the impact would be **negligible**.

11.8.2.41 Taking the low sensitivity of vessels engaged in demersal trawling and scallop dredging and the negligible magnitude of the impact, the significance of the effect is considered to be of **negligible** and **not significant** in EIA terms.

Displacement of Fishing Activity into other Areas

Moray Firth Projects

Creel Fleet, Mackerel Jigging, Local Demersal Trawl and Scallop Dredging Fleet

11.8.2.42 The extent of potential displacement of fishing activity into other areas during construction would be a function of the level of temporary loss or restricted access to traditional fishing grounds that each fleet is subject to. As described previously, the cumulative effect of temporary loss or restricted access to fishing grounds for all local fleets within the Moray Firth was assessed to be of **minor** significance, and therefore **not significant** in EIA terms. The assessment carried out in respect of temporary loss or restricted access to traditional fishing grounds is therefore considered to also apply in respect of displacement and is summarised in Table 11.8.2.

Table 11.8.2: Assessment of Cumulative Displacement of Fishing Activity into Other Areas			
Receptor	**Sensitivity**	**Impact Magnitude**	**Effect Significance**
Creel fleet	Moderate	Low	Minor
Mackerel jigging fleet	Moderate	Low	Minor
Local Nephrops fleet	Low	Low	Minor
Local squid fleet	Moderate	Low	Minor
Local whitefish fleet	Low	Low	Minor
Local scallop fleet	Moderate	Low	Minor

Moray Firth, Forth and Tay and Wider Area and English Projects

Demersal Trawl Fleet and Nomadic Scallop Fleet

11.8.2.43 The extent of potential displacement of fishing activity into other areas during construction would be a function of the level of temporary loss or restricted access to traditional fishing grounds that each fleet is subject to. As described previously, the cumulative effect of temporary loss or restricted access to fishing grounds on the demersal trawl and the nomadic scallop fleet was assessed to be of **minor** significance, and therefore **not significant** in EIA terms.

11.8.2.44 The assessment carried out in respect of cumulative temporary loss or restricted access to traditional fishing grounds is therefore considered to also apply in respect of displacement and is summarised in Table 11.8.3.

11.8.2.45 In the context of this assessment, it should be recognised that given the operational ranges and the extent of the grounds of the fleets of concern, it is possible that skippers might continue fishing within their traditional grounds, rather than exploring new grounds as a result of the limited area of fishing lost during construction. Furthermore, it should be recognised that in the particular case of the demersal trawl fleet, a significant level of fishing activity occurs for the most part inshore, coinciding with areas relevant to the location of export cables of the projects included for cumulative assessment rather within the wind farm arrays (Volume 3a - Figure 11.8.1 and Figure 11.8.2).

Table 11.8.3: Assessment of Displacement of Fishing Activity into Other Areas during Construction				
Projects	**Receptor**	**Sensitivity**	**Impact Magnitude**	**Effect Significance**
Moray Firth, Forth and Tay and wider area and English Projects	Demersal trawl fleet	Low	Low	Minor
	Nomadic scallop fleet	Low	Low	Minor

11.8.3 Cumulative Operational Effects

<u>Adverse Impacts on Commercially Exploited Fish and Shellfish Populations</u>

All Fleets

11.8.3.1 The potential cumulative impacts of the Development and other projects during operation on fish and shellfish species, including those of commercial importance, have been assessed in Chapter 8: Fish and Shellfish Ecology (Volume 2), and are not expected to exceed minor significance (for all impacts). Any resulting cumulative effects on commercial fisheries are therefore also not expected to exceed **minor significance**.

<u>Permanent Loss or Restricted Access to Traditional Fishing Grounds</u>

Projects in the Moray Firth

<u>*Creel Fleet and Mackerel Jigging*</u>

11.8.3.2 Local creeling and mackerel jigging fishing grounds overlap with the Moray West Offshore Export Cable Corridor as well as the Moray East Offshore Wind Farm export cables. In addition, they are in close proximity to the export cables of BOWL and to the Caithness Moray Interconnector (Volume 3a - Figure 11.8.5 and Figure 11.8.6).

11.8.3.3 Following installation of the cables (burial) and any additional cable protection measures where required, creeling and mackerel jigging will be able to resume over these cables. The sensitivity of these fleets to long term loss or restricted access to fishing grounds is considered to be **negligible**.

11.8.3.4 Whilst the potential impact would last for the operational life of the cables, resulting potential exclusion from fishing grounds would only occur in instances when maintenance works are carried out. Considering this in the context of the extent of fishing grounds (Volume 3a - Figure 11.8.5. and Figure 11.8.6), the impact is considered to be of **negligible** magnitude.

11.8.3.5 Taking the negligible sensitivity of the creel fleet and of vessels engaged in mackerel jigging and the negligible impact magnitude, the significance of the effect of long term loss or restricted access is considered to be **negligible** and **not significant** in EIA terms.

<u>*Local Demersal Trawl Fisheries*</u>

11.8.3.6 There is potential for the physical presence of three wind farms in the Moray Firth (BOWL, Moray East and Moray West) and the Caithness Moray Interconnector to lead to a long term loss or restriction in access to traditional grounds targeted by local demersal trawl vessels (including Nephrops, squid and whitefish vessels).

11.8.3.7 Activity by these vessels is primarily concentrated in areas to the south of the Moray West Site (particularly in the case of the Nephrops and the whitefish fishery). These areas overlap with the Moray West Offshore Export Cable Corridor, as well as the Moray East and BOWL export cables and the Caithness Moray Interconnector (Volume 3a - Figure 11.8.7).

11.8.3.8 In the case of squid fishing, whilst the majority of activity occurs in inshore areas, some level of activity is understood to also occur further north, including the area of the Moray West, Moray East and BOWL Sites (Volume 3a - Figure 11.8.8).

11.8.3.9 As discussed in Section 11.7.3, given that cables will be buried or protected, and taking into account the spacing between turbines (at least 1 km for each offshore wind farm), it is expected that the local demersal fleet will be able to regain access to grounds across export cables and within the wind farm arrays. Where individual skippers may consider it unsafe to fish within wind farm sites due to the presence of wind farm infrastructure, this would result in an effective loss of access for these vessels. This would, however, be on a vessel specific basis rather than applicable to local demersal trawl fisheries as a whole. The sensitivity of the local demersal trawl fisheries (Nephrops, squid and whitefish) to long term restricted access to traditional fishing grounds is therefore considered to be **low**.

11.8.3.10 The impact would last for the operation life of all three offshore wind farms and the area of fishing grounds lost would increase when considering the three projects. However, the extent of the areas where fishing will be restricted in each site will still be limited to 50 m safety zones and 500 m safety zones where major maintenance works are required. Considering this in the context of the overall fishing grounds of this fleet in the Moray Firth, and the fact that the majority of fishing activity (including local Nephrops, squid and whitefish fisheries), concentrates inshore of the three offshore wind farm sites, the magnitude of the impact is considered **low.**

11.8.3.11 Taking the low sensitivity of the local demersal trawl fisheries (Nephrops, squid and whitefish) and the low impact magnitude, the significance of the effect of long term loss or restricted access is considered to be **minor** and **not significant** in EIA terms.

Local Scallop Fleet

11.8.3.12 There is potential for the physical presence of three offshore wind farms in the Moray Firth (BOWL, Moray East and Moray West) and the Caithness Moray Interconnector to lead to a long term loss or restriction in access to traditional grounds targeted by the local scallop fleet.

11.8.3.13 Local scallop fishing grounds identified during consultation extend over the inshore area of the Moray Firth overlapping with the Moray East, Moray West and BOWL export cables and the Caithness Moray Interconnector. In addition, local grounds have been identified further north, including the Moray West Site and a small section of the Moray East Site (Volume 3a - Figure 11.8.9).

11.8.3.14 The local scallop dredges, by virtue of their smaller operational ranges and their dependence only one species (namely scallops) have increased sensitivity to loss or restricted access to fishing grounds. However, with inter array, OSP interconnection and the offshore export cable circuits buried, it is possible that these vessels could resume their activity within these wind farms and along their export cables. Considering the above, their sensitivity is considered to be **moderate**.

11.8.3.15 It should be noted that as a condition of the Moray East Development consents, trials are to be conducted to evaluate the feasibility of different and modified scallop dredges fishing within an operational wind farm site and the findings of the trials could be carried forward to the Development. As set out in the draft CFMS, where appropriate, key findings from these trials will be taken into account, in the final design of the Moray West Offshore Wind Farm. However, this is highly dependent on necessary information from the trails being available in the timescales required.

11.8.3.16 The areas from which vessels would be excluded would be those associated with 50 m advisory safety zones around infrastructure and 500 m safety zones around maintenance operations and discrete areas within the projects where cables may be protected and fishermen will seek to avoid. Although the impact will occur for the duration of the operational phase of the wind farm projects, considering the relatively small area of grounds lost in the context of the fishing grounds available to local scallop dredge vessels in the Moray Firth (Volume 3a - Figure 11.8.9 and Figure 11.8.10), the potential impact magnitude is considered to be **low**.

11.8.3.17 Taking the moderate sensitivity of local scallop dredgers to cumulative permanent loss or restricted access to fishing grounds and the low impact magnitude, the significance of the effect is considered **minor** and **not significant** in EIA terms.

Moray Firth, Forth and Tay and Wider Area and English Projects

Demersal Trawl Fleet

11.8.3.18 Due to the wider regional extent of grounds targeted by the demersal trawl fleet, there is potential for cumulative impacts to arise during the operation phase from projects located outside the Moray Firth, including those in the Forth and Tay and the wider area and relevant projects located in English waters (Table 11.8.1).

11.8.3.19 It should be noted, however, that fishing activity by demersal trawlers in the Moray Firth concentrates to the south of the Moray West Site. In addition, the areas where other relevant wind farm projects are located (Table 11.8.1), support relatively low fishing intensity by this fleet (Volume 3a - Figure 11.8.1 and Figure 11.8.2). Considering this, together with the wide operational range of the fleet and its ability to target a range of species, the sensitivity to cumulative loss or restricted access to traditional fishing grounds is considered to be **low**.

11.8.3.20 Although there is potential for long term access restrictions to fishing grounds to extend over a wider geographical spatial scale, the actual physical restrictions within each project site will still be limited on the basis that, for most projects, even though 50 m safety zones will be in place, the spacing between the turbines will be more than 1 km and all cables will be buried or protected. It is therefore expected that the demersal fleet will be able to resume fishing within the wind farm sites once they are operational. The overall magnitude of the impact is considered to be **low.**

11.8.3.21 Taking into account the low sensitivity of the demersal fleet to cumulative long term restricted access to traditional fishing grounds, and the low magnitude of the impact, the significance of the effect is considered to be **minor** and **not significant** in EIA terms.

Nomadic Scallop Fleet

11.8.3.22 Given the UK wide operational range and distribution of fishing grounds of the nomadic scallop fleet, there is potential for cumulative impacts to arise during the operation phase from projects located outside the Moray Firth, including those in the Forth and Tay and wider area, and those further afield in English waters (Table 11.8.1).

11.8.3.23 As discussed previously, the nomadic scallop fleet is more restricted than the demersal fleet in terms of the species they target (e.g. scallops only), however has a UK wide operational range and availability of fishing grounds. Consequently, the sensitivity of this fleet to cumulative long term loss or restricted access to fishing grounds is considered to be **low**.

11.8.3.24 As described for assessment of the Development alone, it has been assumed that nomadic vessels will choose not to fish within the wind farms due to constraints relating to potential interactions with wind farm cables (due to gear penetration depths) and manoeuvrability issues. Considering this and taking account of the extent of fishing grounds potentially lost, assuming total exclusion of nomadic vessels from the projects in the Moray Firth, Forth and Tay and wider area as well as in English waters (Volume 3a - Figure 11.8.3 and Figure 11.8.4), the magnitude of the impact is considered to be **moderate**.

11.8.3.25 Taking into account the low sensitivity of the nomadic scallop fleet to cumulative long term restricted access to traditional fishing grounds, and the moderate magnitude of the impact, the significance of the effect is considered to be **minor** and **not significant** in EIA terms.

Increased Steaming Times to Fishing Grounds

All Fleets and All Projects

11.8.3.26 The minimum spacing between turbines at offshore wind farms is wider than many of the fairways, harbour entrances and other restricted passages though which fishing vessel skippers have to navigate their vessels. Taking that during the operational phase, fishing vessel skippers would have the option to steam thought the projects included in the cumulative assessment

(Table 11.8.1), subject to their own assessment of the conditions at the time, the sensitivity of all fleets is considered to be **negligible**.

11.8.3.27 The potential effect would last for the operational life of the projects. However, the only aspects that could potentially result in small increases in steaming times would be the implementation of advisory safety zones around infrastructure and safety zones around major maintenance works at these projects. Taking the small areas affected by these safety zones, the magnitude of the impact is considered to be **negligible**.

11.8.3.28 The significance of the effect of increased steaming times to fishing grounds is therefore considered to be **negligible** and **not significant** in EIA terms.

<u>Interference with Fishing Activities (Navigational Conflict)</u>

Moray Firth Projects

<u>Creel Fleet</u>

11.8.3.29 There is the potential for transiting vessels from maintenance activities associated with the Development, BOWL, the Caithness Interconnector and the Moray East Offshore Wind Farm to interact and potentially damage deployed static gears (Volume 3a - Figure 11.8.5). Recognising the more limited adaptability of this fleet to interference given the static nature of the gear used in comparison to towed gear fleets the sensitivity of this fleet is considered to be **moderate**.

11.8.3.30 It is recognised that the cumulative level of operation and maintenance vessel transits which may occur associated with other projects in the Moray Firth will be significantly higher than that associated with the Development alone (Volume 3a - Figure 11.8.5). However, provided that in line with the embedded mitigation measures proposed for the Development (Section 11.6.2), other projects also implement adequate liaison and information gathering to obtain the coordinates of static gear deployments to minimise the risks of interactions with maintenance vessels, the magnitude of the effect would be **negligible**.

11.8.3.31 The cumulative effect associated with interference with fishing activities on the creel fleet during construction is therefore considered to be of **minor significance** and **not significant** in EIA terms.

Moray Firth, Forth and Tay and Wider Area and English Projects

<u>Mackerel Jigging, Demersal Trawl and Scallop Dredging Fleet</u>

11.8.3.32 In the case of fishing vessels engaged in mackerel jigging and those operating towed gears (namely demersal otter trawlers and scallop dredgers), it should be noted that under the hierarchy of COLREGS Rule 18, vessels other than those of restricted manoeuvrability or constrained by draft are obliged to keep out of the way of vessels engaged in fishing. Therefore, unless restricted in their manoeuvrability or constrained by draft, operation and maintenance vessels will be required to pass at safe distances from vessels engaged in fishing operations. With this in mind the sensitivity of vessels targeting mackerel by jigging, demersal trawlers and scallop dredgers are considered of **low** sensitivity to interference.

11.8.3.33 Provided that in line with the embedded mitigation proposed for the Development (Section 11.6.2), other projects included in the assessment (Table 11.8.1) also implement adequate navigation safety and vessel management plans to avoid fishing activity and mitigate as far as possible, interference with fishing activities, the magnitude of the impact would be **negligible**.

11.8.3.34 Taking the low sensitivity of vessels engaged in mackerel jigging, demersal trawling and scallop dredging and the negligible magnitude of the impact, the significance of the effect is considered to be **negligible** and **not significant** in EIA terms. Displacement of Fishing Activity into other Areas

Displacement of Fishing Activity into other Areas

All Fleets and Projects

11.8.3.35 The extent of potential cumulative displacement of fishing activity into other areas during operation would be a function of the level of permanent loss or restricted access to traditional fishing grounds which each fleet is subject to. As described above this was assessed to not exceed minor significance for all the fisheries included in the assessment. The assessment carried out in respect of permanent loss or restricted access to traditional fishing grounds is therefore considered to also apply in respect of displacement and is summarised in Table 11.8.4.

11.8.3.36 In the context of this assessment, it should be recognised that given the operational ranges and the extent of the grounds of the fleets of concern, it is possible that skippers might continue fishing within their traditional grounds, rather than exploring new grounds as a result of the limited area of fishing lost during operation. Furthermore, it should be recognised that a significant level of fishing activity (particularly demersal otter trawling and creeling) currently occurs for the most part inshore, coinciding with areas relevant to the location of export cables of the majority of projects included for cumulative assessment rather than to infrastructure associated to wind farm arrays (Volume 3a - Figure 11.8.1, Figure 11.8.2 and Figure 11.8.5).

Table 11.8.4: Assessment of Cumulative Displacement of Fishing Activity into Other Areas

Projects	Receptor	Sensitivity	Impact Magnitude	Effect Significance
Moray Firth Projects	Creel fleet	Negligible	Negligible	Negligible
	Mackerel jigging fleet	Negligible	Negligible	Negligible
	Local demersal trawl fleet (Nephrops, squid and whitefish fleet)	Low	Low	Minor
	Local scallop fleet	Moderate	Low	Minor
Moray Firth, Forth and Tay wider area and English Projects	Demersal trawl fleet	Low	Low	Minor
Moray Firth, Forth and Tay wider area projects and English Projects	Nomadic scallop fleet	Low	Moderate	Minor

11.8.4 Cumulative Decommissioning Effects

11.8.4.1 As there is no specified timeline for the programmes of decommissioning at the time of writing this commercial fisheries assessment, it is not possible to provide a cumulative assessment with other proposed marine developments. However, it is considered that the cumulative impacts resulting from decommissioning will be less than or in the worst case equal to the impact levels identified for the construction phase.

11.8.5 Cumulative Assessment Summary

11.8.5.1 A summary of the outcomes of the cumulative assessment is provided in Table 11.8.5 below.

Table 11.8.5: Summary of Cumulative Effects					
Potential Impact	**Projects Considered**	**Receptor**	**Impact Magnitude**	**Sensitivity**	**Effect Significance**
Construction					
Adverse effects on commercially exploited Fish and Shellfish Populations	All projects	All fleets		For full details see Chapter 8: Fish and Shellfish Ecology	Minor
Temporary loss or restricted access to traditional fishing grounds	Moray Firth Projects	Creel fleet	Low	Moderate	Minor
		Mackerel jigging fleet	Low	Moderate	Minor
		Local demersal trawl fleet (Nephrops and whitefish)	Low	Low	Minor
		Local squid fleet	Low	Moderate	Minor
		Local scallop fleet	Low	Moderate	Minor
	Projects in the Moray Firth, Forth and Tay, wider area and English Projects	Demersal trawl fleet	Low	Low	Minor
		Nomadic scallop fleet	Low	Low	Minor
Increased steaming times to fishing grounds	Moray Firth Projects	Creel fleet and mackerel jigging fleet	Negligible	Low	Negligible
		Local demersal and scallop fleet	Low	Low	Minor
	Projects in the Moray Firth, Forth and Tay, wider area and English Projects	Demersal trawl fleet	Low	Low	Minor
		Nomadic scallop fleet	Low	Low	Minor
Interference with fishing activities (navigational conflict)	Moray Firth Projects	Creel fleet	Negligible	Moderate	Minor
		Mackerel jigging, local demersal and scallop fleet	Negligible	Low	Negligible

Table 11.8.5: Summary of Cumulative Effects

Potential Impact	Projects Considered	Receptor	Impact Magnitude	Sensitivity	Effect Significance
Interference with fishing activities (navigational conflict)	Projects in the Moray Firth, Forth and Tay, wider area and English Projects	Demersal trawl fleet	Negligible	Low	Negligible
		Nomadic scallop fleet	Negligible	Low	Negligible
Displacement	As above for temporary loss or restricted access to traditional fishing grounds				
Operation and Maintenance					
Adverse effects on commercially exploited Fish and Shellfish Populations	All projects	All fleets	For full details see Chapter 8: Fish and Shellfish Ecology		Minor
Permanent loss or restricted access to traditional fishing grounds	Moray Firth Projects	Creel fleet and mackerel jigging fleet	Negligible	Negligible	Negligible
		Local demersal trawl fleet (including Nephrops, squid and whitefish fisheries)	Low	Low	Minor
		Local scallop fleet	Low	Moderate	Minor
	Projects in the Moray Firth, Forth and Tay, wider area and English Projects	Demersal trawl fleet	Low	Low	Minor
		Nomadic scallop fleet	Low	Low	Minor
Increased steaming times to fishing grounds	All Projects	All fleets	Negligible	Negligible	Negligible
Interference with fishing activities (navigational conflict)	All Projects	Creel fleet	Negligible	Moderate	Minor
		All other fleets	Negligible	Low	Negligible
Displacement	As above for permanent loss or restricted access to traditional fishing grounds				
Decommissioning					
Assumed to be less than or in the worst case equal to the impact levels identified for the construction phase.					

11.9 References

Centre for Environment, Fisheries and Aquaculture Science (Cefas) (2012) Guidelines for data acquisition to support marine environmental assessments of offshore renewable energy projects. Contract report: ME5403, May 2012.

Cefas, Marine Consents and Environment Unit (MCEU), Department for Environment, Food and Rural Affairs (DEFRA) and Department of Trade and Industry (DTI) (2004) Offshore Wind Farms - Guidance note for Environmental Impact Assessment In respect of FEPA and CPA requirements, Version 2.

FLOWW Best Practice Guidance for Offshore Renewables Developments: Recommendations for Fisheries Liaison: FLOWW (Fishing Liaison with Offshore Wind and Wet Renewables Group) (2014).

International Cable Protection Committee (2009) Fishing and Submarine Cables - Working Together.

Marine Scotland: Economic Assessment of Short Term Options for Offshore Wind Energy in Scottish Territorial Waters: Costs and Benefits to Other Marine Users and Interests (2011) ISBN 978 1 78045 162 6.

Marine Scotland: Scotland's National Marine Plan (27th March 2015) ISBN: 9781785442148.

RenewableUK (2013) Cumulative impact assessment guidelines, guiding principles for cumulative impacts assessments in offshore wind farms.

Sea Fish Industry Authority and UK Fisheries Economic Network (UKFEN) (2012) Best practise guidance for fishing industry financial and economic impact assessments.

SeaPlan. Options for Cooperation between Commercial Fishing and Offshore Wind Energy Industries. A Review of Relevant Tools and Best Practices. (2015).

Subsea Cables UK (2015). Emergency procedures for fouling gear (now incorporated in KIS-ORCA and European Subsea Cables Association web guidance).

Subsea Cables UK (2012). Guidance on overlaps with fishing (now incorporated in KIS-ORCA and the European Subsea Cables Association web guidance).

UK Oil and Gas (2015) Fisheries Liaison Guidelines - Issue 6.

MORAY WEST

OFFSHORE WINDFARM

Offshore EIA Report

Moray Offshore Windfarm (West) Limited

Chapter 12 Shipping and Navigation

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Acronyms	
Acronym	**Expanded Term**
AIS	Automatic Identification Systems
ALARP	As Low As Reasonably Practicable
AtoN	Aids to Navigation
BOWL	Beatrice Offshore Windfarm Ltd
CA	Cruising Association
CAA	Civil Aviation Authority
CBRA	Cable Burial Risk Assessment
COLREGs	International Convention for the Prevention of Collisions at Sea
CoS	Chamber of Shipping
DSLP	Development Specification and Layout Plan
EIA	Environmental Impact Assessment
EU	European Union
FSA	Formal Safety Assessment
GT	Gross Tonnage
HAT	Highest Astronomical Tide
HSC	High Speed Craft
IALA	International Association of Lighthouse Authorities
IMO	International Maritime Organization
km	Kilometer
LOA	Lengths Overall
LMP	Lighting and Marking Plan
m	meter
MAIB	Maritime Accident Investigation Branch
MCA	Maritime and Coastguard Agency
MGN	Marine Guidance Note
MHWS	Mean High Water Springs
NLB	Northern Lighthouse Board
nm	Nautical mile
NRA	Navigational Risk Assessment
NSP	Navigational Safety Plan
OfTI	Offshore Transmission Infrastructure
OnTI	Onshore Transmission Infrastructure

Acronyms	
Acronym	**Expanded Term**
OREI	Offshore Renewable Energy Installations
OSP	Offshore Substation Platform
OWF	Offshore Wind Farm
RNLI	Royal National Lifeboat Institution
RYA	Royal Yachting Association
REZ	Renewable Energy Zone
SAR	Search and Rescue
SFF	Scottish Fishermen's Federation
SOLAS	Safety of Life at Sea
UK	United Kingdom
UKHO	United Kingdom Hydrographic Office
VHF	Very High Frequency
VMP	Vessel Management Plan
WTG	Wind Turbine Generator

Glossary of Terms	
Term	**Definition**
Allision	The act of striking or collision of a moving vessel against a stationary object.
Automatic Identification Systems (AIS)	Automatic Identification System. A system via which vessels automatically broadcast their identity, key statistics e.g. length, brief navigation details e.g. location, destination, speed and current status e.g. survey. Most commercial vessels and EU fishing vessels over 15m are required to have AIS.
Base Case	The assessment of risk based on current shipping densities and traffic types as well as the marine environment.
Collision	The act or process of colliding (crashing) between two moving objects.
Formal Safety Assessment (FSA)	A structured and systematic process for assessing the risks and costs (if applicable) associated with shipping activity.
Future Case	The assessment of risk based on the predicted growth in future shipping densities and traffic types as well as foreseeable changes in the marine environment.
Marine Guidance Note (MGN)	A system of guidance notes issued by the Maritime and Coastguard Agency which provide significant advice relating to the improvement of the safety of shipping and of life at sea, and to prevent or minimize pollution from shipping.

Glossary of Terms	
Term	**Definition**
Offshore Export Cable Corridor	The specific corridor of seabed from Moray West to the landfall location within which the cables will be located.
Offshore Renewable Energy Infrastructure (OREI)	OREIs as defined by Guidance to Mariners Operating in the Vicinity of UK OREIs, MGN 372. For the purpose of this chapter and in keeping with the EIA, OREI can mean offshore wind turbines and the associated electrical infrastructures.
Radar	Radio Detection and Ranging – an object-detection system which uses radio waves to determine the range, altitude, direction or speed of objects.
Safety Zone	A marine zone demarcated for the purposes of safety around a possibly hazardous installation or works / construction area under the Energy Act 2004.

12 Shipping and Navigation

12.1 Introduction

12.1.1.1 This chapter considers the likely significant effects associated with the construction, operation and decommissioning of the Moray West Offshore Wind Farm and associated Offshore Transmission Infrastructure (OfTI) (hereafter referred to as the Development) on shipping and navigation. The specific objectives of the chapter are to:

- Define the legislation, policy and guidance framework that is of relevance to shipping and navigation;
- Detail the consultation activities and responses that are relevant to, and have informed, this shipping and navigation impact assessment;
- Describe the shipping and navigation baseline;
- Describe the assessment methodology and significance criteria used in completing the impact assessment;
- Describe the potential effects, including direct, indirect and cumulative effects;
- Describe the mitigation measures proposed to address likely significant effects; and
- Assess the residual effects remaining following the implementation of mitigation.

12.1.1.2 The assessment has been carried out by Anatec Ltd. (hereby referred to as Anatec) in line with regulatory guidance and methodologies. Anatec have 20 years' experience in undertaking Navigational Risk Assessments (NRAs) for offshore installations and will use methods and models successfully applied to previously consented applications. The Lead Assessor, Samantha Westwood, has been specifically working on NRAs for offshore windfarms within UK and European areas for over 10 years, and has over 20 years' experience in the maritime field.

12.1.1.3 This chapter is supported by EIA Report Volume 4 - Technical Appendix 12.1: NRA. The NRA has been included within the consent application in compliance with requirements of the Maritime and Coastguard Agency (MCA) Marine Guidance Note (MGN) 543 (MCA, 2016). The NRA also forms the main input into the assessment of impacts on shipping and navigation undertaken within this chapter.

12.2 Legislation, Policy and Guidance Framework

12.2.1.1 The principal guidance documents and information used to inform the assessment of potential impacts on shipping and navigation are as listed in Table 12.2.1.

Table 12.2.1: Guidance and Legislation

Guidance	Relevance to the Development
MCA MGN 543 (MCA 2016)	Highlights issues which should be considered by Offshore Renewable Energy Installation (OREI) developers with regards to navigational safety and emergency response.
MCA Methodology for Assessing Marine Navigational Risk of OREIs (MCA, 2015)	Provides methodology for assessing issues relating to navigational risk and emergency response.
International Maritime Organization (IMO) Formal Safety Assessment (FSA) Process (IMO 2002)	Provides the process by which a FSA should be carried out (noting that as per MCA Methodology (MCA, 2015), shipping and navigation impact assessments should use a FSA approach.

Table 12.2.1: Guidance and Legislation	
Guidance	**Relevance to the Development**
MCA MGN 372 (M+F) Guidance to Mariners Operating in the Vicinity of United Kingdom (UK) Offshore Renewable Energy Installations (OREIs) (MCA, 2008)	Provides guidance and advice to third party vessels transiting within the vicinity of an OREI.
International Association of Lighthouse Authorities (IALA) Recommendations O-139 on the Marking of Man-Made Structures (IALA 2013)	International standard guidance on how OREI should be marked and lit.
The Royal Yachting Association's (RYA) Position on Offshore Renewable Energy Developments: Paper 1 – Wind Energy (RYA, 2015).	Provides RYA recommendations in relation to OREI developers in relation to ensuring recreational vessel safety.

12.3 Consultation

12.3.1.1 Moray West has framed its assessment of potential effects on shipping and navigation through consultation with key stakeholders.

12.3.1.2 Table 12.3.1 details the key issues raised in relation to shipping and navigation in the Moray West Offshore Wind Farm Scoping Opinion (August 2016) and the OfTI Scoping Opinion (August 2017). Table 12.3.2 summarises other issues / concerns that have been raised during additional consultation activities undertaken as part of the EIA process and how these have been addressed in the preparation of this EIA Report.

Table 12.3.1: Consultation Responses to Scoping Report		
Consultee and Date	**Comment**	**Moray West Approach**
MCA (Offshore Wind Farm Scoping Opinion in August 2016)	EIA should include commercial and recreational vessel impacts.	Impacts to both considered within this Chapter (Volume 2 - Chapter 12: Shipping and Navigation).
	Cumulative effects with Moray East and BOWL must be considered.	Cumulative effects are considered in Section 12.8.
	Principle of Rochdale Envelope (Design Envelope) approach should be used in EIA.	Impact assessment in Section 12.7 assumes the worst case envelope parameters.
	Inclusion of Radar and visual observations in marine traffic analysis to ensure capture of non-Automatic Identification System (AIS) traffic.	Approach to marine traffic collection agreed with the MCA and NLB.
MCA (Offshore Wind Farm Scoping Opinion in August 2016 and OfTI Scoping Opinion in August 2017)	NRA must be submitted in line with MGN543 (MCA, 2016) and required OREI assessment methodology (MCA, 2015).	This NRA is in line with the guidance referenced (Table 12.2.1).
	Consideration must be given to potential navigable water depth reduction (noting MGN543 requirement that depth reductions of greater than 5% of chart datum require MCA consultation).	Assessment of Cable Protection will be undertaken post consent (Section 12.6.2), with the MCA consulted as necessary.
	Final layout must consider safe passage of Search and Rescue (SAR) helicopters and vessels during SAR operations. OSPs must be in	Final layout will be agreed with the MCA post consent (Section 12.6.2).

Table 12.3.1: Consultation Responses to Scoping Report		
Consultee and Date	**Comment**	**Moray West Approach**
	line with WTG row/columns. Implications on ERCoP must be considered.	
	Automatic granting of safety zones should not be assumed.	Application for safety zones (rather than safety zones themselves) assumed as embedded mitigation (Section 12.6.2).
Moray Council (Offshore Wind Farm Scoping Opinion in August 2016)	Seeks early engagement on likely impacts to Moray Harbours.	Invite to Hazard Workshop (summarised in NRA) was extended to Moray Council. Ports used to be decided post consent – impacts assessed in Section 12.7.
NLB (Offshore Wind Farm Scoping Opinion in August 2016)	Lighting and marking should be in line with IALA O-139, and in continuity with Moray East. Marking of cable landfall may be necessary.	All lighting and marking will be agreed with NLB post consent (Section 12.6.2) and will be in line with IALA O-139.
	NRA submitted in line with MGN 543 (MCA, 2016). NRA informed by land observations, local user consultation, and desktop study.	This NRA is in line with MGN543 (see Table 12.2.1). Marine traffic data approach agreed with MCA and NLB.
Civil Aviation Authority (CAA) (Offshore Wind Farm Scoping Opinion in August 2016)	Any WTG of height 60 m or more above Highest Astronomical Tide (HAT) in United Kingdom (UK) waters must be lit/marked in line with the Air Navigation Order.	All lighting and marking will be agreed in consultation with the CAA (Section 12.6.2) and will be in line with the Air Navigation Order.
	Issue of Notice to Airmen while aviation charts are being updated.	Promulgation of information (which includes Notice to Airmen) assumed embedded mitigation (Section 12.6.2).
CoS (Offshore Wind Farm Scoping Opinion in August 2016)	Traffic data required updating (noting Moray East data used within Moray West Scoping Process), including recording of non-AIS traffic.	Approach to marine traffic data collection agreed with the MCA and NLB.
	Adverse weather routing and anchorages must be considered.	Adverse weather considered in Section 13.4 of the NRA. Anchorages included in baseline assessment (Section 12.4).
	Layout must consider MGN 543 (MCA, 2016) guidelines.	MGN 543 checklist provided in Annex B. Layout to be agreed with MCA post consent (Section 12.6.2).
RYA (Offshore Wind Farm Scoping Opinion in August 2016)	Mitigation must include publicity of timing and location of construction. RYA policy is that there is no need for an operational safety zone for small vessels	Promulgation of information counted as embedded mitigation (Section 12.6.2). Moray West do not intend to apply for operational safety zones, however this will be assessed prior to the safety zone application.
RYA (OfTI Scoping Opinion in August 2017)	The proposal of no-anchor zones in waters of less than 10m depth would require RYA consultation.	Cable protection will be agreed post consent (Section 12.6.2).
	Data sources should include updated RYA Coastal Atlas (RYA, 2016).	Updated Coastal Atlas considered (Section 12.4.3).
BOWL (OfTI Scoping Opinion in August 2017)	BOWL should be treated as part of the baseline.	BOWL has been considered as part of the baseline assessment (Section 12.4).

Table 12.3.2: Consultation Responses Post Scoping		
Meeting Date and Stakeholder	**Comment**	**Moray West Approach**
20/04/2017 MCA and NLB	MCA agreed AIS only winter survey based on data already collected, however summer survey must include non AIS traffic.	Moray West have complied with the approach agreed with the MCA and NLB for marine traffic survey data collection.
	NLB noted that potential increases in traffic associated with BOWL construction and Beatrice Oil Field decommissioning should be accounted for.	Potential traffic increases have been accounted for within the future case routing and modelling assessment (Section 15.2 of the NRA).
May 2017 Cruising Association (CA)	OSPs should be internal within Moray West Site and in line with WTG row/columns.	Layout to be agreed as part of the Development Specification and Layout Plan (DSLP) to be submitted to MS-LOT post consent. DSLP will be drafted in consultation with MCA (Section 12.6.2).
	Cable burial should exceed 1.5 m in areas where recreational vessels may anchor if possible, with preservation of a smooth seabed ideal. Burial of 1 m may be acceptable depending on location, but beacon marker may be required.	Assessment of Cable Protection will be undertaken post consent (Section 12.6.2).
	Requested coordinated lighting between the Development, Moray East, and BOWL.	A Lighting and Marking Plan will be submitted to MS-LOT post consent, drafted in consultation with NLB (Section 12.6.2).
	Requested use of an OSP to operate a relay service improving mobile phone reception of the area.	Given the complexity of installing additional hardware and licensing it is unlikely that a mobile phone mast would be considered. Noted that marine VHF remains the primary method of communication for offshore vessels.
	Request consideration of horizontal black band for corner wind turbines and possibly some intermediate wind turbines to indicate Mean High Water Springs (MHWS) level.	Given the uniform and standardised requirements for offshore lighting and marking this request is not considered feasible.
	Under-tip clearance of WTG blades should be at least 22 m above HAT.	MGN 543 requires 22 m from MHWS – this would be complied with as a minimum (Section 12.6.2).
May 2017 CoS	Queried as to if final layout would align with Moray East.	Layout to be agreed as part of the Development Specification and Layout Plan (DSLP) to be submitted to MS-LOT post consent. DSLP will be drafted in consultation with MCA (Section 12.6.2).
23/10/2017 MCA and NLB	Agreed NRA and EIA methodology, worst case envelope and marine traffic survey data.	NRA/EIA undertaken in line with agreed approach.
14/11/2017 RYA Scotland	Mitigation required by law is “embedded”, any further mitigation is therefore “additional” and should be presented as such.	Embedded mitigation measures are listed in Section 12.6.2.
	Requested more publicity related to the Development and its progress.	Promulgation of information (including with local recreational stakeholders)

Table 12.3.2: Consultation Responses Post Scoping		
Meeting Date and Stakeholder	**Comment**	**Moray West Approach**
		assumed as embedded mitigation (Section 12.6.2).
16/01/2018 CoS, CA, and BP Shipping	BP Shipping raised concern over impact of cables on shuttle tanker anchorage within Moray Firth.	Anchoring impacts assessed in Section 12.7.
	CoS noted that marine traffic is specific to market conditions of the period and may not capture all relevant shipping movements.	Marine traffic data approach agreed with MCA and NLB. Data validated against Anatec's long term shipping database.
	CA raised point that small local sailing vessels may not be on AIS.	The summer marine traffic survey utilised radar and visual observations to record non-AIS vessel movements. Additionally, the latest RYA Coastal Atlas (RYA, 2016) has been used as input to the assessment.

12.3.2 Regular Operators

12.3.2.1 In order that opinion of vessel operators utilising the Moray Firth could be incorporated into the NRA process (and hence the EIA), the marine traffic data (see Section 12.4.2) was used to identify regular operators of the area. Consultation was then undertaken with these operators, as summarised within Section 5.3 of the NRA (Volume 4 - Appendix 12.1). Responses were limited; however one operator indicated concern over the cumulative impact that export cables may have on existing anchorages. This will be considered within a future Cable Burial Risk Assessment (CBRA), undertaken post-consent to inform final cable burial and/or protection specifications.

12.3.3 Hazard Workshop

12.3.3.1 A Hazard Workshop was held in September 2017 for the purpose of validating the baseline assessment, and to identify potential impacts to shipping and navigation receptors. Results of the Hazard Workshop can be found in the NRA (Volume 4 - Appendix 12.1) Section 20, and in Annex A.

12.3.3.2 Impacts scoped into the EIA are assessed in Section 12.7 of this chapter.

12.4 Baseline Conditions

12.4.1 Baseline Characterisation Approach

Study Area

Offshore Wind Farm Study Area

12.4.1.1 To ensure focus on the traffic relevant to the Moray West Site, marine traffic survey data within a 10 nautical mile (nm) buffer of the site (hereby referred to as the "offshore wind farm study area"), has been collated and assessed. This extent of buffer encompasses all relevant shipping routes within the vicinity of the offshore wind farm.

Offshore Export Cable Corridor Study Area for the OfTI

12.4.1.2 In addition to the offshore wind farm study area, marine traffic data (AIS data only) has also been considered within a 5 nm buffer around the Offshore Export Cable Corridor (hereby referred to as the "OfTI study area").

Desk Study / Field Survey

12.4.2 Marine Traffic Survey Studies

12.4.2.1 In order to establish the baseline conditions, marine traffic survey data has been collected during 2016 and 2017 for both the offshore wind farm and the OfTI study areas, with the survey periods chosen to account for seasonal variations, as summarised below:

- Summer: 25 days of AIS and Radar data collected by an on-site vessel during 15th August to 13th September 2017, supplemented with AIS data collected from onshore receivers; and
- Winter: 28 days of AIS data collected by onshore receivers during 4th November to 22nd December 2016.

12.4.2.2 The scope of the traffic surveys and the approach to marine traffic data collection was agreed in advance with the MCA.

12.4.2.3 AIS is required on board all vessels of more than 300 GT engaged on international voyages, cargo vessels of more than 500 GT not engaged on international voyages and passenger vessels irrespective of size built on or after 1 July 2002. At the time of completion of the marine traffic surveys, fishing vessels of 15 m length and over were required to carry AIS under European Union Directive 2009/17/EC which establishes a community vessel traffic monitoring and information system. In addition to the EU Directive requirements, some smaller fishing and recreational vessels broadcast via AIS on a voluntary basis due to the added safety benefits.

12.4.2.4 Non-AIS vessels (mainly recreational vessels and smaller fishing vessels) were also recorded during the summer survey from an Automatic Radar Plotting Aid. These Radar track data were supplemented by manual observations of vessels within visual range to obtain type and size information.

12.4.2.5 Any traffic deemed to be temporary (i.e., associated with activities that will be complete prior to construction of the Project, for example, vessels associated with the BOWL construction) has been excluded. However, based on consultation, vessels associated with activities in the Beatrice Oil Field have been retained, given that decommissioning of the Beatrice Oil Field structures may overlap with the construction and operational phases of the Project.

12.4.3 Other Sources of Information

12.4.3.1 In addition to the marine traffic data collected during the traffic surveys within the Development, the following data sources were also used to inform the description of the baseline environment:

- Maritime Incident Data (Marine Accident Investigation Branch (MAIB) 2005-2014 and Royal National Lifeboat Institution (RNLI) 2005-2014). Although all UK commercial vessels are required to report accidents to the MAIB, non-UK vessels do not have to report unless they are in a UK port or within 12 nm territorial waters and carrying passengers to a UK port. There are also no requirements for non-commercial recreational craft to report accidents to the MAIB;
- RYA UK Coastal Atlas of Recreational Boating (2016), Cruising Routes (2010), recreational AIS densities (summers of 2011-2013) and Geographic Information System (GIS) Shape Files (2016);
- UK Admiralty Chart 115-0. It is noted that the Admiralty Charts are updated on a periodic basis. As a result, information shown on the charts may not reflect the real time features within the sea with 100% accuracy;
- Admiralty Sailing Directions – North Coast of Scotland Pilot, NP 52 (UKHO, 2015); and

- Metocean Data - The probability of poor visibility has been estimated based on information given in the Pilot Book (UKHO, 2015), average statistics for the North Sea, and data collected from onshore receivers. Based on the available data, the UK North Sea average was assumed to be representative of the Moray Firth. Tidal stream information has been taken from UK Admiralty Charts, and it has been assumed that the provided details are accurate.

12.4.3.2 Further information on data sources can be found in the NRA (Volume 4 - Appendix 12.1).

12.4.4 Navigational Features

12.4.4.1 An overview of the main navigational features in proximity to the Development is presented in Volume 3a - Figure 12.4.1. These have been identified using desk-based studies of Admiralty Charts and the Admiralty Sailing Directions for the Moray Firth (UKHO 2015).

12.4.4.2 There are two military Practice and Exercise Areas that intersect the offshore wind farm study area. One of these intersects the east corner of the offshore wind farm study area and the other intersects the west corner.

12.4.4.3 The Admiralty Sailing Directions (UKHO, 2015) and navigational charts were used to identify the anchorage areas relevant to the OfTI study area. The Cullen Bay anchorage lies immediately to the west of the Landfall Area, offering anchorage in depths of 9 to 11 m over sand. The Admiralty Sailing Directions also state that temporary refuge for small vessels unable to enter Cullen Harbour in strong winds is available in Port Long, a rocky cove in the west of Cullen Bay. Vessels awaiting entrance to Portsoy harbour (east of the Landfall Area) can also anchor in the position indicated in depths of approximately 12 m.

12.4.4.4 There are no chartered spoil grounds in the vicinity of the Development; the closest is located approximately 0.5 nm west of the Offshore Export Cable Corridor and the nearest spoil ground to the Moray West Site is located approximately 13.2 nm west of the nearest point on the site boundary.

12.4.4.5 There are a number of pre-existing Aids to Navigation (AtoN) located in proximity to the Development; these are presented based on the assessment of UKHO Admiralty Charts. It is noted that the figure includes temporary AtoNs (cardinal and special mark buoys) placed to mark the buoyed construction area surrounding the BOWL. No additional buoyage is expected to be used to mark the BOWL during its operational phase; however the WTGs would be marked and lit as agreed with the relevant stakeholders (BOWL, 2017).

12.4.4.6 The export cable for the Beatrice Oil Field currently intersects the Moray West Site. Once installed the BOWL export cables (which make landfall at Portgordon on the south coast of the Moray Firth), will also intersect the Moray West Site on a north south alignment.

12.4.4.7 There is an active telecommunication cable connecting Banff and Mance Bay which passes approximately 5.1 nm east of the Offshore Export Cable Corridor and 8.8 nm from the Moray West Site.

12.4.4.8 The route of the Caithness to Moray Interconnector cable passes through the Offshore Export Cable Corridor but does not intersect the Moray West Site. This cable, which is currently being installed, is expected to be commissioned by the end of the year (2018). There is an active telecommunication cable connecting Banff and Mance Bay which passes approximately 5.1 nm east of the Offshore Export Cable Corridor and 8.8 nm from the Moray West Site.

12.4.4.9 The BOWL and Beatrice Demonstrator Turbines are located within the offshore wind farm study area. The BOWL offshore wind farm is currently under construction and will be fully commissioned and operational in early 2019. As such, vessels associated with the construction of BOWL are considered temporary and have therefore not been included in the marine traffic analysis. The Beatrice Demonstrator Turbines are no longer operational, and will be removed as part of the decommissioning in of the Beatrice Oil Field.

12.4.4.10 There are six oil and gas surface platforms within the offshore wind farm study area, five of these belong to the Beatrice Oil Field and one to the Jacky Oil Field. It should be noted that production has ceased at these platforms and plans are underway to fully decommission the oil fields. Decommissioning of these oil fields is currently expected to take place between 2024 and 2027; vessel displacement, allision and collision risk will therefore be assessed but is limited by the unknown variable of the number and type of vessels associated with the decommissioning activity. The closest operational surface platforms are located at the Captain Oil Field, located approximately 24.7 nm east of the offshore wind farm study area.

12.4.4.11 There are no licensed aggregate dredging sites in the vicinity of the Development.

12.4.4.12 Details of other navigational features not listed above that have been scoped out of the EIA assessment process can be found in the NRA (Volume 4 - Appendix 12.1).

12.4.5 Marine Traffic – Offshore Wind Farm

<u>Summary</u>

12.4.5.1 Figure 12.4.2 (Volume 3a) presents the vessel tracks recorded on AIS and Radar during the summer survey period, colour-coded by vessel type, while Figure 12.4.3 (Volume 3a) presents the vessel tracks recorded on AIS during the winter survey period, colour-coded by vessel type.

12.4.5.2 In order to provide a comparison between the two survey periods (with periods of differing length), plots of the vessel tracks for each survey period, converted to a density grid are presented in Volume 3a - Figure 12.4.4 and Figure 12.4.5. Furthermore, the analysis presented in the remainder of this section is given in terms of the unique vessels per day.

12.4.5.3 During the summer survey, an average of ten unique vessels per day was recorded on AIS and Radar passing within the offshore wind farm study area, four of which intersected the Moray West Site. The majority of activity was from vessels associated with the Beatrice Oil Field and fishing vessels. Commercial vessels (cargo and tanker) and passenger vessels (the majority of which were cruise liners) were also commonly recorded.

12.4.5.4 During the winter survey, an average of four unique vessels per day were recorded on AIS passing within the offshore wind farm study area, with two vessels per day interesting the Moray West Site. As noted during summer, the majority of traffic recorded was associated with the Beatrice Oil Field and fishing vessels.

12.4.5.5 No anchoring activity was recorded during either survey.

<u>Commercial Vessel Routeing</u>

12.4.5.6 The AIS and Radar data presented has been assessed and vessels transiting at similar headings and locations have been identified as a main route. A total of eight main routes have been identified as transiting within the offshore wind farm study area. These main routes and their corresponding 90th percentiles within the offshore wind farm study area are presented in Volume 3a - Figure 12.4.6. Details of the routes are provided in Table 12.4.1.

12.4.5.7 The busiest routes were those observed to be those associated with the Beatrice Oil Field (crew transfer from Buckie – Route 7, and supply traffic from Peterhead – Route 8), and the commercial route passing inshore of the Moray West Site (Route 1).

12.4.5.8 It should be noted that the winter marine traffic data used was collected prior to the commencement of construction of BOWL, and that one route (Route 6) was observed to intersect the buoyed construction area. In order to provide a realistic basis on which to undertake the EIA, this route has been deviated around the BOWL buoyed construction area. Full details are provided in the NRA.

Table 12.4.1: Main Routes			
Route ID	**Ports**	**Approximate Vessels per Year**	**Summary**
1	Cromarty or Inverness Firth – Kirkwall or Lerwick	350	Route used by cargo vessels, tankers, passenger vessels and oil and gas vessels
2	Invergordon - Lerwick	145	Mainly used by passenger vessels
3	Invergordon – Captain Field	100	Mainly used by vessels associated with the Captain Field
4	Wick – Immingham	30	Used by tankers, passenger vessels and “other” vessels
5	Invergordon - Dunbar	40	Used mainly by cargo vessels and passenger vessels
6	Buckie - Orkney	30	Used mainly by cargo vessels.
7	Buckie – Beatrice Oil Field	370	Crew transfer to the Beatrice Oil Field
8	Aberdeen / Peterhead – Beatrice Oil Field	140	Supply vessel traffic to Beatrice Oil Field

Fishing Vessel Activity

12.4.5.9 Figure 12.4.7 (Volume 3a) presents fishing activity recorded within 10 nm of the Moray West Site. Active fishing was observed within the Moray West Site, with further activity also recorded within the southern section of the offshore wind farm study area.

12.4.5.10 Fishing method information was available for approximately 85% of fishing vessels recorded on AIS, visual and Radar within the offshore wind farm study area. Of the fishing methods identified, the most common were demersal trawling (51%) and dredgers (15%). Other fishing methods identified included unspecified trawlers (10%), paired trawlers (4%), pelagic trawlers (2%) and seiners (2%). Unspecified fishing methods accounted for 16% of the fishing vessels recorded.

12.4.5.11 Flag state (nationality) information was available for approximately 85% of fishing vessels recorded on AIS, visual and Radar within the offshore wind farm study area. All of the fishing vessels with available nationality information were UK registered (85%). The remaining 15% of tracks were recorded on Radar and therefore their nationalities could not be identified.

12.4.5.12 Sightings and satellite recorded data correlated well overall with the results of the survey data analysis.

Recreational Vessel Activity

12.4.5.13 There were no recreational vessels recorded throughout the winter survey period and an average of one unique vessel every three days during the summer survey period within the offshore wind farm study area. It is noted that all recreational tracks were recorded on AIS, with no tracks recorded on Radar.

12.4.5.14 The RYA Coastal Atlas (RYA, 2016) shows the estimated direction of offshore cruising routes, and approximate densities of recreational vessel density within the UK 12 nm limit. A plot of this data is shown in Volume 3a - Figure 12.4.8, which has been overlaid with the recreational tracks recorded during the marine traffic surveys (noting that no activity was recorded during the winter survey period). It can be seen that recreational density within the offshore wind farm study area is low when compared to the coastal areas. This correlates well with the marine traffic data.

12.4.5.15 The highest recreational AIS densities are located along Moray coast and approaches to the Cromarty Firth. The Moray West Site is located outside of the UK coastal waters 12 nm limits therefore no AIS density is available for within Moray West Site but it can be deduced that density is low.

12.4.6 Marine Traffic - Offshore Export Cable Corridor

Summary

12.4.6.1 Figure 12.4.9 (Figure 3a) presents the vessel tracks during the combined summer and winter survey periods, colour-coded by vessel type.

12.4.6.2 During the summer survey, an average of 15 unique vessels per day was recorded on AIS and Radar passing within the OfTI study area, with eight intersecting the Offshore Export Cable Corridor itself. Traffic levels dropped during the winter survey, with an average of eight unique vessels per day recorded as passing within the OfTI study area, four of which intersected the Offshore Export Cable Corridor itself.

12.4.6.3 The most commonly recorded traffic within the OfTI study area during both summer and winter was associated with the fishing industry.

Commercial Vessel Routeing

12.4.6.4 The majority of commercial vessel activity within the OfTI study area was observed to be coastal, from vessels on routes associated with the Cromarty Firth, Inverness Firth, and Nigg. Passenger vessel traffic was observed to comprise mainly cruise ships.

12.4.6.5 The OfTI study area also captured the crew transfer activity from Buckie to the Beatrice/Jacky Oil Fields, and other associated traffic, largely from Peterhead and Aberdeen.

Fishing Activity

12.4.6.6 Throughout the combined summer and winter survey periods there was an average of four unique fishing vessels per day within the OfTI study area.

12.4.6.7 The majority of vessels tracked within the Offshore Export Cable Corridor were actively engaged in fishing rather than transiting.

12.4.6.8 Fishing method information was available for approximately 91% of fishing vessels recorded on AIS, visual and Radar within the OfTI study area. Of the fishing methods identified, the most common were demersal trawlers (32%) long liner / drift netters (13%) and dredgers (13%). Other fishing methods identified included unspecified trawlers (11%), potter/whelkers (11%), beam trawlers (5%), pair trawlers (5%) and pelagic trawlers (1%). Unspecified fishing methods accounted for 9% of the fishing vessels recorded.

12.4.6.9 Flag state (nationality) information was available for approximately 96% of fishing vessels recorded on AIS, visual and Radar within the OfTI study area. Of the nationalities identified, the most common was the UK (96%). No other nationalities were identified due to the remaining 4% of tracks being recorded by Radar.

12.4.6.10 The sightings and satellite data showed good correlation overall with the survey data.

Recreational Vessels

12.4.6.11 There were no recreational vessels recorded throughout the winter survey period and an average of two unique vessels every per day during the summer survey period within the OfTI study area. It is noted that all recreational tracks were recorded on AIS, with no tracks recorded on Radar.

12.4.6.12 A general boating area intersects the Offshore Export Cable Corridor at the nearshore area and an estimated five offshore routes intersect the offshore wind farm study area.

12.4.7 Emergency Response

12.4.7.1 The organisation of emergency response in the UK is a combination of separate government departments but primarily managed by the MCA.

12.4.7.2 The MCA (which includes Her Majesty's Coastguard) provides a comprehensive SAR service for UK waters on land, on water and in the air. As well as SAR, emergency services provided by the MCA also include counter pollution and salvage. Emergency response on behalf of the MCA coverage is primarily provided by civilian contracts.

12.4.7.3 In March 2013, the Bristow Group were awarded the contract by the MCA (as an executive agency of Department for Transport) to provide helicopter SAR operations in the UK over a ten year period. Bristow have now been operating the service since April 2015. There are ten base locations for the SAR helicopter service. The nearest SAR helicopter base to the Development is the Inverness base which is approximately 47 nm from the centre of the Moray West Site and has been in operation since April 2015. This base operates two Agusta Westland AW189 aircraft.

12.4.7.4 When on an operational mission, SAR aircraft are not constrained by the normal rules of the air, and operate in accordance with their Aircraft Operator Certificate. This allows pilots total flexibility to manoeuvre using best judgement thus making them highly adaptable to the environment they operate in.

12.4.7.5 The SAR Framework for the UK also recognises the role of supporting services that are able to assist in the event of an emergency including organisations such as the RNLI and offshore installations. Companies operating offshore typically have resources of vessels, helicopters and other equipment available for normal operations that can also assist with emergencies offshore. Alongside that, all vessels under IMO obligations set out in the International Convention for the Safety of Life at Sea 1974 as amended, are required to render assistance to any person or vessel in distress if safely able to do so.

12.4.7.6 For further detail on emergency response resources, please refer to the NRA (Volume 2 - Appendix 12.1) which considers the guidance set out by the MCA within MGN 543; in relation to SAR and the development of offshore wind farms.

12.4.8 Maritime Accidents and Incidents

12.4.8.1 The location of accidents, injuries and hazardous incidents reported to the MAIB within the offshore wind farm study area and OfTI study area for the period between 2005 and 2014 were identified.

<u>Moray West Site</u>

12.4.8.2 Throughout the period 2005 to 2014, there were two incidents recorded by MAIB within the offshore wind farm study area as "Hazardous Incidents". The first occurred on the 24th May 2005 and involved two fishing vessels. The second was recorded as occurring on the 17th January 2010, and involved an oil and gas supply vessel. Neither incident resulted in casualties or damage based on the available information. Neither incident occurred within the Moray West Site boundaries.

12.4.8.3 A total of 13 incidents were recorded by the RNLI between 2005 and 2014 within the offshore wind farm study area surrounding the Moray West Site. No incidents were recorded within the Moray West Site itself. Lifeboats were most often sent from either Wick or Buckie; however lifeboats responses from Invergordon and Macduff were also noted. Further details on RNLI resources within the area can be found in the NRA (Volume 2 - Appendix 12.1).

Offshore Export Cable Corridor

12.4.8.4 Throughout the period 2005 to 2014, there were 17 incidents recorded by MAIB within the OfTI study area. Of the 17, four were recorded within the Offshore Export Cable Corridor (two "Hazardous Incidents" and two "Machinery Failures"). The majority of incidents occurred coastally (15 of the 17 were within 3 nm of the coast), with two incidents (both classed as "Accident to Person" incidents) occurring within a port or harbour area. The majority of incidents (14 of the 17) involved a fishing vessel, with the remaining three involving small commercial vessels. None of the incidents led to fatalities, however two injuries were recorded. One incident resulted in "minor damage", and two in "material damage".

12.4.8.5 A total of 90 incidents were recorded within the OfTI study area between 2005 and 2014 by the RNLI, with 40 occurring within the Offshore Export Cable Corridor itself. The majority of incidents occurred coastally, with 92% of incidents recorded as being within 2 nm of the coastline[1].

12.4.9 Future Baseline

12.4.9.1 Given the proximity to the coastline and significant ports within Scottish waters it is likely that there may be fluctuations, both increases and decreases in port traffic, i.e. vessels entering and exiting ports, which may impact the general traffic levels around the Development. However, given the limited information available of any proposed changes (especially given commercial sensitivities) a general increase of 10% is applied in the future baseline scenario (as agreed with MCA and NLB in October 2017).

12.4.9.2 To ensure a consistent approach, (and given that reliable information on future activity levels on which any firm assumption could be made is limited), a 10% increase has also been assumed for fishing vessel transits.

12.4.9.3 For recreational vessel transits, there are no known major developments that would increase the activity of these vessels in the vicinity of the Development. As with fishing activity, given the lack of reliable information into future trends a general increase of 10% is applied in the future baseline scenario compared to the current low levels.

12.4.9.4 Vessel numbers associated with the construction and operation of the Development are considered in Table 12.6.1, which provides the worst case scenario parameters considered within the EIA.

12.5 Assessment Methodology

12.5.1.1 This section outlines the assessment methodology, which has been agreed with the MCA and the NLB. As per the guidance listed in Table 12.2.1, the impact assessment is based on the IMO FSA Process (IMO, 2002), as required by the MCA Methodology for Assessing Marine Navigation Risk (MCA, 2015). Further detail on the FSA approach is provided in the NRA (Volume 4 - Appendix 12.1).

12.5.1.2 This assessment has been undertaken to identify any shipping and navigation receptors which may be affected by the construction, operation, and decommissioning of the Development. Receptors are identified as follows:

- Commercial vessels including commercial passenger ferries/cruise liners;
- Commercial fishing vessels;
- Oil and gas support vessels; and
- Recreational vessels 2.5 to 24 metres (m).

[1] Note that 2014 is the most recent data available, due to issues with date release and data protection.

12.5.2 Impacts Identified as Requiring Assessment

12.5.2.1 Table 12.5.1 below lists all potential impacts on shipping and navigation identified as requiring consideration as part of the assessment (impacts have been scoped in/out of the EIA as part of the NRA (Volume 4 - Technical Appendix 12.1) process). This list of impacts is based on the baseline assessment and the output from the hazard workshop (the hazard log, Annex A of the NRA (Volume 4 Technical - Appendix 12.1)). The list of impacts also reflects responses provided by statutory consultees and other stakeholders in the wind farm and OfTI scoping opinions (August 2016 and August 2017) respectively.

12.5.2.2 The list of impacts scoped out is provided in Section 22 of the NRA (Volume 4 - Technical Appendix 12.1).

Table 12.5.1: Impacts on Shipping and Navigation Requiring Assessment

Potential Impact	Receptors	Inter-Relationships with Other EIA Topics / Receptors
Construction Impacts		
Vessel displacement	Commercial vessels Beatrice and Jacky Oil Field vessels Recreational vessels Fishing vessels	Chapter 11: Commercial Fisheries
Increased vessel to vessel collision risk	All vessels	Chapter 11: Commercial Fisheries Chapter 6: Physical Process and Water Quality Chapter 8: Fish and Shellfish Ecology Chapter 9: Marine Mammal Ecology Chapter 10: Ornithology
Vessel to structure allision risk	All vessels	Chapter 11: Commercial Fisheries Chapter 6: Physical Process and Water Quality Chapter 8: Fish and Shellfish Ecology Chapter 9: Marine Mammal Ecology Chapter 10: Ornithology
Anchor interaction and snagging	All vessels	Chapter 11: Commercial Fisheries
Operation and Maintenance Impacts		
Vessel displacement	Commercial vessels Beatrice and Jacky Oil Field vessels Recreational vessels Fishing vessels	Chapter 11: Commercial Fisheries
Increased vessel to vessel collision risk	All vessels	Chapter 11: Commercial Fisheries Chapter 6: Physical Process and Water Quality Chapter 8: Fish and Shellfish Ecology Chapter 9: Marine Mammal Ecology Chapter 10: Ornithology
Vessel to structure allision risk	All vessels	Chapter 11: Commercial Fisheries Chapter 6: Physical Process and Water Quality

Table 12.5.1: Impacts on Shipping and Navigation Requiring Assessment		
Potential Impact	**Receptors**	**Inter-Relationships with Other EIA Topics / Receptors**
		Chapter 8: Fish and Shellfish Ecology Chapter 9: Marine Mammal Ecology Chapter 10: Ornithology
Diminishing emergency response capabilities	Emergency response resources	Chapter 13: Civil and Military Aviation
Anchor interaction and snagging	All vessels	Chapter 11: Commercial Fisheries
Reduction in underkeel clearance	Fishing vessels Recreational vessels	Chapter 11: Commercial Fisheries
Decommissioning Impacts		
Vessel displacement	Fishing vessels	Chapter 11: Commercial Fisheries
Vessel to structure allision risk with decommissioning and partially deconstructed structures	All vessels	Chapter 11: Commercial Fisheries Chapter 6: Physical Process and Water Quality Chapter 8: Fish and Shellfish Ecology Chapter 9: Marine Mammal Ecology Chapter 10: Ornithology
Anchor interaction and snagging	All vessels	Chapter 11: Commercial Fisheries

12.5.3 Scoped Out Impacts

12.5.3.1 The following impacts on shipping and navigation have been scoped out of the assessment based on screening carried out as part of the NRA. These impacts and a summary of key reasons for scoping these impacts out of the EIA is provided in Table 12.5.2 below. Further justification is provided in the NRA (Volume 4 - Technical Appendix 12.1).

Table 12.5.2: Scoped Out Impacts on Shipping and Navigation		
Potential Impact	**Phase**	**Justification**
Marine radar interference	Construction Operation and maintenance Decommissioning	Given the level of understanding and experience from constructed and operational wind farms, and along with embedded mitigation there are no effects associated with marine radar interference that required re assessment specifically for Moray West.
Diminishing emergency response capabilities	Construction Decommissioning	Given the level of support vessels on site including for the developments own personnel there would be no reduction in emergency response capabilities given the ability to self-help.
Allision scenario associated with a towing operation within the Moray Firth	Construction Operation and maintenance Decommissioning	Although raised during the hazard workshop process, no specific risk associated with towing vessels and increased allision was found.
Reduction in underkeel clearance	Construction and Decommissioning	During construction and decommissioning any areas of underkeel clearance would be controlled by embedded mitigation meaning that the impact can be scoped out.

12.5.4 Assessment Criteria

12.5.4.1 Shipping and navigation impacts have been assessed using the FSA process, as required by the MCA. The FSA assigns each impact a "frequency" ranking, and a "severity of consequence" ranking as defined in the proceeding sections. These are then used to determine the "significance" of each impact as either "broadly acceptable", "tolerable", or "unacceptable". Any impact assessed as "unacceptable" is considered significant under EIA terms, with further mitigation required to reduce the impact to within "tolerable" or "broadly acceptable" levels.

12.5.4.2 It is noted that this approach is broadly similar to that used detailed in Chapter 5: EIA Methodology. However, it primarily follows the required FSA process (as required by the MCA Methodology (MCA, 2015)).

12.5.4.3 Identified effects and their initial significance rankings were provided to the relevant shipping and navigation stakeholders in the form of a hazard log, with a request for input. All responses received were considered prior to finalisation of the log, and the final log was agreed with all stakeholders. The responses received are available in the NRA Appendix 12.1. The rankings in the log were used in conjunction with the modelling results and expert opinion to inform the rankings used in the FSA.

Frequency

12.5.4.4 The definitions of "frequency" used to assess shipping and navigation impacts are presented in Table 12.5.3.

Table 12.5.3: Frequency Bands

Rank	Description	Definition
1	Negligible	< 1 occurrence per 10,000 years
2	Extremely Unlikely	1 per 100 to 10,000 years
3	Remote	1 per 10 to 100 years
4	Reasonably Probable	1 per 1 to 10 years
5	Frequent	Yearly

Severity of Consequence

12.5.4.5 The definitions of "severity of consequence" used to assess shipping and navigation impacts are presented in Table 12.5.4.

Table 12.5.4: Consequence Bands					
Rank	**Description**	**Definition**			
		People	**Property**	**Environment**	**Business**
1	Negligible	No injury	<£10k	<£10k	<£10k
2	Minor	Slight injury(s)	£10k - £100k	Tier 1 Local assistance required	£10k - £100k
3	Moderate	Multiple moderate or single serious injury	£100k - £1M	Tier 2 Limited external assistance required	£100k - £1M
4	Serious	Serious injury or single fatality	£1M - £10M	Tier 2 Regional assistance required	£1M - £10M
5	Major	More than 1 fatality	>£10M	Tier 3 National assistance required	>£10M International Publicity

Significance Criteria

12.5.4.6 Once an impact is assigned a "frequency" and "severity" ranking, the significance of the effect on shipping and navigation receptors is then determined based on the matrix shown in Table 12.5.5, as either "Broadly Acceptable", "Tolerable", or "Unacceptable". Definitions of the significance rankings are given alongside significance definitions provided in Table 12.5.6. Where an effect is designated as "Unacceptable", therefore Significant in EIA terms, additional mitigation (beyond that listed in embedded mitigation) is required to be identified in order to bring the effect to within "Tolerable" or "Broadly Acceptable" levels, which are deemed Not Significant in EIA terms.

Table 12.5.5: Significance Risk Matrix					
Consequence	**Frequency**				
	1	**2**	**3**	**4**	**5**
Major (5)	Tolerable	Tolerable	Unacceptable	Unacceptable	Unacceptable
Serious (4)	Broadly Acceptable	Tolerable	Tolerable	Unacceptable	Unacceptable
Moderate (3)	Broadly Acceptable	Broadly Acceptable	Tolerable	Tolerable	Unacceptable
Minor (2)	Broadly Acceptable	Broadly Acceptable	Broadly Acceptable	Tolerable	Tolerable
Negligible (1)	Broadly Acceptable	Broadly Acceptable	Broadly Acceptable	Broadly Acceptable	Tolerable

Table 12.5.6: Significance Definitions	
Significance	**Definition**
Broadly Acceptable	Risk As Low As Reasonably Practicable (ALARP) with no additional mitigations or monitoring required above embedded mitigation
Tolerable	Risk acceptable but may require additional mitigation measures and monitoring in place to control and reduce to ALARP
Unacceptable	Significant risk mitigation or design modification required to reduce to ALARP

12.5.5 Data Limitations

12.5.5.1 The shipping and navigation baseline and impact assessment has been carried out based on the information available and response received at the time of preparation. The desk based data sources used are the most up to date publicly available information as well as those provided through consultation as detailed in Section 0 and Section 12.4.3. The data is therefore limited by what is available and by what has been made available, at the time of writing this chapter.

12.6 Design Envelope Parameters

12.6.1 Realistic Worst Case

12.6.1.1 As identified in Volume 2 - Chapter 4: Development Description, Moray West is considering a range of potential construction methods and design options for the Development. The Design Envelope presented in Chapter 4 (Volume 2) represents the maximum design parameters for each of the options under consideration e.g. substructure type or turbine model.

12.6.1.2 In order to determine potential impacts of the various options it is necessary to define the 'realistic worst case scenario'. The realistic worst case scenario represents, for any given receptor and potential impact on that receptor, various options in the Design Envelope that would result in the greatest potential for change to the receptor in question.

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

12.6.1.4 Table 12.6.1 presents the realistic worst case scenario for potential impacts on shipping and navigation during construction, operational and maintenance and decommissioning phases of the Development and provides justification as to why the options and design parameters identified are considered to be the realistic worst case scenario.

<table>
<tr><th colspan="3">Table 12.6.1: Design Envelope Parameters Relevant to the Shipping and Navigational Impact Assessment</th></tr>
<tr><th>Potential Impact</th><th>Realistic Worst Case Scenario</th><th>Justification</th></tr>
<tr><td colspan="3">Construction</td></tr>
<tr><td>Vessel displacement</td><td rowspan="3">

Three years of offshore construction;
Buoyed construction area;
Minimum safe passing distances;
Application for safety zones (500 m during construction or major maintenance, 50 m pre- commissioning);
Up to 85 WTGs;
Up to two OSPs; and
Maximum number of vessels during construction = 25 based on:

WTGs and substructures (installation periods do not overlap):

2 x installation vessels (Jack-up Vessel (JUV) or Heavy Lift Vessel (HLV));
2 x support vessels; and
4 x transport (barges and tugs).

Inter-array and OSP interconnector cables (installation overlaps with installation of export cables):

2 x Cable Lay Vessel (CLV) ;
2 x Cable Burial Vessel (CBV); and
2 x support vessels.

Export cables:

2 x CLV;
2 x CBV; and
2 x support.

Crew Transfer Vessels (CTVs) and guard vessels (up to five).

Maximum vessel movements:

Up to 46 return trips for installation vessels, up to 16 return trips for support vessels and up to five transport vessels per week; and
Cables: number of return trips dependent on final cable lengths.

</td><td>Maximum duration and extent of construction period marked by construction buoyage or minimum safe passing distances throughout (all phases of constructing and not constructing) may cause maximum displacement to vessels operating including in adverse weather.</td></tr>
<tr><td>Increased vessel to vessel collision risk</td><td>Maximum duration and extent of construction period marked by construction buoyage or minimum safe passing distances would cause the maximum displacement of vessels. As a consequence of displacement encounters and collision risk may be increased.

Maximum number of vessel movements to and from the Moray West Site would create maximum encounters and vessel to structure collision risk.</td></tr>
<tr><td>Increased vessel to structure allision risk</td><td>Pre-commissioned structures may create new vessel to structure allision risk throughout the construction phase(s). Maximum extent of largest pre- commissioned jacket foundations (under consideration for Model 1) may create maximum increase to vessel to structure allision return period given the size of the structures at the waterline.

It is noted that the worst case assumed (85 Model 1 WTGs on jacket foundations with surface dimensions of 35 x 35 m). Should larger WTGs (Model 4) be installed on larger jackets (40 x 40 m surface dimensions) the total number of WTGs would be less (up to 62).</td></tr>
</table>

Table 12.6.1: Design Envelope Parameters Relevant to the Shipping and Navigational Impact Assessment		
Potential Impact	**Realistic Worst Case Scenario**	**Justification**
	• Up 14 helicopter trips per week. • Maximum number of personnel working on site.	Therefore, in the case of allusion, 85 Model 1 WTGs on 35 x 35 m jackets is considered the 'realistic worst case'.
Anchor interaction and snagging	• Pre- commissioned radials, branches or loops of inter-array cables of up to 275 km (up to 150 nm); • Up to six months inter-array installation; • OfTI inter-array - Up to two laying and two burial vessels (return trips dependent on final cable length); • OfTI inter-array - Up to two support vessels; • Up to one pre- commissioned interconnector cable circuit linking the OSPs; • Pre- commissioned export cable of 65 km length per circuit (total 130 km for both cable circuits); • Up to 3,000 m wide Offshore Export Cable Corridor within which the offshore export cable circuits will be located. The working corridor for each offshore export cable circuit will be 15 m; • Up to six months export cable installation; • OfTI export cable - Up to two laying and two burial vessels (return trips dependent on final cable length); and • OfTI export cable - Up to two support vessels.	Maximum length and installation period of pre-commissioned cables may increase the risk of anchor snagging and interaction.
Operation and Maintenance		
Vessel displacement	• 225 km^2 (65.5 nm^2) total wind farm area and minimum distance to shore 22.5 km (12 nm); • Up to 85 Model One WTGs; • Minimum spacing 1,200 m downwind and 1,050 m crosswind; • The WTG will have some form of regularity in plan (i.e. Grid); • Use of Jacket Foundations (35 x 35 m at HAT); • Minimum blade clearance of 22 m Mean High Water Springs; • No permanently manned platforms are planned; • Up to three crew transfer vessels (CTVs);	Maximum development area may cause a maximum deviation to vessels operating including in adverse weather. Could temporarily increase with periods of maintenance which require safety zones.
Increased vessel to vessel collision risk		Maximum development area may cause maximum displacement of vessels and increased encounters and vessel to vessel collision risk. Maximum number of vessel movements to and from the Moray West Offshore Wind Farm would create

Table 12.6.1: Design Envelope Parameters Relevant to the Shipping and Navigational Impact Assessment		
Potential Impact	**Realistic Worst Case Scenario**	**Justification**
	• Up to one Service Operation Vessel (SOV); • Up to one Jack Up for periods of maintenance; • Maximum number of personnel working on site; • Application for maintenance safety zones of up to 500 m; and • Up to two OSPs on jacket foundations within the WTG grid (50 x 50 m at HAT).	maximum encounters and vessel to structure collision risk.
Increased vessel to structure allision risk		Maximum amount of new infrastructure within the development area including with increased structure density on the perimeter may cause maximum vessel to structure allision risk for all vessels. It is noted that the worst case assumed (85 Model 1 WTGs on jacket foundations with surface dimensions of 35 x 35 m). Should larger WTGs (Model 4) be installed on larger jackets (40 x 40 m surface dimensions) the total number of WTGs would be less (up to 62). Therefore, in the case of allusion, 85 Model 1 WTGs on 35 x 35 m jackets is considered the 'realistic worst case'.
Diminishing emergency response resources capability		Maximum intensity of people, vessels and aircraft on-site causing the greatest potential for an emergency response event and therefore maximum effect on existing resources.
Anchor interaction and snagging	• Export cable landfall between Findlater Castle and Redhythe Point; • Cable trench up to 15 m wide with target burial depth of at least 1 m; • Cable burial shall be the primary method of protection, in areas where site conditions are not suitable for burial remedial protection will be applied to the cable, this will be by way of a combination of the following methods rock placement, concrete mattresses, cable protection system (polymer or steels sleeves) and grout bags; • Six cable crossings on export cable; • Radials, branches or loops of inter-array cables (up to 275 km (up to 150 nm)); • Inter-array cables buried or protected; • Up to 15 cable crossings within the inter-array; and • Up to one interconnector cable circuit.	Maximum length of export and inter-array cables may create maximum snagging risk for anchoring vessels.
Reduction in underkeel clearance		Maximum length of export and inter-array cables leading to maximum potential for cable protection to reduce underkeel clearance.

Table 12.6.1: Design Envelope Parameters Relevant to the Shipping and Navigational Impact Assessment		
Potential Impact	**Realistic Worst Case Scenario**	**Justification**
Decommissioning		
Vessel displacement	• Maximum decommissioning phase; • Cable (export) left in situ post decommissioning; • Application for decommissioning safety zones; • Decommissioned and partially uninstalled structures, inter-array and interconnector cables); • Assumed minimum safe passing distances for vessels restricted in their ability to manoeuvre; • Guard vessels as required by risk assessment and Marine Coordination Centre; and • Maximum number of vessels and personnel on site.	Maximum duration and extent of decommissioning period marked by decommissioning buoyage or minimum safe passing distances throughout may cause maximum displacement to vessels operating including in adverse weather.
Vessel to structure allision risk with decommissioning and partially deconstructed structures		Decommissioning structures may create new vessel to structure allision risk throughout the decommissioning phase(s).
Anchor interaction and snagging	• Cable (export) left in situ post decommissioning; and • Decommissioned and partially uninstalled structures, inter-array and interconnector cables).	Decommissioned cables left in situ may increase snagging.

12.6.2 Embedded Measures

12.6.2.1 The following mitigation measures are assumed to be in place during the construction, operation, maintenance and decommissioning of the Development.

- Application, and use of safety zones, of up to 500 m (rolling) during construction / maintenance and decommissioning as well as 50 m pre-commissioning;
- Buoyed construction area - temporary (as per NLB requirements);
- Blade clearance (at least 22 m above MHWS);
- Cable Burial Risk Assessment (CBRA) to be carried out post consent to inform final cable design (for all cables) including cable burial method, target burial depth and requirements for any additional cable protection. Where additional protection is required, the effect on water depths in nearshore and coastal areas will be assessed to ensure minimum water depths are maintained (noting MGN543 requirement that depth reductions of greater than 5% of chart datum will require further consultation to the MCA);
- Compliance from all vessels with international maritime regulations as adopted by the flag estate, including the International Convention for the Prevention of Collisions at Sea (COLREGs) (IMO, 1972);
- Design Specification and Layout Plan (DSLP), which will be developed post consent and facilitate discussions with regulators as to the final layout design for various constraints;
- Emergency Response and Cooperation Plan (ERCoP);
- Fisheries Liaison Officer (FLO) who will facilitate promulgation of information post consent to ensure fishing stakeholders are fully informed;
- Vessel health and safety requirements including competency assessments and audits;
- Lighting and Marking Plan (LMP) which will detail lighting and marking (for installations and cables). All lighting and marking will be agreed with NLB post consent and will be in line with IALA O-139;
- Marine coordination to monitor and control Moray West vessels and personnel;
- Marine pollution contingency planning to ensure any pollutions events are effectively managed in line with MCA requirements;
- Compliance with MGN 543 – including SAR annex;
- Monitoring by AIS to ensure mitigations are working;
- Navigational Safety Plan (NSP) to ensure that Moray West vessels do not interact with other third parties during the construction phase;
- Permanent Aids to Navigation (AtoN) e.g. IALA Requirements, NLB Requirements, CAA Requirements and MCA SAR Requirements;
- Promulgation of information (including Notice to Mariners, Kingfisher Bulletins);
- Provision of the positions of all OSPs and cables to Clyde Cruising Club, for inclusion in the "Clyde Cruising Club Sailing Directions and Anchorages";
- Use of guard vessels during construction and decommissioning (as required by risk assessment); and
- WTGs, cables and OSP(s) marking on Admiralty Navigational Charts.

12.7 Assessment of Potential Effects

12.7.1 Potential Construction Effects

Vessel Displacement

Commercial Vessels

12.7.1.1 The Buoyed Construction Area (i.e. the area within which construction works will be undertaken, marked via buoyage, which will be defined in consultation with the NLB post consent), minimum safe passing distances and the associated construction vessel activity may lead to third party vessel displacement and re-routeing.

12.7.1.2 During the construction phase, it is considered likely that third party commercial vessels will avoid the buoyed construction area by passage planning in advance to pass a safe distance from the Moray West Site. While there would be no restriction to enter the buoyed construction area (aside from any authorised 500 m and 50 m safety zones), based on MGN 372 (MCA, 2008), lessons learnt from other developed projects within the Renewable Energy Zone, consultation and hazard workshop feedback, it is likely that large commercial vessels would not enter. The displacement of third party commercial vessels[2] is also likely to be dictated by the number and density of construction associated vessels, which will include those Restricted in their Ability to Manoeuvre (RAM) and may deter vessels from entering the construction area.

12.7.1.3 As seen in Volume 3a - Figure 12.4.6 three of the eight identified routes intersected the Moray West Site, and therefore are expected to have to deviate around the buoyed construction area. Worst case deviations expected during the operational phase were assessed within the NRA, and the construction phase deviations are expected to be similar. These routes include:

- Route 2: Invergordon - Lerwick. This route is used by 145 vessels per year mainly consisting of cruise vessels which do not routinely use the same heading;
- Route 7: Buckie - Beatrice Oil Field. This route is used by 370 vessels per year consisting of small manoeuvrable crew transfer vessels; and
- Route 8: Peterhead – Beatrice Oil Field. This route is used by 140 vessels per year, consisting of larger oil field support and supply vessels which are also manoeuvrable (see paragraph 12.7.1.7).

12.7.1.4 Vessels using the Invergordon - Lerwick route are expected to pass south of the buoyed construction area. As this route is used by vessels on an irregular routine including cruise vessels, cargo vessels and tankers and given that the deviation is minor (with ample sea room to safely deviate around the Moray West Site during construction) displacement from the route is unlikely to lead to disruption to passage plans to vessels on this route.

12.7.1.5 On this basis the frequency of a deviation is expected to be on a regular basis throughout the three year construction period however the frequency of associated negative effects of that deviation is anticipated to be **reasonably probable**, with a severity of consequence of **negligible** given that there would not be any anticipated consequences to people or the environment, and no notable commercial effects. Significance is therefore assessed as **broadly acceptable** and therefore **not significant** in EIA terms, with no further mitigation required.

Beatrice and Jacky Oil Field Vessels

12.7.1.6 It is anticipated that decommissioning of the Beatrice and Jacky Oil Fields will be complete by 2027.

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[2] Vessels not chartered by Moray West.

12.7.1.7 Vessels associated with the Beatrice and Jacky Oil Field (on Route 7 or 8 to and from Buckie or Peterhead respectively), as a worst case scenario, may be required to transit around the southern and western boundaries of the buoyed construction area for access to the oil field platforms. During the construction phase, the oil field vessels may transit through the Moray West Site depending on the current location of construction activities (including any authorised safety zones) and the weather conditions, significantly reducing the deviation that would be required.

12.7.1.8 On this basis, deviations are expected to occur on a regular basis throughout the three year construction phase, however the frequency of associated negative effects of that deviation is anticipated to be **frequent**. Severity of consequence is considered to be **negligible** given that there would not be any anticipated consequences to people or the environment, and no notable commercial effects. Significance is therefore assessed as **tolerable** given the embedded mitigation in place, which is **not significant** in EIA terms, with no further mitigation required.

Recreational Vessels (2.5 to 24 m)

12.7.1.9 As discussed in the baseline section (Section 12.4), recreational sailing activity is considered to be low – only one recreational vessel was recorded as intersecting the Moray West Site during the marine traffic survey. The RYA Coastal Atlas (RYA, 2016) did not cover the Moray West Site itself. However, it showed that recreational activity within the Moray Firth was largely coastal, noting four offshore route indicators which mean that vessels may transit within proximity to the buoyed construction area.

12.7.1.10 The construction vessel activity (including from RAM vessels requiring minimum safe passing distances) is likely to deter a small number of recreational vessels from transiting within the buoyed construction area where obvious construction activity is occurring; noting recreational vessels will not be able to enter authorised 500 m construction or 50 m pre- commissioning safety zones. However, given the levels of recreation activity recorded and predicted, there are not expected to be any notable displacement impacts to recreational vessels arising from the construction activity.

12.7.1.11 Given that recreational activity is very low, frequency of occurrence is anticipated to be **extremely unlikely** with a severity of consequence of any deviation expected to be **negligible** given there would be no effects of people or the environment. Significance is therefore assessed as **broadly acceptable** and **not significant** in EIA terms with no further mitigation required.

Commercial Fishing Vessels

12.7.1.12 Fishing vessels were recorded navigating within the Moray West Site during the marine traffic surveys. Given that 500 m safety zones will only be active around structures where construction work is underway, fishing vessels are likely to continue to undertake transits in areas were construction activity is not occurring (based on experience at other constructing or constructed wind farms) and outside of the 50 m pre- commissioning safety zones around all installations.

12.7.1.13 The construction vessel activity (including from RAM vessels requiring minimum safe passing distances) may deter some fishing vessels from navigating within the buoyed construction area where obvious construction activity is occurring; noting fishing vessels will not be able to enter authorised 500 m construction or 50 m pre- commissioning safety zones.

12.7.1.14 On this basis, frequency of occurrence is anticipated to be **remote**, with a severity of consequence of **minor** with no effect on people or the environment anticipated. Significance is therefore assessed as **broadly acceptable** and therefore **not significant** in EIA terms.

12.7.1.15 Commercial fishing activity is considered within Chapter 11: Commercial Fisheries (Volume 2).

Adverse Weather

12.7.1.16 Adverse weather is detailed within Section 13.4 of the NRA (Volume 4 - Appendix 12.1); there are not anticipated to be any effects of current adverse weather routeing within proximity to the Moray West Site.

Increased Vessel to Vessel Collision Risk

All Vessels

12.7.1.17 During the construction phase, there will be increased levels of traffic within the Moray West Site associated with the construction of the Development (worst case up to 25 vessels including jack-ups at any one time). This increased vessel activity may lead to increased rate of vessel encounters and therefore increase the risk of collision currently assessed for the area and at baseline conditions. Additionally, third party vessels may be displaced by the construction work into other sea areas increasing vessel densities in that area (creating 'hot spots') and again increasing collision risk.

12.7.1.18 The increase in vessel traffic during construction will largely be present within the buoyed area, which third party vessels are likely to avoid (see Vessel Displacement). However, certain activities (including offshore export cable installation) will require vessel presence outwith the buoyed construction area and minimum safe passing distances will be in place to protect the associated vessels located within the area of the Offshore Export Cable Corridor (up to six) from an increased risk of collision. Given the small working area of these vessels (and their minimum safe passing distance) there are not expected to be any increases in collision risk associated with displacement of third party vessels around them. The offshore export cable circuits are expected to take up to six months to install.

12.7.1.19 Outside of the buoyed construction area and as shown in the re-routeing assessment within the NRA (Volume 4 – Technical Appendix 12.1 Section 14), vessels on three regular routes are expected to be required to deviate to avoid the Moray West Site. It is considered likely that the associated vessels will pass south of the Moray West Site, due to the presence of the Beatrice Offshore Wind Farm (BOWL) to the north and their final destination or departure port. For vessels transiting past the area there is sufficient sea room for them to navigate without creating hotspots. However, areas in which vessels bound to/from the Beatrice and Jacky Oil Fields transit (shown in Figure 17.1 of the NRA (Volume 4 – Technical Appendix 12.1)) do show hot spots of encounters[3]. However, as discussed, this assessment is based on worst case scenarios and in reality vessels are expected to maintain a safe distance from construction vessels present in the area or pass through other parts of the Moray West Site.

12.7.1.20 Given the small potential for increase in encounters and therefore collision risk and when considering the mitigation in place, the frequency of occurrence for all third party vessels is **extremely unlikely**, and the severity of consequence is **moderate** given the potential for effects of person, property or environment. This giving a significance ranking of **broadly acceptable** and therefore not significant in EIA terms.

Vessel to Structure (Partially Constructed or Pre- Commissioned) Allision Risk

All Vessels

12.7.1.21 The presence of partially constructed or pre- commissioned structures (up to 85 WTGs and two OSPs - referred to as structures) within the Moray West Site during the construction phase may create an allision risk to passing third party traffic; mitigations measures as per Section 12.6.2 will be in place to ensure risk is within ALARP parameters (as Table 12.5.6).

[3] Noting that while this is modelled only for the operational phase, the construction phase scenario would be considered similar with construction vessels impacts mitigated by effective marine coordination.

12.7.1.22 A number of offshore wind farms have been successfully constructed within dense shipping and development areas. Consequently, industry standard mitigation measures (outlined in Section 12.6.2) are tried and tested and contractor and the vessel operators experience implementing these measures is now extensive.

12.7.1.23 It is expected that larger commercial vessels (cargo and tanker) will avoid the Moray West Site during all phases due to the minimal deviations required. An allision scenario involving such a vessel is therefore be expected to begin when the vessel is outside of the Moray West Site, and either drifting (not under power) into a structure, or alliding under power with a structure within the Moray West Site due to human error or mechanical failure. The frequency of this occurrence is considered to be very low in comparison to other consented and constructed wind farms.

12.7.1.24 Some vessels (commercial fishing or recreation) or supply vessels associated with the Beatrice and Jacky Oil Field may still choose to transit through the Moray West Site during the construction phase. However, they are expected to avoid current areas of activity as promulgated by Notice To Mariners, the presence of large construction vessels on site and the associated authorised safety zones.

12.7.1.25 It is also assumed that Moray West's own vessels will take necessary precautions and mitigation measures to avoid allision with structures outside of their risk assessed work where by proximity to structures would be required (i.e. transiting through the Moray West Site on transit to a WTG or other structure to undertake work).

12.7.1.26 With likely displacement, and mitigations in place third party vessels will safely avoid the area and the structures being constructed within the Moray West Site over the three year construction period. On this basis the frequency of occurrence of allision is **extremely unlikely.** However, the severity of consequence is **moderate** given the potential for effects on persons, property and the environment should an allision occur. This giving a significance ranking of **broadly acceptable** and therefore **not significant** in EIA terms.

<u>Anchor Interaction and Snagging</u>

All Vessels

12.7.1.27 During the construction phase, there could be periods of time (e.g. few months) when the inter-array, OPS interconnector and export cable cables are yet to be buried or additional protection is still to be implemented. During this time the presence of subsea cables on the seabed could create a snagging risk to vessel anchors.

12.7.1.28 Although the Offshore Export Cable Corridor does not intersect any charted anchorages a vessel may anchor anywhere outside of no anchoring areas or harbours limits (assuming it is safe to do so). However, assuming that cables are marked or charted, vessels should avoid anchoring over, or in close proximity to the cables. Emergency anchoring (due to mechanical or technical issue) is also considered a low frequency event and again a vessel would typically have time to check its position if not in close proximity to danger (i.e. at risk of allision, collision or grounding). However, if a vessel did drop its anchor on a cable there is potential for damage to the cable, or for the vessel to suffer a lost anchor. Smaller vessels are also at risk of capsize should the anchor snag.

12.7.1.29 Any areas of temporarily exposed cable or sand/gravel berms should be additionally marked and promulgated in consultation with the MCA and NLB.

12.7.1.30 No anchoring activity was recorded within the marine traffic surveys. However, consultation indicated that recreational users and regular operators may utilise the coastal anchorages in Cullen Bay (west of the Landfall Area) and shuttle vessels occasionally anchor in the Moray Firth.

12.7.1.31 On this basis, and given the low level of anchoring in the area, the frequency of occurrence is considered **extremely unlikely**, and the severity of consequence is considered **minor** due to a low risk of substantial damage, giving a significance ranking of **broadly acceptable** and therefore deemed **not significant** in EIA terms**.**

12.7.1.32 Fishing gear snagging is considered in Chapter 11: Commercial Fisheries (Volume 2).

12.7.2 Potential Operational (and Maintenance) Effects

Vessel Displacement

Commercial Vessels

12.7.2.1 During the operational phase, it is expected that larger commercial vessels will deviate to avoid the Moray West Site (with deviations similar to those taken to avoid the buoyed construction area during the construction phase). Observations from other offshore wind farms indicate that some smaller commercial vessels may still transit through the Moray West Site noting that the minimum spacing is 1,050 m crosswind and 1,200 m downwind giving ample room in which to plan passage. Any routeing through the offshore wind farm will be dependent on weather conditions, lighting and marking of the WTGs and the regularity of the layout (i.e. grid or diamond pattern).

12.7.2.2 As seen in Volume 3a - Figure 12.4.6, and as discussed in the corresponding impact for the construction phase, three of the eight routes identified in the NRA intersected the Moray West Site; the Invergordon – Lerwick Route and routes to Beatrice and Jacky Platforms from Peterhead and Buckie.

12.7.2.3 It is also noted that collision modelling is assessed at a worst case as it assumes all displaced vessels will pass in close proximity to the Moray West Site. However, in reality, and based on experience at other operational offshore wind farm sites, vessels will use available sea room reducing hot spots and therefore collision risk. Encounter risk is considered in Section 16.2 of the NRA (Volume 4 – Technical Appendix 12.1). This showed that encounters at base case were infrequent outside of those associated with Beatrice Oil Field traffic and commercial fishing vessels (which are considered independently in the following paragraphs).

12.7.2.4 On this basis, while deviation is expected to be a regular occurrence for first few years of the operation of the wind farm, vessel are likely to slowly adapt to the alternative routes over time. Frequency of occurrence is anticipated to be **extremely unlikely** with a severity of consequence of **negligible** given that there would not be any anticipated consequences to people or the environmental and no notable commercial effects. Significance is therefore assessed as **broadly acceptable** and therefore **not significant** in EIA terms.

Beatrice and Jacky Oil Field Vessels

12.7.2.5 It is anticipated that decommissioning of the Beatrice and Jacky Oil Fields will be complete by 2027. Vessels associated with the Beatrice Oil Field (from Peterhead or Buckie) may transit through the Moray West Site during the operational phase rather than deviate to avoid the structures (as they are expected to do during the construction phase). However, any large vessels required for major maintenance, or decommissioning associated with the Beatrice Oil Field would be considered likely to avoid the structures within the Moray West Site.

12.7.2.6 Proposals have recently been submitted for the decommissioning of the Beatrice Oil Field and associated infrastructure and the Jacky Platform. This is due to be completed by 2027. It is therefore unlikely that vessel movements associated with these developments will continue for the duration of the operational phase of the wind farm. On this basis, frequency of occurrence is anticipated to be **extremely unlikely,** with a severity of consequence of **negligible** given that that are unlikely to be effects on persons, property or the environment. Significance is therefore assessed as **broadly acceptable** and therefore **not significant** in EIA terms.

Recreational Vessels

12.7.2.7 As with the impact on commercial vessels, experience at other operational offshore wind farms shows that some recreational vessels may also still transit through the Moray West Site noting that the minimum spacing is 1,050 m crosswind and 1,200 m downwind giving ample room in which to plan passage. However, decisions to route through the wind farm would be dependent on weather conditions, lighting and marking of the WTGs and the regularity of the layout (i.e. grid or diamond pattern).

12.7.2.8 There were no recreational vessels recorded during the winter survey period and an average of one unique vessel every three days during the summer survey period within the offshore wind farm study area, therefore recreational activity within the Moray West Site is considered to be very low (Section 12.2.8 of Technical Appendix 12.1 NRA – Volume 4). Considering that there will be no restrictions on navigation through the Moray West Site (outside of any authorised 500 m major maintenance safety zones), any displacement impact is considered likely to be insignificant.

12.7.2.9 Considering this, the frequency of occurrence is anticipated to be **extremely unlikely**, with a severity of consequence of **negligible** with no effects of person, property or the environment expected. Significance is therefore assessed as **broadly acceptable** and therefore **not significant** in EIA terms.

Commercial Fishing Vessels

12.7.2.10 Moderate fishing activity was observed within the offshore wind farm study area. However, as with recreational vessels, given the minimum spacing between structures and regularity of the layout, outside of authorised 500 m major maintenance safety zones there will not be any restrictions on fishing vessels navigating within the Moray West Site. It is noted that fishing vessels may be reluctant to deploy gear4 within the Moray West Site (depending on the final layout and foundation type).

12.7.2.11 Considering this the frequency of occurrence is anticipated to be **extremely unlikely**, with a severity of consequence of **negligible** with no effects of person, property or the environment expected. Significance is therefore assessed as **broadly acceptable** and therefore **not significant** in EIA terms.

12.7.2.12 Operational displacement for commercial fishing vessels is considered further within Chapter 11: Commercial Fisheries (Volume 2).

<u>Increased Vessel to Vessel Collision Risk</u>

All Vessels

12.7.2.13 Following on from impacts associated with displacement, which were assessed to be broadly acceptable for all vessels, this impact considers any subsequent increases in collision risk associated with the displacement of vessels.

12.7.2.14 It was noted that third party deviations and displacement associated with the Moray West Site may lead to increased vessel density outside of the wind farm structures (see encounters in Section 16.2 of the NRA Technical Appendix 12.1 – Volume 4) which although may be acceptable in terms of increased vessel length it may subsequently lead to an increase in collision risk within the area.

[4] This is assessed within Chapter 11: Commercial Fisheries.

12.7.2.15 Collision modelling undertaken within the NRA for vessels on regular routes estimated that, post wind farm[5], commercial vessels would be involved in a collision within the area once every 13,800 years[6], compared to once every 28,600 years pre wind farm. The majority of this risk was observed to be associated with the worst case routes assessed for vessels attending the Beatrice and Jacky Oil Fields. In reality it is expected that vessels will either passage plan alternative routes to avoid the Moray West Site or, if conditions and manoeuvrability of the vessel allow, will continue to transit through the wind farm site.

12.7.2.16 It is also noted that proposals have recently been submitted to decommission the Beatrice Oil Field (and associated infrastructure) and the Jacky Platform. It is therefore expected that, once decommissioning is complete (estimated 2027), vessels traffic associated with the two oil field will reduce significantly or cease completely, further reducing the potential for an increased risk of vessel to vessel collisions between vessels using these, and any alternative, routes.

12.7.2.17 The above modelling does not account for fishing and recreational vessels (as they are not regular routed vessels). Fishing activity was observed to be most prominent within, and to the south of the Moray West Site. Commercial vessels rerouted south may therefore experience increased fishing vessel encounters and collision risk. Recreational activity was observed to be low, and largely coastal. However embedded mitigations and industry standard practice will be in place to manage increased traffic levels and encounters.

12.7.2.18 The worst case during the operation phase is up to three crew transfer vessels, one service operation vessel and a jack up, and there is not anticipated to be a notable increase in collision risk associated with these vessels given the mitigations in place including marine coordination, authorised 500 m major maintenance safety zones, recommended minimum safe passing distances and promulgation of information.

12.7.2.19 Given the low estimated collision rates, and the expectation that vessels will adapt to alternative routes during operation of the wind farm, the frequency of occurrence is considered to be **negligible.** The severity of consequence assessed as **moderate** given the potential for effects on people, property and the environment. This gives a significance ranking of **broadly acceptable** and therefore **not significant** in EIA terms.

<u>Vessel to Structure Allision Risk</u>

All Vessels Excluding Commercial Fishing

12.7.2.20 During the operational phase, the WTGs (up to 85) and OSPs (up to two) will present an allision risk to passing marine traffic. An allision may occur whilst a vessel is under power (due to human error, or mechanical failure), or while a vessel is drifting (Not under Command (NUC)).

12.7.2.21 Allision modelling undertaken within the NRA (Section 15 of Technical Appendix 12.1 – Volume 4) for regular routed vessels estimated that a vessel would allide with a structure within the Moray West Site whilst under power once every 17,400 years. A drifting allision (i.e., a vessel alliding with a structure whilst not under power) was estimated to occur once every 135,300 years.

12.7.2.22 When considering the allision return period and the mitigation in place, the frequency of occurrence is considered to be **extremely unlikely**, with severity of consequence assessed as **minor**, giving a significance ranking of **broadly acceptable** and therefore not significant in EIA terms.

[5] Note that "post wind farm" refers to vessel rerouteing arising from deviations to avoid the Moray West Site
[6] Assumes a 10% increase in vessel traffic from the base case.

Vessel to Structure Allision Risk

Fishing Vessels

12.7.2.23 Given that fishing vessels are the most likely vessel to enter the Moray West Site, allision modelling was also undertaken separately for those vessels recorded within the marine traffic survey resulting in an estimated allision frequency of once every six years.

12.7.2.24 This allision rate is associated with assumption that fishing levels within the Moray West Site will not be impacted by the presence of the structures (whereas the commercial assessment above assumes vessels will largely reroute). It is also noted that fishing vessel allisions are expected to be low energy impacts given the low speed at which they are travelling meaning they will have lower consequence than that an allision involving a larger vessel underway.

12.7.2.25 It is considered likely that during the operation of the offshore wind farm fishing vessels will adapt to activity within the Moray West Site.

12.7.2.26 When considering the allision return period and the mitigation in place, the frequency of occurrence is considered to be **remote**, with severity of consequence assessed as **minor** (with most likely consequences being minor damage to a vessel), giving a significance ranking of **broadly acceptable** and therefore **not significant** in EIA terms.

Diminishing Emergency Response Capability

Emergency Response Resources

12.7.2.27 The operation and maintenance of Moray West Wind Farm may lead to an increase in incidents requiring the deployment of SAR resources, leading to a reduction in the overall emergency response resources available within the Moray Firth area. However, with embedded mitigations as follows in place, and effects associated with the Development's activities managed by their own resources the impact can be minimised.

12.7.2.28 An assessment of past third party maritime incidents indicated that the baseline incident rate is low, and the additional activity, or locations of structures associated with the wind farm, is not expected to increase this significantly. However, should an incident occur requiring a SAR response, embedded mitigation includes compliance with MGN 543 (MCA, 2016) notably that the layout will be developed within a recognisable pattern which will allow for defined SAR access corridors.

12.7.2.29 Therefore, the frequency of occurrence for which there will not be emergency response capability available is considered to be **negligible**, taking into account that the likelihood the presence of the Development would continue to build and improve the resources that are already there for all users. However, the severity of consequence is considered **minor** given the potential for harm to persons should a response not be possible for a reason directly attributable to the Development. This gives a significance ranking of **broadly acceptable** and therefore **not significant** in EIA terms.

Anchor Interaction and Snagging

All Vessels

12.7.2.30 As described in Volume 2 - Chapter 4: Development Description, all cables (inter-array, OSP interconnector and export) will be buried to a depth of at least 1 m. Where burial is not possible, the cables will be protected with rock placement, concrete mattresses or grout bags. Protection will potentially be required along approximately 10% of the inter-array and OSP interconnection cables and 20% of the export cable circuits. Specific requirements for cable burial and additional protection will be agreed as part of a CBRA.

12.7.2.31 No anchoring activity was recorded within the marine traffic surveys. However, consultation with key stakeholder indicated that recreational users may utilise the coastal anchorages identified within the baseline (Cullen Bay, west of the Landfall Area). Shuttle tankers may also occasionally anchor in the Moray Firth.

12.7.2.32 Although the Offshore Export Cable Corridor does not intersect any charted anchorages, a vessel may anchor anywhere outside of no anchoring areas or harbours limits (where safe to do so). However, cables shall be marked or charted so that vessels will be able to plan anchoring effectively and avoid anchoring over or in close proximity to the cables. Although the burial and protection methods assessed and implemented shall reduce the potential for any damage to a cable an exceptionally large anchor could still pose a very low snag risk.

12.7.2.33 During the operation of the Development there is potential that the cable could become exposed and become a risk of snagging over time due to changes in the seabed conditions or damage. However, burial of the cables to at least 1 m and use of additional protection measures where burial is not possible will ensure the risk of potential exposure of the cables during operation are minimised. Furthermore, it was concluded in Volume 2 - Chapter 6: Physical Processes and Water Quality that the potential for cable exposure due to seabed variability is limited given the low energy nature of the seabed bedforms and substrate types present within the Moray West Site and along the Offshore Export Cable Corridor and limited horizontal movement in the position of the positions of the MHWS contour observed in the Landfall Area. In the event that a cable does become exposed, appropriate remedial action will be taken (e.g. mechanical reburial) to ensure that the cable does not become a risk to vessels anchoring or have any impacts on other receptors.

12.7.2.34 Emergency anchoring (due to mechanical or technical issue) is considered a low frequency event as with the construction phase and again a vessel would typically have time to check its position is not in close proximity to danger (i.e. at risk of allision, collision or grounding). However, if a vessel did drop its anchor on a cable there is again a low risk for potential damage to the cable or a vessel to suffer a lost anchor. Smaller vessels are also at risk of capsize should the anchor snag. However, as described above, effective cable burial and protection will significantly reduce the risk of snagging on exposed cables.

12.7.2.35 Therefore, given the low level of anchoring in the area and effective burial and/or protection, monitoring and charting to ensure users are aware of the presence of the cables frequency of occurrence is considered as **extremely unlikely**, and the severity of consequence is considered **minor** due to a low risk on substantial damage, giving a significance ranking of **broadly acceptable** and is therefore **not significant** in EIA terms.

12.7.2.36 Fishing gear snagging is considered in Chapter 11: Commercial Fisheries (Volume 2).

<u>Reduction in Underkeel Clearance</u>

Commercial Fishing and Recreation Vessels

12.7.2.37 The implementation of cable protection may reduce navigable water depths within the Moray Firth. The extent to which depths may be reduced will be determined as part of risk assessment post consent noting that MGN 543 (MCA, 2016) requires that the MCA are consulted should reduction in depth be greater than 5% of the overall charted depth.

12.7.2.38 Moray West's preferred method of cable protection is cable burial, which will have limited impacts on water depths assuming that any berms or spoil (created by trenching) are considered and mitigated as part of the post consent CBRA. However, in the event of sections of cable being unable to be buried to the required depth (e.g., due to seabed conditions), additional cable protection may be required (this could include rock placement, mattressing or grout bags). There will also be requirements in certain locations to cross other cables. Where cable crossings are required, the resulting berms will have a maximum height of 1 m.

12.7.2.39 The presence of cable protection and cable crossing berms are therefore only likely to impact upon navigable water depths in the approach to the landfall, where water depths drop below 10 m and therefore it is likely that some reduction in navigable water depth could occur for smaller vessels with shallower draughts most notably small commercial fishing or recreational vessels.

12.7.2.40 The frequency of occurrence is assessed as **extremely unlikely**, with severity of consequence assessed as **moderate** given the potential of damage to a vessels keel and the cable should it not be managed to ALARP parameters. This gives a significance ranking of **broadly acceptable** and therefore **not significant** in EIA terms.

12.7.3 Potential Decommissioning Effects

<u>Vessel Displacement</u>

Fishing vessels

12.7.3.1 Displacement of commercial fishing vessels during the active decommissioning phase will be similar to that observed during the construction phase assuming that fishing activity within the Moray West Site does occur during and following the end of the operational period. As with the construction phase fishing vessels will not be prohibited from the buoyed decommissioning area and will be able to navigate outside of any areas where there is ongoing decommissioning work notably any authorised safety zones. Mitigations such as promulgation of information, safety zones and guard vessels will ensure that vessels can navigate safely through passage planning.

12.7.3.2 Once decommissioning is complete, the displacement impact will cease and fishing vessels will likely return to the base case environment (pre wind farm) on the basis that there will be no restrictions to navigation put in place.

12.7.3.3 Frequency of occurrence is anticipated to be **remote**, with a severity of consequence of **minor**. Significance is therefore assessed as **broadly acceptable** which is **not significant** in EIA terms.

<u>Vessel to Structure Allision Risk with Decommissioning and Partially Deconstructed Structures</u>

All Vessels

12.7.3.4 During active decommissioning it is considered likely that third party vessels used to navigating within the offshore wind farm during operation will navigate around the Moray West Site in order to avoid interactions with vessels involved in decommissioning activities. This will reduce the potential for allision risk along with embedded mitigations in place.

12.7.3.5 Once decommissioning is complete it is assumed no structures above the seabed will remain in situ.

12.7.3.6 On this basis, the frequency of occurrence is considered to be **extremely unlikely**, with severity of consequence assessed as **moderate** given the potential for effects on persons, property and the environment. This will give a significance ranking of **broadly acceptable**, and therefore **not significant** in EIA terms, with no further mitigation required.

<u>Anchor Interaction and Snagging</u>

All Vessels

12.7.3.7 Any cables or other subsea infrastructure left in situ will create a snagging risk to vessel anchors, and it should be noted that cable protection implemented during the operational phase may no longer be monitored and maintained.

12.7.3.8 The last known position of abandoned cables shall remain on nautical charts (as per industry standard practice), and this should be taken into consideration by a vessel prior to anchoring in the area.

12.7.3.9 The frequency of occurrence is considered to be **extremely unlikely**, with severity of consequence assessed as **moderate** given the potential for damage to property, giving a significance ranking of **broadly acceptable** which is **not significant** in EIA terms, with no further mitigation required.

12.7.4 Summary of Development Specific Effects

12.7.4.1 Table 12.7.1 below summarises the conclusions from the assessment of impacts during construction, operation and maintenance and decommissioning phases of the Development on shipping and navigation. The results presented in the table take into account both embedded, and where relevant, any additional mitigation that has been identified to mitigate potentially significant effects and identifies the resulting residual effects.

Table 12.7.1: Summary of Development Specific Effects							
Likely Effect	**Receptor**	**Frequency of Occurrence**	**Severity of Consequence**	**Effect Significance**	**Mitigation (in addition to embedded measures)**	**Residual Significance**	**Significant in EIA Terms?**
Construction							
Vessel displacement	Commercial Vessels	Reasonably Probable	Negligible	Broadly Acceptable	N/A	N/A	No
	Oil and gas vessels	Frequent	Negligible	Tolerable with mitigation	N/A	N/A	No
	Recreational Vessels	Extremely Unlikely	Negligible	Broadly Acceptable	N/A	N/A	No
	Fishing Vessels	Remote	Minor	Broadly Acceptable	N/A	N/A	No
Increased collision (vessel to vessel) risk	All vessels	Extremely Unlikely	Moderate	Broadly Acceptable	N/A	N/A	No
Allision (vessel to structure) risk	All vessels	Extremely Unlikely	Moderate	Broadly Acceptable	N/A	N/A	No
Anchor interaction and snagging	All vessels	Extremely Unlikely	Minor	Broadly Acceptable	N/A	N/A	No
Operation and Maintenance							
Vessel displacement	Commercial Vessels	Extremely Unlikely	Negligible	Broadly Acceptable	N/A	N/A	No
	Oil and gas vessels	Extremely Unlikely	Negligible	Broadly Acceptable	N/A	N/A	No
	Recreational Vessels	Extremely Unlikely	Negligible	Broadly Acceptable	N/A	N/A	No
	Fishing Vessels	Extremely Unlikely	Negligible	Broadly Acceptable	N/A	N/A	No
Increased collision (vessel to vessel) risk	All vessels	Negligible	Moderate	Broadly Acceptable	N/A	N/A	No

Table 12.7.1: Summary of Development Specific Effects							
Likely Effect	**Receptor**	**Frequency of Occurrence**	**Severity of Consequence**	**Effect Significance**	**Mitigation (in addition to embedded measures)**	**Residual Significance**	**Significant in EIA Terms?**
Allision (vessel to structure) risk	All vessels excluding commercial fishing	Extremely Unlikely	Minor	Broadly Acceptable	N/A	N/A	No
	Fishing Vessels	Remote	Minor	Broadly Acceptable	N/A	N/A	No
Anchor interaction and snagging	All vessels	Extremely Unlikely	Minor	Broadly Acceptable	N/A	N/A	No
Diminishing emergency response capability	Emergency Response Resources	Negligible	Minor	Broadly Acceptable	N/A	N/A	No
Reduction in under keel clearance	All vessels	Extremely Unlikely	Minor	Broadly Acceptable	N/A	N/A	No
Decommissioning							
Vessel displacement	Commercial Fishing Vessels	Remote	Minor	Broadly Acceptable	N/A	N/A	No
Allision (vessel to structure) risk	All vessels	Extremely Unlikely	Moderate	Broadly Acceptable	N/A	N/A	No
Anchor interaction and snagging	All vessels	Extremely Unlikely	Moderate	Broadly Acceptable	N/A	N/A	No

12.8 Assessment of Cumulative Effects

12.8.1.1 Cumulative effects refer to effects upon receptors arising from the development of Moray West Offshore Wind Farm when considered alongside other proposed developments and activities and any other *reasonably foreseeable project(s)* proposals. In this context the term *projects* is considered to refer to any project with comparable effects and is not necessarily limited to offshore wind projects.

12.8.1.2 As vessel routeing (at the time of writing) has been impacted by works at BOWL, and based on consultation with maritime regulators, BOWL has been considered baseline.

12.8.1.3 The projects selected as relevant to the assessment of impacts to shipping & navigation are based upon an initial screening exercise undertaken on a long list. The outcome from this screening process is provided in the NRA (Volume 4 - Technical Appendix 12.1). Each project has been considered and scoped in on the basis of effect–receptor pathway, data confidence and the temporal and spatial scales involved. The specific projects scoped into this CIA are presented in Table 12.8.1.

Table 12.8.1 Initial Screening of Offshore Projects and Activities and their Potential to Cause a Cumulative Effect on Shipping and Navigation

Development Type	Project	Status	Location	Data Confidence Assessment/ Phase
Offshore Wind Farm	Moray East offshore wind farm (Telford, Stevenson and MacColl wind farms)	Consent authorised	Bordering the development Site	High - Third party project details published in the public domain and confirmed as being 'accurate'
Offshore Wind Farm	Beatrice Wind Farm Demonstrator Project	Operational – to be decommissioned	Within the development Site	High - Third party project details published in the public domain and confirmed as being 'accurate'
Oil and Gas	Beatrice and Jacky Oil Field Infrastructure	Operational – to be decommissioned	0.2 to 1.2 km from the development Site	High - Third party project details published in the public domain and confirmed as being 'accurate'

12.8.2 Cumulative Construction Effects

<u>Vessel Displacement</u>

12.8.2.1 During construction, it is anticipated that the majority of vessels will avoid both the Moray East and Moray West sites. Given that the largest cumulative impacts would be on east – west vessel routeing it is noted that small deviations to course would ensure that vessels can route clear of both developments (passing either north or south) without significant impacts on time or distance (from their base case routes).

12.8.2.2 On this basis, while deviation to larger is expected to be a regular occurrence during the construction of the Development, vessels are likely to slowly adapt to the alternative routes over time, and there is considered to be ample sea space near shore and offshore of the Moray Sites when considered cumulatively for this purpose.

12.8.2.3 Frequency of occurrence is anticipated to be **reasonably probable** with a severity of consequence of **negligible** given that there would not be any anticipated consequences to people or the environmental and no notable commercial effects. Significance is therefore assessed as **broadly acceptable** and not significant in EIA terms.

Increased Collision Risk

12.8.2.4 Final decommissioning of the Beatrice Oil Field platforms is expected to be completed by 2027. Given that there is likely to be an overlap with construction of the Moray West Offshore Wind Farm, there is therefore potential that this could lead to an increase in marine traffic numbers within the area, which may increase vessel to vessel encounters and thus increase collision risk in the area. Timescales for the decommissioning of the Jacky Platform are unknown, but it is expected to be complete prior to the completion of the Beatrice Oil Field decommissioning.

12.8.2.5 Moray West and the operators of the oil field have information sharing agreements in place which will allow communication between the Moray West and oil field contractor responsible for decommissioning. Moray West will be required (under their marine licence including the VMP and NSP) to ensure that their construction traffic does not interact with third party activity, and it is expected that Beatrice/Jacky Oil Field operators would have a similar condition. Therefore, as communication between operations will be open and their vessels controlled to avoid encounters or increased traffic densities, there are not expected to be significant effects on other third party vessels.

12.8.2.6 Frequency of occurrence is anticipated to be **reasonably probable** with a severity of consequence of **negligible** given that there would not anticipated be any anticipated consequences to people, commercial effects or the environment and is therefore assessed as **broadly acceptable** and not significant in EIA terms.

Cumulative Vessel to Structure Allision Risk

12.8.2.7 Moray West Offshore Wind Farm considered cumulatively with Moray East Offshore Wind Farm may increase allision risk in the area above base case levels. Moray East will be operational by 2022, therefore the initial operational phase (first three years) will overlap with the Moray West construction phase. During this overlap it is considered likely that the majority of vessels will avoid both sites, however smaller vessels may transit through the Moray East Site.

12.8.2.8 Given there will mitigations specific to the construction phase of the Project (e.g., guard vessels, safety zones), and operation mitigations in place for the Moray East Offshore Wind Farm to alert mariners and protect the structures, there are not anticipated to be significant effects on third party vessels, particularly as the majority of vessels are likely to avoid both sites.

12.8.2.9 The frequency of occurrence is considered to be **extremely unlikely** given the marine coordination in place, with severity of consequence assessed as **moderate** given the potential for damage to people, property and the environment. This gives a significance ranking of **broadly acceptable** which is **not significant** in EIA terms and no further mitigation is required.

Cumulative Anchor Interaction and Snagging

12.8.2.10 Given the distance between proposed offshore export cables, and the other cables and pipelines, the potential for a vessel to interact with more than one of the cables during an anchoring operation is not considered to be a likely occurrence. Therefore there is not anticipated to be any significant cumulative anchor snagging risk beyond that associated with the OfTI in isolation.

12.8.2.11 Frequency of occurrence is assessed to be **extremely unlikely**, with severity of consequence considered to be **minor**. This gives a significance ranking of **broadly acceptable** which is **not significant** in EIA terms and no further mitigation is required.

12.8.3 Cumulative Operational Effects

Vessel Displacement

12.8.3.1 During the operational phase, it is expected that vessels will deviate to avoid the Moray West Site (with deviations similar to those taken to avoid the buoyed construction area during the construction phase) and Moray East. Observations from other offshore wind farms indicate that some smaller vessels may still transit through both sites however given that the largest cumulative impacts would be on east – west vessel routeing it is noted that small deviations to course would ensure that vessels can route clear of both developments (passing either north or south) without significant impacts on time or distance (from their base case routes).

12.8.3.2 On this basis, while deviation is expected to be a regular occurrence for first few years of the operation of the wind farm, vessels are likely to slowly adapt to the alternative routes over time, and there is considered to be ample sea space near shore and offshore of the Moray West Site when considered cumulatively for this purpose.

12.8.3.3 Frequency of occurrence is anticipated to be **extremely unlikely** with a severity of consequence of **negligible** given that there would not be any anticipated consequences to people or the environmental and no notable commercial effects. Significance is therefore assessed as **broadly acceptable** and therefore **not significant** in EIA terms.

Vessel to Structure Allision Risk

Cumulative Effects with Oil Field Installations

12.8.3.4 There are six oil and gas surface platforms located within the vicinity, five of which are located on the northern boundary of the Moray West Site (each associated with the Beatrice Oil Field). These are in the process of being decommissioned, however it is currently unknown as to the structures/infrastructure that will be left in situ.

12.8.3.5 Impacts associated with routeing to oil and gas field has been considered as part of the baseline and assessed in Paragraphs 12.7.1.7 and 12.7.1.8.

12.8.3.6 Given the limited spatial extent of the platforms, and that routeing is already shielded by BOWL within the area, there is not considered to be any routeing impacts during the operational phase when the Project and the Beatrice/Jacky platforms are considered cumulatively, and therefore allision risk is not considered to be of greater significance than that assessed for the Project alone.

12.8.3.7 The frequency of occurrence is considered to be **negligible**, with severity of consequence assessed as **minor** given the potential for damage to people, property and the environment. This gives a significance ranking of **broadly acceptable** which is not significant under EIA and no further mitigation required.

Cumulative Effects with Other Offshore Wind Farms

12.8.3.8 Moray East and Moray West in combination may increase allision risk in the area above base case levels. Moray East is due to commissioned by 2022, and therefore its operational phase will overlap with the Moray West operational phase (due to be commissioned by 2024). As both Moray East and Moray West Offshore Wind Farms will be operational, smaller vessels may choose to transit through the sites, however it is considered likely that the majority of vessels will avoid the structures.

12.8.3.9 Given the embedded mitigation in place for each Development to alert vessels and protect the Development there are not anticipated to be significant effects on third party vessels above those identified for the Moray East and Moray West in isolation, particularly given that the majority of vessels are expected to avoid the sites.

12.8.3.10 The frequency of occurrence is therefore considered to be **extremely unlikely** given the marine coordination in place (for both Projects), with severity of consequence assessed as **minor** given the potential for damage to people, property and the environment. This gives a significance ranking of **broadly acceptable** which is **not significant** in EIA terms and no further mitigation is required.

Diminished Emergency Response Capability

12.8.3.11 As with the construction phase, BOWL has been assessed within the base case. There are no emergency response impacts associated with any other cumulative impacts outside of Moray East.

12.8.3.12 There are not anticipated to be any cumulative impacts associated with the operation of Moray West and Moray East with embedded mitigations in place, given that they are not considered likely to raise incident levels significantly above the base case, as assessed within the baseline assessment. Any impacts relating to SAR access will have been addressed through the DSLP in consideration of MGN 543 (MCA, 2016).

12.8.3.13 The frequency of occurrence is considered to be **extremely unlikely** given the marine coordination in place**,** with severity of consequence assessed as **minor** given the potential for damage to people, property and the environment. This gives a significance ranking of **broadly acceptable** which is **not significant** in EIA terms and no further mitigation is required

12.8.4 Cumulative Decommissioning Effects

12.8.4.1 Given that the Moray West Offshore Wind Farm is predicted to be the last project within the Moray Firth to decommissioned there are not anticipated to be any cumulative impacts with the screened in projects or any cables/pipelines that may have been left in situ.

12.9 Reference

BOWL (2017). Beatrice Offshore Wind Farm Lighting & Marking Plan.

International Maritime Organisation (1972). International Regulations for the Prevention of Collisions at Sea – Annex 3. London: IMO.

International Maritime Organisation (1974) Convention on the Safety of Life at Sea (SOLAS). London: IMO.

International Maritime Organisation (2002). Guidelines for Formal Safety Assessment for use in the IMO Rule Making Process. London: IMO.

International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) (2013). IALA Recommendations O-139 on the Marking of Man-Made Structures. Edition 2. Saint Germaine n Laye, France: IALA.

Maritime and Coast Guard Agency (2008). Marine Guidance Note 372 (M+F) Guidance to Mariners Operating in the Vicinity of UK OREIs. London: MCA.

Maritime and Coast Guard Agency (2015). Methodology for Assessing Marine Navigational Risks of Offshore Wind Farms. Southampton: MCA.

Maritime and Coast Guard Agency (2016). Marine Guidance Note 543 (M+F) – Safety of Navigation: OREIs – Guidance on UK Navigational Practice, Safety and Emergency Response.

Royal Yachting Association and Coastguard Agency. (2004). Sharing the Wind. Recreational Boating in the Offshore Wind Farm Strategic Areas.

Royal Yachting Association. (2013). The RYA's Position on Offshore Renewable Energy Developments: Paper 1 – Wind Energy.

UK Hydrographic Office (2015). Admiralty Sailing Directions - North Coast of Scotland Pilot, NP 52.

MORAY WEST
OFFSHORE WINDFARM

Offshore EIA Report

Moray Offshore Windfarm (West) Limited

Chapter 13 Military and Civil Aviation

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Acronyms	
Acronym	**Expanded Term**
AD	Air Defence
ADR	Air Defence Radar
AIS	Aeronautical Information Service
AMSL	Above Mean Sea Level
ANO	Air Navigation Order
ARA	Airborne Radar Approach
ASACS	Air Surveillance and Control Systems
ATC	Air Traffic Control
ATS	Air Traffic Services
CAA	Civil Aviation Authority
CAP	Civil Aviation Publication
FL	Flight Level
FIR	Flight Information Region
ft	feet
HIAL	Highlands and Islands Airports Limited
HMR	Helicopter Main Route
hrs	hours
IFR	Instrument Flight Rules
IMC	Instrument Meteorological Conditions
LPA	Local Planning Authority
MAA	Military Aviation Authority
MCA	Maritime and Coastguard Agency
MDA	Managed Danger Area
MGN	Marine Guidance Note
MoD	Ministry of Defence
MRT	Multi-Radar Tracker
NATS	National Air Traffic Services
NERL	National Air Traffic Services (En-Route) PLC
nm	nautical miles
OREI	Offshore Renewable Energy Installations
PSR	Primary Surveillance Radar
RAF	Royal Air Force
RLOS	Radar-Line-Of-Sight
SAR	Search and Rescue

Acronyms	
Acronym	**Expanded Term**
TMZ	Transponder Mandatory Zone
TOPA	Technical and Operational Assessment
TRA	Temporary Reserved Area
UK	United Kingdom
UKIAIP	United Kingdom Integrated Aeronautical Information Publication
UK Mil AIP	United Kingdom Military Aeronautical Information Publication
VFR	Visual Flight Rules

13 Military and Civil Aviation

13.1 Introduction

13.1.1.1 This chapter considers the likely significant effects on military and civil aviation associated with the construction, operation and decommissioning of the Moray West Offshore Wind farm and Offshore Transmission Infrastructure (OfTI) (hereafter referred to as the Development). The specific objectives of the chapter are to:

- Define the legislation, policy and guidance framework that is of relevance to military and civil aviation;
- Detail the consultation activities and responses that are relevant to, and have informed, this military and civil aviation impact assessment;
- Describe the military and civil aviation baseline;
- Describe the assessment methodology and significance criteria used in completing the impact assessment;
- Describe the potential effects, including direct, indirect and cumulative effects;
- Describe the mitigation measures proposed to address likely significant effects; and
- Assess the residual effects remaining following the implementation of mitigation.

13.1.1.2 The military and civil aviation assessment has been carried out by Wing Commander Mike Coleman Royal Air Force (RAF) (Retd) of Coleman Aviation Ltd. Coleman Aviation Ltd was set up to provide independent consultancy services to the wind farm industry on aviation issues. Wing Commander Coleman retired from the RAF in December 2012 after 27 years' service. His last appointment was as Head of the Air Traffic Control (ATC) and Air Defence (AD) operational teams responsible for assessing and responding to wind farm applications on behalf of the Ministry of Defence (MoD). In this role, Wing Commander Coleman defined RAF policy for dealing with the operational impact of wind turbines on ATC radars and was pivotal in deciding whether objections against wind farms should be lodged. In his RAF career, he was employed at every level within the ATC specialization from operational controller through to Head of the RAF ATC Standards organization. Prior to converting to ATC, he completed operational tours as a fast-jet navigator compiling nearly 1,000 flying hours on the Tornado GR1. Since leaving the RAF, he has worked for over five years as an aviation consultant and provided advice to numerous wind farm developers in resolving wind farm-related aviation issues.

13.1.1.3 This chapter is supported by the following Aviation Technical Appendices which were included as part of the Moray East ES 2012 (Moray East, 2012) and have direct relevance to the aviation issues associated with the Moray West Site:

- Volume 4 - Technical Appendix 13.1: Moray East (2012) Technical Appendix 5.3 A - Initial Aviation Assessment Report;
- Volume 4 - Technical Appendix 13.2: Moray East (2012) Technical Appendix 5.3 B - Beatrice and Moray Offshore Wind Farms Helicopter Impact Assessment; and
- Volume 4 - Technical Appendix 13.3: Moray East (2012) Technical Appendix 5.3 C - Osprey Radar Propagation Modelling Results.

13.2 Legislation, Policy and Guidance Framework

13.2.1.1 In addition to the legislation and policy discussed in Volume 2, Chapter 2: Policy and Legislative Context of this EIA Report, the following legislation, policy and guidance (Table 13.2.1) has been identified as being of direct relevance to the assessment of impacts on military and civil aviation. This includes a range of documents that have been published by the Civil Aviation Authority (CAA) and Military Aviation Authority (MAA) with respect to dealing with the impacts of offshore wind farm developments on aviation stakeholders.

Table 13.2.1: Legislation, Policy and Guidance

Legislation	**Description**
Civil Aviation Publication (CAP) 393 – Air Navigation: The Order and the Regulations.	Contains the Air Navigation Order (ANO) 2016 and Regulations made under the order; and Defines the Rules of the Air regarding civil aviation in the United Kingdom (UK).
Policy	**Description**
CAP 670 – Air Traffic Services Safety Requirements (Version 3, 23 May 2014).	Sets out the safety regulatory framework and requirements associated with the provision of Air Traffic Services (ATS).
CAP 764 – CAA Policy and Guidelines on Wind Turbines (Version 6, February 2016).	Provides CAA policy and guidance on a range of issues associated with wind turbines and their effect on aviation that need to be considered by aviation stakeholders, wind energy developers and Local Planning Authorities (LPAs) when assessing the viability of wind turbine developments.
CAP 774 – The UK Flight Information Services (Version 3, 25 May 2017).	Details the suite of ATS which (excluding aerodrome services) are the only services provided in Class G airspace within the UK Flight Information Region (FIR). This document is equally applicable to civilian and military pilots and air traffic controllers.
MAA: MAA Regulatory Publication 3000 Series: Air Traffic Management Regulations (last updated 23 Nov 2016).	Provides the regulatory framework and instructions to military personnel for provision of military air traffic control.
MAA: Manual of Military Air Traffic Management (last updated 26 Oct 2016).	Provides regulations for military ATC and emergency procedures and utilisation of military designated airspace.
Guidance	**Description**
UK Integrated Aeronautical Information Package (UKIAIP).	Provides comprehensive information on UK civilian aerodromes and aviation procedures within UK airspace.
UK Military Aeronautical Information Publication (UK Mil AIP).	Provides comprehensive information on UK military aerodromes and guidance to military aircrew on in-flight navigation procedures.
Marine Guidance Note (MGN) 543: Offshore Renewable Energy Installations (OREIs) - Guidance on UK Navigational Practice, Safety and Emergency Response Issues (last updated 19 August 2016).	Highlights issues with assessing the impact on navigational safety and emergency response caused by OREIs in UK internal waters, Territorial Sea and Exclusive Economic Zone.

13.3 Consultation

13.3.1.1 Consultation with key aviation stakeholders on developments in the Moray Firth Zone has been ongoing since work commenced on the EIA for the Moray East Offshore Wind Farm in 2011. In terms of specific consultations on the Moray West Offshore Wind Farm, Table 13.3.1 details the key issues raised in relation to aviation in the Moray West Offshore Wind Farm Scoping Opinion (August 2016) and the OfTI Scoping Opinion (August 2017). It also summarises other issues / concerns that have been raised during additional consultation activities undertaken as part of the EIA process and how these have been addressed in the preparation of this EIA Report.

Table 13.3.1: Consultation

Date and Consultee	Issue Raised	Moray West Approach
CAA Moray West Offshore Wind Farm Scoping Opinion (August 2016)	In their response to the Moray West Scoping Report 2016 (Moray West, 2016), CAA confirmed that the appropriate aviation consultees had been identified and that consultation was required with each stakeholder. Furthermore, the CAA expressed the following: Potential use of a Transponder Mandatory Zone (TMZ) as mitigation of radar effects should be discussed with the CAA if necessary; Turbines are to be installed with lighting in accordance with Article 223 of the UK ANO; Wind turbine and met mast details should be reported to the Defence Geographic Centre for inclusion on aviation charts; and Aviation stakeholders are to be informed of construction infrastructure, turbines and/or meteorological masts by means of a Notice to Airmen (NOTAM).	Consultation with the CAA has been ongoing since their response to the Moray West Offshore Wind Farm Scoping Report 2016 was received. Discussions have taken place about potential use of a TMZ and aviation lighting requirements. In terms of aviation lighting, the CAA has confirmed that Moray West must take account of Article 223 of the UK ANO and changes to International Civil Aviation Organization (ICAO) Annex 14 Volume 2, Chapter 6, paragraph 6.2.4 promulgated in November 2016.
NERL Moray West Offshore Wind Farm Scoping Opinion (August 2016)	NERL has confirmed that there will be adverse impact on the Allanshill Primary Surveillance Radar (PSR).	Consultation with NERL is ongoing about the mitigation options available (see Section 13.7.3.1-5).
MoD Moray West Offshore Wind Farm Scoping Opinion (August 2016)	MoD confirmed in their response to the Moray West Offshore Wind Farm Scoping Report (2016) that the turbines will cause unacceptable interference to the RAF Lossiemouth PSR. This is due to desensitisation of radar in vicinity of the turbine and creation of unwanted aircraft returns which air traffic controllers have to treat as aircraft returns. Radar interference can lead to restrictions the development would impose on departure routes including Standard Instrument Departures (SIDS); restrictions the development would impose on approach and arrival procedures; restrictions on traffic patterns in particular radar to visual profile; restrictions on LARS/Zone traffic patterns; restrictions on manoeuvering areas; restrictions on Tactical Aid to Navigation (TACAN) procedures and restrictions imposed on holding areas. Other concerns relate to the position of development in	Consultation with MoD has confirmed the mitigation options available to Moray West (see Section 13.7.3.6-9).

Table 13.3.1: Consultation		
Date and Consultee	**Issue Raised**	**Moray West Approach**
	relation to controlled airspace; positions of development in relation to restricted / danger areas; position in relation to entry / exit points to/from Low Flying System; air traffic density in the vicinity of the proposed wind farm; existing clutter or windfarms in area; complexity of the ATC task and workload of the controllers.	
Wick Airport Moray West Offshore Wind Farm Scoping Opinion (August 2016)	Potential impact on Wick Airport flight patterns and procedures.	Consultation has commenced with Wick Airport but cannot be concluded until the final turbine layout is decided (see Section 13.7.3.10).
Moray Firth helicopter operators Moray West Offshore Wind Farm Scoping Opinion (August 2016)	Potential impact on helicopter operations operating on Helicopter Main Route (HMR) X-RAY.	Consultation has commenced with Moray Firth helicopter operators but cannot be concluded until the final turbine layout is decided (see Section 13.7.3.11-13).
	Potential impact on Helicopter Approach Procedures to offshore installations.	Consultation has commenced with Moray Firth helicopter operators but cannot be concluded until the final turbine layout is decided (see Section 13.7.3.14-17).
CAA Ongoing consultation (March to December 2017)	Potential impact on Minimum Safe Altitude to which aircraft are safely separated from known obstacles.	Consultation has commenced with the CAA but cannot be concluded until the final turbine layout is decided (see Section 13.7.3.18).
Maritime Coastguard Agency (MCA) Moray West Offshore Wind Farm Scoping Opinion (August 2016)	In their response to the Moray West Offshore Wind Farm Scoping Report 2016, the MCA expressed that due consideration must be given to the turbine layout to enable SAR helicopters to safely manoeuvre through or around the turbine site.	Consultation with the MCA is ongoing over turbine layouts but cannot be concluded until the final turbine layout is decided.

13.4 Baseline Conditions

13.4.1 *Baseline Characterisation Approach*

Study Area

13.4.1.1 In terms of aviation, the size of the study area is determined by the range of the affected aviation receptors; in particular, ATC and Are Defence Radar (ADR) systems. Given that the Moray West Site occupies the same airspace environment as Moray East, it has been determined, for the purpose of this assessment, that the key receptors, and aviation issues associated with those key receptors, will be the same as those assessed for the Moray East Offshore Wind Farm (Moray East Environmental Statement (ES) 2012). These aviation receptors have been identified over a large geographical area, extending beyond both the Moray West and Moray East Sites and the Moray West Offshore Export Cable Corridor and include:

- NATS En-Route PLC (NERL) - Allanshill PSR which supports civil ATC and en-route operations;
- MoD Air Surveillance and Control Systems (ASACS) – Buchan ADR which supports UK AD operations and training;
- MoD ATC – RAF Lossiemouth PSR used to provide navigational services to aircraft inbound to, and outbound from, RAF Lossiemouth, and to military aircraft operating over the Moray Firth;
- Highland and Islands Airports Limited (HIAL) Wick Airport regarding potential impacts on aircraft flight patterns and procedures;
- HMR X-RAY used by helicopters transiting between Aberdeen, via Wick, to the Atlantic Rim offshore installations west of the Shetland Islands;
- Helicopter Approach Procedures to offshore platforms; and
- Minimum Safe Altitude which is the lowest altitude set in areas to ensure separation between aircraft and known obstacles.

13.4.1.2 The furthest aviation receptors from the Moray West Site are the ATC PSRs at Allanshill and Lossiemouth. The extent of the study area and locations of the relevant aviation receptors can be found at Figure 13.4.1.

Desk Study

13.4.1.3 A desk-top study has been undertaken to characterise existing and future baseline conditions in the study area. This involved a review of the relevant data sources used in the Moray East ES 2012 and the Moray East Modified TI ES 2014; a review of updated data sources that have been made available since submission of the Moray East ES 2012 including updated aviation documentation and charts; a review of data contained within the UK IAIP and the Mil AIP; consultation with the CAA, MoD, NERL, HIAL Wick Airport and Moray Firth helicopter operators and reference to the relevant aviation legislation, policy and guidance listed in Table 13.2.1 above.

13.4.1.4 In addition to information included in Chapters 5.3 and 8.3 of the Moray East ES 2012 and the associated Technical Appendices (listed in Section 13.1) other key data sources that have been reviewed to obtain a clear understanding of potential effects on military and civil aviation are summarised in Table 13.4.1 below:

Table 13.4.1: Additional Data Sources (In Addition to Moray East ES 2012 – Technical Appendices)

Dataset	Geographical Coverage	Source	Date
Technical and Operational Assessment (TOPA)	Moray East Site	NERL	March 2012
Pre-Application Consultation Request	Moray East Site	MoD	March 2012
Moray Firth TMZ Airspace Change Proposal for Moray East.	Moray East and BOWL Sites	Moray East (and subsequent decision letter from CAA)	January 2016

13.4.2 *Current Baseline*

13.4.2.1 The airspace environment within which the Moray West Site is situated is described below. This description should be read in conjunction with Figure 13.4.1 (Aviation Receptor Locations) and Figure 13.4.2 (Cross-Section of Airspace):

- Military Aviation. In terms of military aviation, RAF Lossiemouth is located to the west of the town of Lossiemouth in Moray. Located at RAF Lossiemouth is an ATC PSR which is used to provide navigational services to aircraft inbound to and outbound from the airfield; and to military and civilian aircraft operating over the Moray Firth;
- Civil Aviation. Regarding civil aviation, NERL operate a PSR at Allanshill, west of Fraserburgh. This is used to support civilian ATC and en-route operations for helicopters and fixed wing aircraft operating to the north and north-east of Aberdeen. HIAL also operate an airport at Wick, to the north-east of the Moray West Site, and a PSR at Inverness, to the west of the Moray West Site; and
- Airspace Structure. The Moray West Site is situated in an area of Class G uncontrolled airspace which is established from the sea surface up to Flight Level (FL) 195 (approximately 19,500 ft Above Mean Sea Level (AMSL)). The airspace above FL 195 is Class C controlled airspace. Within the Class G uncontrolled airspace there is an area of Class E airspace (HMR X-RAY). This follows the track of Y904 which is a Class E Airway established from FL 75 to FL 115. These areas of airspace are illustrated in Figure 13.4.2. Various regulations apply to each of these areas of airspace. These are described below:
  - Class G Airspace. Aircraft can operate in this area of uncontrolled airspace without any mandatory requirement to be in communication with or receive a radar service from an ATC unit. Pilots of aircraft operating under Visual Flight Rules (VFR) in Class G airspace are ultimately responsible for seeing and avoiding other aircraft and obstructions;
  - Class C Airspace. Aircraft operating within Class C controlled airspace (i.e. above FL 195) must be in receipt of an ATS from NERL or a separate authorised military service provider; and
  - Class E Airspace. Civilian aircraft operating on a Class E airspace airway must be in receipt of an ATS from NERL; military aircraft intending to transit across a Class E airspace airway must seek permission from the relevant NERL controller or be in receipt of an ATS from an authorised military service provider.

13.4.2.2 In the area of the Moray West Site, the Class G uncontrolled airspace is sub-divided into areas with the following aviation stakeholder responsibility:

- RAF Lossiemouth ATC uses their PSR to provide services to aircraft inbound to and outbound from the airfield, and to military aircraft operating over the Moray Firth, including the Moray West Site. In addition, RAF Lossiemouth is responsible for navigational services to transitory military and civil aircraft operating within a 40 nm radius of the airfield, up to 9,500 ft, from Monday to Friday between 0900 and 1700 hrs;
- HMR X-RAY, which crosses south to north through the Moray West Site, is used by helicopters transiting between Aberdeen, via Wick to the Atlantic Rim offshore installations west of the Shetland Islands. HMR X-RAY is established between 1,500 ft and FL 75 (approximately 7,500 ft). Navigational services for aircraft operating on this route are provided by Aberdeen Airport, using a radar feed from NERL Allanshill, and RAF Lossiemouth when aircraft are operating at low altitudes due to better Lossiemouth coverage. These helicopters normally fly at 1,500 ft or above; however, in some weather

conditions, they may wish to fly at less than 1,500 ft. Obstacle clearance from tall structures could then become an issue;

- Helicopters are used to access the Beatrice oil platforms. When weather conditions preclude visual flight, helicopters operating to and from these platforms carry out instrument approach procedures. CAA guidance in CAP 764 recommends an obstacle-free zone of 6 nm around the platforms in order to protect these procedures;
- Class E Airway Y904 follows the same route as HMR X-Ray between Aberdeen and Wick but extends from FL 75 up to FL 115. The responsibility for the provision of navigation services on Class E airways lies with NERL. Class E Airways provide a degree of protection to aircraft using them, but unlike fully controlled airspace, do not provide separation against all other aircraft. Y904 is predominantly used by scheduled passenger services between Wick and Aberdeen Airports and by aircraft on transatlantic flights between the UK / Europe and North America; and
- Above 9,500 ft, the responsibility for the provision of navigation services lies with NERL and the military service providers based at the NERL Centre in Prestwick, Ayrshire.

13.4.2.3 It should also be noted that the CAA has approved a Transponder Mandatory Zone (TMZ) to be implemented over the BOWL and Moray East sites. Details of the TMZ can be found in the Moray Firth TMZ Airspace Change Proposal and subsequent CAA decision letter (January 2016) as mentioned in Table 13.4.1.

13.4.3 *Future Baseline*

13.4.3.1 Planned decommissioning of the Beatrice Oil Field between 2024 and 2027 (Repsol Sinopec, 2017) involves the removal of the three Beatrice oil platforms that are currently accessed by helicopter. Consequently, this will lead to a significant reduction in the number of helicopters transiting through the Moray Firth and Moray West Site once decommissioning is complete. It is also noted that preparatory works for decommissioning and subsequent removal of the Jacky Platform (also accessed by helicopter) commenced in 2017.

13.4.3.2 There are no other anticipated future changes to the airspace environment in the vicinity of the Moray West Site that will affect this assessment of the impact on military and civil aviation.

13.5 Assessment Methodology

13.5.1 *Assessment Approach*

13.5.1.1 The methodology utilised to assess the effect of the Development on military and civil aviation is the same as that used in the Moray East ES 2012 (Moray East, 2012). This is based on criteria included in Chapter 8.3 of the Moray East ES 2012, updated where necessary to reflect any changes in assessment approaches and guidance since 2012. The assessment methodology has been informed by on-going discussions with key aviation stakeholders as part of the discharge of the existing consents on the Telford, Stevenson and MacColl wind farms and on the scope of the proposed Moray West Offshore Wind Farm. Due to the nature of the potential impacts on military and civil aviation, there will also be a requirement for ongoing consultation with aviation stakeholders post consent, once final layouts are developed, as part of the negotiations for, and development of, specific measures that will be required to mitigate any potential significant impacts.

13.5.2 *Impacts Identified as Requiring Assessment*

13.5.2.1 Table 13.5.1 below lists all potential impacts on aviation identified as requiring consideration as part of the assessment. This list of impacts is based on expert judgement, reflects responses provided by statutory consultees and other stakeholders in the Moray West Offshore Wind Farm and the Moray West OfTI Scoping Opinions (2016 and 2017 respectively) and takes into account further comments received as part of ongoing community consultation activities.

Table 13.5.1: Impacts on Aviation Receptors Requiring Assessment

Potential Impact	Nature of Impact (direct or indirect)	Inter-Relationships with Other EIA Topics / Receptors
Construction Impacts		
Interference with Wick Airport Approach Procedures	Direct	None
Interference with Helicopter Approach Procedures to Offshore Installations	Direct	None
Impacts on Minimum Safe Altitude	Direct	None
Operation and Maintenance (O&M) Impacts		
Radar Interference with NERL Allanshill PSR	Direct	None
Radar Interference with RAF Lossiemouth PSR	Direct	None
Interference with Wick Airport Approach Procedures	Direct	None
Interference with HMR X-Ray	Direct	None
Interference with Helicopter Approach Procedures to Offshore Installations	Direct	None
Impacts on Minimum Safe Altitude	Direct	None
Decommissioning Impacts		
Radar Interference to NERL Allanshill PSR	Direct	None
Radar Interference to RAF Lossiemouth PSR	Direct	None
Interference with Wick Airport Approach Procedures	Direct	None
Interference with HMR X-Ray	Direct	None
Interference with Helicopter Approach Procedures to Offshore Installations	Direct	None
Impacts on Minimum Safe Altitude	Direct	None

13.5.3 *Scoped Out Impacts*

13.5.3.1 For the OfTI element of the Development, due to its predominantly subsea nature, potential impacts on all of the aviation receptors identified at 13.3.1.1 can be scoped out. This approach was agreed in the MS-LOT Scoping Opinion (August 2017). In terms of the OfTI, the only requirement for the Moray West Site is for installation of aviation lighting to be considered for the OSPs; no other potential mitigation measures are required.

13.5.3.2 In terms of lighting the OSPs have the same aviation lighting requirement as the WTGs in terms of SAR (red light turned off except during rescue) and Helihoist (green light). However, they do not require the 2000 candela flashing red aviation lights which are required for the peripheral WTGs. However, final lighting requirements for the OSPs (which have a maximum height of 70 m above HAT) will be confirmed with relevant aviation stakeholders post-consent as detailed design for the final Development (e.g. wind farm layout and OSP positions). There will also be a requirement to ensure that aviation charts are updated and that aviation safety stakeholders are notified.

13.5.3.3 In terms of scoping out the potential effects of the Moray West Offshore Wind Farm on military and civil aviation, it is only the potential impact on the MoD Buchan ADR that can be scoped out. In their scoping response, the MoD expressed no concerns about potential impact on the Buchan ADR and, since then, consultation has taken place on a variety of turbine layout options with a maximum tip height of 285 m above HAT. The MoD has confirmed that even with the highest turbines being considered, there will be no impact on the Buchan ADR.

13.5.4 *Assessment of Potential Effects*

13.5.4.1 The criteria used for assessing the effect of the Moray West Offshore Wind Farm on aviation receptors is the same as that used in the Moray East ES 2012. Given that there is no published legislation or guidance to define how the significance of impacts on aviation receptors should be determined, these criteria were devised using professional judgement and developed in consultation with the relevant aviation stakeholders. Equally, by adopting the criteria utilized in the Moray East ES 2012, this provides a degree of consistency in the assessment of both the Moray East and Moray West developments.

13.5.4.2 In line with other EIA topics, the assessment of effect significance is derived from combining the sensitivity (defined as low, moderate or high) of the receptor with the magnitude (defined as negligible, low, medium or high) of the effect to produce an overall significance rating. However, with respect to impacts on civil and military aviation, given the safety critical function of aviation receptors, any predicted effect upon aviation stakeholders which results in restricted activities or has the potential to affect aviation or navigation abilities is regarded as unacceptable and therefore significant. Consequently, the threshold for distinguishing whether an effect is not significant is when the magnitude is assessed as being negligible.

13.5.4.3 In terms of assessing cumulative effects, the impact on any aviation receptor is generally treated as a standalone impact. As a result, if one wind farm has an unacceptable effect on an aviation receptor, it will not impact on any other wind farm. Whilst other wind turbine developments may be located in close proximity, the impact on each receptor is considered on a case-by-case basis as any adverse impact can be deemed unacceptable by the relevant aviation stakeholder.

13.5.4.4 The significant criteria utilised for defining the overall significance of an aviation receptor can be found at Table 13.5.2 below.

Table 13.5.2: Significance Criteria				
Sensitivity of Receptor	**Magnitude of Impact**			
	Negligible	**Low**	**Moderate**	**Major**
Negligible	Not significant	Significant	Significant	Significant
Low	Not significant	Significant	Significant	Significant
Medium	Not significant	Significant	Significant	Significant
High	Not significant	Significant	Significant	Significant

13.5.5 *Data Limitations*

13.5.5.1 There are no known data limitations affecting the aviation impact assessment for the Development.

13.6 Design Envelope Parameters

13.6.1 *Realistic Worst Case Design Scenario*

13.6.1.1 As identified in Volume 2 - Chapter 4: Development Description, Moray West is considering a range of potential construction methods and design options for the Development. The Design Envelope presented in Chapter 4 (Volume 2) represents the maximum design parameters for each of the options under consideration e.g. substructure type or turbine model.

13.6.1.2 In order to determine potential impacts of the various options it is necessary to define the 'realistic worst case scenario'. The realistic worst case scenario represents, for any given receptor and potential impact on that receptor, various options in the Design Envelope that would result in the greatest potential for change to the receptor in question.

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

13.6.1.4 Table 13.6.1 presents the realistic worst case scenario for potential impacts on aviation during construction, operation and maintenance and decommissioning phases of the Development and provides justification as to why the options and design parameters identified are considered to be the realistic worst case scenario.

Table 13.6.1: Design Envelope Parameters Relevant to the Civil and Military Aviation Impact Assessment		
Potential Impact	**Realistic Worst Case Scenario**	**Justification**
Construction		
Interference with Wick Airport Approach Procedures	Maximum turbine blade tip height of 285 m (935 ft) above HAT.	This is the maximum blade tip height of largest turbines (Model 4) being considered in the Design Envelope. Given that the key potential impact on aviation is radar interference and physical obstruction, maximum turbine blade tip height is considered to be the key design parameter requiring assessment with regard to potential impacts on civil and military aviation.
Interference with helicopter Approach Procedures to offshore installations		
Impacts on Minimum Safe Altitude		
Operation and Maintenance		
Radar interference with NERL Allanshill PSR	Maximum turbine blade tip height of 285 m (935 ft) above HAT.	This is the maximum blade tip height of largest turbines (Model 4) being considered in the Design Envelope. Given that the key potential impact on aviation is radar interference and physical obstruction, maximum turbine blade tip height is considered to be the key design parameter requiring assessment with regard to potential impacts on civil and military aviation.
Radar interference with RAF Lossiemouth PSR		
Interference with Wick Airport Approach Procedures		
Interference with HMR X-Ray		
Interference with helicopter Approach Procedures to offshore installations		
Impacts on Minimum Safe Altitude		
Decommissioning		
Radar Interference to NERL Allanshill PSR	Maximum turbine blade tip height of 285 m (935 ft) above HAT.	This is the maximum blade tip height of largest turbines (Model 4) being considered in the Design Envelope. Given that the key potential impact on aviation is radar interference and physical obstruction, maximum turbine blade tip height is considered to be the key design parameter requiring assessment with regard to potential impacts on civil and military aviation.
Radar Interference to RAF Lossiemouth PSR		
Interference with Wick Airport Approach Procedures		
Interference with HMR X-Ray		
Interference with helicopter Approach Procedures to offshore installations		
Impacts on Minimum Safe Altitude		

13.6.2 *Embedded Measures*

13.6.2.1 The following embedded measures will be implemented specifically in relation to military or civil aviation receptors:

- Approval and implementation of the Lighting and Marking Plan (LMP) which will set out specific requirements in terms of aviation lighting for the Offshore Wind Farm. The LMP will be prepared in consultation with the CAA and other aviation stakeholders and will take into account requirements for aviation lighting as specified in Article 223 of the UK Air Navigation Order (ANO) 2016 and changes to International Civil Aviation Organization (ICAO) Annex 14 Volume 2, Chapter 6, paragraph 6.2.4 promulgated in November 2016; and
- All structures >91.4 m in height will be charted on aeronautical charts and reported to the Defence Geographic Centre (DGC) which maintains the UKs database of tall structures (Digital Vertical Obstruction File) at least 10 weeks prior to construction.

13.7 Assessment of Potential Effects

13.7.1.1 As mentioned in section 13.5.4, potential impacts of the Moray West OfTI on military and civil aviation receptors have been scoped out of the assessment. The following sections therefore describe the potential impacts associated with the construction, operation and maintenance and decommissioning of the Moray West Offshore Wind Farm and the significance of the effect of those impacts on the relevant aviation receptors. The effect on aviation of wind turbines is such that, unless mitigated, impacts are direct and remain permanent.

13.7.2 *Potential Construction Effects*

13.7.2.1 In assessing the potential impacts of construction on aviation, it has not been necessary to consider potential effects on the NERL Allanshill and MoD Lossiemouth PSRs. Adverse effect on PSRs is only possible if the wind turbine blades are moving. As the wind turbine blades are static during construction activities, they will not be processed by the PSRs and therefore, will not be presented on the ATC radar displays.

<u>Interference with Wick Airport Approach Procedures</u>

13.7.2.2 The northern boundary of the Moray West Site is located 33.2 km (17.9 nm) south of Wick Airport. Instrument Flight Rules (IFR) traffic that are inbound to Wick from the south east mainly route via Advisory Route Y904. In the area within a 25 nm radius of Wick Airport, the lowest altitude to which aircraft can safely descend while maintaining 1,000 ft vertical separation from all terrain and obstacles is 1,800 ft. Further descent below 1,800 ft is not authorised until the aircraft is established on the final approach track, which is more than 5 nm from the northern boundary of the Moray West Site.

13.7.2.3 During lift operations, crane tips could temporarily exceed turbine tip heights, the maximum tip height of which is 285 m (935 ft). At these heights, this would encroach on the safety altitude for aircraft approaching Wick Airport.

13.7.2.4 The sensitivity of this receptor is therefore considered **high** and impact magnitude is also considered **high**. The overall effect is assessed as **significant**.

13.7.2.5 In terms of mitigation, given that there is potential for turbine blade tip heights and cranes used during construction to encroach on the safety altitude for Wick Airport. Wick Airport has advised that Moray West will be required to fund a review of the airport's Instrument Flight Procedures to ensure that appropriate changes are made. It is considered that the lowest altitude to which inbound aircraft can currently descend (1,800 ft) will need to be increased to 2,000 ft to ensure that at least 1,000 ft vertical separation is maintained from all terrain and obstacles. Once this mitigation is implemented, the residual effect can be assessed as **not significant**.

Interference with Helicopter Approach Procedures to Offshore Installations

13.7.2.6 Turbine construction infrastructure (e.g. cranes) will need to be considered as physical obstructions and, when installing WTGs with a maximum tip blade height of 285 m could also potentially infringe the minimum obstacle clearance criteria of 1,000 ft on helicopter approaches to the offshore oil platforms. The minimum obstacle clearance dictates the height at which helicopters can transit in the region of the Moray West Site and the height that instrument approaches to offshore platforms commence.

13.7.2.7 Although the existing platforms will be removed as part of the decommissioning of the Beatrice Oil Field, this is not due to commence until 2024. Therefore, it is expected that helicopters will continue to require access to the platforms for the duration of the construction period for the Moray West Offshore Wind Farm. The sensitivity of this receptor has therefore been assessed as **high.** Given that the impact magnitude is also considered to the **high**. The overall effect is assessed as **significant**.

13.7.2.8 In terms of mitigation, to reduce the risk of safety incidents, it will be necessary to notify the presence of physical obstructions to NATS AIS for inclusion in appropriate aviation related documentation and addition to aviation mapping. Information required will include the final locations of the constructed turbines and location / movement and maximum height of construction infrastructure. Once this mitigation is implemented, the residual effect can be assessed as **not significant**.

Impacts on Minimum Safe Altitude

13.7.2.9 The Minimum Safe Altitude dictates the height at which instrument approaches to offshore platforms commence. The Minimum Safe Altitude for aircraft operations in Instrument Meteorological Conditions (IMC), essentially poor weather, in the Moray Firth region is 1,500 ft (457 m). This allows for a minimum of 1,000 ft (305 m) clearance between aircraft and known en-route obstacles (the highest point the Beatrice platform complex). The maximum tip height of the proposed turbines is 285 m (935 ft). Therefore, the Minimum Safe Altitude in the area of the Moray West Offshore Wind Farm will need to be raised to ensure that a minimum of 1,000 ft vertical separation between the anticipated turbine tip heights and aircraft is maintained.

13.7.2.10 The sensitivity of this receptor is therefore considered **high**. The impact magnitude is also considered to be **high**. The overall effect is therefore assessed as **significant**.

13.7.2.11 In terms of mitigation, Minimum Safe Altitude in the Moray Firth region will need to be raised from 1,500 ft to 2,000 ft from the point of the first turbine being installed. This will allow a minimum 1,000 ft vertical clearance between aircraft and the turbines. Updates to aviation charts and other relevant documentation will reflect this change. Once this mitigation is implemented, the residual effect can be assessed as **not significant**.

13.7.3 *Potential Operational Effects*

Radar Interference with NERL Allanshill PSR

13.7.3.1 NERL uses the Allanshill PSR to support their provision of navigational services to aircraft operating between the UK and mainland Europe and to those overflying the UK FIR. In facilitating this task, a number of established airways (above FL 195) cross the Moray West Site. Surveillance data from Allanshill is also used by other air traffic service providers such as the MoD and Aberdeen Airport. Military ATC units are based in NERL's Control Centres to facilitate the control of aircraft that require ATC services outside the civil airspace structure. Aberdeen Airport is responsible for the provision of navigational services to aircraft operating on Class E Airway Y904 and NERL has a contracted responsibility to provide appropriate PSR coverage to support this task. At a minimum distance of 60 km (32 nm), the Moray West Site is well within the operational range of the Allanshill PSR.

13.7.3.2 Air traffic controllers are responsible for maintaining typically 5 nm lateral separation between aircraft. Where line of sight to a PSR exists, turbines may appear as genuine aircraft targets and could mask genuine aircraft responses. The radar may also be de-sensitised by its clutter processing within the sector containing turbines meaning that real aircraft targets may disappear from radar.

13.7.3.3 Consultation with NERL has confirmed that there is potential for the Moray West Offshore Wind Farm to have an impact on the Allanshill PSR.

13.7.3.4 The sensitivity of this receptor is therefore considered **high** and impact magnitude is also considered **high**. The overall effect is assessed as **significant**.

13.7.3.5 Consultation with NERL has identified that the impact of the Development can be mitigated by means of Multi-Radar Tracker (MRT) blanking; which is a technical mitigation technique offered by NERL and the same as the mitigation agreed for the consented Moray East Offshore Wind Farm. NERL has confirmed that it will not enter into an agreement with a developer until a planning application has been submitted and a planning reference is available. However, once a commercial agreement is in place and the mitigation implemented, the residual effect can be assessed as **not significant**.

Radar Interference with RAF Lossiemouth PSR

13.7.3.6 RAF Lossiemouth not only provides navigational services to aircraft approaching and departing the airfield, they are also responsible for the provision of such services to aircraft operating over the Moray Firth region. This includes aircraft operating on HMR X-RAY and some aircraft operating on the lower levels of Class E Airway Y904.

13.7.3.7 At a minimum distance of 33.6 km (18 nm), the Moray West Site is within the operational range of Lossiemouth PSR and the proposed wind farm will be detectable on ATC radar displays. This direct, permanent effect will hamper the ATC operators' ability to distinguish actual aircraft returns from those created by the wind turbines and degrade the safety and efficiency of the ATS being provided; as also explained in 13.7.3.2.

13.7.3.8 Where radar interference occurs this could lead to restrictions on departure routes including Standard Instrument Departures (SIDS); restrictions on approach and arrival procedures; restrictions on traffic patterns in particular radar to visual profile; restrictions on LARS/Zone traffic patterns; restrictions on manoeuvering areas; restrictions on Tactical Aid to Navigation (TACAN) procedures; restrictions imposed on holding areas and increased complexity of the ATC task. The sensitivity of this receptor is therefore considered **high** and the impact magnitude is also considered **high**. The overall effect is assessed as **significant**.

13.7.3.9 In terms of mitigation, the MoD has a recognised process for entering into agreement for implementation of suitable ATC PSR mitigation. This process requires developers receiving an ATC PSR objection to submit a proposal to the MoD outlining their intention to mitigate the impacts of their windfarm. Moray West has submitted such a proposal to the MoD at the same time as submitting this application. Once accepted, the MoD will be in a position to withdraw its objection subject to agreeing a suitably worded planning condition. Once the planning condition is in place, Moray West will engage with the MoD to commence the process for entering into such a mitigation agreement. Once PSR mitigation is implemented, the residual effect can be assessed as **not significant**.

Interference with Wick Airport Approach Procedures

13.7.3.10 On the basis that the minimum altitude that inbound aircraft can descend to Wick Airport will have been changed from 1,800 ft to 2,000 ft in the revised Approach Procedures to mitigate potential impacts during construction, it can be concluded that there is no potential for impacts to occur during the operational phase of the Development. Therefore, no further assessment of impacts on Wick Airport Approach Procedures is required.

Interference with HMR X-RAY

13.7.3.11 Consultation with helicopter operators in the Moray Firth carried out as part of the work on the Moray East ES 2012, confirmed that aircraft routinely operate along HMR X-RAY between 2,000 ft (610 m) and 3,000 ft (914 m), depending on prevailing meteorological conditions. Under normal operating conditions, this altitude band is sufficient to prevent any helicopters operating on the HMR from coming into direct physical conflict with the potential 285 m (935 ft) wind turbines.

13.7.3.12 Construction of turbines within 2 nm either side of the route of HMR X-RAY will have the potential to restrict operations below the routine operational altitudes when icing conditions exist. The ability of a helicopter to operate at the expected altitudes would be dependent upon the 0° isotherm (icing level); the presence of turbines within the Moray West Site may preclude the aircraft from operating on days of low cloud base if the 0° isotherm (icing level) was at 3,000 ft or below. However, as identified in the Moray East ES 2012, the existence of an overland route which is already used in icing conditions mitigates the potential impact on HMR X-RAY operations below 2,000 ft.

13.7.3.13 The sensitivity of this receptor is therefore considered **low** and impact magnitude is also considered **negligible**. The overall effect is assessed as **not significant**. No mitigation is required as there are no significant effects as a result of the operation of the proposed Development.

Interference with Helicopter Approach Procedures to Offshore Installations

13.7.3.14 The complexity of helicopter operations to offshore installations is covered in detail in Chapter 8.3 of the Moray East ES 2012 and the Moray East (2012) Technical Appendix 5.3 B - Beatrice and Moray Offshore Wind Farms Helicopter Impact Assessment (see Appendix 13.2 of this EIA Report). Meaningful discussions with the relevant aviation stakeholders had taken place prior to submission of the Moray East ES 2012 and it was accepted that changes to operational procedures would be achievable and deliverable to mitigate the impact of all three sites (Moray East, BOWL and Moray West). However, it was understood that mitigation measures cannot be agreed until the final turbine layouts were decided.

13.7.3.15 Further to that, and as discussed previously, Moray West understands that proposals for the decommissioning of the Beatrice oil field have been progressed and, based on information presented in the Beatrice Decommissioning Scoping Report (Repsol Sinopec, 2017), this is anticipated to take place between 2024 - 2027. It is also understood that preparatory works for decommissioning of the Jacky Platform commenced in 2017 and will involve removal of the platform. Consequently, mitigation measures involving changes to operational procedures will potentially need to be implemented if decommissioning activities coincide with the construction and operation of the Moray West Offshore Wind Farm.

13.7.3.16 The sensitivity of this receptor is considered **high** and the magnitude of effect is also considered **high**. The overall effect is assessed as **significant**.

13.7.3.17 In terms of mitigation, it was accepted by the relevant aviation stakeholders that although changes to operational procedures may be required, these would be achievable and deliverable. Equally, to reduce the risk of safety incidents, it will be necessary to notify the presence of physical obstructions to NATS AIS for inclusion in appropriate aviation related documentation and addition to aviation mapping. Information required will include the final locations of the constructed turbines and location / movement and maximum height of construction infrastructure. Once this mitigation is implemented, the residual effect can be assessed as **not significant**.

Impacts on Minimum Safe Altitude

13.7.3.18 On the basis that the Minimum Safe Altitude will have been changed from 1,800 ft to 2,000 ft to mitigate potential impacts during construction, it can be concluded that there is no potential for impacts to occur during the operational phase of the Development. Therefore, no further assessment of effects on Minimum Safe Altitude is required.

13.7.4 *Potential Decommissioning Effects*

13.7.4.1 During the decommissioning phase, the impacts on military and civil aviation will be the same or less than those identified for the construction and operational phases. The specific effects on each aviation receptor during decommissioning is as follows:

- Radar Interference with NERL Allanshill PSR - The static nature of the infrastructure is such that it will not be processed and presented onto ATC displays by the radar. As a result, there will be **no effect** on the NERL Allanshill PSR during decommissioning;
- Radar Interference with MoD Lossiemouth PSR - The static nature of the infrastructure is such that it will not be processed and presented onto ATC displays by the radar. As a result, there will be **no effect** on the MoD Lossiemouth PSR during decommissioning;
- Interference with HIAL Wick Airport - During decommissioning operations, crane tips could temporarily exceed turbine tip heights. However, the implemented Minimum Sector Altitude of 2,000 ft will continue to provide the required minimum 1,000 ft vertical separation over the turbines and any decommissioning infrastructure. As a result, there will be **no effect** on Wick Airport;
- Interference with HMR X-RAY - Turbine decommissioning infrastructure (e.g. cranes) could present a physical obstruction for helicopters operating on the section of HMR X-RAY between Aberdeen and Wick Airports; However, given that it was concluded there would be **no significant effects** as a result of the operation of the proposed Development, effects associated with turbine decommissioning are also assessed as **not significant**;
- Interference with Helicopter Approach Procedures to Offshore Installations – Given that the offshore oil installations are expected to be decommissioned early into the operation of the Moray West Offshore Wind Farm, there will be **no effect** on helicopter approach procedures associated with these platforms as the platforms will have been removed; and
- Impacts on Minimum Safe Altitude – The increased Minimum Safe Altitude will remain at 2,000 ft until all turbines are decommissioned. As a result, there will be **no effect** on Minimum Safe Altitude.

13.7.5 *Additional Mitigation*

13.7.5.1 As identified in the assessment above, in order to prevent significant effects on key civil and military aviation receptors associated with the Moray Firth there is a requirement to implement a number of receptor specific measures. These measures, as identified above, include:

- Revise and re-publish the Approach Procedures for Wick Airport. As part of this Moray West will be required to fund a review of the Instrument Flight Procedures;
- To prevent significant effect on helicopter approach procedures to offshore installations Moray West will be required to notify NATS AIS of the final locations and heights of the turbines and other infrastructure so that aviation charts and other relevant documents can be updated;
- Raise Minimum Safe Altitude in the Moray Firth Region from 1,500 ft (current) to 2,000 ft to ensure 1,000 ft clearance from blade tip;

- Implementation of Multi-Radar Tracker (MRT) Blanking to mitigate effects at the Allanshill PSR; and
- Agreement and implementation of suitable ATC PSR mitigation to prevent significant effects on RAF Lossiemouth.

13.7.6 *Summary of Development Specific Effects*

13.7.6.1 Table 13.7.1 below summarises the conclusions of the assessment of effects on civil and military aviation. The results presented in the table reflect significance of effects both prior to mitigation being implemented as well as after mitigation is implemented (residual significance).

Table 13.7.1: Summary of Development Specific Effects					
Potential Impact	**Impact Magnitude**	**Sensitivity of Receptor**	**Effect Significance**	**Mitigation (in addition to embedded measures)**	**Residual Significance**
Construction					
Interference with Wick Airport Approach Procedures	High	High	Significant	Revise and re-publish Approach Procedures	Not significant
Interference with helicopter Approach Procedures to offshore installations	High	High	Significant	Notify NATS AIS to update aviation charts and other relevant documents	Not significant
Impacts on Minimum Safe Altitude	High	High	Significant	Raise Minimum Safe Altitude from 1,500 ft (current) to 2,000 ft to ensure 1,000 ft clearance from blade tip	Not significant
Operation and Maintenance					
Radar interference with NERL Allanshill PSR	High	High	Significant	Multi-Radar Tracker (MRT) Blanking	Not significant
Radar interference with RAF Lossiemouth PSR	High	High	Significant	ATC PSR mitigation	Not significant
Interference with Wick Airport Approach Procedures	No effect based on mitigation implemented during construction				
Interference with HMR X-Ray	Negligible	Low	Not significant	No mitigation required	Not significant
Interference with helicopter Approach Procedures to offshore installations	High	High	Significant	Notify NATS AIS to update aviation charts and other relevant documents	Not significant
Impacts on Minimum Safe Altitude	No impact based on mitigation implemented during construction				

Table 13.7.1: Summary of Development Specific Effects					
Potential Impact	**Impact Magnitude**	**Sensitivity of Receptor**	**Effect Significance**	**Mitigation (in addition to embedded measures)**	**Residual Significance**
Decommissioning					
Radar interference with NERL Allanshill PSR	No effect as turbines will be static				
Radar interference with RAF Lossiemouth PSR	No effect as turbines will be static				
Interference with Wick Airport Approach Procedures	No effect based on mitigation implemented during construction				
Interference with HMR X-Ray	Negligible	Low	Not significant	No mitigation required	Not significant
Interference with helicopter Approach Procedures to offshore installations	Low	Negligible (oil platforms will have been decommissioned)	Not significant	No mitigation required	Not significant
Impacts on Minimum Safe Altitude	No effect based on mitigation implemented during construction				

13.8 Assessment of Cumulative Effects

13.8.1.1 As mentioned in Section 13.5.2.3, the impact on any aviation receptor is generally treated as a standalone effect. Whilst other wind turbine developments may be located in close proximity, the effect on each receptor is considered on a case-by-case basis and any significant effect is sufficient to trigger an objection from the relevant aviation stakeholder.

13.8.1.2 Although some of the mitigation agreed for Moray East (and BOWL) through consultation has been identified as also being of relevance for Moray West, it is still necessary for negotiations and discussions with aviation stakeholders on these mitigation measures to be carried out under separate arrangements. No further assessment with respect to cumulative effects is therefore required.

13.9 Reference

Civil Aviation Publication (CAP) 393 – Air Navigation Order 2016: The Order and the Regulations.

CAP 670 – Air Traffic Services Safety Requirements; Version 3 dated 23 May 2014.

CAP 764 – CAA Policy and Guidelines on Wind Turbines; Version 6, February 2016.

CAP 774 – The UK Flight Information Services; Version 2.3, 4 February 2015.

MAA Regulatory Publication 3000 Series: Air Traffic Management Regulations; last updated 23 November 2016.

MAA Manual of Military Air Traffic Management; last updated 26 October 2016.

Marine Guidance Note (MGN) 543: Offshore Renewable Energy Installations (OREIs) - Guidance on UK Navigational Practice, Safety and Emergency Response Issues; last updated 19 August 2016.

Moray East (2012). Moray Offshore Renewables Limited - Environmental Statement. Telford, Stevenson and MacColl Offshore Wind Farms and Transmission Infrastructure. Volume 3 – Offshore Generating Station Environmental Impact Assessment, Chapter 8.3 & Volume 4 – Transmission Infrastructure Environmental Impact Assessment, Chapter 11.3. Available at: http://www.morayoffshore.com/moray-east/document-library/

Moray East (2014). Moray Offshore Renewables Limited – Environmental Statement Modified Transmission Infrastructure for Telford, Stevenson and MacColl Wind Farms. Available at: http://www.morayoffshore.com/moray-east/document-library/

Moray West (2016). Moray Offshore Renewables Ltd. Developing Wind Energy In The Outer Moray Firth. Environmental Impact Assessment Scoping Report. Western Development Area Offshore Wind Farm Infrastructure: Offshore Wind Turbines, Foundations / Substructures and Inter-Array Cables. May 2016.

Repsol Sinopec (2017). Beatrice Decommissioning Scoping Report

UK Integrated Aeronautical Information Package (UKIAIP).

UK Military Aeronautical Information Publication (UK Mil AIP). Available at: https://www.aidu.mod.uk/Milflip/milAipLink.php

MORAY WEST
OFFSHORE WINDFARM

Offshore EIA Report

Moray Offshore Windfarm (West) Limited

Chapter 14 Seascape, Landscape and Visual

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Acronyms	
Acroynm	**Expanded Term**
AC	Aberdeenshire Council
AGLV	Area of Great Landscape Value
ANO	Air Navigation Order
AOD	Above Ordnance Datum
BOWL	Beatrice Offshore Windfarm Limited
CAA	Civil Aviation Authority
CAP	Civil Aviation Publication
CIA	Cumulative Impact Assessment
CSLVIA	Cumulative Seascape Landscape and Visual Impact Assessment
CZTV	Cumulative Zone of Theoretical Visibility
DSLP	Development Specification and Layout Plan
DTI	Department of Trade and Industry
EDPR	Energias de Portugal Renewables
ELC	European Landscape Convention
GDL	Gardens and Designed Landscapes
GLVIA3	Guidelines for Visual Impact Assessment Version 3
HDD	Horizontal Directional Drilling
HwLDP	Highland-wide Local Development Plan
IEMA	Institute of Environmental Management & Assessment
LCT	Landscape Character Type
LI	Landscape Institute
MC	Moray Council
MS	Marine Scotland
MWELCS	Moray Council Wind Energy Landscape Capacity Study
NCR	National Cycle Route
NPF3	National Planning Framework 3
NSA	National Scenic Area
OfTI	Offshore Transmission Infrastructure
OS	Ordnance Survey
OWE	Onshore Wind Energy
RCCA	Regional Coastal Character Area
SLA	Special Landscape Areas
SLCA-WE	Strategic Landscape Capacity Assessment for Wind Energy
SLVIA	Seascape Landscape and Visual Assessment
SNH	Scottish Natural Heritage
SPP	Scottish Planning Policy
TA	Technical Appendix

Acronyms	
Acroynm	**Expanded Term**
THC	The Highland Council
WCS	Worst Case Scenario
WLA	Wild Land Areas
WTG	Wind Turbine Generator
ZTV	Zone of Theoretical Visibility

Glossary of Terms	
Term	**Definition**
Bokeh	The way a camera lens renders out-of-focus points of light.
Graham	Also known as 'lesser Corbetts' Fiona Graham listed these Scottish Mountains with tops between 610m (approx. 2000ft) and 762m (approx. 2499ft) above mean sea-level with at least 152m (approx. 500ft) of 'ascent' or 'prominence' on all sides. There are currently 224 Grahams in Scotland.

14 Seascape, Landscape and Visual Impact Assessment

14.1 Introduction

14.1.1.1 This chapter considers the likely significant effects on the seascape, landscape and visual resource associated with the construction, operation and decommissioning of the Moray West Offshore Wind Farm and OfTI (hereafter referred to as the Development). The specific objectives of the chapter are to:

- Define the legislation, policy and guidance framework that is of relevance to Seascape, Landscape and Visual Impact Assessment (SLVIA);
- Detail the consultation relevant to SLVIA that has informed this assessment;
- Describe the SLVIA baseline;
- Describe the assessment methodology and significance criteria used in completing the impact assessment;
- Describe the primary mitigation measures proposed to address likely significant effects; and
- Assess the residual effects remaining following the implementation of primary mitigation.

14.1.1.2 The assessment has been carried out by Optimised Environments Limited (OPEN). It has been carried out by Chartered Landscape Architects and takes account of the Guidelines for Landscape and Visual Impact Assessment (Version 3) (GLVIA3) (LI and IEMA, 2013).

14.1.1.3 This chapter is supported by:

- Volume 4 - Technical Appendix 14.1 SLVIA Methodology;
- Volume 4 - Technical Appendix 14.2 Baseline Landscape Character;
- Volume 4 - Technical Appendix 14.3 Offshore Wind Farm Visibility; and
- Volume 3b - Technical Appendix 14.4 Assessment and Cumulative Wirelines Illustrating Moray East Current Base Case Layout (presented with Volume 3b Visualisations).

14.1.1.4 Note - the turbine numbering shown in the SLVIA plan figures and visualisations is for SLVIA purposes only. Turbine numbering will be finalised through the Development Specification and Layout Plan process, post consent / CfD.

14.2 Legislation, Policy and Guidance Framework

14.2.1.1 EIA Report (Volume 2) Chapter 2: Policy and Legislative Context sets out the policy and legislation associated with the Development.

14.2.1.2 The Development largely lies outwith areas covered by the local planning authorities' jurisdiction. This is with the exception of the offshore cable route and landfall, which are, in part, located within Aberdeenshire Council's area.

14.2.1.3 International, regional and local policies that relate to the value and importance placed on the seascape, landscape and visual resource are described in this section.

14.2.1.4 Table 14.2.1 sets out the Legislation and Policy Framework relevant to the SLVIA.

Table 14.2.1: Legislation and Policy Framework Relevant to the SLVIA	
Legislation	**Description**
Civil Aviation Publication (CAP) 393 – Air Navigation: The Order and the Regulations.	Contains the Air Navigation Order (ANO) 2016 and Regulations made under the order. Relevant to night time assessment of lighting effects.
International Policy	
European Landscape Convention (ELC)	Convention devoted exclusively to the protection, management and planning of all landscapes in Europe. Landscape is described as "an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors" (ELC, 2000). The definition applies to all urban and peri-urban landscapes, towns, villages, rural areas, the coast and inland areas. In addition, it applies to ordinary or even degraded landscape as well as those areas that are outstanding or protected. The ELC became binding in the UK from 1 March 2007. As a signatory, the UK government has therefore undertaken to adopt general policies and measures to protect, manage and plan landscapes.
National Policy	
National Planning Framework 3 (NPF3)	Published by the Scottish Government in June 2014. NPF3 is a long-term strategy for Scotland and is the spatial expression of the Government's Economic Strategy and plans for development and investment in infrastructure.
Scottish Planning Policy, 2014 (SPP)	Sets out national planning policies which reflect Scottish Ministers' priorities for operation of the planning system and for the development and use of land. As part of Scotland's commitment to sustainable economic growth it is recognised in Paragraph 2 that the planning system should "…take a positive approach to enabling high-quality development and making efficient use of land to deliver long-term benefits for the public while protecting and enhancing natural and cultural resources". Sets out policies for the protection of nationally and locally important landscapes including Gardens and Designed Landscapes and Wild Land Areas. Advises at para 169 that 'Proposals for energy infrastructure developments should always take account of spatial frameworks for wind farms and heat maps where these are relevant.' A list of considerations is provided, which includes visual impacts on residents and communities, landscape and visual impacts (including wild land) and cumulative effects.
Local Planning Policy	
The Highland-wide Local Development Plan (HwLDP)(2012)	Provides the overarching vision for the Highlands. This replaces the Highland Structure Plan and updates or supersedes the 'general policies' of the existing adopted Local Plans. THC consulted on the HWLDP Main Issues Report in 2016. Following this SG published potential changes to the Planning Bill. In light of these changes THC considers that the review of the HwLDP should be postponed until the implications of the Planning Bill are more clearly understood. In the meantime, THC has agreed an interim position based on the comments received. **Policy 67** is a multi-criteria based policy which provides general support for wind energy proposals provided they will not be significantly detrimental overall, having regard in particular to any significant effects on the specific criteria contained in the policy. In respect of this SLVIA, the relevant criteria include the following:

Table 14.2.1: Legislation and Policy Framework Relevant to the SLVIA	
Legislation	**Description**
	‘Natural, built and cultural heritage features; Visual impact and impact on the landscape character of the surrounding area (the design and location of the proposal should reflect the scale and character of the landscape and seek to minimise landscape and visual impact, subject to any other considerations); Amenity at sensitive locations, including residential properties, work places and recognised visitor sites (in or out with a settlement boundary);’ **Policy 57** states that the following relevant criteria will also apply: ‘For features of local/regional importance we will allow developments if it can be satisfactorily demonstrated that they will not have an unacceptable impact on the natural environment, amenity and heritage resource. For features of national importance, we will allow developments that can be shown not to compromise the natural environment, amenity and heritage resource. Where there may be any significant adverse effects, these must be clearly outweighed by social or economic benefits of national importance. It must also be shown that the development will support communities in fragile areas who are having difficulties in keeping their population and services.’ **Policy 61: Landscape** advises: ‘New developments should be designed to reflect the landscape characteristics and special qualities identified in the Landscape Character Assessment of the area in which they are proposed. This will include consideration of the appropriate scale, form, pattern and construction materials, as well as the potential cumulative effect of developments where this may be an issue. The Council would wish to encourage those undertaking development to include measures to enhance the landscape characteristics of the area. This will apply particularly where the condition of the landscape characteristics has deteriorated to such an extent that there has been a loss of landscape quality or distinctive sense of place. In the assessment of new developments, the Council will take account of Landscape Character Assessments, Landscape Capacity Studies and its supplementary guidance on Siting and Design and Sustainable Design, together with any other relevant design guidance.’ **Policy 78: Long Distance Routes** advises that: ‘The Council, with its partners, will safeguard and seek to enhance long distance routes (as indicated on Figure 11), and their settings. Consideration will be given to developing/improving further strategic multi user routes both inland and along the coast with due regard to the impact on the Natural Heritage features along these routes.’
Moray Local Development Plan (2015)	Provides the vision for Moray. **Policy E7: Areas of Great Landscape Value (AGLV) and impacts upon the wider landscape.** The policy is as follows: 'Development proposals which would have a significant adverse effect upon an Area of Great Landscape Value will be refused unless: They incorporate the highest standards of siting and design for rural areas. They will not have a significant adverse effect on the landscape character of the area, in the case of wind energy proposals the assessment of landscape impact will be made with reference to the terms of the Moray Wind Energy Landscape Capacity Study. They are in general accordance with the guidance in the Moray and Nairn Landscape Character Assessment.' **Policy BE5: Battlefields, Gardens and Designed Landscapes (GDL)**

Table 14.2.1: Legislation and Policy Framework Relevant to the SLVIA	
Legislation	**Description**
	'Development proposals which adversely affect Battlefields or Gardens and Designed Landscapes or their setting will be refused unless: The overall character and reasons for the designation will be not compromised, or Any significant adverse effects can be satisfactorily mitigated and are clearly outweighed by social, environmental, economic or strategic benefits. The Council will consult Historic Scotland on any proposal which may affect Inventory sites.' **Policy ER1: Renewable Energy Proposals** Sets out Moray Council's policy in relation to such developments. There is no specific mention of offshore wind development. The policy states that: 'All renewable energy proposals will be considered favorably where they meet the following criteria: i) They are compatible with policies to safeguard and enhance the built and natural environment. ii) They do not result in the permanent loss or damage of agricultural land. iii)They avoid or address any unacceptable significant adverse impacts including: - Landscape and visual impacts.'
Aberdeenshire Local Development Plan (2017)	Sets out the vision for Aberdeenshire. **Policy E2: Landscape** advises that: 'We will refuse development that causes unacceptable effects through its scale, location or design on key natural landscape elements, historic features or the composition or quality of the landscape character. These impacts can be either alone or cumulatively with other recent developments. Development should not otherwise significantly erode the characteristics of landscapes as defined in the Landscape Character Assessments produced by Scottish Natural Heritage (see www.snh.gov.uk/protecting-scotlandsnature/looking-after-landscapes/lca/) or have been identified as Special Landscape Areas of local importance.' **Supplementary Guidance SG9** identifies and describes the Special Landscape Areas of Aberdeenshire, including the 'North Aberdeenshire Coast' SLA. **Policy C2: Renewable Energy** Description for renewable wind development within this policy is focused around onshore wind development citing the more detailed guidance set out in the 'Strategic Landscape Capacity Assessment for wind turbines' for which it is assumed refers to the Strategic Landscape Capacity Assessment for Wind Energy, 2014 and which is also focused on onshore wind development. **Policy C2** states the more general advice which is relevant to offshore wind developments - 'All windfarms must be appropriately sited and designed and avoid unacceptable environmental effects taking into account the cumulative effects of existing and consented wind turbines.'
Strategic Landscape Capacity Assessment for Wind Energy, 2014 (SLCA-WE)	Offshore wind development is acknowledged in this capacity assessment in relation to the baseline assessment of existing wind turbine development, stating the following in Section 6.3.2. - 'In the 30km buffer area beyond Aberdeen there are significant numbers of turbines. Some of these developments (such as the European Offshore Wind Deployment Centre (EOWDC) Site) have an influence on the landscape character of Aberdeenshire.' The SLCA-WE does not however identify areas of seascape character or provide an assessment of capacity for offshore areas that relate to the Aberdeenshire area.

14.2.2 Guidance

14.2.2.1 The following guidance and data is used to inform the SLVIA:

- EDPR (2012). Moray East Environmental Statement;
- DTI (2005). Guidance on the Assessment of the Impact of Offshore Wind farms: Seascape and Visual Impact Report;
- Landscape Institute and IEMA (2013). Guidelines for Landscape and Visual Impact Assessment: Third Edition;
- Landscape Institute (2011) Use of Photography and Photomontage in Landscape and Visual Impact Assessment, Note 01/11;
- Landscape Institute (2017). Visual representation of development proposals LI Technical Guidance Note 02/2017;
- SNH (2012). Assessing the Cumulative Impact of Onshore Wind Energy Developments;
- SNH (2012) Offshore Renewables – guidance on assessing the impact on coastal landscape and seascape. Guidance for Scoping an Environmental Statement;
- SNH (2017). Visual Representation of Wind Farms (Version 2.2);
- SNH (2017). Siting and designing wind farms in the landscape - Version 3;
- SNH (2017). Guidance on Coastal Character Assessment Prepared by Carol Anderson Landscape Associates;
- SNH (2017) Scottish Natural Heritage consultation on draft guidance: Assessing impacts on Wild Land Areas – technical guidance. SNH's website advises that this consultative draft guidance should be used in place of the 2007 guidance while it considers responses;
- SNH (2017). Wild Land Areas descriptions and maps. https://www.nature.scot/wild-land-area-descriptions;
- Scottish Natural Heritage (2010). The special qualities of the National Scenic Areas. SNH Commissioned Report No.374;
- Horner + Maclennan, With Mike Wood, Landscape Architect (2011). Assessment of Highland Special Landscape Areas on behalf of SNH and The Highland Council.
- The Highland Council (2016). Visualisation Standards for Wind Energy Developments;
- The Highland Council in partnership with Scottish Natural Heritage (2011). Assessment of Highland Special Landscape Areas produced by Horner + Maclennan with Mike Wood, Landscape Architect;
- The Highland Council (2017). Landscape Sensitivity Appraisal: Black Isle, Surrounding Hills and Moray Firth Coast Caithness – Version for Committee August 2017;
- Moray Council (2012). Moray Wind Energy Landscape Capacity Study Final Main Study Report prepared by Alison Grant and Carol Anderson, Landscape Architects;
- Moray Council (2017). Moray Onshore Wind Energy Guidance;
- Aberdeenshire Council (2017). Aberdeenshire Local Development Plan 2017 Supplementary Guidance 9 – Aberdeenshire Special Landscape Areas; and
- Aberdeenshire Council (2014). Strategic Landscape Capacity Assessment for Wind Energy in Aberdeenshire.

14.3 Consultation

14.3.1.1 Reference should be made to the consultation register contained in Volume 4 - Technical Appendix 5.1: Scoping & Consultation Gap Analysis for further information on the consultation that has taken place.

14.3.1.2 Table 14.3.1 details the key issues raised in relation to SLVIA in the Moray West Offshore Wind Farm Scoping Opinion (August 2016) and the OfTI Scoping Opinion (August 2017) and summarises other issues / concerns that have been raised during additional consultation activities undertaken as part of the EIA process and how these have been addressed in the preparation of this EIA Report.

Table 14.3.1: Consultation

Consultee and Dates	Issue Raised	Moray West Approach
Marine Scotland OfTI Scoping Opinion August 2017	In agreement with the consultation responses from SNH, MC and AC on the proposed scope of the SLVIA. Note AC's consultation response on the views/receptors to be assessed, guidance etc. and the cumulative impact assessment. MC's consultation response - detail the extent of nautical or aviation lighting on the platforms. AC's requirement to consider oil/gas platforms.	MC and AC's requirements noted and included in Section 14.7.
Marine Scotland Offshore Wind Farm Scoping Wind August 2016	SLVIA required. CSLVIA to include current and proposed developments. Recommendations from SNH must be taken into account. Visual impact assessment to be carried out in co-operation with MS-LOT, the Local Authorities and the SNCBs. SLVIA to accord with GLVIA3 and SNH guidelines and guidance provided by the Local Authorities.	Cumulative SLVIA at Section 14.8. SNH requirements accounted for. Guidance set out in 14.2.2. Scope agreed SNH, THC, MC and AC.
SNH OfTI Scoping Opinion August 2017	Welcomes the proposed assessment, layout and design of the OSPs as part of Moray West offshore wind farm.	OSPs included as part of the Development assessed in SLVIA.
SNH Offshore Wind Farm Scoping Opinion August 2016	SNH provided a list of guidance to be referenced as part of the SLVIA. This list is provided in Technical Appendix 5.1. **Coastal character -** Utilise the baseline assessment Moray East prepared for the Moray East ES (2012). Review to ensure it takes account of all operational (or in-construction) terrestrial wind farms. SNH advises use of the term "coastal character" in preference to "seascape character". **Visibility and zones of theoretical visibility (ZTVs)-** Key need to determine those areas where the Moray West may potentially extend the ZTV of offshore wind farms when considered in combination with Moray East and BOWL. Comparative ZTVs helpful in informing any changes or extensions to patterns of cumulative visibility and viewpoint selection. **Viewpoint Selection and Visual Assessment -**The viewpoint selection that was agreed for the Moray East provides the starting point for discussion in respect of the Moray West. Focus on those areas where the Moray West might extend the ZTV or	BOWL included as baseline in 14.4 and 14.7. Moray East in CSLVIA at 14.8 and in Technical Appendix 14.4. Guidance used set out in 14.2.7. Coastal Character descriptions reviewed and described in 14.4.2 and 14.7.4. CZTV Figures 14.8.6 and 14.8.7 illustrate the extent of additional visibility of the Development with BOWL and Moray East.

Table 14.3.1: Consultation		
Consultee and Dates	**Issue Raised**	**Moray West Approach**
	expand the extent of development, and / or increase the density of turbines seen on the horizon as compared to BOWL/Moray East. Recommend that visualisations are produced in accordance with SNH's guidance on Visual Representation of Wind Farms. It may be possible to utilise the existing baseline photography for those viewpoints previously assessed in relation to Moray East. **Potential Mitigation and Monitoring -**ES should clearly articulate the design principles for the Moray West particularly its relationship with the consented development. Understand that much of the detailed design will take place post-consent. At application stage it should still be possible to set out the design principles and the key constraints which may affect turbine siting and design. **Cumulative Assessment** - Potential impacts from the Moray West will need to be considered in combination with those predicted from the Moray East and BOWL.	Photography from the Moray East ES (2012) re used. Approach to the SLVIA has been to assess the WCS as agreed in consultation with SNH and THC. Initial discussions included consideration of an alternative WCS based on a packed boundary layout. However, this option has since been discounted by Moray West and therefore no longer considered in the assessment. Any further design changes through mitigation would occur post-consent.
18/08/2017 SNH letter 20/10/2017 SNH letter 14/12/2017 SNH email 15/12/2017 SNH email 21/12/2017 SNH email	**Further matters raised through subsequent consultation** **Representative Viewpoints -** Largely agree with the draft viewpoint list (of 24 viewpoints). Recommend consideration of additional viewpoints as follows: Speyside Way LDR; in Aberdeenshire at MacDuff or Knock Head (following consultation with AC); Sutherland Monument, Golspie (with respect to cumulative effects) and from the defined viewpoint in Leitch's Wood (GR 354, 562) west of Fochabers. SNH happy to discuss and agree which viewpoints should be photomontages and which should model night-time visibility. SNH consider that in terms of detailed location and general composition the existing photography (from Moray East ES 2012) is satisfactory and can be reused. **Worst case scenario -** most likely from larger turbines, which are significantly more visible, increasing the clarity of the individual turbines and rotating blades due to the wider spacing, from further afield. No strong preference in the choice of the WCS from the layouts shown in model 4e (packed) and model 4f (non-packed). Further design consideration should be given to avoid outliers, as appears in model 4f (non-packed), which has more outliers to the south west of the development. SNH confirmed content that the (unpacked boundaries) scenario (4f) is used as the basis for impact assessment (since Model 4f no longer an option). **Night time visualisations -** SNH initial advice on the likely effects of (aviation) lighting in Siting and Designing Wind Farms in the Landscape. Recommend that applicants only provide	Representative viewpoints and views for photomontages agreed with SNH. Figures included in Volumes 3a and 3b, assessment of viewpoints included in Sections 14.7 and 14.8. No VPs for Speyside Way LDR, McDuff, Knock Head subsequently agreed. No viewpoint included at the Duke of Sutherland's Monument as THC preferred Dornoch alternative. No viewpoint at Leitch's Wood agreed as not in GDL. WCS agreed and used in SLVIA Sections 14.7 and 14.8. Night time views and WCS agreed and used in SLVIA. Consideration of lighting effects at dusk and dawn

Table 14.3.1: Consultation		
Consultee and Dates	**Issue Raised**	**Moray West Approach**
	visualisations showing lighting from a small selection of viewpoints. SLVIA to consider twilight and night time conditions. Advise that the night time assessment should be based on the same layout and WCS as daytime. Acknowledge THC advice that the Model 2 layout with more turbines of a smaller height (and therefore more densely packed) will increase the number of night time lights, in comparison to the WCS (currently agreed) of Model 4e. To focus on an increase in turbines and therefore lights will not reflect the full range of potential impacts. SNH advice based on consideration of impacts throughout the Moray Firth and not just those impacts that will be experienced from THC region. **Cumulative Assessment** – requirement to consider onshore wind farm projects (to be provided by councils), reference to relevant landscape capacity and sensitivity studies for onshore wind developments. Consider removal of Beatrice Demonstrator turbines. **Wind Farm Layout and potential significant effects -** The orientation of the layout will introduce development significantly closer and in a greater spread with respect to the wider Highland and Moray/Aberdeenshire coastlines and sensitive receptors. Moray West will significantly increase the horizontal extent of wind energy development visible in the Moray Firth, in addition to that of the BOWL and Moray East developments. The potentially much larger turbines which require larger spacing, means that in some views the development begins to interact with the coastline, both in terms of turbines in proximity to the coastal edge and overlapping/interrupting views to the more distant coastlines, which are a distinctive part of experiencing the wider Moray Firth Landscape – the interaction of the two main coasts – in views from Highland to Moray/Aberdeenshire and vice versa. The east Sutherland coast (part of the increasingly popular North Coast 500 route) has a distinctive linear character which can be experienced at the regional level and advise that this should be carefully considered in the SLVIA assessment, and in particular (but not limited to) the sequential assessment. Consider that this proposal has the potential for significant adverse individual and cumulative effects on distinctive regional landscape and seascape character and visual receptors.	included in Section 14.7.3. Cumulative wireline Figures 14.7.9-14.7.34 Cumulative wind farms agreed with THC, MC and AC. Interactions with other offshore developments considered in Section 14.7 and 14.8. Viewpoints for night time assessment agreed and guidance for aviation lighting followed. North Coast 500 route and coastal character considered and assessed in Sections 14.7.3 and 14.7.4 respectively. SNH advice on design and outlier avoidance noted.
01/09/2016 The Highland Council Scoping Opinion for Offshore Wind Farm	**Landscape assessment** - ES needs to identify all designated sites which may be affected by the development either directly or indirectly including: including designations such as National Parks, National Scenic Areas, Areas of Great Landscape Value, Gardens and Designed Landscapes and general setting of the development. Landscape assessment should include perceptual aspect. **Visual assessment -** Photomontages should follow the Council's 2016 Visualisation Standards. Images should form part of the ES and not be separate from it.	Sections 14.5.4 and 14.7.4 considers such effects. Viewpoints and visualisations prepared following agreement with THC and included in Volumes 3a and 3b of the EIA report.

Table 14.3.1: Consultation		
Consultee and Dates	**Issue Raised**	**Moray West Approach**
	Expected that the same viewpoints used in the assessment of Moray East. Take account of 'valued' and 'legacy' viewpoints. Viewpoints (VP) to be agreed but broadly appear appropriate. Visual impact baseline work should include the identification of receptor classes along with characterisation of each class's existing experience of their visual environment. The LVIA should then clearly describe the value attached to visual receptor classes and their susceptibility to the development. For visual impact it should recognise changes to the experience of the area. Avoid confusion of receptors with viewpoint locations. **Cumulative assessment** -Include cumulative impact of project with consented or operational development. Assessment of cumulative impacts should aid a clear understanding of how the development would fit into the development matrix of the area and how the landscape, and people's perception of the area may be affected. **Methodology** - The potential significant effects of development must have regard to the extent, magnitude and complexity, probability, the duration, frequency and reversibility of the impacts. A four-point scale should be used advising any effect to be either strong positive, positive, negative or strong negative. Consideration of the significance of any adverse impacts of a development will of course be balanced against the projected benefits of the proposal. Valid concerns can be overcome or minimised by mitigation by design, approach or the offer of additional features, both on and off site. A description of the measures envisaged to prevent, reduce and where possible offset any significant adverse effects on the environment must be set out within the ES statement and be followed through within the application for development.	Where agreed, the visualisations have been prepared in accordance with THC standards, in addition to those required by SNH. SLVIA accounts for THC requirements. Cumulative assessment included Section 14.8. Four-point scale of significance and nature of effects is used in the SLVIA. Further mitigation (relating to offshore wind farm design and layouts) to be agreed as part of detailed design work carried out post consent. WCS subsequently agreed with THC. CSLVIA included at Section 14.8. Viewpoints for night time visualisations agreed. Sequential effects on routes - Sections 14.5.4 and 14.7.3.
30/10/2017 THC by email 07/11/2017 Meeting THC 07/11/2017 Email THC 21/12/17 email THC 01/02/2017 THC email	**Further matters raised through subsequent consultation** **Visual assessment** - SLVIA must assess extent of identified effects and typical exposure of different categories of visual receptors to those effects. Viewpoints with foreground to have photomontages and wireframes. Note attached providing guidance on Receptor Led VIA. Confirmed the Moray East photography to be used and if there are any changes to the onshore wind farm baseline this could be picked up in the renders. VPs and visualisation requirements were all agreed – add a higher location VP to Dunbeath and a VP into the location between VP13 and VP14 at Dornoch, create a 75 mm wireline from Whiteness/Nairn Beach. THC prefers the use of the viewer images for providing information to Councilors and the public via THC website. No need for 50 mm photomontage views.	Formats for day and night time visualisations for each viewpoint agreed with THC and included in Vol. 2. Viewpoints for night time visualisations agreed and presented in Vol 2. Included in CLVIA Section 14.8 Further information provided in order to inform THC advice. WCS of 4f agreed for daytime. Model 4f and Model 2 shown in night time views.

Table 14.3.1: Consultation		
Consultee and Dates	**Issue Raised**	**Moray West Approach**
	THC advised that 65.5 degree field of view panoramas not required. **Worst Case Scenarios** - Following discussion focusing primarily on the two alternative layouts with the tallest turbines (4e and 4f) the 'packed boundary' layout (4e) with 62 turbines of 285m to tip confirmed as 'worst case' layout for SLVIA daytime assessment. It was considered marginally 'worse' than the non-packed boundary layout (4f). If the previously agreed WCS, Model 4(e), is to be dropped THC accepts Model 4 (f) as WCS for daytime assessment. **Night time assessment** -Night-time photomontages from Dunbeath, Navidale and Wick agreed. If the WCS for day and night are not the same, then the SLVIA process should provide a means of deciding which scenarios to place most weight on and that that balancing process should be transparent and justifiable. Requirement for some level of comparative work, which takes account of the scenarios which will be experienced by visual receptors. If mitigation of increased numbers at reduced height remains within the parameters, then Model 2 would have to be assessed as the WCS for dark hours. Consideration also needs to be given to the period of gloaming or twilight when towers may be both lit and visible in the natural light. **Cumulative assessment** - THC to review and confirm the list of projects identified for CSLVIA. Cogle Moss and Gordonbush Extension consented. Navidale application. Visualisations should illustrate cumulative effects particularly offshore.	Photomontages and assessment of model 4f included in SLVIA. Agreed THC 5.2.18
MC Scoping Opinion for Offshore Transmission Infrastructure	Confirm MC are generally content with the content of the Scoping Report. Appropriate photomontages to be prepared from the Moray coastline. Make clear the extent of any nautical or aviation lighting requirement on the platforms and how they might be observed from the coast.	Photomontage views from Moray agreed with MC and included in Vol 2. Lighting assessment Section 14.7.3.
MC Scoping Opinion for Offshore Wind Farm	Include several key viewpoints within settlements along the coastline, and Moray Council would wish to be party to the selection process. Figures showing the visual impact of any nautical or aviation lighting on the turbines from the Moray coast would also be beneficial.	Viewpoints and visualisations agreed with MC. Lighting assessment included in Section 14.7.3.
AC Scoping Opinion for Offshore Wind Farm	The scope and methodology outlined appears to be acceptable. SLVIA should be primarily graphic, based on ZTV information for hub height and tip height of an appropriate wind energy development layout. Panoramas, photomontages and wireline models should be produced. Any proposed wind monitoring masts, maintenance platforms etc. should also be included.	Detailed ZTV prepared and provided to AC. CLVIA included at Section 14.8 including onshore wind farms agreed with MC.

Table 14.3.1: Consultation		
Consultee and Dates	**Issue Raised**	**Moray West Approach**
	CSLVIA to fully address the potential combined visual affects between the Moray West and the onshore wind energy projects. Further consultation requested on viewpoint selection and all aspects of assessment with reference to ZTV.	Viewpoints agreed with AC.
AC Scoping Opinion for Offshore Transmission Infrastructure	Scope SLVIA including Baseline Data Sources, inclusion of BOWL as an operational development, range of viewpoints initially selected generally considered appropriate. Aberdeenshire Local Development Plan 2012 superseded by the Aberdeenshire Local Development Plan 2017. Graphical information should be provided within any finalised EIA Report illustrating the visual impacts of the infrastructure proposed. Information should be primarily graphic with decisions on the locations of appropriate viewpoints and receptors based on ZTV. Viewpoint selection to remain flexible. OSPs should be designed to be similar to that of the wind energy development and positively assimilate into the valued seascape and the landscape character context of the setting of the Development. The applicant needs to fully address the issue of cumulative impact as part of the seascape, landscape and visual impact assessment to fully address the potential combined visual affects between the MORL West proposed development and the onshore wind energy projects that fall within the agreed extent of a cumulative ZTV. The cumulative seascape, landscape and visual impact assessment should be primarily graphic based, with ZTV information, panoramas, photomontages and wireline models etc. An assessment of cumulative visual affects should be supplied in accordance with up to date SNH guidance etc. The appropriate extent of the base map and related ZTV for the cumulative assessment of all publicly known wind energy development should be confirmed with SNH.	OSPs included in SLVIA for all offshore development of Moray West. Viewpoints agreed with AC and visualisations included in Volumes 3a and 3b. Cumulative sites agreed with AC. Section 14.8. Oil platforms - Section 14.7.
22/09/2017 MC and AC joint meeting. 27/09/2017 MC email 28/09/2017 AC email 15/12/2017 AC email 21/12/2017 AC email	**Further matters raised through subsequent consultation** **Visual Assessment** - AC and MC confirmed proposed VPs satisfactory. AC advised SNH suggested viewpoints on Speyside Way and MacDuff / Knockhead not to be necessary/ are impractical. Agreement to re-use photography from Moray East ES (2012) where suitable. Portsoy photographs still appear to be representative. AC and MC agreed VPs of Lossiemouth and Buckie for photomontage. One night-time photomontage from Lossiemouth to be completed. **Cumulative Assessment** - list of projects identified for CSLVIA to be reviewed by MC and AC.	Agreed viewpoints and photomontages included in SLVIA Volumes 3a and 3b and assessed in Sections 14.7.3 and 14.8. Cumulative wind farms agreed and included in Section 14.8. Medium intensity aviation lighting assessed in Section 14.7.3. BOWL included in baseline 14.4.2 and

Table 14.3.1: Consultation		
Consultee and Dates	**Issue Raised**	**Moray West Approach**
	MC advised turbines at Garrelhill and Drodland not commenced. Consent expired. Application at Lurg Hill, Deskford to be validated. Webpage advised by AC as source for cumulative development. Agreed photomontage of BOWL would be included within the baseline views. Moray West to be assessed in context of Moray East in CLVIA. Moray East has won a CfD and is due to commence construction in 2019 (2018 onshore). Moray East development will be one large wind farm but there would be fewer turbines than consented. Concluded that as oil rigs are different in scale and appearance then they would not be an issue, although THC may see them as 'clutter'. AC stated not seen as an issue to be assessed. **Night time assessment -** MC advised lighting on the Beatrice Demonstrator Turbines not visible from Moray. SLVIA to focus on the effects of the medium intensity CAA lighting. Same WCS should be used during night-time as during daytime. **Worst Case Scenario** -Tallest turbines within a layout that had rows aligned perpendicular to the Caithness coast creating 'stacking' in views agreed as WCS. Moray West considering there may be 'Packed boundary' layouts for some of the turbine options. MC and AC confirmed that although the 'packed boundary' appeared to look worse on the wirelines happy to go with whatever THC identified as the WCS. Model 4e includes a large amount of stacking and clutter from most viewpoints, while other Models also demonstrate this layout of the turbines means that this impact is more acute on this model. As Model 4e dropped Model 4f can now be considered as the WCS for the development. Increase in height to 285m was also noted by MC. **Methodology** - Discussion around whether or not infrequent views of the Development in the clearest weather conditions would be significant or did the likely low level of frequency have an influence. MC advised that the Beatrice Demonstrator Turbines are only visible with detailed scrutiny during clear weather.	Moray West included in CSLVIA Section 14.8. Model 4f subsequently agreed as WCS as Model 4e dropped.

14.4 Baseline Conditions

14.4.1 Baseline Characterisation Approach

Study Area

14.4.1.1 The study area for the SLVIA is defined as the Moray West Site plus a 50 km radius (Volume 3a - Figure 14.4.1: SLVIA Study Area). This has been agreed with SNH, THC, MC and AC.

Desk Study / Field Survey

14.4.1.2 The SLVIA for the Development is largely based upon the description of the baseline seascape, landscape and visual conditions of the identified receptors as set out in the Moray East ES (2012). This is due to the similarities of the Study Areas. Re-use of certain baseline information has been agreed with SNH, THC, MC and AC and all relevant information has been included in this SLVIA. The baseline has been updated as necessary to take account of revised guidance, definition of valued landscapes through policy and new development that has arisen. Additional baseline information has also been gathered through desk study and fieldwork with the different extents of the SLVIA Study Area being taken into account. The key references that have informed this work are included at the end of this chapter.

Coastal Characterisation

14.4.1.3 The parts of the coastline that were not included within the Moray East 2012 Study Area have been defined and, where necessary, described in accordance with Guidance on Coastal Character Assessment (SNH, 2017).

14.4.2 Current Baseline

14.4.2.1 The following section provides an overview of the key landscape, seascape and visual characteristics of the Study Area. Detailed descriptions of the baseline environment associated with specific receptors identified as requiring assessment are included with the assessments in Section 14.7 or for landscape receptors in Volume 4 - Technical Appendix 14.2: Baseline Landscape Character.

14.4.2.2 The Moray West Site is located approximately 22 km from Caithness, at its closest point near Lybster. The SLVIA Study Area (EIA Report Volume 3a - Figure 14.4.1) includes the coast between Duncansby Head and Ballintore in Highland, and extends up to approximately 28 km inland. The southern part of the Study Area includes the Morayshire and Aberdeenshire coast between Culbin Forest and Forres in the west and Banff in the east. Lossiemouth is approximately 31.5 km from the closest point on this coast to the Moray West Site. The landfall for the offshore export cables will be located within the Landfall Area which extends along a stretch of the Aberdeenshire coast between Findlater Castle and Redhythe Point (Volume 3a- Figure 14.4.6h).

14.4.2.3 The coastline is generally rural in character with a predominantly agricultural land use and a strong association with the sea. There are numerous settlements along the coastline and these are connected by roads that generally run close to, or on, the coast.

14.4.2.4 The concentrations of visual receptors along routes, in settlements and at visitor attractions (Volume 3a - Figure 14.4.2) and representative viewpoints (Volume 3a - Figure 14.4.3) located along the coast are generally sited slightly above sea level due to the underlying geology of the area. The main transport routes tend to run along the coast or are set back from it, running along more even ground, and provide links between the various settlements and linking the bridging points of the numerous water bodies. Locations around the confluences of the rivers and smaller water bodies present coastal areas, which have been eroded and these have often been exploited as areas suitable for settlement.

14.4.2.5 Older settlement areas and housing along the coast tends to have been sited and designed to reduce exposure from the coastal weather conditions. This means that older properties often do not have open outlooks towards the sea.

14.4.2.6 Modern parts of settlements and individual properties tend to still be arranged in order to limit the effects of exposure through their orientation and planting. However, modern building and glazing techniques mean that some newer properties or additions tend to be designed in order to obtain sea views.

Visual Receptor Concentrations

14.4.2.7 There are a number of locations within the Study Area where visual receptors (people) are most usually found. These include settlements, routes and features/attractions.

Settlements

14.4.2.8 Settlement along the Highland coast consists predominantly of scattered farms and crofts, with occasional small towns and villages such as Helmsdale, Dunbeath, Lybster, Keiss, Brora, Golspie, Dornoch, Portmahomack and Balintore. Wick is the largest settlement in the Highland part of the SLVIA Study Area; the town straddles the River Wick and extends along both sides of Wick Bay. It lies at a distance of approximately 27.5 km from the Wind Farm boundary. Dunbeath in Caithness is the closest small settlement to the Wind Farm boundary at a distance of approximately 22 km. Lybster lies at a slightly greater distance.

14.4.2.9 In the Moray / Aberdeenshire part of the Study Area, the population is much greater than in Highland. The density of urban areas is higher with numerous towns and villages many of which are along the coast to take advantage of proximity to the sea which was and is important for fishing as well as for communication/transportation.

14.4.2.10 The closest settlement to the Moray West Site is Lossiemouth at a distance of 31.5 km. The areas to the south of the Study Area covering the Morayshire and Aberdeenshire coasts contain a substantial amount of development, the main settlements include Burghead, Forres, Elgin, Lossiemouth, Buckie, Cullen and Banff, with smaller settlements at Findhorn, Kinloss, Portgordon, Findochty, Portknockie, Portsoy and Whitehills located within the sheltered bays along this coast.

14.4.2.11 The settlement of Sandend lies on the coast within the area within which the landfall would be located and will therefore be the closest settlement to the export cable corridor.

Roads

14.4.2.12 There are numerous road corridors traversing the Study Area, many of which are associated with urban development, while others provide access to the wider countryside. The main road corridors within the Highland part of the Study Area are the A9(T), A99, A882, A836 and A897, with minor roads connecting the more remote parts of the Study Area including the B870, B874 and B876. The main road corridors within the Morayshire/Aberdeenshire part of the Study Area are the A98, A96, A941 and A942.

14.4.2.13 Within the Study Area coastal sections of the A9, the A99 and the A836, form part of the North Coast 500 (NC500). This idea was created in 2014 by the North Highland Initiative to promote tourism within the north Highlands. It is described on the associated website (http://www.northcoast500.com/home/about-the-route.aspx) as

14.4.2.14 'Bringing together a route of just over 500 miles of stunning coastal scenery, the route path naturally follows the main roads across the coastal edges of the North Highlands taking in the villages and towns of places like Ullapool, Durness, John O'Groats, Dornoch and Inverness.'

14.4.2.15 The closest main road to the Moray West Site is the A9 and the A99 where the routes run near the coast between Berriedale and Ulbster. This stretch of the route is located approximately 22.5 km northwest of the Moray West Site boundary at its closest point.

14.4.2.16 In the south of the Study Area the A941 and A942 road corridors are located at minimum distances of approximately 31.5 km and 38.5 km respectively from the Moray West Site with other road corridors in Moray and Aberdeenshire located at greater distances. The Moray Firth is one of 12 national tourist routes, designed to provide the travelling holidaymaker with an alternative to the main trunk roads and motorways. The route has been selected because it is attractive in its own right but also to offer a variety of things to see and do on the way to a main destination.

14.4.2.17 The A9 Berriedale Braes Improvement Scheme has been approved and will be a baseline consideration.

Railways

14.4.2.18 The Study Area includes one main railway line in Highland, running between Inverness to Wick and Thurso (namely the Far North Line). The line follows the coast between Golspie, Brora and Helmsdale before turning inland to a route along Strath of Kildonan and following the alignment of the A897 to Forsinard (outwith the Study Area) before turning eastwards towards Halkirk. Here, at Georgemass Junction it branches north to Thurso and south-east to Wick. The railway line is located at approximately 27.5 km from the Moray West Site at its closest point at Helmsdale, but is generally located at longer distances.

14.4.2.19 Within Moray/Aberdeenshire a railway line (Aberdeen-Inverness) runs east from Forres through Elgin before turning south towards the crossing of the River Spey where it exits the Study Area.

Long distance routes

14.4.2.20 National Cycle Route 1 (NCR1) traverses the northern part of the Study Area, running along the north Caithness coast between John O' Groats and Thurso through Highland.

14.4.2.21 To the south NCR 1 passes through Moray and Aberdeenshire between Forres in the south-west, Elgin, Portnockie, Buckie and Cullen before heading south-east to Fordyce and then north to the coast where it runs through Portsoy and Bamff before leaving the Study Area.

14.4.2.22 The coastline and settlements of Moray are linked by a waymarked coastal walking trail, the Moray Coast trail, of approximately 80km between Findhorn and Cullen. The Moray Trail takes in landscapes from rugged cliffs, caves and sheltered coves to fisher-town harbours and sweeping stretches of sandy beaches.

Attractions and Visitor Facilities

14.4.2.23 The effect on tourism and recreation as a result of the Development in the area is addressed in Volume 2 - Chapter 15: Socio-economics, Toursim and Recreation. There are features and resources of interest to visitors in the Study Area. In Highland John o' Groats is popular with tourists because it is one end of the longest distance between two inhabited points on the British mainland. Some of the coastal villages and harbours provide attractive locations to stay for tourist visitors, including Keiss, Dunbeath, Brora, Helmsdale, Golpsie, Portmahomack and Dornoch.

14.4.2.24 The natural and historic environment of the coastline provides extensive interest to visitors. The Highland landscape, and particularly the coastline, is rich with the remains of human occupation from the pre-historic era to the present day, and there are numerous sites where this history is interpreted for visitors. The underlying geology, harsh climate and long history of human occupation have shaped the distinctive natural heritage. The landscape incorporates both common and rare habitats and species, and the Highlands provide a stronghold for many once common breeding species of interest.

14.4.2.25 The Moray coastline has a string of sandy beaches and accessible coastal settlements such as Buckie, Lossiemouth, Findochty, Portknockie, Burghead, Findhorn, Cullen and Sandend, that have long been popular for family holidays. For walkers, there are extensive coastal walks in the Study Area, taking in cliffs, arches and stacks as well as sand and dunes and historic features.

Night Time Visual Baseline

14.4.2.26 Night time (dusk) photographs have been taken from the viewpoints shown on Volume 3a - Figure 14.4.3 as follows: Viewpoint 3: Wick (path south of South View), Viewpoint 9a: Dunbeath (nr Heritage Centre), Viewpoint 12: Navidale and Viewpoint 16: Lossiemouth (harbour) to illustrate the night–time visual baseline and consider the visual effects of turbine lighting.

14.4.2.27 The selection of the views for the preparation of night-time visualisations takes into account the potential for views that include lighting along the Highland coast and the closest range viewpoint on the Moray Coast. The use of photographic views taken at dusk allows recognition of the landscape features that are the context for the lights and also represents a time of day when both the features of the landscape and seascape resource are visible as well as the lights.

14.4.2.28 This far north in Scotland, night time/low light views are prevalent for much of the 24 hour period from late autumn to early spring, particularly when people are travelling to and from their places of work/school. Whilst this is the case, most activity that takes place outdoors or for appreciation of the landscape/seascape occurs during daylight hours. When people are indoors they generally exclude the views out of their homes with curtains or blinds, which are also used for insulation.

14.4.2.29 The highest levels of lighting in the baseline environment tend to be in and around settlements where there are lights in and around buildings as well as street lights and a higher concentration of vehicle lights. The concentration of lights in settlements can also create light glow. In the countryside lights tend to be clustered around or emitted from the scattered settlement and farmsteads. When moving through the countryside people tend to be in vehicles which have their own lighting. Once it is dark this tends to make the focus of any views ahead of the vehicle. This is with the exception of locations which draw attention due to their lighting.

14.4.2.30 Lighthouses and navigational markers are also lit and are often visible from the coast.

14.4.2.31 Out at sea there are flashing lights on the hubs of the two Beatrice Demonstrator Turbines and static lights on the platforms of the Beatrice Oil Field. Ships and fishing boats out at sea also have lights that may be visible at different ranges from the coast. These are seen as spots of light, with one particularly bright platform to the south. It is understood that the Beatrice Demonstrator Turbines and the associated oil platforms are to be removed during the early years of the operation of the Development.

14.4.2.32 BOWL is currently under construction and it is likely that some of the bright lights seen in the baseline views are associated with that construction and would not be there once BOWL is operational. The BOWL operational lighting will be visible at night as shown in the baseline night time photographs where the aviation lighting has been added to the views as photomontage.

Viewpoints

14.4.2.33 The SLVIA is informed by a series of viewpoints, which have been agreed with SNH, THC, MC and AC and are listed in Table 14.4.1: Representative Viewpoints and shown on Volume 3a - Figure 14.4.3. These are largely similar to those agreed for the Moray East ES 2012, but with less concentration of viewpoints in the north-west of the Study Area where the Moray West Offshore Wind Farm would be less visible than the Moray East Offshore Wind Farm. In some cases viewpoints have been re-sited e.g. around Wick and Keiss, in order to gain a higher degree of visibility of the Development. Alternative viewpoints have been included to take account of the more southerly location of the Development and its corresponding Study Area or at the request of consultees. A viewpoint has also been included at Sandend beach, within the landfall area, to illustrate the location of where the OfTI approaches landfall and close to where there is a concentration of visual receptor.

Table 14.4.1: Representative Viewpoints					
No	**Location**	**Grid Reference**		**Distance to Moray West Site (km)**	**Representative of Receptors**
1	Duncansby Head	340525	973250	53.35	High Cliffs and Sheltered Bays LCT, Duncansby Head RCCA, Duncansby Head SLA, visitor attraction.
2	Keiss (A99)	334622	961190	43.01	Small Farms and Crofts LCT, Close to Sinclair's Bay RCCA, settlement, major road,
3	Wick (path south of South View) – day and night time	337892	950970	32.28	Town LCT, Wick Bay RCCA, settlement, Core Path
4	Sarclet (Sarclet Haven Info Board)	334992	943334	26.55	Small Farms and Crofts LCT, Sarclet Head RCCA, visitor attraction, scattered settlement
5	Whaligoe Steps	332051	940296	25.77	Small Farms and Crofts LCT, Sarclet Head RCCA, visitor attraction
6	Minor Road (south east of Osclay)	323133	938505	28.42	Small Farms and Crofts LCT, minor road, scattered settlement
7	Lybster (end of Main Street)	324843	935082	24.61	Small Farms and Crofts LCT, Lybster Bay RCCA, settlement, Core Path
8	Latheron (A9)	319803	933152	25.24	Small Farms and Crofts LCT, Dunbeath Bay RCCA, major road, settlement
9a	Dunbeath (nr Heritage Centre)	316071	929526	24.78	Small Farms and Crofts LCT, Dunbeath Bay RCCA, in vicinity of Dunbeath Castle, settlement
9b	Dunbeath (by harbour)	316616	929366	24.3	Harbour LCT, Dunbeath Bay RCCA, Core Path, settlement, visitor attraction
10	Morven	300482	928539	35.7	Lone Mountains LCT, Flow Country and Berriedale Coast SLA, Causeymire-Knockfin Flows WLA, hill walkers
11	Berriedale (A9)	313153	924611	23.2	Small Farms and Crofts LCT, Dunbeath Bay RCCA, close to Flow Country and Berriedale Coast SLA, major road, Core Path
12	Navidale – day and night time	303766	916161	27.62	Coastal Shelf LCT, Helmsdale to Berriedale Coastal Shelf RCCA, in vicinity of Loch Fleet, Loch Bora and Glen Loth SLA, major road, scattered settlement, close to settlement
13a	Brora (picnic area off Salt Street)	291013	903634	37.33	Long Beaches Dunes and Links LCT, Brora to Helmsdale Deposition Coast RCCA, in vicinity of Loch Fleet, Loch Bora and Glen Loth SLA, in vicinity of Dunrobin Castle GDL, settlement, visitor attraction, Core Paths.
13b	Dornoch (beach parking)	280610	889539	49.47	Long Beaches Dunes and Links LCT, Golspie, Embo & Dornoch Coast RCCA, in vicinity of

Table 14.4.1: Representative Viewpoints					
No	**Location**	**Grid Reference**		**Distance to Moray West Site (km)**	**Representative of Receptors**
					Dunrobin Castle GDL, near to Dornoch Firth NSA, settlement, core path
14	Tarbat Ness Lighthouse	294745	887604	36.78	Hard Coastal Shore LCT, Tarbat Ness to North Sutor Coast RCCA, visitor attraction, core path
15	Burghead Visitor Centre	310836	869179	37.73	Coastal LCT, Burghead to Nairn Coast RCCA, settlement, visitor attraction, Core Path, close to Moray Coastal Trail
16	Lossiemouth Harbour – day and night time	323654	871295	31.66	Coastal LCT, Rossiemouth to Burghead Coast RCCA, settlement, close to Moray Coastal Trail, close to major road, harbour, close to Core Path
17	Buckie (Cliff Terrace)	343136	865829	39.65	Coastal LCT, Portgordon to Portnockie Coast RCCA, settlement, close to major road, close to Moray Coastal Trail, close to Core Path.
18	Bin Hill	347987	864271	43.01	Uplands LCT, hill walkers
19	Portnockie (Bow Fiddle Rock Info Point)	349411	868741	39.11	Coastal LCT, Portgordon to Portnockie Coast RCCA, visitor attraction, Core Path, close to settlement
20	Cullen (viaduct)	350995	867102	41.17	Coastal Lowlands LCT, Close to Cullen Bay RCCA, close to Cullen GDL, settlement, NCR 1, close to Moray Coastal Trail
21	Findlater Castle	354169	867086	42.34	The Coast LCT, Sandend Bay RCCA, visitor attraction, castle access path.
22	Sandend	355619	866117	43.71	The Coast LCT, Sandend Bay RCCA, settlement
23	Portsoy	359071	866382	44.67	The Coast LCT, Sandend Bay RCCA, settlement
24	Ferry Route (Kirkwall to Aberdeen) – wireline only	397455	906915	50.16	Travellers on ferries and other boats.

Landscape and Coastal Character

14.4.2.34 The coast between Duncansby Head and Ballintore in Highland encompasses the Flat Peatlands and the Moorland Slopes and Hills landscape types of Caithness and Sutherland, which define the inland extent of visibility of the sea (Volume 3a - Figure 14.4.4). The Highland section of coastline is within National Seascape Unit 7 – East Caithness and Sutherland, and is defined mainly by National Seascape Character Type 2: Rocky Coastline with Open Sea Views, with smaller sections of Type 1: Remote High Cliffs and Type 3: Deposition Coastline with Open Sea Views (Volume 3a - Figure 14.5).

14.4.2.35 The south-western extents of the Study Area include the area to the north of the Dornoch Firth. This stretch of coast corresponds with the National Seascape Unit 6: Moray Firth and with National Seascape Character Type 2: Rocky Coastline with Open Sea Views and Type 4: Outer Firths. The closest point of this coastline is at Tarbat Ness where the Moray West Site lies at a distance of approximately 36.5 km.

14.4.2.36 The Moray and Aberdeenshire coastline is within the North Aberdeenshire / Morayshire Coast National Seascape Unit 5. This coastline is defined mainly by National Seascape Character Type 2: Rocky Coastline with Open Sea Views, Type 3: Deposition Coastline with Open Sea Views and Type 4: Outer Firths.

14.4.2.37 Coastal Character Areas that correspond with the coastlines of the Study Area were mostly defined and described within the Moray East ES (2012) Chapter 5.4 SLVIA. Recent Coastal Character Assessment Guidance (SNH, 2017) on this matter advises that the appropriate scale of characterisation 'for the assessment of offshore wind farm developments located beyond approximately 12 nm from shore where visibility from the coast may be more extensive' would be as Regional Coastal Character Areas. Given that 12 nm equates to 22.2 km, it is considered that such a level of characterisation is appropriate for this SLVIA.

14.4.2.38 Further coastal characterisation work has been undertaken as part of the baseline assessment for the areas in Easter Ross, East Sutherland and Moray as required.

14.4.2.39 The SNH (2017) Guidance Note on Coastal Character Assessment sets out the hierarchy of coastal characterisation which can be applied at a number of different scales. Coastal character types were defined at a national level in the research report SNH Seascapes Study (Scott et al., 2005). This broad classification still stands and five of the National Coastal Character Types are located within the Study Area, as shown in Volume 3a - Figure 14.4.5. As character types they are generic and occur in different locations around the Study Area. This national characterisation provides a context for the Regional Coastal Character Areas.

Type 1: Remote High Cliffs

14.4.2.40 **Location within Study Area**: North Caithness

14.4.2.41 **Physical characteristics:** High cliffs, often over 200 m tall, with occasional small sandy or stony bays at their base, contained by rocky headlands. Stacks, caves and collapsed cliffs are often features of this coastline. There is a strong contrast of line and form arising between the sheer verticality of cliffs and wide horizontal expanse of the sea.

14.4.2.42 This type usually has a high moorland, or occasionally, mountainous, hinterland where semi–natural heathland is the dominant land cover. Settlement is generally absent although occasional small villages can be found tucked in bays and inlets or extensive crofting on tops within Highland areas. Light houses can be prominent features on headlands. This type has a remote, wild character due to the absence of roads and settlement. Where roads exist, they are aligned parallel to the coast.

14.4.2.43 Access and views to the coast from the hinterland are restricted due to the cliffs. Wide elevated views are directed along the coast and out to open sea, although views of other islands are possible, such as Orkney. Views of offshore turbines, rigs or boats can be a focus within the maritime component of this type. The Northern quality of light often gives intense clarity in views.

14.4.2.44 **Experiential qualities:** Coastline has a particularly exposed character and is physically remote from settlement. The coast is difficult to access and the water's edge is often blocked by impassable steep cliffs. These are exhilarating and awe–inspiring coastlines due to the great height of cliffs giving elevated and distant views and being particularly dramatic when the sea is turbulent. The noise of sea birds nesting on cliffs and waves add to the attraction and excitement of this seascape type.

Type 2: Rocky Coastline with Open Sea Views

14.4.2.45 **Location within Study Area**: Caithness, Sutherland, Moray and Aberdeenshire coasts.

14.4.2.46 **Physical characteristics:** Long straight stretches of coastline with cliffs rising to some 30 m height and often with a raised beach edge. There are few significant headlands although geological differences create variety with softer sandstone forming an indented coast with bays and inlets, arches and caves; harder volcanic rocks producing a more resistant coastline of promontories, low cliffs and rocky shoreline. Notable blow holes on the north east coast. Productive arable farming occurs up to the cliff edge and tree cover is minimal. Compact fishing villages are located at the base of cliffs in small bays while castles and cliff top forts occur on dramatic headland locations, and are highlighted against the simple sea backdrop. These settlements and built features appear to be spaced at even intervals and thus provide a visual rhythm of foci along the coast. Views over the North Sea are generally wide and open, although parts of the Caithness coast have views of Hoy over the Pentland Firth. Shipping is a common feature seen out to sea. Some isolated industry occurs along this coast (for example: the pipeline fabrication facility in Sinclair’s Bay).

14.4.2.47 **Experiential qualities:** Exposed coastline with open views and strong historical associations of castles and cliff top forts and cultural interest of fishing villages. These coastlines are of geological and ecological interest and support nesting birds. While these are exposed seascapes, their agricultural hinterland, the presence of settlement and nearby roads and also views of shipping, offshore wind turbines and occasional industry, limits the sense of wildness likely to be experienced.

Type 3: Mainland Deposition Coastline with Open Views

14.4.2.48 **Location within Study Area**: East Caithness and Morayshire coasts.

14.4.2.49 **Physical characteristics:** Low sections of coast comprising long, sweeping curved sandy beaches, often backed by dunes and forming a soft linear edge to the sea. This type tends to have a simple horizontal visual composition of sky, sea and land. Grassland and gorse occurs behind dunes and this is backed in turn by flat, mixed or arable farmland. Some areas of dunes are reserved for military live firing. Golf courses occur within this type and settlements are located within farmland. Larger settlements are popular holiday and golf resorts. Views are long and expansive along beaches and uninterrupted, although low level, views occur over the North Sea. Ships and from some locations, oil platforms, are commonly seen at sea.

14.4.2.50 **Experiential qualities:** This type is often located within relatively well–populated areas and beaches are an important recreational resource. The straightness of the coast and open views of the sea give a degree of exposure. The northern coastal light can often accentuate particular textures, shapes and colours. This type has a dynamic character – both physically and experientially – visible in the migration of sand and the constantly changing character of the sea and passing weather systems.

Type 4: Outer Firths

14.4.2.51 **Location within Study Area:** Outer Moray Firth, Morayshire coast.

14.4.2.52 **Physical characteristics:** Sandy beaches interspersed with low rocky headlands. Backed by broader agricultural plains, views are often restricted by coastal forestry located on dune systems. Relatively well populated with small towns and villages along coast, some of these comprising small holiday resorts. Golf courses are located on links and dunes backing coast. Occasional industry and roads and railways are aligned parallel to the coast. Islands are occasional features in views over the Moray Firth. Land on either side of the Firth is a focus common to this type, with settlements, and often masts and other infrastructure located on ridges, forming significant features in views. The profile of land on the opposite side of the Firth tends to flatten due to both the distance and often subtle topography. The Outer Firth contains major shipping routes.

14.4.2.53 **Experiential qualities:** The containment of the Firth, where land is visible and provides shelter, generally gives a less exposed and dramatic seascape. The sense of enclosure is weakened further to the east of the Moray Firth where the Firth suddenly broadens and land flattens creating a more open seascape. The presence of ships, rigs, settlements (particularly visible at night) and other built features and well farmed hinterland gives this type a developed character away from the open sea.

Type 6: Narrow Coastal Shelf

14.4.2.54 **Location within Study Area:** East Sutherland Coast between Golspie and north of Helmsdale.

14.4.2.55 **Physical characteristics:** Predominantly rocky but 'straight' coastline, backed by a narrow corridor of level land tightly constricted by inland hills and the open sea, creating a distinctly linear space. The coastal shelf forms an important corridor for communications including major roads, railway lines and power lines. Steep sided narrow glens intersect the coastal shelf and these are often wooded. The coastal shelf is largely utilised for agriculture due to favourable drainage and soils.

14.4.2.56 In Sutherland, crofts are often located in a linear fashion parallel to the coast. This type is generally sparsely settled with small harbour settlements situated on inlets; and with historic churches, harbours and houses within these settlements forming foci. Views focus on open sea with some offshore wind farm visibility.

14.4.2.57 **Experiential qualities:** The Coastal Shelf can feel remote due to the containment of inland hills / coastal scarp, although communications often are aligned close to or within this type. Views directed over sea rather than hinterland due to the presence of steep hills inland.

Terrestrial Landscape Character Types

14.4.2.58 The Study Area covers a sizeable area covering the Moray Firth, its adjacent coastline in Caithness, Sutherland, Ross and Cromarty, Morayshire and Aberdeenshire. The existing terrestrial SNH character assessment for Caithness, Moray and Nairn, and Banff and Buchan cover the coastal parts of the Study Area (Caithness and Sutherland LCA (SNH, 1998); Inner Moray Firth (SNH, 1998); Moray and Nairn LCA (SNH, 1998); and Banff and Buchan LCA (1997)). These reviews divide the landscape into tracts that are generally referred to as landscape character types. Character descriptions may also be informed by the onshore wind farm capacity work that has been carried out in Moray and Aberdeenshire.

14.4.2.59 For the purposes of this assessment, Landscape Types provide an overview of the landscape of the Study Area and describe where the sea or coast influence or define the characteristics of the landscape. Volume 3a - Figure 14.4.4 identifies all of the Landscape Types within the Study Area.

14.4.2.60 Landscape types situated along or near to the coast directly inform the definition of Coastal Character Areas, where the sea or coast provide the defining characteristics. Other landscape types near the coast are influenced by the sea, but the sea and coast do not provide the defining characteristic. These landscape character types are listed, along with a summary of their key characteristics in Table 14.4.2 below.

14.4.2.61 All other landscape types in the Study Area shown in Volume 3a - Figure 14.4.4, but not listed in Table 14.4.2 below have limited influence on the coastal characterisation. Located further inland, they have little or no relationship with the coast and the sea is not a characteristic element. Therefore, due to their lesser relationship with the sea their character is assessed as being unlikely to be significantly affected by changes that occur at a substantial distance out to sea. Effects on such terrestrial Landscape Character Types (LCTs) are not assessed further within the SLVIA.

Table 14.4.2: Landscape Character Types Defined or Influenced by the Sea			
Landscape Character Assessment	**Landscape Type Defined or Influenced by the Sea**	**Location**	**Summary of Key Characteristics**
Caithness and Sutherland (SNH Review No. 103)	11. High Cliffs and Sheltered Bays	North and north–east coast of Caithness	Long narrow exposed stretches of very high cliffs interrupted by bays at glen intersections. Stacks, caves, pebbles and collapsed cliffs views directed along coast and out to sea focusing on islands, rigs and boats. Backed by moorland or small farms / crofts. Road aligned parallel to coast. Access and views to coast restricted due to cliffs.
	16. Long Beaches Dunes and Links	East Caithness and Sutherland (Sinclair's Bay, Brora Bays)	Soft linear edge to sea. Wide open space, extensive visibility. Recreation / golf links / caravan parks. May be backed by farmland or settlements.
	6. Coastal Shelf	East Caithness Coast (near Helmsdale, Lothbeg and Golspie)	Elevated platform, linear semi–enclosed by inland hills thus directing views out to sea. Transport corridor / small settlements and often farmed.
	21. Open Intensive Farmland	North East Caithness (near Wick)	Characteristics of clear light quality, exposure to extreme weather conditions and extensive views are augmented in areas located near the coast.
	17. Mixed Agriculture and Settlement	North Caithness coast	Edged in some places by high cliffs and bays or long beaches, dunes and links. Open vistas generally edged by the distant horizon of the sea or distinctive profiles of far– away hills. Clear skies and light allow some sense of direction to be gained from the distinct character of the sea.
	23. Small Farms and Crofts	North and East Caithness, East Sutherland, Ross and Cromarty	Nature of the sea and the coastline strongly influences the areas that lie adjacent to the coast. The land division tends to relate directly to the coastal edge. Influenced by the sea, clarity of coastal light, the activity and sound of the waves, strong wind and sea birds.
	9. Harbour	Wick, Dunbeath, Latheronwheel, Helmsdale	Harbours create a focus in the landscape – where the sea abuts the land against high harbour walls. Mainly located where a glen intersects the coastline or at the edge of a bay. Most activity within this character type is sea based – the level of this varying. Rich assortment of experiential characteristics associated with the combination of sea, land and human activity.
	18. Moorland Slopes	East Caithness and Sutherland	The coastline is generally not visible because of the convex slope of the landform.

Table 14.4.2: Landscape Character Types Defined or Influenced by the Sea			
Landscape Character Assessment	**Landscape Type Defined or Influenced by the Sea**	**Location**	**Summary of Key Characteristics**
	and Hills		Variable landform allows distant views of the sea and its bays further along the coast.
	25. Sweeping Moorland	Interior Sutherland and interior and coastal Caithness.	Sometimes forms a raised shelf or plateau near to the sea, running adjacent to the high cliffs and sheltered bays LCT. In such locations, coastline is often not visible from inland areas, resulting in an experience of surprise when the sea is finally viewed and heard upon arrival.
Inner Moray Firth (SNH Review No. 90)	20. Open Firth	Morrich More	Flat to gently undulating coastal edge gently shelving into water with tidal changes exposing vast stretches of sand and shingle beaches. Wide panoramic views, with a dominance of sea/sky horizon and a lack of prominent visual foci. Low angle views foreshorten the expanse of sea with the opposite coastline appearing as a pale band receding into the sea/sky horizon. There is a sense of great space and distance. The absence of built form increases the experience of isolation and openness.
	19. Open Farmed Slopes	Tarbat Ness promontory	Main roads within this character type tend to follow the break of slope giving extensive panoramic views over the landscape towards distant mountains and coastline.
	10. Hard Coastal Shore	South-eastern coast of Tarbat Ness promontory	Sharp steep transition between land and sea. Generally, a raised beach is backed by old red sandstone cliffs. From the higher elevation of the cliff tops, views out are extensive. The great area of sea visible, increases the perception of scale. Looking out to sea from the cliff, the actual shoreline is hidden from view, this deceives our sense of distance and proximity to the shoreline. Strongly natural landscape dominated by the rugged nature of the vertical, irregular coastline, and dynamic qualities of the sea, and birds nesting and roosting on the cliffs.
Moray and Nairn (SNH Review No. 101)	2. Coastal	Moray coast	Narrow strip expanding at the mouths of the major rivers. From soft coastal shore of mud flats, salt marsh and beaches character is dominated by Moray Firth as views are focused across the Firth to the Black Isle, Sutherland and Caithness. Many long distance views east and west along the coast to prominent features.

Table 14.4.2: Landscape Character Types Defined or Influenced by the Sea			
Landscape Character Assessment	**Landscape Type Defined or Influenced by the Sea**	**Location**	**Summary of Key Characteristics**
			Hard coastal shore consists of irregular coastal edge of relatively remote, small coves and beaches backed by sandstone cliffs. Cliffs to south focus views out over the Firth and distant land on the horizon. Cliffs partially screen the rocky foreshore from the south.
	5. Coastal Lowlands	Moray coast and hinterland	Flat to gently undulating, large-scale plain, borders the coastal LCT and narrows to the east.
Banff and Buchan (SNH Review No. 37)	26. The Coast	Aberdeenshire	Coastal strip dominated by well-defined cliff-edged headlands, frequently fissured and bitten into by narrow inlets, and more rarely, hugging sheltered sandy bays. Overall impression of an open, large-scale landscape, the wide expanses of sea and sky merging into one at the uninterrupted horizon line. Wealth of the seas has encouraged frequent settlement.
	3. Coastal Farmland	Aberdeenshire	A variety of strikingly different landscapes influenced by their varied proximity of the sea. Defined by high, cliff edged headlands and lower dune-fringed coastal plains. Even when views to the sea are not possible one is always aware of its presence nearby. Infrequent and rounded hills allow glimpses of the sea. Boggier parts of the plains planted with coniferous forestry combined with large, arable fields giving way to pasture. Despite the proximity of this area to the sea, and the frequent views of it from hillsides, the substantial amount of forestry lessens the coastal influence.

Regional Coastal Character Areas

14.4.2.62 Using the layers of desk information available on National Coastal Character Types and terrestrial Landscape Character Types, together with detailed site survey information and in accordance with Guidance on Coastal Character Assessment (SNH, 2017), Regional Coastal Character Areas (RCCAs) within the Study Area are defined in Table 14.4.3 below and mapped in Volume 3a - Figures 14.4.6 a-h. The coastline within the Study Area is characterised by 23 RCCAs. The baseline coastal character is described in Section 14.7 for the RCCAs where their key characteristics and features may be influenced significantly by the Development, alongside the sensitivity analysis and assessment of effects.

Table 14.4.3: Regional Coastal Character Areas	
Regional Coastal Character Area	**Location**
A. Gills Bay and John O' Groats	Gills Bay and adjacent coast between St John's Point and Duncansby Head
B. Duncansby Head	Eastern coast of Duncansby Head
C. Freswick Bay and Nybster Coast	Freswick Bay between Skirza Head and Ness Head
D. Sinclair's Bay	Sinclair's Bay between Keiss and Noss Head
E. Noss Head	Coastline around Noss Head between Castle Sinclair and Wick Bay
F. Wick Bay	Wick Bay between Staxigoe and Castle of Old Wick
G. Sarclet Head	Coastline round Sarclet Head between Wick Bay and Lybster Bay
H. Lybster Bay	Lybster Bay and adjacent coast
I. Dunbeath Bay	Coastline between Berriedale and Latheronwheel, encompassing Dunbeath Bay
J. Helmsdale to Berriedale Coastal Shelf	Coastal shelf between Berriedale and Helmsdale
K. Brora to Helmsdale Deposition Coast	Coastal shelf between Brora and Helmsdale
L. Dunrobin Bay	Dunrobin Bay between Strathsteven and Golspie
M. Golspie, Embo and Dornoch Coast	Coastline between Golspie and the Dornoch Firth
N. Whiteness to Portmahomack Coast	Coastline between the Dornoch Firth and Portmahomack
O. Tarbat Ness to North Sutor Coast	Coastline between Portmahomack and North Sutor
P. Burghead to Nairn Coast	Coastline between Nairn and Burghead
Q. Lossiemouth to Burghead Coast	Coastline between Burghead and Lossiemouth
R. Spey Bay	Spey Bay between Lossiemouth and Portgordon
S. Portgordon to Portnockie Coast	Coastline between Portgordon and Portnockie
T. Cullen Bay	Culen Bay between Portnockie and Logie Head
U. Sandend Bay	Sandend Bay between Logie Head and East Head
V. Boyne Bay	Boyne Bay between East Head and Whitehills
W. Boyndie Bay	Boyndie Bay between Whitehills and Banff

Landscape planning designations and wild land areas

14.4.2.63 Within the Study Area there are a number of landscape planning designations that heighten the sensitivity of the seascape, landscape and visual environment and receptors as listed in Table 14.4.4 and shown on Volume 3a - Figure 14.4.7: Landscape Planning Designations. The baseline character is described in Section 14.7 for the landscape planning designations and wild land areas where their key characteristics and features may be influenced significantly by the Development, alongside the sensitivity analysis and assessment of effects.

Table 14.4.4: Landscape Planning Designations in the Study Area	
Designating Authority	**Designation**
Scottish Natural Heritage	Dornoch Firth National Scenic Area
Historic Environment Scotland	Dunbeath Castle Garden and Designed Landscape (GDL)
	Dunrobin Castle GDL
	House of the Geanies GDL
	Innes House GDL
	Cullen House GDL
	Gordon Castle (Bog of Gight) GDL
	Grant Park and Clunie Hill GDL
The Highland Council	Flow Country and Berriedale Coast Special Landscape Area (SLA)
	Loch Fleet, Loch Brora and Glen Loth SLA
	Ben Griam and Loch nan Clar SLA
	Duncansby Head SLA
Moray Council	Moray Area of Great Landscape Value (AGLV) centred on Hill of the Wangie
	Moray AGLV around the Spey Valley
Aberdeenshire Council	North Aberdeenshire Coast SLA

14.4.2.64 SNH has defined Wild Land Areas as shown on Volume 3a - Figure 14.4.8: Wild Land Areas. Those lying within the Study Area are:

- 35. Ben Klibreck- Armine Forest
- 36. Causeymire-Knockfin Flows
- 39. East Halladale Flows

Cumulative Wind Farms

14.4.2.65 Volume 3a - Figure 14.8.1 shows the locations of the operational and under construction cumulative wind farms within the 50 km radius Study Area. These wind farms are included in the baseline assessment and shown in the cumulative wirelines for each viewpoint. BOWL has been added as a photomontage to the baseline photographs.

14.4.2.66 Further information about the scale and status of these wind farms is included in Section 14.8.

14.4.2.67 Operational, smaller scale turbines (less than 50 m to blade tip) have not been mapped but may be considered in the assessments where they form part of the baseline landscape. The cumulative wirelines do not show onshore wind farms where they are located at distances of over 50 km from the viewpoint. This is in order to avoid unnecessary confusion within the views where it is unlikely that such wind farms would contribute notably to the cumulative context.

14.4.2.68 The Beatrice Demonstrator turbines and the Beatrice Oil Platforms are part of the baseline. However, it is understood that the turbines and the associated oil platforms would be removed during the early years of the Development's operation. Their concurrent operation and decommissioning with the construction/operation of the Development has not been included in the cumulative assessment. This is because such effects are likely to occur for a relatively short time at a long distance from the visual receptors. This approach has been agreed with SNH.

14.4.2.69 In the assessment BOWL is included as part of the baseline receiving seascape for the Development. Although it is not fully constructed at the time of the assessment, some foundations are seen above sea level and it seems very likely that it will be constructed and become operational within the consenting period of the Development. The layout co-ordinates and dimensions for the turbines are as contained in the Development Specification and Layout Plan (DSLP) (BOWL, Jan 2016). The lighting information used in this assessment has been drawn from the BOWL Lighting and Marking Plan, BOWL (Nov 2016).

14.4.3 Future Baseline

14.4.3.1 The consented Moray East now has CfD funding and is moving towards a revised layout based on further investigations and technical/economic factors. It is intended that the actual layout will be confirmed via Moray East DSLP in early 2018. However, at this stage it is known that the changes to the layout are likely to include development of the Moray East as a single development, with reduced turbine numbers and turbines of 197 m to tip. Until the DSLP submission is made there is no certainty over what this layout will be and therefore the cumulative assessment contained in Section 14.8 includes the consented Moray East as part of the main cumulative assessment. In the cumulative SLVIA this is assessed as being the WCS included in the Moray East ES (2012), which included the three consented wind farm sites (Telford, Stevenson and MacColl) in Layout 4c with 216 turbines of 204 m to tip.

14.4.3.2 Moray East has issued an interim, more likely Moray East Current Base Case Layout, which provides the basis for a secondary assessment of the effect of the Development included in this SLVIA, in the context of BOWL and Moray East Offshore. Wirelines illustrating this more likely layout are contained in Volume 3b (SLVIA Visualisations) - Technical Appendix 14.4: Assessment and Cumulative Wirelines Illustrating Moray East Current Base Case Layout.

14.4.3.3 Consented onshore and offshore wind farms may be constructed and are therefore included in the cumulative assessment; however, it is anticipated that a number of the consented onshore wind farms may not be built. This is due to the UK Government's withdrawal of financial assistance and therefore they may not be financially viable.

14.4.3.4 Oil and gas installations may be brought in from the North Sea so that they may become more visible from coastal areas or in the case of the Beatrice Oil Field may no longer be a feature of sea views.

14.4.3.5 Changes around harbours may include facilities for the maintenance and construction of offshore renewable energy installations.

14.4.3.6 Further tree planting may be encouraged through changes in policy and peat restoration may take place in order to increase carbon capture.

14.4.3.7 Road improvements and tourism facilities may become more widespread through the encouragement of visitors along the North Coast 500 route.

14.5 Assessment Methodology

14.5.1 Assessment Approach

14.5.1.1 The methodology is set out in detail in Volume 4 - Technical Appendix 14.1: SLVIA Methodology. The methodology used to carry out the SLVIA has been developed by Optimised Environments Ltd (OPEN) for the SLVIA of wind farms and draws on guidance from several other reference documents listed in Section 14.2.

14.5.1.2 The SLVIA is based on a Design Envelope approach with worst case scenarios for the different elements of the Development having been agreed with SNH, THC, MC and AC.

14.5.1 Impacts Identified as Requiring Assessment

14.5.1.1 Table 14.5.1 below lists all potential impacts on seascape, landscape and visual receptors identified as requiring consideration as part of the assessment. This list of impacts is based on expert judgement, reflects responses provided by statutory consultees and other stakeholders in the wind farm and OfTI Scoping Opinions and takes into account further comments received as part of ongoing community consultation activities.

Table 14.5.1: Seascape, Landscape and Visual Impacts Requiring Assessment		
Potential Impacts	**Nature of Impact (direct or indirect)**	**Inter-Relationships with Other EIA Topics / Receptors**
Construction Impacts		
Short to medium term, localised effects on the views from the Sandend Bay Regional Coastal Character Area (RCCA) associated with construction activities in the Landfall Area (Findlater Castle to Redhythe Point).	Direct	N/A
Short to medium term effects on distant views from visual and seascape/ landscape character receptors of the Moray West Offshore Wind Farm being constructed in the immediate context of Beatrice Offshore Windfarm Limited (BOWL)	Direct	N/A
Operation and Maintenance (O&M) Impacts		
Long term effects on the perceived character of seascape/ landscape character receptors and distant views from onshore visual receptors of the Development in the context of BOWL.	Direct	Chapter 16: Marine Archaeology and Cultural Heritage
Decommissioning Impacts		
Short term effects on distant views from visual and character receptors of the Development being decommissioned and all above sea level elements removed.	Direct	N/A

Potential Cumulative Impacts

14.5.1.2 BOWL is consented and started construction in April 2017 and is therefore considered to be operational as part of the baseline within the SLVIA for the Development. Once operational, the Development would have an influence on the views obtained from the receptors that are also affected by BOWL. The baseline to which the Development would be added is therefore assumed to include the operational BOWL along with other operational and under construction onshore wind farms.

14.5.2 Scoped Out Impacts

14.5.2.1 Guidance suggests that the SLVIA should focus on impact that may give rise to significant effects. In SLVIA there are no defined thresholds that can be used to inform this. Therefore, preliminary assessment work is carried out to identify effects that can be scoped out of the assessment. This preliminary assessment work is carried out following the collation and review of the baseline information and the generation of ZTVs and representative viewpoint information for the Development.

14.5.2.2 All of the representative viewpoints, mapped on Volume 3a - Figure 14.7.1a-b with the ZTV, are included in the assessment as this work is important in determining and illustrating the threshold of where significant effects on seascape, landscape and visual receptors may arise. The assessment of the effects on the viewpoints has informed the determination of the potential for significant effects on the visual receptors in settlements or using routes as set out below. In addition, the assessment of the effects on viewpoints (Section 14.7) has also informed the preliminary assessment of effects on landscape/seascape character receptors.

14.5.2.3 The scoped out effects identified from the preliminary assessment and rationale for scoping these effects out from further assessment is set out in the following sections.

Preliminary Assessment of Effects on Landscape/ Seascape Character Receptors (Scoped Out Effects)

14.5.2.4 Effects on landscape / seascape character are manifested where the pattern of elements that characterises the landscape / seascape will be altered by the addition of the Development to the seascape and where visibility of the Development may alter the way in which this pattern of elements is perceived.

14.5.2.5 Landscape / seascape character receptors fall into three groups:

- Landscape Character Types (LCTs);
- Regional Coastal Character Areas (RCCAs) (as defined by coastal character assessment); and
- Landscape designations or Wild Land Areas e.g. pSLAs, NSAs, WLAs.

Landscape Character Types

14.5.2.6 Terrestrial LCTs are shown in conjunction with the ZTV in Volume 3a - Figure 14.7.4. This preliminary assessment considers the likely significant effects of the Development on the LCTs in the Study Area and was carried out through a desk study and site survey which examined the characteristics of the LCTs and the visibility of the Development from the LCTs using the ZTV and wirelines.

14.5.2.7 The baseline study and initial assessment identified that LCTs within the Study Area can be described in three categories:

- Landscape types identified along the coast where the sea or coast provide the defining characteristics.
- Landscape types next to the coast that are influenced by the sea, but the sea and coast do not provide the defining characteristic.

- Landscape types located further inland, which have little or no relationship with the coast, where the sea is not a characteristic element and there is limited / no visibility of the Development or it forms a limited part of wide views where numerous intervening or contextual influences arise.

14.5.2.8 Taking into account the increased sensitivity of parts of the LCTs due to their recognised value or wild land characteristics the effect of the Development on the LCTs in the Study Area located within Moray, Aberdeenshire, Highland to the south and west of the River Brora and north of Sarclet Head would be not significant for one of, or a combination of, the following factors:

- Distance between the LCT and the Development;
- The separation of the Development and the LCT by a considerable extent of sea and, in some cases, land;
- The existing characterising influence of BOWL, on LCTs, particularly to the north of Sarclet;
- A range of characterising contextual influences where the Development is only one of these; and
- The strength of character of the LCT itself so that external elements have lesser influence.

14.5.2.9 The effect of the Development on the LCTs located inland in Highland, which have little or no relationship with the coast / sea, and where the Development has limited influence on character through visibility as part of wide views where numerous intervening or contextual influences arise is assessed as not significant. This includes the following inland LCTs because the Development cannot become a characteristic element of the landscape character:

- Strath;
- Flat Peatland;
- Coniferous Woodland Plantation;
- Lone Mountains;
- Agricultural Heartland;
- Inland Loch;
- River Valleys;
- Strath;
- Town;
- Uplands; and
- Urban.

Regional Coastal Character Areas

14.5.2.10 RCCAs are illustrated on Volume 3a - Figures 14.7.5 a-f with the ZTV. The majority of representative viewpoints are located within the RCCAs, however whilst a significant visual effect may arise in relation to the change in view as a result of the Development, it does not follow that a significant effect on character would necessarily arise. It is unlikely, however, that a significant effect on character would arise where significant visual effects are not found to occur.

14.5.2.11 A preliminary assessment of the effect of the Development on RCCAs has been undertaken. This has established that the effect on the RCCAs located in Moray, Aberdeenshire and Highland to the south of the River Brora and north of Sarclet Head would be not significant. This is with the exception of the landfall area where there may be significant, but temporary short to medium term effects during construction that require to be assessed in more detail.

14.5.2.12 This takes into account the increased sensitivity of parts of the RCCAs due to their recognised value or wild land characteristics and is largely as a result of one of or a combination of the following factors:

- Distance between the RCCA and the Development;
- The separation of the Development and the RCCA by a considerable extent of sea and, in some cases, land;
- The existing characterising influence of BOWL, on the RCCA, particularly to the north of Sarclet;
- A range of characterising contextual influences where the Development is only one of these; and
- The strength of character of the RCCA itself so that external elements have lesser influence.

Landscape Planning Designations and Wild Land Areas

14.5.2.13 Landscape Planning Designations and Wild Land Areas are illustrated on Volume 3a - Figure 14.7.6 with the ZTV.

14.5.2.14 A preliminary assessment of the effects on Landscape Planning Designations and WLAs has been undertaken and it has been assessed that the effects on the character of the following receptors would be not significant:

- Dornoch Firth National Scenic Area;
- Ben Griam and Loch nan Clar Highland SLA;
- Duncansby Head Highland SLA;
- Moray AGLV (Hill of the Wangie);
- Moray AGLV (River Spey);
- House of the Geanies GDL;
- Innes House GDL;
- Cullen House GDL;
- Gordon Castle (Bog of Gight) GDL;
- Grant Park and Clunie Hill GDL;
- 39. East Halladale Flows WLA;
- 36. Causeymire – Knockfin Flows; and
- 35. Ben Klibreck – Armine Forest WLA.

14.5.2.15 This takes account of the higher levels of sensitivity attributed to these areas due to their recognised value. It is the relatively low levels of magnitude of change that would occur as a result of the Development that ensure its effects would be not significant. This is as a result of one of or a combination of the following factors:

- No or limited theoretical visibility of the Development as part of the context of the Designation/WLA;
- The distance between the Development and the Landscape Planning Designation or Wild Land Area;

- The separation of the Development and the receptor by a considerable extent of sea and, in some cases, land;
- The key focus/orientation/aspect of the designation is not towards the Development so that other parts of its context are more influential;
- A range of characterising contextual influences where the Development is only one of these and its distance and orientation ensure that it is a relatively minor feature; and
- Actual visibility and therefore influence is reduced by intervening features such as built form and woodland/forestry.

14.5.2.16 In relation to the effects on Wild Land Areas (WLAs) SNH advises on its website that its draft Consultation - Assessing Impacts on Wild Land Areas – Technical Guidance should be used until such times as this document is formally published.

14.5.2.17 The draft guidance states that:

14.5.2.18 'Outwith WLAs, the need for an assessment will be more the exception and may only be necessary where significant effects on WLA qualities are likely.'

14.5.2.19 The closest WLA area to the Development is 36. Causeymire – Knockfin Flows, which lies at a distance of approximately 25 km. The associated SNH (2017) Description of Wild Land Area provides information on the key attributes and qualities of the wild land area. There is no mention of views out to sea within this description.

14.5.2.20 The other WLAs are considerably inland. It has therefore been assessed that there would not be a significant effect on WLAs, although wildness qualities will be considered as part of the characteristics of the character area receptors assessed in more detail, including the Flow Country and Berriedale Coast SLA, which partially coincides with the Causeymire – Knockfin Flows WLA.

14.5.2.21 The effects on the Dornoch Firth NSA are considered in relation to its special qualities as set out in Scottish Natural Heritage (2010). Much of the NSA is enclosed by the surrounding landform whilst at its eastern end, where the Firth meets the wider Moray Firth, this opens out.

14.5.2.22 The special qualities of the National Scenic Areas are set out in SNH (2010) SNH Commissioned Report No.374. These are:

- The contrast between the enclosed west and the expansive east;
- Inhabited surrounds within a wilder backdrop of hills and moors;
- A wide diversity of woodland cover;
- A rich variety of alluvial lands, dunes and links;
- The ever-changing firth;
- The tranquillity of an undeveloped coastline; and
- Migdale, a microcosm of the wider Dornoch Firth.

14.5.2.23 Under the special quality of 'the contrast between the enclosed west and the expansive east' it is noted that 'To the east there is expansiveness where offshore views lead out to sea and a limitless horizon.'

14.5.2.24 It is considered that whilst the Development would be visible from areas of sea and land, primarily at the eastern extents of the NSA (Volume 3a - Figure 14.7.6 and Figure 14.7.1b), this would be at a range of 43 km. The orientation of the Development to the NSA is such that the field of view of the 'limitless horizon' that would be affected would be limited with a wide expanse of sea on either side and in the intervening area.

14.5.2.25 Under the special quality of 'The ever-changing firth' it is noted that 'The reflections off the water and the wet sands, together with wide-open skies, show dramatic changes in colour and texture on a daily and seasonal basis, with light itself the determining factor in the experience'

14.5.2.26 It is considered that this special quality would not be affected by the Development.

Preliminary Assessment of Effects on Concentrations of Visual Receptors (Scoped Out Effects)

14.5.2.27 Volume 3a - Figure 14.7.7 illustrates the blade tip ZTV with concentrations of visual receptors such as settlements, roads, rail routes, LDRs and visitor attractions.

Settlements

14.5.2.28 The settlements considered in the SLVIA are those that have been included in: the proposed Caithness and Sutherland LDP (Proposed CaSPlan) as settlements or growing settlements; the Moray Local Development Plan Spatial Strategy as Primary Centres, Secondary Centres or Third Tier Settlements; and the Identified Settlements in the Aberdeenshire LDP.

14.5.2.29 The preliminary assessment has found that there would be no significant effects during construction, operation and decommissioning or cumulatively on people living in the following settlements:

- Highland - John o'Groats, Keiss, Watten, Halkirk, Brora, Golspie, Embo, Dornoch and Portmahomack;
- Moray – Portknockie, Cullen, Findhorn, Kinloss, Cummingston, Hopeman, Burghead, Lhanbryde, Elgin, Urquhart, Portgordon, Garmouth, Kingston, Buckie, Forres, Fochabers, Mosstodloch, Lossiemouth, Findochty, Duffus, Alves and Embo; and
- Aberdeenshire – Banff, Whitehills, Fordyce and Portsoy.

14.5.2.30 This assessment takes account of the medium to high or high levels of sensitivity generally attributed to the people in settlements (see Volume 4 - Technical Appendix 14.1: SLVIA Methodology) and is largely due to either no theoretical visibility, such as in the case of John o'Groats or limited levels of magnitude of change in views due to the Development. This may arise due to the more prominent visibility of BOWL in views, the predominant orientation of a settlement so that views are not directed towards the Development, the distance between the settlement and the Development or the field of view affected by it as a component of the wider contextual views. In most cases it is a combination of these factors.

Roads

14.5.2.31 A preliminary assessment of the visual effect on people using roads during construction, operation and decommissioning has found that there would be no significant effect on people using roads within Moray and Aberdeenshire or the A897, A882, A836, B870, B876, B874 and B9165 in Highland. In addition, significant effects would not arise on views from the A9 south west of Brora or north of Spittal. The consideration of the A9 between Latheron and Spittal is to take account of the sequential cumulative effects in the context of the wind farm cluster around Causeymire, south of Spittal.

14.5.2.32 This takes into account the transient nature of road users and their generally more moderate levels of sensitivity. However, this finding is largely as a result of the people using the roads having no visibility such as the A897, limited extents of the route that have theoretical visibility and the relatively low levels of magnitude of change in the views due to distance, the more prominent visibility of BOWL in views, the predominant orientation of a route so that views are not directed towards the Development, the incidence of intervening landscape features or the field of view affected by the Development as a component of the wider contextual views. In most cases it is a combination of these factors.

Rail Lines

14.5.2.33 The preliminary assessment of the effects on people travelling by train within the Study Area takes into account the transient nature of rail users and their more moderate levels of sensitivity. It has found that there would be no significant visual effects on people travelling on trains on the Far North Line between Wick and Helmsdale or south west of Brora. The effect on rail travellers on the Aberdeen – Inverness rail line would be not significant.

14.5.2.34 This is due largely to a combination of limited areas lying within the ZTV and distance between the rail lines and the Development.

Long Distance Routes

14.5.2.35 The preliminary assessment has found that there will be no significant visual effect on people using NCR 1 in Highland as there would be no visibility of the Development from this section of the route.

14.5.2.36 NCR 1 passes through Moray and Aberdeenshire between Forres in the south-west, Elgin, Portnockie, Buckie and Cullen before heading south-east to Fordyce and then north to the coast where it runs through Portsoy and Bamff before leaving the Study Area. The preliminary assessment has found that there would be no significant effects on people using NCR 1 along the route. Whilst the Development would be visible from sections of the route, its distance and separation by a large expanse of sea as well as the limited horizontal and vertical fields of view affected (as part of what are generally wide, expansive views) ensures that such visibility is not of sufficient magnitude to have a significant effect on cyclists.

14.5.2.37 The preliminary assessment has considered the relatively higher sensitivity of walkers using the Moray Coast trail between Findhorn and Cullen and has found that there would not be a significant effect on the views of walkers using this route. This is largely as a result of the relatively low levels of magnitude of change in the views primarily due to distance and separation, the incidence of close range features of interest that often offer an alternative focus to views and the field of view affected by the Development as a component of the wider contextual views. In most cases it is a combination of these factors.

Attractions and Visitor Facilities

14.5.2.38 Attractions and Visitor Facilities of note, which may be significantly affected are included in the assessment of viewpoints and other receptors.

Night Time Effects

14.5.2.39 In addition to high intensity lighting required for aviation, low intensity lighting in different colours and positions on the turbines and OSPs is also required for operations, maintenance, navigation and aviation purposes. However, the effects of the low intensity lights on the Development on seascape/landscape character receptors has been scoped out of the assessment since these low intensity lights would not be seen by people on the coast.

14.5.2.40 The night time effects of the medium intensity aviation lighting of the Development on landscape, seascape and coastal character have been scoped out of the SLVIA, since the baseline character of these receptors formed by the pattern and distribution of landscape elements, is not apparent at night time.

14.5.3 Assessment of Potential Effects

14.5.3.1 The significance of the effect on visual and character receptors is dependent on the multiple factors considered in determining the sensitivity and the magnitude of change and by applying professional judgement to assess whether or not the Development would have an effect that is significant or not significant.

14.5.3.2 A significant effect occurs where the Development will provide a defining influence on a landscape element, landscape character receptor or view. A not significant effect occurs where the effect of the Development is not defining, and the baseline characteristics of the landscape element, landscape character receptor, view or visual receptor continue to provide the definitive influence. In this instance a not significant effect would indicate that the Development may have an influence but this influence will not be defining.

14.5.3.3 This assessment assumes clear weather and optimum viewing conditions. This means that effects that are assessed to be significant may be not-significant under different, less clear conditions. Viewing conditions and visibility have been found to vary widely within the Study Area, and the effects of the Development will vary greatly according to the weather and time of day.

Sensitivity Criteria

14.5.3.4 Sensitivity is an expression of the ability of a landscape element, landscape character receptor, view or visual receptor to accommodate the Development, and is dependent on baseline characteristics including its susceptibility to change, value, quality, importance, the nature of the viewer, and existing character. The criteria differs depending on the receptor being considered and therefore reference should be made to Volume 4 - Technical Appendix 14.1: SLVIA Methodology for further information.

Magnitude of Change

14.5.3.5 Magnitude of change is an expression of the scale of the change on landscape elements, landscape character receptors and visual receptors that will result from the Development. Geographical extent and duration/reversibility will also be taken into account.

14.5.3.6 The key elements of the Development that will influence the level of change are the distance, movement, form, material, colour and scale of the WTGs, although the transmission infrastructure is also considered.

14.5.3.7 The criteria used to define the levels of magnitude varies depending on the type of receptor being considered. Reference should be made to Volume 4 - Technical Appendix 14.1 for this information.

Significance Criteria

14.5.3.8 The significance of effects will be assessed through a combination of two considerations; (i) the sensitivity of the landscape element, character receptor, view or visual receptor, and (ii) the magnitude of change that will result from the introduction of the Development.

14.5.3.9 The approach to determining effect significance requires the application of professional judgement in accordance with GLVIA3. Although it is not reliant on the use of a matrix, the following matrix in Table 14.5.2 has been included to illustrate how combinations of the ratings for sensitivity and magnitude of change can give rise to significant effects, as well as to give an understanding of the threshold at which significant effects may arise. This approach to identifying significant effects is in line with the requirements of the Marine Works (Environmental Impact Assessment) (Scotland) Regulations 2017, the Marine Works (Environmental Impact Assessment) Regulations 2007 and the Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017.

Table 14.5.2: Effect Significance Criteria					
Magnitude	**Sensitivity**				
	High	**High-Medium**	**Medium**	**Medium-Low**	**Low**
High	Significant	Significant	Significant	Significant or Not significant	Significant or Not significant
High-Medium	Significant	Significant	Significant or Not significant	Significant or Not significant	Not significant
Medium	Significant	Significant or Not significant	Significant or Not significant	Not significant	Not significant
Medium-Low	Significant or Not significant	Significant or Not significant	Not significant	Not significant	Not significant
Low	Not significant	Not significant	Not significant	Not significant	Not significant
Negligible/none	Not significant	Not significant	Not significant	Not significant	Not significant

14.5.3.10 Combinations of higher magnitude and sensitivity are generally assessed as significant effects in terms of the requirements of the EIA Regulations. Combinations of lower levels of magnitude and sensitivity are generally assessed as not significant.

14.5.3.11 It should be noted however that intermediate combinations may be significant, or not significant, depending on the specific factors and effect that is assessed in respect of a particular landscape or visual receptor. In accordance with the GLVIA3 (paragraph 6.43), experienced professional judgement is applied to the assessment of all effects and reasoned argument is presented in respect of the findings in each case.

14.5.3.12 Following this process, it is assessed whether such an impact is positive, negative or neutral; whether it is permanent or reversible; long, medium or short term; and over what geographical extent this may occur.

14.5.4 Data Limitations

14.5.4.1 Limitations are set out in Volume 4 - Technical Appendix 14.1: SLVIA Methodology.

14.6 Design Envelope Parameters

14.6.1 Realistic Worst Case Design Scenario

14.6.1.1 As identified in Chapter 4: Development Description, Moray West is considering a range of potential construction methods and design options for the Development. The Design Envelope presented in Chapter 4 represents the maximum design parameters for each of the options under consideration e.g. substructure type or turbine model.

14.6.1.2 In order to determine potential impacts of the various options it is necessary to define the ‘realistic worst case scenario’. The realistic worst case scenario represents, for any given receptor and potential impact on that receptor, various options in the Design Envelope that would result in the greatest potential for change to the receptor in question.

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

14.6.1.4 Table 14.6.1 presents the realistic worst case scenario for potential impacts on SLVIA during construction, operational and maintenance and decommissioning phases of the Development and provides justification as to why the options and design parameters identified are considered to be the realistic worst case scenario.

WTG Layout

14.6.1.5 The following general assumptions are made with regards to the worst case scenario layout for SLVIA:

- Turbines laid out in grid spacing, where rows are aligned both down and cross wind. The cross wind rows would be aligned perpendicular to the predominant wind direction which is 230 degrees plus or minus 10 degrees (with due north as 0 degrees). The worst case alignment within these parameters would be where the rows are aligned perpendicular to the closest section of the Caithness coast. This is due to the potential for turbine stacking in views from these locations; and
- Minimum turbine spacing of 1,200 m downwind and 1,050 m crosswind.

14.6.1.6 The export cables from BOWL, once installed, will also route through the central section of the Moray West Site on a north south alignment. Consequently, this will result in an area where larger turbine spacing would be required within the layout in order to avoid these cables.

14.6.1.7 With the exception of the BOWL cable corridor, turbines may be installed anywhere within the Moray West Site. However, due to technical or environmental constraints, certain areas within wind farm sites may not be developed. As such the effective site boundary may be reduced and the layouts assessed here have considered the maximum site boundaries.

14.6.1.8 The WTG height will be consistent across the Moray West Site.

14.6.1.9 The SLVIA layout scenarios considered and reviewed with SNH, THC, MC and AC are described below and the layouts shown in Volume 3a - Figures 14.6.1:

- Model 2 – 85 WTG in a grid layout. Turbines of up to 230 m to tip. This layout and turbine height equate to the scenario with the greatest number of the tallest turbines considered at this density;
- Model 3 – 72 WTG in a grid layout. Turbines of up to 265 m to tip. This layout and turbine height equate to an intermediate height and density of turbines;
- Model 4a - 41 WTG in a grid layout. Turbines of up to 285 m to tip. This layout and turbine height equates to the scenario with the lowest number of turbines at the tallest turbine height. It was considered as a possible WCS due to the divergence in the layout spacing (as well as height) when compared with the adjacent, more tightly packed BOWL and Moray East developments; and
- Model 4f - 62 WTG in a grid layout. Turbines of up to 285 m to tip. This layout and turbine height equate to the scenario with the greatest number of the tallest turbines considered at this density.

14.6.1.10 During initial work on potential layouts, layouts with a packed boundary (Models 4d and 4e) were also included for consideration. However, following initial consultation on these layouts and further internal discussion with Moray West engineers it was determined that these layouts would not be taken forward and therefore are not considered further.

14.6.1.11 It was determined and agreed through consultation that the worst case scenario for daytime assessment would be the Model 4f layout. This layout has also been assessed for night time effects. The Model 2 layout has also been considered in the night time assessment to illustrate the potential additional lighting that would be visible due to the greater number of turbines.

14.6.1.12 Visualisations illustrating the worst case scenarios for the Model 2 and Model 3 layouts have been included as cumulative wirelines for Viewpoint 3: Wick (path south of South View); Viewpoint 7: Lybster (end of Main Street); Viewpoint 9a: Dunbeath (nr Heritage Centre); Viewpoint 12: Navidale; and Viewpoint 16: Lossiemouth Harbour. These are included in Volume 3b after each of the other viewpoint figures.

Foundation Substructure

14.6.1.13 The worst case for the SLVIA assumes that the substructure design will be a jacket substructure. Field survey and experience of the visual effects of existing offshore wind farms suggests that jacket foundations are worst case for visual impacts. However, given the distance that the Development will lie from the coast, this will not affect the judgements made in this assessment with respect to the magnitude and significance of effect on land-based receptors and therefore jacket foundations are not shown in the visualisations. This is consistent with the approach taken in the BOWL ES (2012), where the turbines are at a similar distance to the coast. The foundation substructures are assumed to have a working platform and tower interface, where the tower connects with the jacket foundation structure. The interface level (above LAT) between the substructure and the WTG is assumed to be approximately 20 m above LAT, which is similar to other projects and a realistic assumption. The jacket foundations are assumed to have four sides and four legs, supported in a lattice tower arrangement. The foundation substructures will be painted yellow for navigational marking and this is illustrated in the photomontages.

Offshore Substation Platforms Assumptions (including foundation substructure)

14.6.1.14 Indicative locations of the OSPs have been assumed for the SLVIA. Sites for two OSPs have been located in likely positions within the Moray West Site. There may only be a requirement for one OSP which would be located more centrally within the wind farm. The dimensions of one large OSP would be as follows:

- Maximum platform length of 100 m, platform width of 100 m and platform height 70 m.

14.6.1.15 The maximum height of 70 m is the total height of the topside structure (the substation 'box') and visible jacket foundations/air gap, above LAT. The SLVIA assumes that the interface level (the height of visible jacket structures above water) is approximately 20 m above LAT and the height of the topside structure is 50 m.

14.6.1.16 The jacket or jack-up foundations for the OSPs will have four sides and be up to 8 legged (for one large OSP), supported in a lattice tower arrangement and painted yellow for navigational marking. The effect of the OSPs in the context of the Development is assessed in Section 14.7.

Lighting

14.6.1.17 Offshore structures will be marked in order to meet the requirements of navigation and aviation standards. Specific requirements for aviation and navigational lighting will be agreed with the relevant stakeholders post-consent and prior to construction.

14.6.1.18 The aviation lighting are likely to require medium intensity (2000 candela), flashing (morse code 'W') red lights located on the turbine hubs of the peripheral turbines in the layout. These lights may be visible from the coast. The intensity of these lights would reduce to low intensity (200 candela) during suitable visibility conditions.

14.6.1.19 Two different scenarios have been considered in the assessment of night time effects. These are the tallest turbines in their greatest number (Model 4f) and the largest number of turbines at their tallest height (Model 2), which would have more lit turbines than Model 4f but at a lower level and therefore having a less widespread influence. Volume 3a - Figure 14.6.2 illustrates the turbines that would be lit in each of these scenarios. Volume 3a - Figure 14.7.1c illustrates the comparison in the areas potentially affected by lighting at the hub heights of the Model 2 and Model 4f layouts.

14.6.1.20 Whilst low intensity lighting would also be fixed to the turbines and OSPs for navigation and aviation purposes it is assessed that from the shore these are unlikely to be visible at the distances proposed and therefore these lights have been excluded from the SLVIA and visualisations.

Table 14.6.1: Design Envelope Parameters Relevant to the Seascape Landscape and Visual Impact Assessment		
Potential Impact	**Realistic Worst Case Scenario**	**Justification**
Construction		
Short to medium term impact on visual receptors (daytime).	Construction of turbine layout scenario – 4f (based on 62 x Model 4 WTGs). Jacket foundations. 2 x OSPs. HDD/Open Cut Trench activities within the Landfall Area and presence of construction vessels offshore from the Landfall (1 x cable lay vessel and up to 3 x support / guard vessels).	The worst case scenario during construction from most visual receptors would be when large numbers of the tallest turbines are in place in addition to concentrations of activity in the form of marine vessels and cranes. In the vicinity of the landfall close range views of the HDD vessels from local visual receptors is likely to be worse than more distant views of the Moray West Offshore Wind Farm under construction.
Short to medium term impact on visual receptors (night time).	Construction of turbine layout scenarios – 2 (85 x Model 2 WTGs) and 4f (62 x Model 4 WTGs). Jacket foundations. 2 x OSPs. HDD/Open Cut Trench activities within the Landfall Area and presence of construction vessels offshore from the Landfall (1 x cable lay vessel and up to 3 x support / guard vessels).	The worst case scenario during construction from most visual receptors would be when large numbers of the WTGs foundations are temporarily lit in addition to concentrations of activity in the form of marine vessels and cranes with lighting. In the vicinity of the landfall close range views of the HDD vessels (when lit) from local visual receptors is likely to be worse than more distant views of the lighting of the Moray West Offshore Wind Farm under construction.
Short to medium term impact on landscape and coastal character.	Construction of turbine layout scenario –4f (62 x Model 4 WTGs). Jacket foundations. 2 x OSPs. HDD/Open Cut Trench activities within the Landfall Area and presence of construction vessels offshore from the Landfall (1 x cable lay vessel and up to 3 x support / guard vessels).	The worst case scenario during construction from most visual receptors would be when large numbers of the tallest WTGs are in place in addition to concentrations of activity in the form of marine vessels and cranes. In the vicinity of the landfall close range views of the HDD vessels from local visual receptors is likely to be worse than more distant views of the Moray West Offshore Wind Farm under construction.
Operation and Maintenance		

Table 14.6.1: Design Envelope Parameters Relevant to the Seascape Landscape and Visual Impact Assessment		
Potential Impact	**Realistic Worst Case Scenario**	**Justification**
Impact on visual receptors (daytime).	Turbine layout scenario – 4f (62 x Model 4 WTGs) Jacket foundations. 2 x OSPs.	Alignment perpendicular to Caithness coast maximises stacking of turbines from the closest part of the coast. Noticeable gap due to cable route corridor through Moray West Site. Largest WTGs will have the greatest extents of visibility and will result in the highest magnitude of change where visible. Irregularity of layout with some stacking of turbines in views from Highland, Moray and Aberdeenshire. Jacket foundations more bulky in form than alternatives. Two large OSPs would be more noticeable and visible from a wider area than one.
Impact on visual receptors (night time).	Turbine layout scenarios – 2 (85 x Model 2 WTGs) and 4f (62 x Model 4 WTGs). Jacket foundations. 2 x OSPs	Alignment perpendicular to Caithness coast maximises stacking of turbines from the closest part of the coast. Noticeable gap due to cable route corridor through Moray West Site. Largest peripheral WTGs will have the greatest extents of visibility due to the maximum height of their medium intensity lights. In addition, the larger forms of the taller turbines may also be visible at the same time as the medium intensity lights in low light levels. Smaller peripheral WTGs (maximum height and number of Model 2) would be seen spread across a similar horizontal field of view but there would potentially be more medium intensity lights visible due to the larger number of peripheral turbines. Foundations irrelevant. OSPs would not be lit with medium intensity lights.
Impact on landscape and coastal character.	Turbine layout scenario – 4f (62 x Model 4 WTGs). Jacket foundations. 2 x OSPs.	Alignment perpendicular to Caithness coast maximises stacking of turbines from the closest part of the coast. Noticeable gap due to cable route corridor through Moray West Site. Largest turbines will have the greatest extents of visibility and will result in the highest magnitude of change where visible. Irregularity of layout with some stacking of turbines in views from Highland, Moray and Aberdeenshire. Jacket foundations more bulky in form than alternatives. Two large OSPs would be more noticeable and visible from a wider area than one.
Decommissioning		

Table 14.6.1: Design Envelope Parameters Relevant to the Seascape Landscape and Visual Impact Assessment		
Potential Impact	**Realistic Worst Case Scenario**	**Justification**
Impact on visual receptors (daytime).	Removal of turbine layout scenario – 4f (based on 62 x Model 4 WTGs). Removal of jacket foundations. Removal of 2 x OSPs	The worst case scenario during decommissioning would be when large numbers of the tallest WTGs are still in place in addition to concentrations of activity in the form of marine vessels and cranes.
Impact on visual receptors (night time).	Removal of turbine layout scenarios – 2 (85 x Model 2 WTGs) and 4f (62 x Model 4 WTGs). Removal of jacket foundations. Removal of 2 x OSPs	The worst case scenario during decommissioning would be when large numbers of theWTGs are still in place and lit in addition to concentrations of activity in the form of marine vessels and cranes, which may have lighting.
Impact on landscape and coastal character.	Removal of turbine layout scenario – 4f (based on 62 x Model 4 WTGs). Removal of jacket foundations. Removal of 2 x OSPs	The worst case scenario during decommissioning would be when large numbers of the tallest WTGs are still in place in addition to concentrations of activity in the form of marine vessels and cranes.

14.6.2 Embedded Measures

14.6.2.1 The likely visual effects of different layout scenarios have been investigated in the absence of mitigation measures as part of the review of the worst case scenario layout for the Development.

14.6.2.2 As part of the final wind farm design and layout Moray West will work with stakeholders to seek to reduce, where possible, the perception of turbines as 'outliers' which could appear to extend the horizontal extent of the wind farm disproportionately when compared to the energy gained, or potentially appear to 'close off' views of the open sea that lie between Moray West and the coast. The final wind farm design and layout will also be required to take into account other stakeholder requirements such as navigation, commercial fisheries and search and rescue (SAR); other technical and environmental factors within the Moray West Site (ground conditions, wind resources etc.); and proximity to the neighbouring BOWL and Moray East offshore wind farms.

14.7 Assessment of Potential Effects

14.7.1.1 In this chapter the construction, operational and decommissioning effects are assessed in relation to each receptor.

14.7.2 Assessment Tools and Factors Influencing the Effect of the Development

14.7.2.1 A number of assessment tools (Zone of Theoretical Visibility (ZTV) analysis, visibility frequency analysis, visualisations etc) are used to aid in the descriptions and substantiate the findings and these are described here. The modelling methodology for the visualisations is set out in Volume 3a – Figure 14.7.8 as well as in Volume 4 - Technical Appendix 14.1: SLVIA Methodology.

14.7.2.2 There are no operational turbines of the scale proposed for the Development to observe in the field in order to determine the range over which they may be visible. There are also no similarly scaled, moving structures in the UK. Emley Moor transmitting station in West Yorkshire, has a 330m tower and is the tallest freestanding structure in the United Kingdom. The SLVIA is largely based on the tallest turbines proposed, which are considered the worst case scenario.

14.7.2.3 There are offshore wind turbines operational within the Moray West Site, the Beatrice Demonstrator Turbines, and these provide some indication of visibility at a similar range from the Highland coast, however, they are considerably smaller than those of the Development, at 151 m to blade tip. OPEN has considerable experience of assessing the visual of offshore wind farms with large scale turbines in other parts of the UK, which we have drawn on when making professional judgements in this SLVIA.

14.7.2.4 Therefore, the assessment of the effects of the Development takes into account a wide range of contributing factors in order to reach its conclusions some of which have been drawn from research and guidance.

14.7.2.5 Relatively recent research into the visibility of offshore wind farms has been published (Robert G Sullivan, Leslie B Kirchler, Jackson Cothren, Snow L Winters (2012)). Whilst the scale of the wind farms is not directly comparable with the Development it provides some helpful analysis based on field survey findings.

14.7.2.6 Further information on the visibility of offshore wind farms is included in Volume 4 - Technical Appendix 14.3: Offshore Wind Farm Visibility. This includes aspects that have been used to inform the likelihood of 'visibility' with distance from locations in Highland coast and the Moray/ Aberdeenshire coast.

Zone of Theoretical Visibility (ZTV)

14.7.2.7 Volume 3a - Figure 14.7.1 illustrates the blade tip ZTV for the Development. It shows the potential visibility of any part of the wind turbines up to its highest point (but not all of the wind turbine would necessarily be seen). The blade tip ZTV for the Development is shown in Volume 3a - Figure 14.7b for the Study Area, at a wide contextual scale of 1:150,000 on 1:50000 OS mapping. This A0 size plan also shows the viewpoint locations, the cumulative wind farms., landscape planning designations and Wild Land Areas. The Blade Tip ZTV is also presented in greater detail on the viewpoint location plans for each viewpoint and in relation to other landscape/ seascape and visual receptors in Volume 3a - Figures 14.7.4-14.7.7. Visibility of the Development (worst case scenario 285 m to tip) is illustrated using six colour bands representing visibility of parts of 1-10, 11-20, 21-30, 31-40, 41-50 and 51-62 turbines.

14.7.2.8 The limitations of this ZTV are discussed in Volume 4 - Technical Appendix 14.1: SLVIA Methodology. In general, the ZTV is likely to over-estimate the spatial extent of visibility of the Development, due mainly to the use of a 'worst-case' model of the turbines (largest turbine height and spread) and the limitations of the digital terrain model, which takes no account of the complex natural and man-made elements in the onshore parts of the surrounding landscape. It is likely therefore, that actual visibility on the ground would be less than that indicated on ZTVs due to the screening effects of surface features and local landforms. While the ZTV indicates the number of turbines theoretically visible, it does not show how much of each turbine is visible and this varies within these bands. For example: an area shown as having visibility of 51-62 turbines may be affected by the smallest extremity of the blade tips, or it may gain visibility of 62 'full' turbines. The hub height ZTV (Volume 3a - Figure 14.7.2a) is used to inform the assessment in these circumstances, as it assists with the identification of areas where only the blades of the proposed wind farms will be visible and not hubs or towers. A comparative hub height ZTV (Figure 14.7.2b) illustrates the difference in the extents of theoretical visibility of the hubs of the turbines in the Model 4f layout compared with the theoretical visibility of the hubs in the Model 2 layout.

14.7.2.9 The following assessment of the visibility of the Development is made using the Blade Tip ZTV (Volume 3a - Figure 14.7.1b):

- Offshore:
    - Visibility of up to 51-62 turbines from all of the offshore parts of the Study Area within approximately 47 km of the Development;
    - Visibility levels dropping in bands over 47 km at sea level to the north-east and south-west due to earth curvature, which prevents views of the more distant turbines, such that visibility at sea level at 50 km is of 41 to 50 turbines; and
    - To the south-east parts of up to 62 turbines are visible out to beyond the Study Area due to the greater number of turbines located within the south-eastern extents of the Moray West site.
- Highland:
    - Visibility of up to 62 turbines from majority of coastal edge between Duncansby Head and Dornoch at distances of 22.5 km to 50 km;
    - Areas with no visibility of the proposed wind farm consent application limited mainly to Sinclair's Bay, Freswick Bay, Wick Bay and smaller locally incised bays;
    - Visibility of 62 turbines within the immediate hinterland of rising ground to generally within 10 km inland of the coastal edge becoming scattered and more variable depending on the degree of enclosure / openness provided by landform;
    - No or very limited visibility of the Development from the majority of the flat peatlands

in the central part of the Study Area within Highland (in Caithness) with visibility limited by rising landforms near the coast which provide a clear view-shed. The relatively low-lying land in these flat peatlands in respect of the landform pattern has the general effect of visibility being precluded by the intervening higher ground;

  - Northern part of the Study Area within Highland (in Caithness) has scattered, long distance inland visibility (35 to 50 km), where landform at the coast offers some screening, but there is no definitive inland viewshed and views of the Development are filtered gradually across the moorlands / agricultural landscape; and
  - Southern part of the Study Area within Highland (in Sutherland), has elevated inland area of sweeping moorland and lone mountains with scattered long distance visibility (25 to 50 km) of the Development over the coastal shelf and high ground.

- Moray / Aberdeenshire:
  - Visibility of 51-62 turbines from Moray coastal edge between Culbin Forest and Cullen at low lying locations in Spey Bay at distances of approximately 31 to 47 km;
  - Visibility of 51-62 turbines from majority of coastal edge, parts of immediate hinterland and high ground of Moray and Aberdeenshire at distances of 40 to 50 km (e.g. Viewpoint 18);
  - Southern part of the Study Area within Moray has elevated inland area of uplands and coastal farmlands with scattered long distance visibility (41 to 50 km) of up to 62 turbines of the Development over the Moray coast; and
  - Limited visibility of the Development from the majority of the coastal lowlands in the western part of the Study Area within Moray, with visibility limited by rising landforms near the coast which provide a clear view-shed.

14.7.2.10 The ZTVs show the effect of curvature of the earth on the likely visibility of the Development. Due to the tall nature of the turbines, however, at least the upper parts of the turbines would be visible from most of the sea area. The influence of earth curvature on visibility is shown as most notable in low lying areas, such as at sea level, whereas with elevation on land, the effects of earth curvature become less pronounced. This is evident in the Blade Tip ZTV (Volume 3a - Figure 14.7.1), which shows visibility levels dropping in bands over 47 km at sea level, while onshore visibility is determined largely by landform.

14.7.2.11 Curvature of the earth has less influence on visibility from the onshore parts of the Study Area, because the land is more elevated and affords visibility from higher areas where earth curvature has less effect. The eastern Highland and Moray coastlines, in particular, are often formed by high cliffs and coastal shelves, with landform rising inland.

14.7.2.12 From a height just above sea level the turbines closest to the Highland coast (e.g. around Berriedale and Lybster) would be visible with approximately 20 m of the lower parts of the jacket foundations of the closest turbines screened behind the horizon due to earth curvature. Curvature of the earth reduces the apparent height of the turbines at greatest distance from the coast, with those furthest away from these locations having approximately 40 m of their towers/foundations concealed. The depth of the layout of the Development results in the most distant turbines appearing markedly lower in the view than those to the front of the wind farm. The role of earth curvature was found to be greater for the Moray / Aberdeenshire section of the Study Area, due to its longer distance from the Development and the lower elevations of this coastline. For example, from Lossiemouth approximately 47 m of the lower parts of the closest turbines would be hidden beyond the horizon, whilst approximately 180 m of the towers of the most distant turbines would be hidden from this location.

14.7.2.13 Volume 3a - Figures 14.8.6 Comparative Blade Tip ZTV with BOWL (as built) uses the same type of analysis to ascertain the locations from where any part of the wind farms being considered would be theoretically visible. Volume 3a - Figure 14.8.6 shows areas where the Development would be theoretically visible where BOWL would not.

Horizontal Angle ZTV

14.7.2.14 The 'horizontal angle ZTV' in Volume 3a - Figure 14.7.3 measures how much of the horizontal field of view is occupied by the Development, in theoretical views. It is calculated from a grid of receptors in the Study Area and measures the maximum spread from the furthest left to the furthest right theoretically visible turbine of the Development. The information is stored as a horizontal angle in degrees. The horizontal angle ZTV provides further analysis of the likely effect of the Development because the results reflect the effect that distance has on the apparent size of the Development: a large object up-close has more visual impact than the same sized object further away (all other things being equal). The horizontal angle ZTV is displayed using coloured bands showing incremental degrees of horizontal angle, in order to highlight areas of higher effect.

14.7.2.15 The horizontal angle ZTV shows that the widest horizontal field of view is occupied in close proximity to the Development, particularly within the site itself, where the turbines occupy 180-360 degrees of the field of view, and in the areas typically within approximately 11 km from the Development where it will occupy 90 to 180 degrees (25 to 50 %) of the field of view available. The ZTV allows the following assessments to be made:

- The horizontal field of view occupied by the Development would decrease considerably with distance;
- The Development would occupy less than 60 degrees of the horizontal field of views from onshore areas in the study area with visibility, and generally less than 50 degrees
- In views from the Highland coast, north of approximately Helmsdale, the northerly part of the Development would be located behind turbines of BOWL, with this increasingly being the case the further north one moves;
- From the closest section of the Caithness coast between approximately Whaligoe Steps and Berriedale, the Development would occupy 50 to 60 degrees of the horizontal field of view in areas with visibility, at distances of between approximately 23 km and 25 km. Such visibility may also occur from inland to approximately 4km from the coast in places;
- From the areas of Caithness coast between approximately Ord Point and Berriedale, and between Whaligoe Steps and Sarclet Head, the Development would occupy 40 to 50 degrees of the horizontal field of view in areas with visibility, at minimum distances of between 23 km to 25 km;
- From the coastal edge between Portgower and Ord Point and between Sarclet Head and Wick the Development would occupy 30 to 40 degrees of the horizontal field of view in areas with visibility, at distances between 23 km to 29 km;
- From areas to the south of Brora and to the north of Wick the Development would occupy less than 30 degrees of the horizontal field of view in areas with visibility, at distances of greater than 30km;
- From the hinterland areas between Brora and Wick, the horizontal angle of view occupied by the proposed wind farm consent application in areas with visibility is much more variable, in the range between 0 to 50 degrees, depending on the degree of enclosure / openness provided by inland hills; and

- From the wider inland areas, the horizontal angle of view occupied by the proposed wind farm consent application in areas with visibility is much more limited, in the range between 0 to 20 degrees, depending on the degree of enclosure / openness provided by inland hills.

14.7.2.16 The horizontal angle ZTV provides a more realistic picture of the likely magnitude of the impact of the Development as it shows the influence that distance has on its apparent horizontal spread. The ZTV illustrates how the visual effect of the Development would diminish with distance; how the Development would have less visual effect from distant locations and a greater visual effect from locations at very close proximity. It should be noted that this theoretical measure includes the full angle from the furthest left to the furthest right extent of the Development, and that in reality the turbines are sited with visible space / gaps between them, which allow views through the site to the seascape or skyline beyond.

14.7.3 Visual Effects

14.7.3.1 Since the Development is offshore all of the receptors to be assessed are affected visually rather than physically and therefore the assessment of the visual effects is presented first, as it is used to inform the effects on landscape/ seascape receptors. The assessment of visual effects from representative viewpoints is also presented first, as this is used to inform the subsequent assessment of effects on visual receptors.

<u>Visual Effect on Representative Viewpoints</u>

14.7.3.2 The assessment of effects of the Development is largely based on the representative viewpoints listed in Table 14.4.1: Representative Viewpoints are identified on Volume 3a - Figures 14.4.3 and 14.7.1a-b. Visual representations have been produced for all of these viewpoints (Volume 3b - Figures 14.7.9-14.7.34b) and photomontages have been produced for the following viewpoints, to provide a photorealistic representation.

- Viewpoint 2: Keiss
- Viewpoint 3: Wick
- Viewpoint 5: Whaligoe Steps
- Viewpoint 6: Minor Road (south east of Osclay)
- Viewpoint 7: Lybster
- Viewpoint 8: Latheron
- Viewpoint 9a: Dunbeath (nr Heritage Centre)*
- Viewpoint 11: Berridale
- Viewpoint 12: Navidale*
- Viewpoint 13a: Brora
- Viewpoint 14: Tarbet Ness Lighthouse
- Viewpoint 16: Lossiemouth (Harbour)*
- Viewpoint 17: Buckie

14.7.3.3 These visualisations have been prepared to SNH's visualisation standards. Those marked with * also have night time views and visualisations. The field of view of the wirelines and photomontages has in some cases been increased by 10 degrees to 63.5 degrees so that the image is wider than the 820 mm prescribed in order to maintain a consistent principle distance of 812.5 mm. This is in order to accommodate with full width of the Development within a single image.

14.7.3.4 In addition, THC requested that a number of viewpoints located in Highland should have 75 mm equivalent single frame photographs, wirelines or photomontages prepared and/or composite panoramic images for use in its viewer in monochrome and colour, in accordance with its visualisation standards.

14.7.3.5 A number of the photographs used in the Moray East ES have been re-used in this SLVIA following agreement with SNH, THC, MC and AC. As agreed with SNH, THC, MC and AC the turbines of the under-construction BOWL are included in baseline views for those viewpoints where a photomontage is to be prepared for the Development.

14.7.3.6 The panoramic photographs in Viewpoint 21: Findlater Castle, do not show the central part of the vertical field of view but instead the pitch has been lowered to show the bottom part of the photographs. This is in order to illustrate the location of the Castle in relation to the Development.

14.7.3.7 The photographs and other graphic material such as wirelines and photomontages used in this assessment are for illustrative purposes only and the assessments are carried out based on assessor observations in the field.

14.7.3.8 It should be noted that bold colours of turbines shown in wirelines can be a misleading representation of likely wind farm visibility, particularly where they are representative of long range views over sea. The more distant the sky within a view the paler it becomes, in nearly all weather conditions, and therefore as a backdrop to pale coloured turbines the contrast between the turbines and the sky will generally be much less apparent than is inferred by the bold colour of turbines in the wirelines.

14.7.3.9 The line work used to indicate turbines on a wireline at this size may not correspond with the width of the turbine components when viewed at this range.

14.7.3.10 Table 14.7.1 sets out the assessment of the effect on viewpoints of the construction, operation and maintenance and decommissioning of the Development.

14.7.3.11 Viewpoint 24: Ferry route (Kirkwall to Aberdeen) is illustrated with a wireline view but not assessed in detail as was the case in the Moray East ES (2012). THC requested a wireline view from Whiteness Beach and this has been included as Figure 14.7.35 in Volume 3b.

Table 14.7.1: Effect on Representative Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
1: Duncansby Head Volume 3b – Figures 14.7.9a to 14.7.9e	Located in RCCA 16 - Duncansby Head and the High Cliffs and Sheltered Bays LCT. Most north-easterly part of mainland Scotland accessed by a minor road from John o'Groats or via a coastal walk. Expansive panoramic views with a strong sense of exposure and connection to the sea, which can be seen across large parts of the view. The Lighthouse is a key feature of views to the north-east and many people visiting this location will do so to see the cliffs and Stacks of Duncansby, which are an attractive, natural, coastal feature to the south, and can be viewed at closer range from the coastal path. The key views are along the rugged coast to the islands further north. Views west are along the settled coastal edge with undulating moorland inland. BOWL is visible across a 19 degree section of the view at a range of 37 km. It is visible in very good or excellent conditions across part of the open sea and separate from the coastal features. The layout of the BOWL turbines means that they appear 'stacked' in rows within parts of their wind farm. The Beatrice Demonstrator Turbines are theoretically visible near the headland but are unlikely to be apparent at their distance of 60 km. The Stroupster onshore wind farm is visible beyond the low moorland and inland from the rugged cliff edge at a distance of approximately 8.4 km. Burn of Whilk onshore wind farm is visible only as blade tips from this location at a range of 33.3 km. **Value of view: medium - high**	**Operation** Field of view affected by the Development is 19.5 degrees. Distance to the Development (closest turbine of WCS) 53.35 km. The increased separation of the viewpoint and the more distant turbines means that they are likely to be less visible than the closest. The distance to the most distant turbine of the WCS is 72 km. This distance results in the turbines theoretically appearing as small scale, vertical features visible in only 'excellent visibility' conditions. The vertical angle of view occupied by the Development theoretically takes up 0-0.5 degrees of the field of view. The Development would theoretically add approximately 11 degrees to the offshore wind farm views created by BOWL, which may be visible at closer proximity. The ZTVs illustrate that 51-62 turbines are theoretically visible, although eleven of these would only be apparent as blades due to landform screening. The Development is located on the skyline within a part of the broad, open, sea views that lie to the south between the coastal headlands and the part of the view that is influenced by BOWL. Views towards the northern coast and the Orkney Isles beyond would not be affected by the Development and would remain the key, scenic focus. At this distance the curvature of the earth reduces the apparent height of all of the turbines with those furthest away having only a relatively short section of their towers visible above the skyline. The angle of view and the depth of the layout of the Development within it result in the most distant turbines appearing markedly lower in the view than those to the front of the wind farm.	**Operation** Not significant, negative, long term, reversible. **Construction and decommissioning** Not significant, negative, short term, reversible. **Likelihood of effect** Excellent visibility required for the Development to be visible at 53.35 km to closest turbine.

Table 14.7.1: Effect on Representative Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
	Lies within and overlooks Duncansby Head SLA, thus increasing its scenic value. Viewpoint is not shown on OS mapping. View from trig point and information board near car parking area, accessed across open grass area to south of Lighthouse. Wide panoramic views with scenic focus towards Orkney and the Pentland Firth to the north and to Duncansby Stacks to south form the viewpoint. Views to the Duncansby Stacks may be missed by some visitors due to screening landform. **Susceptibility to change: medium** Representative of views obtained by visitors, walkers and birdwatchers who are transient. Simple, expansive sea view over a short foreground of rough grassland landcover. BOWL visibility in very good and excellent conditions on the skyline of the open sea between the lighthouse and the cliffs adds offshore wind farm characteristic. Visibility of Stroupster onshore wind farm as part of the landscape context adds an onshore wind farm influence. Rugged, steep cliffs and dramatic coastal edge with stacks and small enclosed bays to the south, which are the focus of the southerly views. The more distant parts of the mainland coast extend out beyond the cliffs. The Development would be sited so that it would be visible in excellent conditions beyond this and therefore near to the cliff features. However, although it would sometimes be influential to the wider view it would not be seen in the immediate context of the key focus of the stacks and cliffs.	The alignment of the turbines of the WCS is apparent within this view, as is the gap necessitated by the cable wayleave that runs through the site. The view direction to the centre of the Development is approximately south. This means that the turbines would generally be back lit and therefore seen in shadow, resulting in them generally being less contrasting with the sky background than turbines lit by the sun. The sun may strike the turbines on their west or east sides during early morning or late afternoon/evening. This could potentially increase contrast, making them more apparent when the visibility is excellent. Due to the prevailing wind the turbines would most usually be seen so that the rotor faces are aligned at an angle to the viewpoint, reducing the influence of the blade movement and also the overall dimension of the part of the view affected by each turbine. The Development, when visible, would appear less prominent than BOWL due to its greater distance. Where the wind farms overlap there would be the possibility of a greater density of turbines being apparent at ranges of greater than 40 km (BOWL) and 53km (the Development). The greater distance to the Development ensures that its turbines would be recessive and that their larger dimensions are not apparent. The wireline shows that the spread of the Development would theoretically create a link between the coast and the turbines of BOWL and that turbines would be apparent close to the part of the view towards the Stacks of Duncasby, which are an attractive feature and focal point of views in this vicinity. However, the turbines that are theoretically apparent where they appear to meet the shoreline and appear above it as blades are at distances of greater than 62 km therefore extremely distant so that even in clear weather their influence would be limited.	

Table 14.7.1: Effect on Representative Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
	The long distance between the viewpoint and the Development means that it would only be clearly visible during infrequent, excellent conditions. Its influence would be limited. **Sensitivity: medium-high**	Only the upper extents of the closest OSP would be visible from this location due to the screening effect of the earth's curvature. Figure 14.17e illustrates the extent of the ZTV within this vicinity. This shows that there is theoretical visibility of the Development from areas close to the south-east facing coast but not John o'Groats or the north coast sections of the coastal path or some sections of the path leading to the Stacks of Duncansby from the lighthouse. ***Magnitude of change: low*** **Construction and decommissioning** The worst case scenario of both the construction and decommissioning will be when large numbers of turbines are in place in addition to concentrations of activity in the form of marine vessels and cranes. These activities associated with the Development turbines and OSPs will be distant with the construction of the cable route occurring at even greater distances, beyond the windfarm. ***Magnitude of change: low***	
2: Keiss (A99) Volume 3b – Figure 14.7.10 a to 14.7.10g	Located close to Sinclair's Bay RCCA and within the Small Farms and Crofts LCT. View is from the A99 on the south westerly edge of the small planned settlement of Keiss. It is representative of views from the road as well as parts of the settlement from where there are views available in this direction. The nearby Core Path sits at lower elevations. This is not part of a National Tourist Route, however this section of the A99 is part of the North Coast 500 route. The view is across the fields adjoining the village with scattered dwellings seen extending further along the road and the wider countryside and coastline beyond. The view is markedly	**Operation** Field of view affected by the Development is approximately 17 degrees. Distance from the Development (closest turbine of WCS) 43 km. The increased separation of the viewpoint and the more distant turbines means that they are likely to be less visible than the closest. The distance to the most distant turbine of the WCS is 59 km. The Development would theoretically add approximately 10 degrees to the offshore wind farm views created by BOWL, which may be visible at closer proximity. The ZTVs illustrate that 31-40 turbines are theoretically visible, although these would mostly only be apparent as blades due to landform screening by the Noss	**Operation** Not significant, negative, long term, reversible. **Construction and decommissioning** Not significant, negative, short term, reversible. **Likelihood of effect** Excellent visibility required for the Development to

Table 14.7.1: Effect on Representative Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
	horizontal in character with the curve of Sinclair's Bay leading the eye round to the low promontory of Noss Head. The pattern of the landscape formed by the field pattern is compressed into a narrow strip of land with the mountains of Morven and Scaraben visible in clear conditions beyond. The numerous poles of transmission lines are also a feature of the view. Ackergill Tower is seen in its walled setting close to the shore in the centre of the view. The land rises slightly to the west and south-west and the operational onshore wind farms of Burn of Whilk, Achairn, Camster, Wathegar and Flex Hill/Bilbster are clearly visible across the view. Causeymire is visible to the south west as blade tips only due to intervening forestry. The under construction Bad a Cheo and Achlachan wind farms do not substantially increase wind farm visibility in this direction due the intervening forestry and other skyline features. The BOWL wind farm is visible in very good or excellent conditions as turbine blades and some hubs above the Noss Head promontory and out into a short section of the skyline formed by the open sea beyond Noss Head. **Value of view: medium** The viewpoint is not located within any landscape planning designations. Only the most distant mountains are located within a SLA. The view will be valued locally as the open outlook from properties and locations such as the interpretation point above Keiss Harbour. **Susceptibility to change: medium - high** Representative of views obtained by people in their homes and when moving around the settlement. The orientation of the	Head promontory. Only one turbine is shown to be visible to hub height. This distance results in the turbines theoretically appearing as small scale, vertical features visible in only 'excellent visibility' conditions. At this distance the curvature of the earth reduces the apparent height of all of the turbines so that only the closest turbines of the Development would be visible. The view direction to the centre of the Development is approximately south and not in the general alignment of the road or main aspect of the settlement, which is to the south-west. In addition, this means that the turbines would generally be back lit and therefore seen in shadow, resulting in them generally being less contrasting with the sky background than turbines lit by the sun. If visible the turbine blades would be seen appearing and disappearing over the landform skyline. The sun may strike the turbines on their west or east sides during early morning or late afternoon/evening. This could potentially increase contrast, making them more apparent when the visibility is excellent. The Development, when visible, would appear less prominent than BOWL due to its greater distance. Where the wind farms overlap there would be the possibility of a greater density of turbines being apparent. The wireline view shows that the Development's blade visibility would occur to a similar degree to that of the BOWL turbines. The greater distance to the Development ensures that its turbines would be recessive and that their larger dimensions are not apparent. In the part of the view that is not affected by BOWL turbine visibility the extent of the Development turbines visible above the landform is limited. Figure 14.17b illustrates the extent of the ZTV within this vicinity. This shows that there is theoretical visibility of the Development from other parts of Keiss as well as the A99 and core paths in the	be visible at 43 km to closest turbine.

Table 14.7.1: Effect on Representative Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
	settlement is such that the view direction is not often the view directly visible from the houses which tend to be orientated to the south west. Oblique rather than directional view available to south-bound users of the main road along the Caithness coast linking Wick and John o'Groats. Wide panoramic view with a varied landscape of simple sea and coast transitioning to a sub-divided crofting landscape of dwellings and fields. The Development is located at a long distance from this viewpoint and is largely screened by the intermediate landform. BOWL as well as a prominent grouping of onshore wind farms are a key characteristic in this view. **Sensitivity: medium - high**	vicinity. From other locations within Keiss it may be possible to gain views of a greater extent of the Development in terms of turbine parts visible as well as their extents. From locations on the A99 to the north of Keiss more turbines may also be visible, however, locations close to Keiss were screened by the settlement itself. The core paths in the vicinity would theoretically gain less visibility than the viewpoint. ***Magnitude of change: Negligible*** **Construction and decommissioning** The worst case scenario of both the construction and decommissioning will be when large numbers of turbines are in place in addition to concentrations of activity in the form of cranes. The activities associated with the Development turbines and OSPs will be distant with vessels largely screened by the headland and the construction of the cable route occurring at even greater distances, beyond the wind farm. ***Magnitude of change: Low***	
3: Wick (path south of South Street) Volume 3b – Figures 14.7.11a to 14.7.11n	Located in Wick Bay RCCA and within the Town LCT. Representative of the views available from a small number of houses around North Head and South Head in Wick along with a small number in Papigoe just to the north. Viewpoint is located on a relatively popular coastal Core Path. View across Wick Bay expands out to the open sea to the east and extends westwards to the harbour area encompassing a wide range of settlement characteristics. Beyond the town the Achairn and Wathegar wind farms are clearly visible above the built form at distances of 7.7 km to 9.8 km. Camster is also partially visible in a slightly separate part of the view, however Burn of Whilk is largely screened by intervening buildings. The more distant wind farms of Causeymire, Bad a Cheo and Achlachan are not apparent.	**Operation** Field of view affected by the Development is approximately 32 degrees. Distance to the Development (closest turbine of WCS) 32.3 km. The increased separation of the viewpoint and the more distant turbines means that they are likely to be less visible than the closest. The distance to the most distant turbine of the WCS is 49 km. This distance results in the turbines theoretically appearing as moderate scale, vertical features visible in only 'very good visibility' conditions. The vertical angle of view occupied by the Development theoretically takes up 0.51 degree of the field of view.	**Operation** Significant, negative, long term, reversible. **Construction and decommissioning** Significant, negative, short term, reversible. **Likelihood of effect** Very good visibility required for the Development to be visible at

Table 14.7.1: Effect on Representative Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
	The cliffs and dwellings of South Head extend the settled influence out to the coast. The BOWL wind farm is visible to its full extent out in the open sea at a range of 18.14 km. From this location within Wick Bay and at this range it takes up a large proportion of the visible sea skyline and is a prominent feature when visibility is good to excellent. It is located so that it is seen separate from the land in views from this location and is visible across approximately 39 degrees of the field of view. The layout of the BOWL turbines means that they appear 'stacked' in rows or there are large gaps within parts of the wind farm. The Beatrice Demonstrator Turbines and the associated oil platforms are theoretically visible near the headland but are less frequently apparent at their distances of approximately 38 km. **Value of view: medium** The viewpoint is not located within and does not look out over any landscape planning designations. The view will be valued locally as the open outlook from properties and locations such as the coastal footpath. **Susceptibility to change: medium - high** Representative of views obtained by people in their homes. The orientation of the settlement is such that the view direction is generally akin to the views from the rears of a small number of properties along the southern edge of North Head. The properties on South Head and Papigoe tend to be orientated further to the east and take in more of the open sea. View representative of users of the coastal path. This provides opportunities for users to gain views of a wide variety of settlement and coastal characteristics and to enjoy being close to the sea. It enables users to leave the confines of the urban area and experience a more natural environment.	The Development would theoretically add approximately 19 degrees to the offshore wind farm views created by BOWL, which would be visible more frequently and at closer proximity. The ZTVs illustrate that 51-62 turbines are theoretically visible with all of these visible to below hub level. The Development is located on the skyline within a part of the broad, partially undeveloped, sea views that lie to the south between the coastal headlands and the part of the view that is influenced by BOWL. Within a few years it is likely that the Beatrice Demonstrator Turbines and the associated oil platforms would no longer form part of the view. At this distance the curvature of the earth reduces the apparent height of all of the turbines with those furthest away having only a relatively short section of their towers visible above the skyline. The angle of view and the depth of the layout of the Development within it result in the most distant turbines appearing markedly lower in the view than those to the front of the wind farm. The alignment of the turbines of the WCS is apparent within this view, as is the gap necessitated by the cable wayleave that runs through the site. This pattern of turbines is similar to that of BOWL. The view direction to the centre of the Development is approximately south. This means that the turbines would generally be back lit and therefore seen in shadow, resulting in them generally being less contrasting with the sky background than turbines lit by the sun. The sun may strike the turbines on their west or east sides during early morning or late afternoon/evening. This could potentially increase contrast, making them more apparent when the visibility is very good. Due to the prevailing wind the turbines would most usually be seen so that the rotor faces are aligned at an angle to the viewpoint, reducing the influence of the blade movement and also	32 km to closest turbine.

Table 14.7.1: Effect on Representative Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
	The visibility of the BOWL and onshore wind farms extend wind farm characteristics across two different parts of the views available from this location and within markedly different landscape/seascape contexts. **Sensitivity: medium-high**	the overall dimension of the part of the view affected by each turbine. The Development, when visible, would appear less prominent than BOWL due to its greater distance. Where the wind farms overlap there would be the possibility of a greater density of turbines being apparent at ranges of greater than 22 km (BOWL) and 32.3km (the Development). The greater distance to the Development ensures that its turbines would be recessive and that their larger dimensions are not apparent. Due to the distance between the viewpoint and the OSPs combined with the curvature of the earth these will be seen as very small, relatively low elements within the context of the much larger, moving turbines. The wireline view shows that the spread of the Development would theoretically create a link between the coast and the turbines of BOWL and this is considered adverse and to locally increase the magnitude of change. The Development would generally appear as an extension to BOWL due to its apparent similarity of scale and layout as well as the context within which they are both located. When apparent the Development would extend offshore wind farm visibility across a further wide part of the available sea views from this location. This, in addition to the existing onshore wind farm influence, results in increasing the overall effect of wind farm development across the wide views from this part of Wick. However, the turbine that is theoretically apparent where the Development appears to meet the shoreline is located at a distance of 49 km so that even in clear weather its influence would be limited. Figure 14.17b illustrates the extent of the ZTV within this vicinity. This shows that there is theoretical visibility of the Development from limited locations with the settlement of Wick and the	

Table 14.7.1: Effect on Representative Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
		surrounding settled areas. Actual visibility is further reduced due to the screening influence of buildings. Visibility such as is represented by the viewpoint would be possible from sections of the Core Paths in the vicinity and on the south side of Wick Bay. Visibility from nearby sections of the A99 is limited. ***Magnitude of change: medium - low*** **Construction and decommissioning** The worst case scenario of both the construction and decommissioning will be when large numbers of turbines are in place in addition to concentrations of activity in the form of marine vessels and cranes. These activities associated with the Development turbines and OSPs will be distant with the construction of the cable route occurring at even greater distances, beyond the wind farm. ***Magnitude of change: medium - low***	
4: Sarclet (Sarclet Haven Info Board) Volume 3b - Figures 14.7.12a to 14.7.12e	Located in RCCA – Sarclet Head and the Small Farms and Crofts LCT. This is an expansive view out over the open sea across a foreground of elevated shores and cliffs. The viewpoint is located at the end of a minor road where there is a small area of parking and an information point promoting access via a Core Path to the harbour. The minor road runs south-east through the small crofting settlement of Sarclet and also leads to a small number of other coastal properties. The natural harbour (the Haven) is set at the bottom of the steep slope below and was at one time important for fishing. BOWL is visible across a large part (over 50 degrees) of the view out to sea at a range of 15.2 km. Beatrice Field oil platforms and demonstrator turbines are visible further to the south at a range of approximately 30 km. The layout of the BOWL turbines means	**Operation** Field of view affected by the Development is approximately 43 degrees. Distance to the Development (closest turbine of WCS) 26.55 km. The increased separation of the viewpoint and the more distant turbines means that they are likely to be less visible than the closest. The distance to the most distant turbine of the WCS is 41 km. This distance results in the turbines theoretically appearing as moderate scale, moving, vertical features visible in only 'very good visibility' conditions. The vertical angle of view occupied by the Development theoretically takes up 0.5-1 degrees of the field of view. The Development would theoretically add approximately 28 degrees to the offshore wind farm views created by BOWL. The	**Operation** Significant, negative, long term, reversible. **Construction and decommissioning** Significant, negative, short term, reversible. **Likelihood of effect** Very good visibility required for the Development to be visible at 26.55 km to closest turbine.

Table 14.7.1: Effect on Representative Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
	that they appear ‘stacked’ in rows or there are large gaps within parts of the wind farm. Burn of Whilk onshore wind farm is visible to the west at a distance of 5.7 km and is partially screened by an intervening house from this location. It will be more visible from other locations in Sarclet. **Value of view: medium** The viewpoint is not located within and does not look out over any landscape planning designations. View from end of minor road leading to informal footpath to Sarclet Haven, with parking/information provided. **Susceptibility to change: medium-high** Representative of view from scattered properties, minor roads and upper part of informal footpath to minor visitor attraction. The lower harbour area is well contained with an open sea outlook to the east to south east and not towards the Development. Expansive view from slightly elevated coast above cliffs, across rough grassland foreground to wide open seas beyond Sarclet Head. Open, flat, simple coastline with no existing, valued focal features in the view. BOWL is a characterising feature of the view out to sea with the existing Beatrice Field platforms and demonstrator turbines also visible further south. Character of landward area is of small farms and crofts. **Sensitivity: medium - high**	Development would be visible less frequently and at a greater distance than BOWL. The ZTVs illustrate that 51-62 turbines are theoretically visible with all of these visible to below hub level. The Development is located on the skyline within a part of the broad, partially undeveloped, sea views that lie to the south. Within a few years it is likely that the Beatrice Demonstrator Turbines and the associated oil platforms would no longer form part of the view. At this distance the curvature of the earth reduces the apparent height of all of the turbines with those furthest away having notably shorter sections of their towers visible above the skyline. The angle of view and the depth of the layout of the Development within it result in the most distant turbines appearing slightly lower in the view than those to the front of the wind farm. The alignment of the turbines of the WCS is apparent within this view, as is the gap necessitated by the cable wayleave that runs through the site. This pattern of turbines is similar to that of BOWL. The view direction to the centre of the Development is approximately south. This means that the turbines would generally be back lit and therefore seen in shadow, resulting in them generally being less contrasting with the sky background than turbines lit by the sun. The sun may strike the turbines on their west or east sides during early morning or late afternoon/evening. This could potentially increase contrast, making them more apparent when the visibility is very good. Due to the prevailing wind the turbines would most usually be seen so that the rotor faces are aligned at an angle to the viewpoint, reducing the influence of the blade movement and also the overall dimension of the part of the view affected by each turbine.	

Table 14.7.1: Effect on Representative Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
		The Development, when visible, may at times appear slightly less prominent than BOWL due to its greater distance. Where the wind farms overlap there would be a greater density of turbines apparent at ranges of greater than 17 km (BOWL) and 26.55 km (the Development). The greater distance to the Development ensures its larger turbine dimensions are not readily apparent. Due to the low elevation of the viewpoint the BOWL turbine bases all appear behind or close to the skyline with those of the Development being generally beyond the horizon. At this range it will not be possible to readily distinguish the varied actual distances to the turbines so that the turbines of the Development are not immediately distinguishable as being larger. Due to the distance between the viewpoint and the OSPs combined with the curvature of the earth these will be seen as relatively small, low elements within the context of the much larger, moving turbines. Their bulkier form will appear much like the Beatrice oil platforms. The Development would generally appear as a large extension to BOWL due to its apparent similarity of scale and layout as well as the context within which they are both located. When apparent the Development would extend offshore wind farm visibility across a further wide part of the available sea views from this location. The offshore wind farm influence would be apparent out in the open sea rather than encroaching close to the land. However, this, in addition to a degree of existing onshore wind farm influence, results in increasing the overall effect of wind farm development across the wide views from this part of the coast. Figure 14.17b illustrates the extent of the ZTV within this vicinity. This shows that there is theoretical visibility of the Development from limited locations but the settlement of Wick and the surrounding settled areas. Actual visibility is further reduced due to the screening influence of buildings. Visibility such as is	

Table 14.7.1: Effect on Representative Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
		represented by the viewpoint would be possible from sections of the Core Paths in the vicinity and on the south side of Wick Bay. Visibility from nearby sections of the A99 is limited. ***Magnitude of change: medium*** **Construction and decommissioning** The worst case scenario of both the construction and decommissioning will be when large numbers of turbines are in place in addition to concentrations of activity in the form of marine vessels and cranes. These activities associated with the Development turbines and OSPs will be distant with the construction of the cable route occurring at even greater distances, beyond the wind farm. ***Magnitude of change: medium***	
5: Whaligoe Steps Volume 3b – Figures 14.7.13a to 14.7.13e	Located in RCCA – Sarclet Head and the Small Farms and Crofts LCT. This viewpoint is located above the cliff enclosed cove of Whaligoe, which is part of the scattered settlement of Ulbster. The viewpoint is representative of views from the high ground which has an outlook over a wide panoramic expanse of sea as well as down to the sheltered harbor below. Views in other directions include the scattered crofts which extend along the A99 with rising moorland hills beyond. BOWL is visible across a wide section (50 degrees) of this view at a range of 15.8 km and is a key characteristic of the wide panoramic view out to sea. Beatrice Field oil platforms and demonstrator turbines are visible further to the south at a range of approximately 27.7 km. The layout of the BOWL turbines means that they appear 'stacked' in rows or there are large gaps within parts of the wind farm. Views out across the cove are in an easterly direction rather than south east towards the Development.	**Operation** Field of view affected by the Development is approximately 49 degrees. Distance to the Development (closest turbine of WCS) 25.8 km. The increased separation of the viewpoint and the more distant turbines means that they are likely to be less visible than the closest. The distance to the most distant turbine of the WCS is 38 km. This distance results in the turbines theoretically appearing as moderate scale, vertical, moving features visible in 'very good visibility' conditions. The vertical angle of view occupied by the Development theoretically takes up 0.5-1 degrees of the field of view. The Development would theoretically add approximately 36.5 degrees to the offshore wind farm views created by BOWL, which would be visible more frequently and at a closer range. The ZTVs	**Operation** Significant, negative, long term, reversible. **Construction and decommissioning** Significant, negative, short term, reversible. **Likelihood of effect** Very good visibility required for the Development to be visible at 25.8 km to closest turbine.

Table 14.7.1: Effect on Representative Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
	Similar, if more distant views will be available from parts of the Loch of the Yarrows Archaeological Trail to the north west. The focus of these trails is, however more localised. **Value of views: medium** There are no scenic landscape designations. Valued locally as coastal outlook from properties and higher sections of the A99, which generally have a foreground of settled landscape. View taken from visitor attraction of Whaligoe Steps - 365 man-made steps cut into cliff to access small port. It is the steps themselves and their confined location within this enclosed natural cove (east facing) which is the key attraction rather than the wider seascape. Open, uniform view of the sea with no valued focal points in existing view out to sea and BOWL. **Susceptibility to change: medium-high** View will be experienced by visitors as well as residents of nearby Ulbster. Framed view extends eastwards out to sea with headlands visible to the left and to the right. The wider view presents the coastline as the key characteristic of the view with the sea and BOWL within it forming the background setting. The dramatic drop of the cliffs and their exposed rocky faces draw the viewer's attention. Sarclet Head comprises hard coastal shore with irregular rocky coastline of Old Red Sandstone cliffs. **Sensitivity: medium - high**	illustrate that 51-62 turbines are theoretically visible with all of these visible to below hub level. The Development is located on the skyline within a part of the broad, partially undeveloped, sea views that lie to the south. Within a few years it is likely that the Beatrice Demonstrator Turbines and the associated oil platforms would no longer form part of the view. At this distance the curvature of the earth reduces the apparent height of all of the turbines with those furthest away having notably shorter sections of their towers visible above the skyline. The angle of view and the depth of the layout of the Development within it result in the most distant turbines appearing slightly lower in the view than those to the front of the wind farm. The alignment of the turbines of the WCS is apparent within this view, as is the gap necessitated by the cable wayleave that runs through the site. This pattern of turbines is similar to that of BOWL. The view direction to the centre of the Development is approximately south. This means that the turbines would generally be back lit and therefore seen in shadow, resulting in them generally being less contrasting with the sky background than turbines lit by the sun. The sun may strike the turbines on their west or east sides during early morning or late afternoon/evening. This could potentially increase contrast, making them more apparent when the visibility is very good. Due to the prevailing wind the turbines would most usually be seen so that the rotor faces are aligned at an angle to the viewpoint, reducing the influence of the blade movement and also the overall dimension of the part of the view affected by each turbine. Where the wind farms overlap there would be a greater density of turbines apparent at ranges of greater than 17 km (BOWL) and	

Table 14.7.1: Effect on Representative Viewpoints

Viewpoint	Baseline Condition and Sensitivity	Magnitude of Change	Significance of Effect
		25.8 km (the Development). The proximity of the Development means that its closest turbines appear larger in scale than those of BOWL. Due to the low elevation of the viewpoint the BOWL turbine bases all appear behind or close to the skyline with those of the Development being generally beyond the horizon. At this range it will not be possible to readily distinguish the varied actual distances to the turbines so that it would require detailed scrutiny to determine that the Development turbines are taller and not merely closer. Due to the distance between the viewpoint and the OSPs combined with the curvature of the earth these will be seen as relatively small, low elements within the context of the much larger, moving turbines. Their bulkier form will appear much like the Beatrice oil platforms. The Development would generally appear as a large extension to BOWL due to its apparent similarity of scale and layout as well as the context within which they are both located. When apparent the Development would extend offshore wind farm visibility across a further wide part of the available sea views from this location. The offshore wind farm influence would be apparent out in the open sea rather than encroaching close to the land. The southerly extents of the Development may be seen against a backdrop of the low Moray coastline when visibility is very clear. Figure 14.17 illustrates the ZTV within the local area and this shows that there would be a similar degree of visibility from much of the coastline. The A99 and the numerous properties strung out along it may also have visibility of the Development, however, the magnitude of change is likely to be slightly less due to characterising foreground influences and/or less focused views. ***Magnitude of change: medium*** **Construction and decommissioning**	

Table 14.7.1: Effect on Representative Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
		The worst case scenario of both the construction and decommissioning will be when large numbers of turbines are in place in addition to concentrations of activity in the form of marine vessels and cranes. These activities associated with the Development turbines and OSPs will be distant with the construction of the cable route occurring at even greater distances, beyond the wind farm. ***Magnitude of change: medium***	
6: Minor Road, south east of Oslcay Volume 3b – Figures 14.7.14a to 14.7.14h	Located in LCT- Small Farms and Crofts. This viewpoint is located near a shallow high point on this minor road which links from the A99, via Rumster Forest to the A9. There is a broad outlook to the south-east along this southerly section of the road across improved pasture, moorland, scattered crofts and the small settlement of Lybster on the coast. The route and surrounding land drops towards the coast so that intervening features increasingly screen and filter views out to sea. There are small patches of fenced improved pasture as well as trees close to the building clusters and these as well as transmission lines and minor road add to the character of scattered settlement. The sea forms a relatively small component of this view but its relatively open and simple form contrasts with the more complex landscape context and is the focus of views due to the low point created by the dip in landform and the orientation of the road. The Beatrice Demonstrator Turbines and the associated oil platforms are visible out to sea. The BOWL wind farm is theoretically visible across 22.5 degrees of the field of view but will be only partially visible from this location, at a range of 22.63 km, due to intervening landform and buildings. It's low level of visibility and position within the view	**Operation** Field of view affected by the Development is approximately 50 degrees. Distance to the Development (closest turbine of WCS) 28.42 km. The increased separation of the viewpoint and the more distant turbines means that they are likely to be less visible than the closest. The distance to the most distant turbine of the WCS is 36 km. This distance results in the turbines theoretically appearing as moderate scale, vertical, moving features visible in 'very good visibility' conditions. The vertical angle of view occupied by the Development theoretically takes up 0.5-1 degrees of the field of view. The Development would theoretically add approximately 44 degrees to the offshore wind farm views created by the, slightly closer, BOWL turbines. The ZTVs illustrate that 51-62 turbines are theoretically visible with all of these visible to below hub level. The Development is located on the skyline across the full extent of the sea view that is seen within the low point in the landform. Within a few years it is likely that the Beatrice Demonstrator Turbines and the associated oil platforms would no longer form part of the view.	**Operation** Significant, negative, long term, reversible. **Construction and decommissioning** Significant, negative, short term, reversible. **Likelihood of effect** Very good visibility required for the Development to be visible at 28.4 km to closest turbine.

Table 14.7.1: Effect on Representative Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
	means that it is not a prominent characteristic, although its apparent relationship with the settled landscape/houses on the skyline causes some visual confusion. **Value of views – medium - low** The viewpoint and the part of the view located in the direction of the Development do not lie within a landscape designation. Land in views to the west has a recognised value but is largely screened from here by intervening high ground. Views from this route are not of particular local value. There are no formal stopping points so that views from the route itself are mostly transient and incidental. **Susceptibility to change – medium- high** The view does represent the type of view that will be gained from residential properties/crofts with some of these orientated to take advantage of the sea views. View contains other existing forms of development both on intervening land and sea with sea forming a relatively small component at the focal point of the view. Views in other directions contain tall masts and coniferous forestry plantations. **Sensitivity: medium**	At this distance the curvature of the earth reduces the apparent height of all of the turbines with those furthest away having slightly shorter sections of their towers visible above the skyline. The angle of view and the depth of the layout of the Development within it result in the most distant turbines appearing slightly lower in the view than those to the front of the wind farm. The alignment of the turbines of the WCS is apparent within this view. This pattern of turbines is similar to what can be seen of BOWL. The view direction to the centre of the Development is approximately south south east. This means that the turbines would generally be back lit and therefore seen in shadow, resulting in them generally being less contrasting with the sky background than turbines lit by the sun. The sun may strike the turbines on their west or east sides during early morning or late afternoon/evening. This could potentially increase contrast, making them more apparent when the visibility is very good. Due to the prevailing wind the turbines would most usually be seen so that the rotor faces are aligned at an angle to the viewpoint, reducing the influence of the blade movement and also the overall dimension of the part of the view affected by each turbine. Where the wind farms overlap there would be a greater density of turbines apparent at ranges of greater than 23 km (BOWL) and 29.7 km (the Development). The proximity of the Development means that its turbines appear larger in scale than those of BOWL. Due to the distance between the viewpoint and the OSPs combined with the curvature of the earth these will be seen as relatively small, low elements within the context of the much larger, moving turbines. Their bulkier form will appear much like the Beatrice oil platforms.	

Table 14.7.1: Effect on Representative Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
		The influence of BOWL and the currently operational Beatrice Demonstrator Turbines on this viewpoint is relatively limited so that the Development would create a much more definitive offshore wind farm component of this view across the full extent of the seascape horizon visible. The offshore wind farm influence would be apparent out in the open sea as well as being apparent immediately above the settled landscape. This would cause a degree of visual confusion due to their scale comparison with the houses and the fact that it would not be clear whether some of the turbines are on the land or out at sea. Figure 14.17b illustrates the ZTV within the local area and this shows that there would be a similar degree of visibility from much of the minor road south of Rumster Forest and across the open parts of the settled, hill slopes to the south of Stemster Hill and Cnoc an Earrannaiche and including Upper Lybster. The A99 and the numerous properties strung out along it may also have visibility of the Development, however, the magnitude of change is likely to be slightly less due to characterising foreground influences and less focused views. ***Magnitude of change: medium*** **Construction and decommissioning** The worst case scenario of both the construction and decommissioning will be when large numbers of turbines are in place in addition to concentrations of activity in the form of marine vessels and cranes. These activities associated with the Development turbines and OSPs will be distant with the construction of the cable route occurring at even greater distances, beyond the wind farm. **Magnitude of change: medium**	

Table 14.7.1: Effect on Representative Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
7: Lybster (end of Main Street) Volume 3b – Figures 14.7.15a to 14.7.15i	Located in RCCA – Lybster Bay and the Small Farms and Crofts LCT. The viewpoint is near to the southerly dead-end of Main Street, which is orientated in a strongly north south direction with houses set out along its length. There are a small number of houses set along the coast, some of which are seen with the views presented. Views out from this location are across a broad expanse of sea, broken by intervening properties and with BOWL a prominent feature to the east at a distance of 19.45 km and taking up approximately 39 degrees of the field of view (although partially screened by the intervening property from this precise location). The layout of the BOWL turbines means that they appear 'stacked' in rows in some locations. The Beatrice Demonstrator turbines and the associated oil platforms are visible as point features on the skyline at a distance of approximately 25 km. The Burn of Whilk wind farm is likely to be visible from the golf course as well as the rears and gardens of some properties at a range of approximately 7.15 km, where they have an open outlook to the north east. It is unlikely that properties will have open views of both Burn of Whilk and the Development due to their different directions. **Value of views: medium** No scenic designations but will be locally valued as coastal outlook. View from end of Main Street in Lybster showing view across final properties that lie nearer to the coast. Views from local Core Paths locally valued. **Susceptibility to change: medium- high**	**Operation** Field of view affected by the Development is approximately 57 degrees. Distance to the Development (closest turbine of WCS) 24.6 km. The increased separation of the viewpoint and the more distant turbines means that they are likely to be less visible than the closest. The distance to the most distant turbine of the WCS is 33 km. This distance results in the turbines theoretically appearing as moderate scale, vertical, moving features visible in 'very good visibility' conditions. The vertical angle of view occupied by the Development theoretically takes up 0.5-1 degrees of the field of view. The Development would theoretically add approximately 50 degrees to the offshore wind farm views created by BOWL, which may be visible more frequently and at a closer range. The ZTVs illustrate that 51-62 turbines are theoretically visible with all of these visible to below hub level. The Development is located on the skyline within a part of the broad, partially undeveloped, sea views that lie to the south round to the south east. Within a few years it is likely that the Beatrice Demonstrator Turbines and the associated oil platforms would no longer form part of the view. At this distance the curvature of the earth reduces the apparent height of all of the turbines with those furthest away having slightly shorter sections of their towers visible above the skyline. The angle of view and the depth of the layout of the Development within it result in the most distant turbines appearing slightly lower in the view than those to the front of the wind farm. The alignment of the turbines of the WCS is apparent within this view. This pattern of turbines is similar to that of BOWL.	**Operation** Significant, negative, long term, reversible. **Construction and decommissioning** Significant, negative, short term, reversible. **Likelihood of effect** Very good visibility required for the Development to be visible at 24.6 km to closest turbine.

Table 14.7.1: Effect on Representative Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
	Representative of views from residential properties and parts of settlement of Lybster. View shows foreground of turning area at end of street with grassed verges, fenced fields and garden boundaries. The properties that generally follow the strong alignment of the road axis, which runs almost due south from the A99 junction, are visible in the wider view. These are generally inward looking to the Main Street. Other properties in the view are a short terrace of two-storey local authority built houses and a more modern, detached property in the view towards the proposed wind farm. All set within small gardens and with urban amenities such as boundary walls and pole mounted transmission lines. Small track leads across agricultural land through field gates. Close proximity to and directly overlooking the sea, which is expansive and large scale, extending uninterrupted to the sky at a horizon that is level with the roof-line of the single storey property. Oil platform/ installations and Beatrice demonstrator turbines visible as small scale, distant elements on the horizon in the south-east. BOWL is a prominent feature of the views east out to sea. **Sensitivity: medium-high**	The view direction to the centre of the Development is approximately south south east. This means that the turbines would generally be back lit and therefore seen in shadow, resulting in them generally being less contrasting with the sky background than turbines lit by the sun. The sun may strike the turbines on their west or east sides during early morning or late afternoon/evening. This could potentially increase contrast, making them more apparent when the visibility is very good. Due to the prevailing wind the turbines would most usually be seen so that the rotor faces are aligned at an angle to the viewpoint, reducing the influence of the blade movement and also the overall dimension of the part of the view affected by each turbine. There is a relatively small apparent overlap between the Development and BOWL in views from this angle. Where the wind farms overlap there would be a greater density of turbines apparent at ranges of greater than 20 km (BOWL) and 26.6 km (the Development). The proximity and larger scale of the Development means that its turbines appear larger in scale than those of BOWL. Due to the distance between the viewpoint and the OSPs combined with the curvature of the earth these will be seen as relatively small, low elements within the context of the much larger, moving turbines. Their bulkier form will appear much like the Beatrice oil platforms. The Development would generally appear as a large extension to BOWL. However, there is some discord between the wind farms due to the notably larger scale and spacing of the Development turbines. This is particularly noticeable where there are outliers to the turbine grouping at the south western extents of the Development. As part of the final wind farm design and layout Moray West will work with stakeholders to seek to reduce, where possible, the	

Table 14.7.1: Effect on Representative Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
		perception of turbines as 'outliers' which could appear to extend the horizontal extent of the wind farm disproportionately when compared to the energy gained. The final wind farm design and layout will also be required to take into account other stakeholder requirements such as navigation, commercial fisheries and search and rescue (SAR); other technical and environmental factors within the Moray West Site (ground conditions, wind resources etc.); and proximity to the neighbouring Beatrice and Moray East offshore wind farms. When apparent the Development would extend offshore wind farm visibility across a further, wide part of the available sea views from this location so that offshore windfarms would be seen across most of the sea horizon. This would occur across a part of the sea view that can be seen along the alignment framed by Main Street. The offshore wind farm influence would be apparent out in the open sea rather than encroaching close to the land and there is a wide stretch of open sea visible from this slightly elevated coast. The southerly extents of the Development may be seen against a backdrop of the low Moray coastline when visibility is very clear. Figure 14.17b illustrates the ZTV within the local area and this shows that there would be a similar degree of visibility from much of the coastline and immediate hinterland where there is scattered settlement and several Core Paths. The A99 and the numerous properties strung out along it may also have visibility of the Development, however, the magnitude of change is likely to be slightly less from non-coastal locations due to characterising foreground influences and/or less focused views. ***Magnitude of change: medium*** **Construction and decommissioning**	

Table 14.7.1: Effect on Representative Viewpoints

Viewpoint	Baseline Condition and Sensitivity	Magnitude of Change	Significance of Effect
		The worst case scenario of both the construction and decommissioning will be when large numbers of turbines are in place in addition to concentrations of activity in the form of marine vessels and cranes. These activities associated with the Development turbines and OSPs will be distant with the construction of the cable route occurring at even greater distances, beyond the wind farm. ***Magnitude of change: medium***	
8: Latheron (A9) Volume 3b – Figures 14.7.16a to 14.7.16f	Located in RCCA – Dunbeath Bay and within the Small Farms and Crofts. Viewpoint is at a stopping point on the A9 and offers wide panoramic views out to sea across a narrow foreground of pastoral land subdivided by ‘dry-stane-dykes’. The elevated position above the sea is made more obvious where the steep, rocky slopes are exposed and are visible at the edge. BOWL apparent as a prominent feature east out at sea at a range of 23.1 km and visible across over 32 degrees of the wide field of view. The layout of the BOWL turbines means that they appear ‘stacked’ in rows in some locations. The Beatrice Demonstrator turbines and the associated oil platforms are visible as point features on the skyline at a distance of approximately 26 km. **Value of views: medium** No scenic designations. View from just inside stone enclosure, close to layby on A9 where stopping to appreciate the view is encouraged. This is not part of a National Tourist Route, however this section of the A9 is part of the North Coast 500 route. **Susceptibility to change: medium - high**	**Operation** Field of view affected by the Development is approximately 55 degrees. Distance to the Development (closest turbine of WCS) 25.24 km. The increased separation of the viewpoint and the more distant turbines means that they are likely to be less visible than the closest. The distance to the most distant turbine of the WCS is 34.5 km. This distance results in the turbines theoretically appearing as moderate scale, vertical, moving features visible in ‘very good visibility’ conditions. The vertical angle of view occupied by the Development theoretically takes up 0.5-1 degrees of the field of view. The Development would theoretically add approximately 50 degrees to the offshore wind farm views created by BOWL, which may be visible more frequently and at a slightly closer range. The ZTVs illustrate that 51-62 turbines are theoretically visible with all of these visible to below hub level. The Development is located on the skyline within a part of the broad, partially undeveloped, sea views that lie to the south round to the east south east. Within a few years it is likely that the Beatrice Demonstrator Turbines and the associated oil platforms would no longer form part of the view.	**Operation** Significant, negative, long term, reversible. **Construction and decommissioning** Significant, negative, short term, reversible. **Likelihood of effect** Very good visibility required for the Development to be visible at 25.24 km to closest turbine.

Table 14.7.1: Effect on Representative Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
	Representative of views from settlement of Latheron and nearby Latheronwheel as well as scattered properties, road users and visitors. Expansive views across narrow strip of farmland to large scale sea beyond and extending from below the viewpoint. View across rough ground and ruined building enclosed by stone walls. Middle distance is formed by medium sized, shallowly undulating, smooth, pastoral fields with stone wall boundaries. Prominent coastal incision crosses view. Made more conspicuous by contrast in vegetation to rough grassland and scrub. Vegetation type continues across steep slopes to sea shore. BOWL, oil platforms and Beatrice Demonstrator offshore wind turbines clearly discernible near to the horizon in clear conditions. **Sensitivity: medium-high**	At this distance the curvature of the earth reduces the apparent height of all of the turbines with those furthest away having slightly shorter sections of their towers visible above the skyline. The angle of view and the depth of the layout of the Development within it result in the most distant turbines appearing slightly lower in the view than those to the front of the wind farm. The alignment of the turbines of the WCS is apparent within this view. This pattern of turbines is similar to that of BOWL. The view direction to the centre of the Development is approximately south east. This means that the turbines would generally be back lit and therefore seen in shadow, resulting in them generally being less contrasting with the sky background than turbines lit by the sun. The sun may strike the turbines on their west sides and this may be apparent from this direction from mid-afternoon through to the evening. This could potentially increase contrast, making them more noticeable when the visibility is very good. Due to the prevailing wind the turbines would most usually be seen so that the rotor faces are aligned at an angle or perpendicular to the viewpoint, reducing the influence of the blade movement and also the overall dimension of the part of the view affected by each turbine. There is a relatively small apparent overlap between the Development and BOWL in views from this angle. Where the wind farms overlap there would be a greater density of turbines apparent at ranges of greater than 24 km (BOWL) and 30.5 km (the Development). The proximity and larger scale of the Development means that its turbines appear larger in scale than those of BOWL. This is particularly noticeable where there are outliers to the turbine grouping at the south western extents of the Development.	

Table 14.7.1: Effect on Representative Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
		Due to the distance between the viewpoint and the OSPs combined with the curvature of the earth these will be seen as relatively small, low elements within the context of the much larger, moving turbines. Their bulkier form will appear much like the Beatrice oil platforms. The Development would generally appear as a large extension to BOWL. However, there is some discord between the wind farms due to the notably larger scale and spacing of the Development turbines. When apparent the Development would extend offshore wind farm visibility across a further, wide part of the available sea views from this location so that offshore windfarms would be seen across the majority of the sea horizon. The Development would be apparent out in the open sea rather than encroaching close to the land and there is a wide stretch of open sea visible from this slightly elevated coast. The southerly extents of the Development may be seen against a backdrop of the low Moray coastline when visibility is very clear. Figure 14.17b illustrates the ZTV within the local area and this shows that there would be a similar degree of visibility from much of the coastline and immediate hinterland where there are the hamlets of Latheronwheel and Smerral as well as scattered settlement. The A99 and the southern extents of the A9 as well as the numerous properties strung out along it may also have visibility of the Development, however, the magnitude of change is likely to be slightly less from non-coastal locations due to characterising foreground influences and/or less focused views. ***Magnitude of change: medium*** **Construction and decommissioning**	

Table 14.7.1: Effect on Representative Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
		The worst case scenario of both the construction and decommissioning will be when large numbers of turbines are in place in addition to concentrations of activity in the form of marine vessels and cranes. These activities associated with the Development turbines and OSPs will be distant with the construction of the cable route occurring at even greater distances, beyond the wind farm. ***Magnitude of change: medium***	
9a: Dunbeath (nr Heritage Centre) Volume 3b – Figures 14.7.17a to 14.7.17k	Located in RCCA – Dunbeath Bay and within Small Farms and Crofts LCT. Viewpoint is sited below the Heritage Centre at the corner where the road turns down the hill. The view is across the harbour and harbourside properties, which are set below the steep slopes which envelope lower Dunbeath. The wider view includes a broad expanse of open sea as well as the valley slopes of the Dunbeath Water and the minor road as it snakes its way down. BOWL is visible across a wide part (26 degrees) of the view to the east from this location at a range of 25.7 km. The Beatrice Demonstrator turbines and the associated oil platforms are visible as point features on the skyline at a distance of approximately 26 km. **Value of views: medium** No scenic designations. Similar views would be available from Dunbeath Castle and its associated GDL located just along the coast to the south-west. The effects on this receptor are considered separately in section 14.7.4. Narrower, more focused but less open views are also available from the A9, which forms part of the North Coast 500 route. **Susceptibility to change: medium - high**	**Operation** Field of view affected by the Development is approximately 54 degrees. Distance to the Development (closest turbine of WCS) 24.78 km. The increased separation of the viewpoint and the more distant turbines means that they are likely to be less visible than the closest. The distance to the most distant turbine of the WCS is 36 km. This distance results in the turbines theoretically appearing as moderate scale, vertical, moving features visible in 'very good visibility' conditions. The vertical angle of view occupied by the Development theoretically takes up 0.5-1degrees of the field of view. The Development would theoretically add approximately 51 degrees to the offshore wind farm views created by BOWLThe ZTVs illustrate that 51-62 turbines are theoretically visible with all of these visible to below hub level. The Development is located on the skyline within a part of the broad, partially undeveloped, sea views that lie approximately to the south south east round to the east. Within a few years it is likely that the Beatrice Demonstrator Turbines and the associated oil platforms would no longer form part of the view.	**Operation** Significant, negative, long term, reversible. **Construction and decommissioning** Significant, negative, short term, reversible. **Likelihood of effect** Very good visibility required for the Development to be visible at 24.78 km to closest turbine.

Table 14.7.1: Effect on Representative Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
	Representative of views from settlement of Dunbeath, residential receptors, visitors to Heritage Centre/ tourist information, beach and around coast. Channeled view along minor road further emphasised by steeply sloping side of Dunbeath Water valley. Fore to mid-ground, medium to large scale and pastoral in character with some limited dwellings and farmsteads strung out along the road and on higher ground above. Fenced field boundaries and some unimproved pasture with wetness characteristics. Visibility of sea beyond is limited by landform so that a lesser extent is visible than from some coastal areas. Sea is large in scale and expansive with distant skyline difficult to discern from the sea in certain weather conditions. BOWL visible across a wide part of the view. Distant oil platforms and Beatrice Demonstrator turbines visible on horizon as small scale elements. **Sensitivity: medium - high**	At this distance the curvature of the earth reduces the apparent height of all of the turbines with those furthest away having slightly shorter sections of their towers visible above the skyline. The angle of view and the depth of the layout of the Development within it result in the most distant turbines appearing slightly lower in the view than those to the front of the wind farm. The alignment of the turbines of the WCS is apparent within this view. This pattern of turbines is similar to that of BOWL. The view direction to the centre of the Development is approximately south east. This means that the turbines would generally be back lit and therefore seen in shadow, resulting in them generally being less contrasting with the sky background than turbines lit by the sun. The sun may strike the turbines on their west sides and this may be apparent from this direction from mid-afternoon through to the evening. This could potentially increase contrast, making them more noticeable when the visibility is very good. Due to the prevailing wind the turbines would most usually be seen so that the rotor faces are aligned at an angle or perpendicular to the viewpoint, reducing the influence of the blade movement and also the overall dimension of the part of the view affected by each turbine. There is a relatively small apparent overlap between the Development and BOWL in views from this angle. Where the wind farms overlap there would be a greater density of turbines apparent at ranges of greater than 30 km (BOWL) and 32 km (the Development). The proximity and larger scale of the Development means that its turbines appear larger in scale than those of BOWL. Due to the distance between the viewpoint and the OSPs combined with the curvature of the earth these will be seen as relatively small, low elements within the context of the much	

Table 14.7.1: Effect on Representative Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
		larger, moving turbines. Their bulkier form will appear much like the Beatrice oil platforms. The Development would generally appear as a large extension to BOWL. However, there is some discord between the wind farms due to the notably larger scale and spacing of the Development turbines. This is particularly noticeable where there are outliers to the turbine grouping at the south western extents of the Development. When apparent the Development would extend offshore wind farm visibility across a further, wide part of the available sea views from this location so that offshore windfarms would be seen across all of the sea horizon. The Development would be apparent out in the open sea rather than encroaching close to the land and there is a wide stretch of intervening, open sea visible from this slightly elevated coast. The southerly extents of the Development may be seen against a backdrop of the low Moray coastline when visibility is very clear. Figure 14.17c illustrates the ZTV within the local area and this shows that there would be a similar degree of visibility from the upper parts of Dunbeath as well as much of the coastline and immediate hinterland where there are the hamlets of Balantrath, Knockinnon, Achavrole and Balnabruich as well as other scattered settlement. The A9 as well as the numerous properties strung out along it may also have visibility of the Development, however, the magnitude of change is likely to be slightly less from non-coastal locations due to characterising foreground influences and/or less focused views. Views from the section of the A9, which passes through Dunbeath, are limited by forestry and other intervening features, however, there is some channeled visibility towards the Development from the road bridge along the valley formed by the Dunbeath Water.	

Table 14.7.1: Effect on Representative Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
		Magnitude of change: medium **Construction and decommissioning** The worst case scenario of both the construction and decommissioning will be when large numbers of turbines are in place in addition to concentrations of activity in the form of marine vessels and cranes. These activities associated with the Development turbines and OSPs will be distant with the construction of the cable route occurring at even greater distances, beyond the wind farm. ***Magnitude of change: medium***	
9b: Dunbeath, by Harbour Volume 3b – Figures 14.7.18a to 14.7.18d	Located in RCCA – Dunbeath Bay and within Small Farms and Crofts LCT. This viewpoint is located along Portmorin Road, which provides access to the harbour, a small number of houses and a parking/picnic area with interpretation. The viewpoint was not located at the parking/picnic area as the nearby cliffs restrict visibility to the east. Along this stretch of the route there are also benches, a memorial and interpretative materials as well as the public toilets and harbour area. Outlook is focused out to sea due to landform enclosure behind the viewpoint. Properties along the coast are of varied use. The harbour itself is used and contains features of its industrial function so that it is not particularly scenic. The coast outwith the enclosed harbour area is formed of rugged rocks with the River emitting into the sea across mud flats. Core Paths provide access from the more settled parts of the village to the harbour.	**Operation** Field of view affected by the Development is approximately 49 degrees. Distance to the Development (closest turbine of WCS) 24.3 km. The increased separation of the viewpoint and the more distant turbines means that they are likely to be less visible than the closest. The distance to the most distant turbine of the WCS is 35 km. This distance results in the turbines theoretically appearing as moderate scale, vertical, moving features visible in 'very good visibility' conditions. The vertical angle of view occupied by the Development theoretically takes up 0.5-1 degrees of the field of view. The Development would theoretically span across approximately 49 degrees of the open sea views. The ZTVs illustrate that 51-62 turbines are theoretically visible with almost all of these visible to below hub level. The Development would be located on the skyline within a part of the broad, largely undeveloped, sea views that lie approximately to the south south east round to the south-east. The most	**Operation** Significant, negative, long term, reversible. **Construction and decommissioning** Significant, negative, short term, reversible. **Likelihood of effect** Very good visibility required for the Development to be visible at 24.3 km to closest turbine.

Table 14.7.1: Effect on Representative Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
	The Beatrice Demonstrator turbines and the associated oil platforms are visible as point features on the skyline at a distance of approximately 25. 7 km. **Value of views – medium** No landscape planning designations. Views locally valued as representative of sea views from properties, the harbour and facilities. Interpretative materials and seating encourage appreciation of the views. **Susceptibility to change – medium – high** Views are obtained by residents as well as users of the harbour facilities and the Core Paths. Interpretation materials and benches encourage attention to the views. The containment created by landform directs views out to sea across a confined extent of open outlook. **Sensitivity: medium - high**	northerly extents of the Development as well as the entire BOWL would be screened from view by intervening landform. Within a few years it is likely that the Beatrice Demonstrator Turbines and the associated oil platforms would no longer form part of the view. At this distance the curvature of the earth reduces the apparent height of all of the turbines with those furthest away having slightly shorter sections of their towers visible above the skyline. The angle of view and the depth of the layout of the Development within it result in the most distant turbines appearing slightly lower in the view than those to the front of the wind farm. The alignment of the turbines of the WCS is apparent within this view. The view direction to the centre of the Development is approximately south east. This means that the turbines would generally be back lit and therefore seen in shadow, resulting in them generally being less contrasting with the sky background than turbines lit by the sun. The sun may strike the turbines on their west sides and this may be apparent from this direction from mid-afternoon through to the evening. This could potentially increase contrast, making them more noticeable when the visibility is very good. Due to the prevailing wind the turbines would most usually be seen so that the rotor faces are aligned at an angle or perpendicular to the viewpoint, reducing the influence of the blade movement and also the overall dimension of the part of the view affected by each turbine. Due to the distance between the viewpoint and the OSPs combined with the curvature of the earth these will be seen as relatively small, low elements within the context of the much larger, moving turbines. Their bulkier form will appear much like the Beatrice oil platforms.	

Table 14.7.1: Effect on Representative Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
		The Development would introduce offshore wind farm visibility across a wide extent of the available sea views from this location. The Development would be apparent out in the open sea rather than encroaching above land. There is a relatively wide stretch of intervening, open sea visible from this section of coast. The extent of the view towards the Development would be less from the car park/ picnic area or further west and from parts of narrow road that leads to the main road due to the intervening cliffs and valley formation. ***Magnitude of change: medium- high*** **Construction and decommissioning** The worst case scenario of both the construction and decommissioning will be when large numbers of turbines are in place in addition to concentrations of activity in the form of marine vessels and cranes. These activities associated with the Development turbines and OSPs will be distant with the construction of the cable route occurring at even greater distances, beyond the wind farm. ***Magnitude of change: medium – high***	
10: Morven Volume 3b – Figures 14.7.19a to 14.7.19g	Located in Lone Mountains terrestrial LCT. Viewpoint taken from rocky summit of Morven (706 m AOD), the highest peak in Caithness and classified as a Graham. Likely to be of interest locally / regionally, rather than nationally. Panoramic views in all directions with distant views to the Cairngorms to the south and round to take in the western Highlands offering impressive views over these mountain ranges where there is very little evidence of man's influence over this landscape. Summit most easily ascended from the east so that views in this direction are available during much of walk, once sufficient	**Operation** Field of view affected by the Development is approximately 36 degrees. Distance to the Development (closest turbine of WCS) 35.7 km. Due to the elevation of the viewpoint it is generally possible to see the full extent of the turbines. This is with the exception of where they are partially hidden by the Scarabens. The turbines would be seen mostly against a backdrop of sea. However, the blade tips of the closest turbines would be visible above the distant sea horizon, which is often not distinguishable from the sky.	**Operation** Not significant, negative, long term, reversible. **Construction and decommissioning** Not significant, negative, short term, reversible. **Likelihood of effect** Very good visibility required for the

Table 14.7.1: Effect on Representative Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
	elevation attained. Morven often walked in conjunction with other peaks to the east. View east with substantial area of fore and middle ground containing further moderately high concave / smoothed, undulating / rocky hills including the Scarabens, Sron Gharbh, Smean and the distinctive conical rock outcrop of Maiden Pap. Large scale landscape of smoothed rock and heather moorland. Lower elevations surround hill forms with well-defined valleys of Berriedale Water and Langwell Water (out of view to south) having some improved pasture and forestry blocks, minor access roads and limited scattered settlement. More distant views contain settled coastal strip of crofting landscape and villages. Across a north east quandrant of the panoramic view, within open moorland / forested areas, the wind farms at Buolfruich, Causeymire, Flex Hill/Bilbster, Achairn, Burn of Whilk and Camster are visible at distances of greater than 16.7 km. Achlachan and Bad a'Cheo consolidate the wind farm character around Causeymire at a distance of around 25 km. The mast on Ben a' chielt lies within the same quadrant. To the south west Gordonbush and Kilbraur wind farms are visible across a narrow section of the view above intermediate ridges but not above the distant, mountainous skyline. Further to the east beyond the settled coastline and to the north east of the Scarabens, BOWL is visible in excellent conditions out in the open sea at a range of 41 km. It spans across approximately 19 degrees of the view. The Beatrice Demonstrator Turbines and the associated oil platforms are visible just above the rounded summit of Sron Gharbh at approximately 39 km in excellent visibility. **Value of views: medium-high**	This distance results in the turbines theoretically appearing as small scale, vertical, moving features visible in 'very good visibility' conditions. The vertical angle of view occupied by the Development theoretically takes up 0-0.5 degrees of the field of view. The Development would theoretically add approximately 22 degrees to the offshore wind farm views created by BOWL. The Development may also be visible more frequently due to its closer range. The ZTVs illustrate that 51-62 turbines are theoretically visible with most of these visible to below hub level. The Development is located within a part of the broad, partially undeveloped, sea views that lie to the south east round to the east. Within a few years it is likely that the Beatrice Demonstrator Turbines and the associated oil platforms would no longer form part of the view. The angle of view and the depth of the layout of the Development within it result in the most distant turbines appearing slightly smaller than those to the front of the wind farm. The view direction to the centre of the Development is approximately south east. This means that the turbines would generally be back lit and therefore seen in shadow, resulting in them generally being less contrasting with the sky background than turbines lit by the sun. The sun may strike the turbines on their west sides and this may be apparent from this direction from mid-afternoon through to the evening. This could potentially increase contrast, making them more noticeable when the visibility is very good, particularly where seen against a dark sea. Due to the prevailing wind the turbines would most usually be seen so that the rotor faces are aligned at an angle or perpendicular to the viewpoint, reducing the influence of the	Development to be visible at 35.7 km to closest turbine.

Table 14.7.1: Effect on Representative Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
	Viewpoint is located within the locally designated SLA – Flow Country and Berriedale Coast and WLA 36. Casueymire - Knockfin Flows. **Susceptibility to change: medium** Viewpoint is representative of views gained by transient walkers who are spending time and making an effort to visit this relatively remote part of Scotland with an expectation of gaining views over an attractive landscape and experiencing a degree of isolation. Sea beyond high ground and coastal strip is a component of distant view that provides a simple backdrop to the hills and coastal area to the fore, which form the setting for the upland area. Views include a sector where there is an onshore wind farm influence set back from the undeveloped moorland and mountains. There is also a sector of the panoramic views where there is offshore wind farm influence out at sea, beyond a substantial extent of foreground landscape. **Sensitivity: medium - high**	blade movement and also the overall dimension of the part of the view affected by each turbine. Due to the distance between the viewpoint and the OSPs combined with the curvature of the earth these will be seen as relatively small, low elements within the context of the much larger, moving turbines. Their bulkier form will appear much like the Beatrice oil platforms. There is a relatively small apparent overlap between the Development and BOWL in views from this angle. Where the wind farms overlap there would be a greater density of turbines apparent at ranges of greater than 45 km (BOWL) and 47 km (the Development). The proximity and larger scale of the Development means that its turbines appear larger in scale than those of BOWL. The Development would generally appear as a large extension to BOWL. However, there is some discord between the wind farms due to the notably larger scale and spacing of the Development turbines. When apparent the Development would extend offshore wind farm visibility across a further, wide part of the available sea views from this location so that offshore windfarms would be seen across a large proportion of the open sea, which forms a distant backdrop to the extensive landscape fore and middle ground of the view. This would occur as part of 360 degree panoramic views that are available from the summit and that take in a wide range of landscapes, some of which are highly scenic and largely undeveloped. The fact that the Development occurs within the same general part of the 360 degree panorama as BOWL, retaining the existing pattern of wind farm development reduces its potential magnitude of change. The Development would be apparent out in the open sea and there is a wide stretch of intermediate open sea visible from this elevated location. Part of the Development is located so that it	

Table 14.7.1: Effect on Representative Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
		forms a component of the distant backdrop to the locally distinctive, close range, rounded peaks of the Scarabens, Sron Gharbh and Smean. This may at times cause visual confusion between the landform and the turbines, however the turbines will mostly be comparatively recessive in the views so that they will be obviously more distant than the landforms and instead associated with the other offshore wind farms. The southerly extents of the Development may be seen to the fore of the low, Moray coastline in very clear conditions. Figure 14.7.19a illustrates the ZTV within the local area and this shows that there would be a similar degree of visibility from a number of the higher peaks within this area. ***Magnitude of change: medium- low*** **Construction and decommissioning** The worst case scenario of both the construction and decommissioning will be when large numbers of turbines are in place in addition to concentrations of activity in the form of marine vessels and cranes. These activities associated with the Development turbines and OSPs will be distant with the construction of the cable route occurring at even greater distances, beyond the wind farm. ***Magnitude of change: medium- low***	
11: Berriedale (A9) Volume 3b – Figures 14.7.20a to 14.7.20f	Located in RCCA – Dunbeath Bay and within the Small Farms and Crofts LCT. Viewpoint taken at junction with minor road off A9 at Newport on stretch of A9 between Berriedale and Borgue. Representative of views from residential properties in the vicinity. Expansive panoramic view across sea, perpendicular to direction of travel along A9, ahead of travellers approaching A9 from	**Operation** Field of view affected by the Development is approximately 53 degrees. Distance to the Development (closest turbine of WCS) 23.2 km. The increased separation of the viewpoint and the more distant turbines means that they are likely to be less visible than the closest. The distance to the most distant turbine of the WCS is 36.5 km.	**Operation** Significant, negative, long term, reversible. **Construction and decommissioning** Significant, negative, short term, reversible. **Likelihood of effect**

Table 14.7.1: Effect on Representative Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
	Newport. Sense of arrival into Dunbeath Bay as view opens out to the north. The Burn of Whilk wind farm is seen above the settled coast and cliffs on forested moorland at a range of 22.7 km. Foreground of road and dry stone wall boundary wall. No middle ground visible due to wall, however, beyond lies narrow expanse of improved pasture down to rough grassland over mounded coastal strip above shoreline (visible around and over wall). Shallow profile of sea extends out to skyline where sky and sea merge in certain weather conditions. In clear visibility is possible to see the Moray coast. BOWL is visible across a wide part (24 degrees) of the view to the east from this location at a range of 28.2 km. The Beatrice Demonstrator turbines and the associated oil platforms are visible as point features to the east south east near the skyline at a distance of approximately 26 km. **Value of views: medium** Viewpoint located close the edge of the Berriedale Coast SLA although no part of the view is across this designated area. This section of the A9 forms part of the North Coast 500 route. View locally valued as view from road and as sea outlook from residential properties. **Susceptibility to change: medium - high** Representative of views from scattered residential properties, users of the bus stop and travellers on A9 and other minor roads. Visible near horizon as small components of the view are oil platforms and the Beatrice Demonstrator Turbines. **Sensitivity: medium-high**	This distance results in the turbines theoretically appearing as moderate scale, vertical, moving features visible in 'very good visibility' conditions. The vertical angle of view occupied by the Development theoretically takes up 0.5-1 degrees of the field of view. The Development would theoretically add approximately 50 degrees to the offshore wind farm views created by BOWL. The Development may be visible more frequently and would be at a closer range than BOWL. The ZTVs illustrate that 51-62 turbines are theoretically visible with all of these visible to below hub level. The Development is located on the skyline within a part of the broad, partially undeveloped, sea views that lie approximately to the south east round to the east. Within a few years it is likely that the Beatrice Demonstrator Turbines and the associated oil platforms would no longer form part of the view. At this distance the curvature of the earth reduces the apparent height of some of the turbines with those furthest away having slightly shorter sections of their towers visible above the skyline. The closest turbines would be visible down to where their foundations meet the sea. The angle of view and the depth of the layout of the Development within it result in the most distant turbines appearing slightly lower in the view than those to the front of the wind farm. The alignment of the turbines of the WCS is apparent within this view. This pattern of turbines is similar to that of BOWL. The view direction to the centre of the Development is approximately east south east. This means that the turbines would mostly be back lit and therefore seen in shadow, resulting in them generally being less contrasting with the sky background than turbines lit by the sun. The sun may strike the turbines on their west sides and this may be apparent from this direction from early-afternoon through to the evening. This could potentially	Very good visibility required for the Development to be visible at 23.2 km to closest turbine.

Table 14.7.1: Effect on Representative Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
		increase contrast, making them more noticeable when the visibility is very good. Due to the prevailing wind the turbines would most usually be seen so that the rotor faces are aligned at an angle or perpendicular to the viewpoint, reducing the influence of the blade movement and also the overall dimension of the part of the view affected by each turbine. Due to the distance between the viewpoint and the OSPs combined with the curvature of the earth these will be seen as relatively small, low elements within the context of the much larger, moving turbines. Their bulkier form will appear much like the Beatrice oil platforms. There is a small apparent overlap between the Development and BOWL in views from this angle. The proximity and larger scale of the Development means that its turbines appear larger in scale than those of BOWL. The Development would generally appear as a large extension to BOWL. However, there is some discord between the wind farms due to the notably larger scale and spacing of the Development turbines. This is particularly noticeable where there are outliers to the turbine grouping at the south western extents of the Development. When apparent the Development would extend offshore wind farm visibility across a further, wide part of the available sea views from this location so that offshore windfarms would be seen across the majority of the sea horizon. The Development would be apparent out in the open sea rather than encroaching close to the land and there is a wide stretch of intervening, open sea visible from this slightly elevated coast. The extreme south westerly extents of the Development may be seen	

Table 14.7.1: Effect on Representative Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
		against a backdrop of the low Moray coastline when visibility is very clear. Figure 14.17c illustrates the ZTV within the local area and this shows that there would be a similar degree of visibility from much of the coastline and immediate hinterland which includes scattered settlement as well as the hamlet of Newport. The lower parts of Berriedale are shown not to gain such visibility. The A9 as well as the numerous properties strung out along it may also have visibility of the Development, however, the magnitude of change may be slightly less due to a higher degree of characterising foreground influences and/or less focused views. ***Magnitude of change: medium*** **Construction and decommissioning** The worst case scenario of both the construction and decommissioning will be when large numbers of turbines are in place in addition to concentrations of activity in the form of marine vessels and cranes. These activities associated with the Development turbines and OSPs will be distant with the construction of the cable route occurring at even greater distances, beyond the wind farm. ***Magnitude of change: medium***	
12: Navidale Volume 3b Figures 14.7.21a to 14.7.21m	Located in RCCA – Helmsdale to Berriedale Coastal Shelf and within Coastal Shelf LCT. Elevated location above A9, a coastal core path and in the vicinity of scattered settlement. Expansive, large scale, rural view with fenced, large to medium sized fields across coastal shelf. Sea extends widely across the background of the view and is large in scale with the Beatrice oil platforms and Demonstrator Turbines near to the horizon at a range of 32.8 km.	**Operation** Field of view affected by the Development is approximately 38 degrees. Distance to the Development (closest turbine of WCS) 27.6 km. The increased separation of the viewpoint and the more distant turbines means that they are likely to be less visible than the closest. The distance to the most distant turbine of the WCS is 45 km.	**Operation** Significant, negative, long term, reversible. **Construction and decommissioning** Significant, negative, short term, reversible. **Likelihood of effect** Very good visibility

Table 14.7.1: Effect on Representative Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
	BOWL is visible in excellent visibility across 17 degrees of the view to the east north east from this location at a range of 38.6 km. Sky and sea appear to merge in certain weather conditions. In clear visibility is possible to see the Moray coast. Northern extent of seaward view restricted by upland area of Creag Thoraraidh, which comes close to the coast and is a large, smooth, conical hill with a heather moorland and rough grassland summit and side slopes to a rugged coastal area. This is where the Moorland Slopes and Hills LCT comes close to the coast forcing the A9 into a series of tight turns to traverse steeply sloping ground. **Value of views: medium** No scenic designations. Locally valued coastal views from A9 which is part of North Coast 500 route. **Susceptibility to change: medium to high** Representative of views from settlements of Navidale, East Helmsdale and Helmsdale. Representative of views gained by north bound travellers on the A9. Higher landform to north-west ensures that views are generally focused along the coast or out across the wide views of generally open sea. **Sensitivity: medium to high**	This distance results in the turbines theoretically appearing as moderate scale, vertical, moving features visible in 'very good visibility' conditions. The vertical angle of view occupied by the Development theoretically takes up 0.51 degrees of the field of view. The Development would theoretically add approximately 37 degrees to the offshore wind farm views created by BOWL. The Development is likely to be visible more frequently and would be at a closer range than BOWL. The ZTVs illustrate that 51-62 turbines are theoretically visible with all of these visible to below hub level. The Development is located on the skyline within a part of the broad, partially undeveloped, sea views that lie approximately to the south east round to the east north east. Within a few years it is likely that the Beatrice Demonstrator Turbines and the associated oil platforms would no longer form part of the view. At this distance the curvature of the earth reduces the apparent height of some of the turbines with those furthest away having slightly shorter sections of their towers visible above the skyline. The closest turbines would be visible down to where their foundations meet the sea. The angle of view and the depth of the layout of the Development within it result in the most distant turbines appearing slightly lower in the view than those to the front of the wind farm. The alignment of the turbines of the WCS is apparent within this view. This pattern of turbines is similar to that of BOWL. The view direction to the centre of the Development is approximately east. This means that the turbines would generally be back lit in the mornings and therefore seen in shadow, resulting in them generally being less contrasting with the sky background than turbines lit by the sun. The sun may strike the turbines on their west sides and this may be apparent from this direction	required for the Development to be visible at 27.6 km to closest turbine.

Table 14.7.1: Effect on Representative Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
		during the afternoon through to the evening. This could potentially increase contrast, making them more noticeable when the visibility is very good. Due to the prevailing wind the turbines would most usually be seen so that the rotor faces are aligned at an angle to the viewpoint, slightly reducing the influence of the blade movement and also the overall dimension of the part of the view affected by each turbine. The rotating blades of the most northerly turbines of the wind farm would be most apparent due to the prevalent angle of view. Due to the distance between the viewpoint and the OSPs combined with the curvature of the earth these will be seen as relatively small, low elements within the context of the much larger, moving turbines. Their bulkier form will appear much like the Beatrice oil platforms. There is a very small apparent overlap between the Development and BOWL in views from this angle. The proximity and larger scale of the Development means that its turbines appear larger in scale than those of BOWL. The Development would generally appear as a large extension to BOWL. However, there is some discord between the wind farms due to the notably larger scale and spacing of the Development turbines. This is particularly noticeable where there are outliers to the turbine grouping at the south western extents of the Development. When apparent the Development would extend offshore wind farm visibility across a further, wide part of the available sea views from this location so that offshore windfarms would be seen across a large part of the sea horizon.	

Table 14.7.1: Effect on Representative Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
		The Development would be apparent out in the open sea rather than encroaching close to the land and there is a wide stretch of intervening, open sea visible from this slightly elevated coast. Figure 14.17c illustrates the ZTV within the local area and this shows that there would be a similar degree of visibility from much of the coastline and immediate hinterland which includes several Core Paths and the hamlet of Navidale and the elevated and coastal parts of Helmsdale. The A9 would also have visibility of the Development, however, the magnitude of change may be slightly less where the road runs away from the coast due to a higher degree of characterising foreground influences and/or less focused views. The A897 is shown to have no visibility of the Development. ***Magnitude of change: medium*** **Construction and decommissioning** The worst case scenario of both the construction and decommissioning will be when large numbers of turbines are in place in addition to concentrations of activity in the form of marine vessels and cranes. These activities associated with the Development turbines and OSPs will be distant with the construction of the cable route occurring at even greater distances, beyond the wind farm. ***Magnitude of change: medium***	
13a: Brora (picnic area off Salt Street) Volume 3b – Figures 14.7.22a to 14.7.22g	Located in RCCA Brora to Helmsdale Deposition Coast and within the Long Beaches Dunes and Links LCT. The viewpoint is taken from an open, grassy area where there are interpretative materials, Core Paths and benches, which are there to facilitate enjoyment of the beach and views across the sea. There is also a parking area to encourage access. The view is representative of views from the settlement of Brora where there is an open outlook across the sea. There are	**Operation** Field of view affected by the Development is approximately 20 degrees. Distance from the Development (closest turbine of WCS) 37.3 km. The increased separation of the viewpoint and the more distant turbines means that they are likely to be markedly less visible than	**Operation** Not significant, negative, long term, reversible. This is largely due to narrow vertical and horizontal fields of view affected as part of a wide panorama of open

Table 14.7.1: Effect on Representative Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
	numerous houses in the vicinity of the viewpoint. The wide panoramic view across the open sea is contained to the north by the rising Highland coastline and there are views south to Tarbat Ness with the Moray coast beyond. It is only the blades of the Beatrice Demonstrator Turbines that are visible above the distant skyline at a range of 46 km. Neither these turbines nor the blade tips of the BOWL turbines are likely to be noticeable from this location due to the distance and limited extents of visibility (theoretically visible across 8.5 degrees). **Value of views – medium – high** The viewpoint is not located within any landscape planning designations. The land rising up from the coast seen in the view to the north is located within the Loch Flett, Loch Brora and Glen Loth SLA. The view also has local value as the outlook from the attractive beaches and coastline as well as from the settlement of Brora and it facilities. **Susceptibility to change – medium-high** The view is representative of the views gained by residents from their properties as well as more transient people visiting the beach and taking in the wide, sea views. It is across a rugged, stony coastline so that the sea and sky are the main component of the views out, framed by settled low lying areas and steeper moorland rising above. The views out to sea are undeveloped, however views inland have development characteristics. The Development is located at a considerable distance from the viewpoint. **Sensitivity: medium to high**	the closest. The distance to the most distant turbine of the WCS 60 km. This distance results in the turbines theoretically appearing as small scale, vertical, moving features visible in 'very good visibility' conditions. The vertical angle of view occupied by the Development theoretically takes up 0-0.5 degrees of the field of view. The ZTVs illustrate that parts of 51-62 turbines are theoretically visible with almost all of these visible to below hub level. The Development would be located on the skyline within a part of the broad, largely undeveloped, sea views that lie approximately to the east round to the east north east. At this distance the curvature of the earth reduces the apparent height of all of the turbines with those furthest away theoretically visible as blades only above the skyline. The alignment of the rows of turbines in the WCS is apparent to a small degree within this view. The view direction to the centre of the Development is approximately east. This means that the turbines would generally be back lit in the mornings and therefore seen in shadow, resulting in them generally being less contrasting with the sky background than turbines lit by the sun. The sun may strike the turbines on their west sides and this may be apparent from this direction during the afternoon through to the evening. This could potentially increase contrast, making them more noticeable when the visibility is very good. Due to the prevailing wind the turbines would most usually be seen so that the rotor faces are aligned at an angle to the viewpoint, slightly reducing the influence of the blade movement and also the overall dimension of the part of the view affected by each turbine. The rotating blades of the most distant, northerly	sea view. Also, the location of the Development set away from the coast. **Construction and decommissioning** Not significant, negative, short term, reversible. **Likelihood of effect** Very good visibility required for the Development to be visible at 37.3 km to closest turbine.

Table 14.7.1: Effect on Representative Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
		turbines of the wind farm would be seen appearing and disappearing above the skyline, however their distance at over 40km would mean that excellent visibility would be required to see these limited parts. Due to the distance between the viewpoint and the OSPs, combined with the curvature of the earth, only the upper parts of one of the OSPs would be visible within this view. The Development would introduce offshore wind farm visibility across a relatively narrow extent of the panoramic sea views from this location. The Development would be apparent out in the open sea rather than encroaching above land. There is a wide stretch of intervening, open sea visible from this section of coast. ***Magnitude of change: medium-low*** **Construction and decommissioning** The worst case scenario of both the construction and decommissioning will be when large numbers of turbines are in place in addition to concentrations of activity in the form of marine vessels and cranes. These activities associated with the Development turbines and OSPs will be distant. The construction of the offshore cable route may introduce visibility of further vessels to the south, however this would occur at greater distances than the construction of the wind farm and would involve few vessels. ***Magnitude of change: medium – low***	
13b: Dornoch Volume 3b – Figures 14.7.23a to 14.7.23b	Located in RCCA Golspie, Embo and Dornoch Coast and within the Long Beaches Dunes and Links LCT. The viewpoint is located at the interpretative signage at the northern pedestrian entrance to the coastal car park. The viewpoint is representative of the views that would be gained from the beach, golf course, hotels and the parts of the settlement that have clear views in this direction although the	**Operation** Field of view affected by the Development is approximately 11 degrees. Distance from the Development (closest turbine of WCS) 49.5 km. The increased separation of the viewpoint and the more distant turbines means that they are likely to be markedly less visible than	**Operation** Not significant, negative, long term, reversible. **Construction and decommissioning**

Table 14.7.1: Effect on Representative Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
	majority of the town would not gain such views or these would be set beyond the intervening links golf courses, dunes or settlement. There is a Core Path extending northwards along the coast. The view is across the sand dunes and beach with golden sands and rocky outcrops. Views are out across the open sea and are contained to the north-east by the upland coast of Highland. To the south east the low promontory of Tarbat Ness is visible with its punctuating lighthouse. **Value of views: medium-high** The viewpoint is not located within any scenic landscape designations. Part of the wider views to the south are located within the Dornoch Firth NSA. Views are locally valued as part of the setting for Dornoch and as views from its coastal facilities **Susceptibility to change: medium-high** The view is representative of the views gained by people in the settlement, residents from their properties as well as more transient people using the paths, visiting the beach, and golf courses and taking in the wide, sea views. Views are open and generally undeveloped out to sea but have urban characteristics inland. The Development is located a considerable distance from the viewpoint. **Sensitivity: medium-high**	the closest. The distance to the most distant turbine of the WCS is 74.5 km. This distance results in the turbines theoretically appearing as small scale, vertical, moving features visible in 'excellent visibility' conditions. The vertical angle of view occupied by the Development theoretically takes up 0-0.5 degrees of the field of view. The Development would theoretically span across approximately 11 degrees of the open sea views. The ZTVs illustrate that parts of 51-62 turbines are theoretically visible with 21-30 of these visible to below hub level. The Development would be located on the skyline within a part of the broad, undeveloped, sea views that lie approximately to the east north east. At this distance the curvature of the earth reduces the apparent height of all of the turbines with those furthest away theoretically visible as blade tips only above the skyline. The closest turbines would have hubs and shorts sections of their towers visible The view direction to the centre of the Development is approximately east north east. This means that the turbines would generally be back lit in the mornings and therefore seen in shadow, resulting in them generally being less contrasting with the sky background than turbines lit by the sun. The sun may strike the turbines on their west sides and this may be apparent from this direction during the afternoon through to the evening. This could potentially increase contrast, making them more noticeable when the visibility is excellent. Due to the prevailing wind the turbines would most usually be seen so that the rotor faces are almost facing directly towards the viewpoint. The rotating blades of the most distant, northerly turbines of the wind farm would be seen appearing and	Not significant, negative, short term, reversible. **Likelihood of effect** Excellent visibility required for the Development to be visible at 49.5 km to closest turbine.

Table 14.7.1: Effect on Representative Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
		disappearing above the skyline, however their distance at over 60km would mean that excellent visibility would be required to see these limited parts and some may not be noticed. Due to the distance between the viewpoint and the OSPs combined with the curvature of the earth these would not be visible within this view. The Development would introduce offshore wind farm visibility across a relatively narrow extent of the panoramic sea views from this location. The Development would be apparent out in the open sea rather than encroaching above land. There is a wide stretch of intervening, open sea visible from this section of coast. ***Magnitude of change: low*** **Construction and decommissioning** The worst case scenario of both the construction and decommissioning will be when large numbers of turbines are in place in addition to concentrations of activity in the form of marine vessels and cranes. These activities associated with the Development turbines and OSPs will be distant. The construction of the offshore cable route may introduce visibility of further vessels to the south, however this would occur at greater distances than the construction of the wind farm and would involve few vessels. **Magnitude of change: low**	
14: Tarbat Ness Lighthouse Volume 3b – Figures 14.7.24a to 14.7.24f	Located in RCCA Tarbat Ness to North Sutor Coast and within the Hard Coastal shore LCT. This viewpoint is located out on the promontory of Tarbat Ness, between the lighthouse and the coast where there is a Core Path and interpretative signage. These are accessible via a small car park located a short distance to the south-west. The lighthouse and its outbuildings/workers houses are privately owned holiday homes.	**Operation** Field of view affected by the Development is approximately 10.5 degrees. Distance from the Development (closest turbine of WCS) 36.8 km. The increased separation of the viewpoint and the more distant turbines means that they are likely to be markedly less visible than	**Operation** Not significant, negative, long term, reversible. This is largely due to narrow vertical and horizontal fields of view affected as part of a wide panorama of open

Table 14.7.1: Effect on Representative Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
	The foreground is rough heather and ground cover with several paths running through it. The views are markedly expansive due to the promontory location with sea across more than 270 degrees of the field of view. Views to the north-east are out to the open sea whilst those to the north include the Caithness coast and those to the south the Moray and Aberdeenshire coast. The extent of visibility and the distances to the onshore and offshore wind farms shown on the wireline are such that they will be barely noticeable. **Value of views: medium** The viewpoint is not within any landscape planning designations and views across designated areas are distant. It is locally valued as an outlook over an expansive sea from paths and holiday/residential properties. There is some interpretative materials to encourage appreciation of the place/views. **Susceptibility to change: medium-high** The wide, panoramic views have little in the way of features and provide the outlook from residences and people who have made the effort to visit this relatively isolated location. The Development is located at a considerable distance from the viewpoint. **Sensitivity: medium - high**	the closest. The distance to the most distant turbine of the WCS is 63 km. This distance results in the turbines theoretically appearing as small scale, vertical, moving features visible in 'very good visibility' conditions. The vertical angle of view occupied by the Development theoretically takes up 0-0.5 degrees of the field of view. This is reduced due to the curvature of the earth, which screens the lower extents of the turbine towers. The ZTVs illustrate that parts of 51-62 turbines are theoretically visible with all of these visible to below hub level. The Development would be located on the skyline within a part of the broad, undeveloped, sea views that lie approximately to the north east. At this distance the curvature of the earth reduces the apparent height of all of the turbines with those furthest away theoretically visible as blade tips only above the skyline. The closest turbines would have hubs and short sections of their towers visible. The orientation of the Development layout means that the turbines appear relatively compact and over a narrow field of view. In most conditions diminishing visibility with distance will ensure that the closer turbines are more apparent than those seen at a greater distance. The view direction to the centre of the Development is approximately east north east. This means that the turbines would generally be back lit in the mornings and therefore seen in shadow, resulting in them generally being less contrasting with the sky background than turbines lit by the sun. The sun may strike the turbines on their west sides and this may be apparent from this direction during the afternoon through to the evening. This could	sea view. Also, the location of the Development set away from the coast. **Construction and decommissioning** Not significant, negative, short term, reversible. **Likelihood of effect** Very good visibility required for the Development to be visible at 36.8 km to closest turbine.

Table 14.7.1: Effect on Representative Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
		potentially increase contrast, making them more noticeable when the visibility is very good. Due to the prevailing wind the turbines would most usually be seen so that the rotor faces are generally facing directly towards the viewpoint. The rotating blades of the most distant, northerly turbines of the wind farm would be seen appearing and disappearing above the skyline, however their distance at over 45km would mean that excellent visibility would be required to see these limited parts and some may not be noticed. Due to the distance between the viewpoint and the OSPs, combined with the curvature of the earth, only the upper parts of one of the OSPs would be visible within this view.. The Development would introduce offshore wind farm visibility across a relatively narrow extent of the wide panoramic sea views from this location. The Development would be apparent out in the open sea rather than encroaching above or near to land. There is a wide stretch of intervening, open sea visible from this section of coast. ***Magnitude of change: medium-low*** **Construction and decommissioning** The worst case scenario of both the construction and decommissioning will be when large numbers of turbines are in place in addition to concentrations of activity in the form of marine vessels and cranes. These activities associated with the Development turbines and OSPs will be distant. The construction of the offshore cable route may introduce visibility of further vessels to the south, however this would occur at greater distances than the construction of the wind farm and would involve few vessels. ***Magnitude of change: medium-low***	

Table 14.7.1: Effect on Representative Viewpoints

Viewpoint	Baseline Condition and Sensitivity	Magnitude of Change	Significance of Effect
15: Burghead Volume 3b – Figures 14.7.25a to 14.7.25c	Located in RCCA Burghead to Nairn Coast and within the Moray Coastal LCT. This viewpoint is located on the publicly accessible roof of the small visitor centre located on the end of a narrow promontory, which extends north-west and is the location of the settlement of Burghhead, which therefore has sea on three sides. The roof has a flag and interpretative signage. Elsewhere in the vicinity there are benches to encourage enjoyment of the views, some of which face out to sea. The viewpoint is representative of views from the north facing properties of the village of Burghead. There would be no views from the southern side and the harbour due to intervening landform and buildings. The western part of the village is laid out in a dense grid of terraced houses so that it is only the most northerly that are exposed to the elements and views. A Core Path runs around part of the headland and the Moray Coastal Trail LDR passes nearby and runs along the coast following the alignment of a disused railway in places. The view is markedly open with the coastline of Caithness and Sutherland extending as a low, undulating form to the north to north west. The Moray coastline, including the harbour and housing of Burghead are seen in close proximity to the south west and east. To the east buildings associated with the Burghead Maltings are visible and these are highly prominent in views from other parts of the settlement. It is only the blades of the Beatrice Demonstrator Turbines that are visible above the distant skyline at a range of 50.5 km. Neither these turbines nor the blade tips of the BOWL turbines are likely to be noticeable from this location due to the distance and limited extents of visibility. **Value of views - medium**	**Operation** Field of view affected by the Development is approximately 14.5 degrees. Distance from the Development (closest turbine of WCS) 37.7 km. The increased separation of the viewpoint and the more distant turbines means that they are likely to be markedly less visible than the closest. The distance to the most distant turbine of the WCS is 63.5 km. This distance results in the turbines theoretically appearing as small scale, vertical, moving features visible in 'very good visibility' conditions. The vertical angle of view occupied by the Development theoretically takes up 0-0.5 degrees of the field of view. This is reduced due to the curvature of the earth, which screens the lower extents of the turbine towers. The ZTVs illustrate that parts of 51-62 turbines are theoretically visible with all of these visible to below hub level. The Development would be located on the skyline within a part of the broad, undeveloped, sea views that lie approximately to the north east. At this distance the curvature of the earth reduces the apparent height of all of the turbines with those furthest away theoretically visible as blade tips only above the skyline. The closest turbines would have hubs and part of their towers visible. The orientation of the Development layout means that the turbines appear relatively compact and over a narrow field of view. In most conditions diminishing visibility with distance will ensure that the closer turbines are more apparent than those seen at a greater distance. The view direction to the centre of the Development is approximately north east. This means that the turbines would	**Operation** Not significant, negative, long term, reversible. This is largely due to narrow vertical and horizontal fields of view affected as part of a wide panorama of open sea view. Also, the location of the Development set away from the coast. **Construction and decommissioning** Not significant, negative, short term, reversible. **Likelihood of effect** Very good visibility required for the Development to be visible at 37.7 km to closest turbine.

Table 14.7.1: Effect on Representative Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
	There are no landscape planning designations. Locally valued as coastal views, which form part of the settings of Burghead and the LDR as well as nearby caravan parks, golf courses and other coastal settlements in the vicinity. **Susceptibility to change – medium-high** Representative of residents in properties who may have views from property frontages directed towards the Development. Visitors and walkers will generally be more transient but will be visiting the area with some focus on the surrounding area and views. Drivers, cyclists and golfers are likely to be more focused on the activity they are undertaking but will have some appreciation of their surroundings. Sea outlook is, highly expansive, open and undeveloped which is in marked contrast to the surrounding developed coastline. The Development is located at a considerable distance from the viewpoint. **Sensitivity – medium - high**	generally be back lit until mid-morning and therefore seen in shadow, resulting in them generally being less contrasting with the sky background than turbines lit by the sun. The sun may strike the turbines on their south east round to their west sides and this may be apparent from this direction during mid-morning through to the evening. This could potentially increase contrast, making them more noticeable when the visibility is very good. Due to the prevailing wind the turbines would most usually be seen so that the rotor faces are generally facing directly towards the viewpoint. The rotating blades of the most distant, northerly turbines of the wind farm would be seen appearing and disappearing above the skyline, however their distance at over 50km would mean that excellent visibility would be required to see these limited parts and some may not be noticed. Due to the distance between the viewpoint and the OSPs, combined with the curvature of the earth, only the upper parts of one of the OSPs would be visible within this view. The Development would introduce offshore wind farm visibility across a relatively narrow extent of the wide panoramic sea views from this location. The Development would be apparent out in the open sea rather than encroaching above or near to land. There is a wide stretch of intervening, open sea visible from this section of coast. ***Magnitude of change: medium-low*** **Construction and decommissioning** The worst case scenario of both the construction and decommissioning will be when large numbers of turbines are in place in addition to concentrations of activity in the form of marine vessels and cranes. These activities associated with the Development turbines and OSPs will be distant. The construction of the offshore cable route may introduce visibility of further vessels to the south and east, however this would occur at greater	

Table 14.7.1: Effect on Representative Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
		distances than the construction of the turbine wind farm and would involve few vessels. **Magnitude of change: medium-low**	
16: Lossiemouth Harbour Volume 3b – Figures 14.7.26a to 14.7.26k	Located in RCCA Spey Bay and within the Moray Coastal LCT. View taken from harbour wall at Lossiemouth Harbour. Views from on the harbour side are limited by the wall itself. Lossiemouth is located largely on a promontory that extends northwards out to sea. The harbour extends around the north and eastern sides and the character of the town in the vicinity is partly industrial/commercial with boats a prominent feature. There are some houses near the harbour, however the harbour walls and uses often screen views to the north or otherwise create a developed foreground influence. The street pattern is markedly geometric, aligned on the harbour layout. The Moray Coastal Trail LDR runs along the coast on either side of Lossiemouth but is set back from the harbour edge through the town. A Core Path runs closer to the harbour. Away from the harbour and the promontory the settlement extends southwards and away from the coast with some homes having their aspects out to sea in a north north west direction and others facing east. Between the housing and the coast lie a variety of recreational land uses. These include a sailing club, play areas, parks, parking and a golf course. Further out of the town there are a several caravan and camping parks and the beaches are attractive with facilities to encourage their use and enjoyment. Due to the promontory location and the fact that Lossiemouth is one of the most northerly points on this coastline the views out to sea are expansive. The sea views often contain vessels, however, there is no visibility of any form of built development, apart from lit navigational markers, in this direction. This open,	**Operation** Field of view affected by the Development is approximately 22.5 degrees. Distance from the Development (closest turbine of WCS) 31.7 km. The increased separation of the viewpoint and the more distant turbines means that they are likely to be markedly less visible than the closest. The distance to the most distant turbine of the WCS is 55 km. This distance results in the turbines theoretically appearing as small scale, vertical, moving features visible in 'very good visibility' conditions. The vertical angle of view occupied by the Development theoretically takes up 0-0.5 degrees of the field of view. This is reduced due to the curvature of the earth, which screens the lower extents of the turbine towers. The ZTVs illustrate that parts of 51-62 turbines are theoretically visible with almost all of these visible to below hub level. The Development would be located on the skyline within a part of the broad, undeveloped, sea views that lie approximately to the north north east. At this distance the curvature of the earth reduces the apparent height of all of the turbines with those furthest away theoretically visible as blades only above the skyline. The closest turbines would have hubs and part of their towers visible. The view direction to the centre of the Development is approximately north north east. This means that the turbines would generally be back lit until mid-morning and therefore seen	**Operation** Not significant, negative, long term, reversible. This is largely due to narrow vertical and horizontal fields of view affected as part of a wide panorama of open sea view. Also, the location of the Development set away from the coast. **Construction and decommissioning** Not significant, negative, short term, reversible. **Likelihood of effect** Very good visibility required for the Development to be visible at 31.7 km to closest turbine.

Table 14.7.1: Effect on Representative Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
	simple character contrasts with the developed character of the settlement which is seen in views to the south. The MOD development, RAF Lossiemouth sits to the south west of the town. The coastline of Sutherland and Caithness is often difficult to discern at a range of 46 km, although Tarbet Ness is closer. **Value of views - medium** There are no landscape planning designations. The views will be locally valued from houses and recreational areas. **Susceptibility to change – medium-high** View towards the Development part of a wider view which takes in Lossiemouth Harbour on the coastal edge. Open sea and skyline is prevailing feature in uniform, simple view. Caithness coastline and hill profiles form distant backdrop to open sea of the Moray Firth. View representative of worst case view from public domain in Lossiemouth as experienced by locals and visitors. **Sensitivity: medium - high**	in shadow, resulting in them generally being less contrasting with the sky background than turbines lit by the sun. The sun may strike the turbines on their south east round to their west sides and this may be apparent from this direction during mid-morning through to the evening. This could potentially increase contrast, making them more noticeable when the visibility is very good. Due to the prevailing wind the turbines would most usually be seen so that the rotor faces are generally facing directly towards the viewpoint. The rotating blades of the most distant, northerly turbines of the wind farm would be seen appearing and disappearing above the skyline, however their distance at over 40km would mean that excellent visibility would be required to see these limited parts and some may not be noticed. Due to the distance between the viewpoint and the OSPs, combined with the curvature of the earth, only the upper parts of one of the OSPs would be visible within this view. The Development would introduce offshore wind farm visibility across a relatively narrow extent of the wide panoramic sea views from this location. The Development would be apparent out in the open sea rather than encroaching above or near to land. There is a wide stretch of intervening, open sea visible from this section of coast. ***Magnitude of change: medium-low*** Construction and decommissioning The worst case scenario of both the construction and decommissioning will be when large numbers of turbines are in place in addition to concentrations of activity in the form of marine vessels and cranes. These activities associated with the Development turbines and OSPs will be distant. The construction of the offshore cable route may introduce visibility of further vessels to the south and east of the wind farm, and this would	

Table 14.7.1: Effect on Representative Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
		occur at closer proximity to the viewpoint. However, this would involve relatively few vessels. ***Magnitude of change: medium-low***	
17: Buckie Volume 3b – Figures 14.7.27a to 14.7.27d	Located in RCCA – Portgordon to Portknockie and within the Coastal LCT. View taken from Cliff Terrace affording elevated view towards harbour and industrial development. Harbour acts as main focus in the view with sea forming background feature. Buckie located on hard coastal shore with low Old Red Sandstone cliffs evident to the left and right of the view. Whilst other parts of the town have views out to sea with a lesser degree of industrial/commercial foreground, such views are a characteristic of Buckie and its coastline. Many of the houses do not face out to sea but are inward facing or are low and set back from the coast to reduce exposure. NCR 1, the Moray Coastal Trail LDR and a number of Core Paths run through Buckie along the coast. BOWL is unlikely to be readily noticeable as only blade tips are theoretically visible at a range of 56 km. The Beatrice Demonstrator Turbines are theoretically visible to below hub height at a range of 47 km, however these are rarely visible. **Value of views: medium** There are no scenic landscape designations. The views out to sea will be locally valued as the views from residences as well as from routes used by local people. **Susceptibility to change: medium - high**	**Operation** Field of view affected by the Development is approximately 29 degrees. Distance from the Development (closest turbine of WCS) 39.7 km. The increased separation of the viewpoint and the more distant turbines means that they are likely to be less visible than the closest. The distance to the most distant turbine of the WCS is 55 km. This distance results in the turbines theoretically appearing as small scale, vertical, moving features visible in 'very good visibility' conditions. The vertical angle of view occupied by the Development theoretically takes up 0-0.5 degrees of the field of view. This is reduced due to the curvature of the earth, which screens the lower extents of the turbine towers. The ZTVs illustrate that parts of 51-62 turbines are theoretically visible with all of these visible to below hub level. The Development would be located on the skyline within a part of the broad, undeveloped, sea views that lie approximately to the north north east. At this distance the curvature of the earth would reduce the apparent height of all of the turbines with those furthest away having hubs and a small section of their towers theoretically visible. The view direction to the centre of the Development is approximately north north east. This means that the turbines would generally be back lit until mid-morning and therefore seen	**Operation** Not significant, negative, long term, reversible. This is largely due to narrow vertical and horizontal fields of view affected as part of a wide panorama of open sea view. Also, the location of the Development set away from the coast. **Construction and decommissioning** Not significant, negative, short term, reversible. **Likelihood of effect** Excellent visibility required for the Development to be visible at 39.7 km to closest turbine.

Table 14.7.1: Effect on Representative Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
	Industrial/commercial development context of many views from Buckie presents less attractive character than in other coastal settlements. View is representative of experience of road users and pedestrians/cyclists as well as users of Harbour Park and residents in town who will gain sea views. **Sensitivity: medium - high**	in shadow, resulting in them generally being less contrasting with the sky background than turbines lit by the sun. The sun may strike the turbines on their south east round to their west sides and this may be apparent from this direction during mid-morning through to the evening. This could potentially increase contrast, making them more noticeable when the visibility is very good. Due to the prevailing wind the turbines would most usually be seen so that the rotor faces are generally facing directly towards the viewpoint. The rotating blades of the most distant, northerly turbines of the wind farm would be seen appearing and disappearing above the skyline, however their distance at over 45km would mean that excellent visibility would be required to see these limited parts and some may not be noticed. Due to the distance between the viewpoint and the OSPs combined with the curvature of the earth these will be seen as relatively small, low elements within the context of the much larger, moving turbines. The Development would introduce offshore wind farm visibility across a moderate extent of the wide panoramic sea views from this location. The alignment of the turbines of the WCS is apparent within this view as is the gap in turbines resulting from the wayleave associated with the undersea cable. The large turbine spacing is made more noticeable by the outlying turbines on the south western extents of the Development. The Development would be apparent out in the open sea rather than encroaching above or near to land. There is a wide stretch of intervening, open sea visible from this section of coast. ***Magnitude of change: medium-low*** **Construction and decommissioning** The worst case scenario of both the construction and decommissioning will be when large numbers of turbines are in place in addition to concentrations of activity in the form of	

Table 14.7.1: Effect on Representative Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
		marine vessels and cranes. These activities associated with the Development turbines and OSPs will be distant. The construction of the offshore cable route may introduce visibility of further vessels to the south and east of the wind farm, and this would occur at closer proximity to the viewpoint. However, this would involve relatively few vessels. ***Magnitude of change: medium-low***	
18: Bin Hill Volume 3b – Figures 14.7.28a to 14.7.28e	Located within terrestrial LCT 37 – Upland Farmland. The viewpoint is the summit of the, 320 m high, Bin of Cullen. This is reached via a locally popular walk which starts through the Seafield Estate and thereafter continues through forestry to the open to an open summit. Northern sector of panoramic view looks across upland farmland to north sea coast and expansive sea beyond. The outline of the Caithness coast, if apparent, is seen as an indistinct land mass at over 65 km distant. Distinct transition between land and sea, both forming strong horizontal bands. Man-modified landscape with commercial forestry and intensive arable agriculture characterizing the view. To the south west Knock Hill is a prominent feature on the skyline. The two turbines of Netherton of Windyhills are located to the north of this hill, on lower ground at a range of 7.2 km. To the east the Boyndie Airfield wind farm is apparent set back from the coast at a distance of 13.45 km. There are other turbines also visible in the same sector of the view – Ley Farm and Cairnton Road at distances of 5.7 km and 13.7 km respectively. The two turbines of Badentoul and the single Braeside turbine are also apparent further inland. Other onshore turbines that are theoretically visible from this location are less apparent due to the distance and extent of visibility.	**Operation** Field of view affected by the Development is approximately 29 degrees. Distance from the Development (closest turbine of WCS) 43 km. The increased separation of the viewpoint and the more distant turbines means that they are likely to be less visible than the closest. The distance to the most distant turbine of the WCS is 56 km. This distance results in the turbines theoretically appearing as small scale, vertical, moving features visible in ‘excellent visibility’ conditions. The vertical angle of view occupied by the Development theoretically takes up 0-0.5 degrees of the field of view. The Development is likely to be visible more frequently and would be at a closer range than BOWL. The ZTVs illustrate that 51-62 turbines are theoretically visible with all of these visible to below hub level. The Development would be located on or near to the skyline within a part of the broad, partially undeveloped, sea views that lie approximately to the north. The full extent of most of the turbines would be visible due to the elevation of the viewpoint. Within a few years it is likely that the Beatrice Demonstrator Turbines and the associated oil platforms would no longer form part of the view. The view direction to the centre of the Development is approximately north. This means that the turbines would generally	**Operation** Not significant, negative, long term, reversible. **Construction and decommissioning** Not significant, negative, short term, reversible. **Likelihood of effect** Excellent visibility required for the Development to be visible at 43 km to closest turbine.

Table 14.7.1: Effect on Representative Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
	The Beatrice Demonstrator Turbines and the BOWL turbines are theoretically visible at ranges of 49 km and 57.6 km but these are unlikely to be visible to the naked eye except in excellent weather conditions. The BOWL wind farm extends across approximately 11.5 degrees of the wide panoramic view. **Value of views: medium** There are no scenic landscape designations. Locally valued as raised vantage point from which to overlook the features of the villages and towns as well as the varied landscape/seascape of the view. **Susceptibility to change: medium** Visibility of settled coast as a feature of the view reduces sense of remoteness. Forestry and farmland characterises view with sea forming background feature. Viewpoint accessed by forestry tracks and representative of views of walkers, probably of interest locally rather than regionally or nationally. Onshore wind farms are part of the existing setting and character of the hill. Sea and location of Development are set back considerably from this location. **Sensitivity: medium**	be back lit until mid-morning and therefore seen in shadow, resulting in them generally being less contrasting with the sky background than turbines lit by the sun. The sun may strike the turbines on their south east round to their and west sides and this may be apparent from this direction during mid-morning through to the evening. This could potentially increase contrast, making them more noticeable when the visibility is excellent. Due to the prevailing wind the turbines would most usually be seen so that the rotor faces are aligned at an angle to the viewpoint, slightly reducing the influence of the blade movement and also the overall dimension of the part of the view affected by each turbine. The rotating blades of the most northerly turbines of the wind farm would be most apparent due to the prevalent angle of view. Due to the distance between the viewpoint and the OSPs combined with the curvature of the earth these will be seen as relatively small, low elements within the context of the much larger, moving turbines. The proximity and larger scale of the Development means that its turbines appear larger in scale than those of BOWL, when visible. In such instances the Development would generally appear as a large extension to BOWL. However, there would be some discord between the wind farms due to the notably larger scale and spacing of the Development turbines. This is particularly noticeable where there are outliers to the turbine grouping at the south western extents of the Development. When apparent the Development would introduce offshore wind farm visibility across a moderate extent of the wide panoramic sea views from this location. The alignment of the turbines of the WCS is apparent within this view as is the gap in turbines resulting from the wayleave associated with the undersea cable. The large	

Table 14.7.1: Effect on Representative Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
		turbine spacing is made more noticeable by the outlying turbines on the south western extents of the Development. The Development would be apparent out in the open sea rather than encroaching above or near to land. There is a wide stretch of intervening, open sea visible from this elevated location. The westerly part of the Development may be seen against the distant outline of the Caithness coast at a range of 70 km when weather conditions are sufficiently clear. ***Magnitude of change: low*** **Construction and decommissioning** The worst case scenario of both the construction and decommissioning will be when large numbers of turbines are in place in addition to concentrations of activity in the form of marine vessels and cranes. These activities associated with the Development turbines and OSPs will be distant. The construction of the offshore cable route may introduce visibility of further vessels to the south and east of the wind farm, and this would occur at closer proximity to the viewpoint. However, this would involve relatively few vessels. ***Magnitude of change: low***	
19: Portnockie (Bow Fiddle Rock Info Point) Volume 3b – Figures 14.7.29a to 14.7.29b	Located within RCCA Portgordon to Portknockie and Coastal LCT. View taken from the Moray Coast Train LDR at the base of the headland to the north-east of Portknockie. View is representative of views from the nearby settlement of Portockie Expansive view of the North Sea available form this viewpoint with few interruptions other than close range rocks. Interpretative signage and seating near the rocks encourage views out to sea.	**Operation** Field of view affected by the Development is approximately 32.5 degrees. Distance from the Development (closest turbine of WCS) 39 km. The increased separation of the viewpoint and the more distant turbines means that they are likely to be less visible than the closest. The distance to the most distant turbine of the WCS is 52 km.	**Operation** Not significant, negative, long term, reversible. This is largely due to narrow vertical and horizontal fields of view affected as part of a wide panorama of open sea view. Also, the location of the

Table 14.7.1: Effect on Representative Viewpoints

Viewpoint	Baseline Condition and Sensitivity	Magnitude of Change	Significance of Effect
	Old Red Sandstone cliffs enclose viewpoint to the south and rocky coastline extends in either direction. Open sea characterises this view and acts as main draw although no specific focus is present. The Beatrice Demonstrator Turbines and the BOWL turbines are theoretically visible at ranges of 45.4 km and 53.3 km as blades and some hubs above the horizon, due to the curvature of the earth but these are unlikely to be visible to the naked eye except in excellent weather conditions. The BOWL wind farm extends across approximately 12.5 degrees of the wide panoramic view. **Value of views: medium** There are no scenic landscape designations. The view is valued locally as the wide setting for Bow Fiddle and other attractive rock formations as well as views from the path and settlement. Importance of viewpoint marked by information point. **Susceptibility to change: high** Representative of views obtained by people undertaking activities where enjoyment of the landscape/ seascape is a key reason for doing so. Views from residents and visitors to settlement will also gain such views. Views out to sea are extensive and panoramic with very little influence by man apparent. **Sensitivity: medium - high**	This distance results in the turbines theoretically appearing as small scale, vertical, moving features visible in ‘very good visibility’ conditions. The vertical angle of view occupied by the Development theoretically takes up 0-0.5 degrees of the field of view. This is reduced due to the curvature of the earth, which screens the lower extents of the turbine towers. The ZTVs illustrate that parts of 51-62 turbines are theoretically visible with all of these visible to below hub level. The Development would be located on the skyline within a part of the broad, largely undeveloped, sea views that lie approximately to the north north west. At this distance the curvature of the earth would reduce the apparent height of all of the turbines with those furthest away having hubs and a small section of their towers theoretically visible. The view direction to the centre of the Development is approximately north of north north west. This means that the sun may strike the turbines on their east round to their west sides and this may be apparent from this direction from morning to late afternoon. This could potentially increase contrast, making them more noticeable when the visibility is very good. Due to the prevailing wind the turbines would most usually be seen so that the rotor faces are aligned at an angle to the viewpoint, slightly reducing the influence of the blade movement and also the overall dimension of the part of the view affected by each turbine. The rotating blades of the most northerly turbines of the wind farm would be most apparent due to the prevalent angle of view.	Development set away from the coast. **Construction and decommissioning** Not significant, negative, short term, reversible. **Likelihood of effect** Excellent visibility required for the Development to be visible at 39 km to closest turbine.

Table 14.7.1: Effect on Representative Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
		Due to the distance between the viewpoint and the OSPs combined with the curvature of the earth these would only just be theoretically visible above the skyline. The Development would introduce offshore wind farm visibility across a moderate extent of the wide panoramic sea views from this location. The alignment of the turbines of the WCS is apparent within parts of this view. The large turbine spacing is made more noticeable by the outlying turbines on the south western extents of the Development. The Development would be apparent out in the open sea rather than encroaching above or near to land. There is a wide stretch of intervening, open sea visible from this section of coast. However, it would occur in the direction of the view that is towards Bow Fiddle Rock, which is the focus of views from this location. ***Magnitude of change: medium-low*** **Construction and decommissioning** The worst case scenario of both the construction and decommissioning will be when large numbers of turbines are in place in addition to concentrations of activity in the form of marine vessels and cranes. These activities associated with the Development turbines and OSPs will be distant. The construction of the offshore cable route may introduce visibility of further vessels to the south and east of the wind farm, and this would occur at closer proximity to the viewpoint. However, this would involve relatively few vessels. ***Magnitude of change: medium-low***	
20: Cullen Volume 3b – Figures 14.7.30a to 14.7.30c	Located in RCCA 20 Cullen Bay and within Coastal LCT. View taken from elevated route near viaduct affording views over roof tops to coastal edge. Viaduct is former rail line and now provides the route for NCR 1 as well as a footpath link	**Operation** Field of view affected by the Development is approximately 31.5 degrees. Distance from the Development (closest turbine of WCS) 41.2 km.	**Operation** Not-significant, negative, long term, reversible.This is largely due distance and the

Table 14.7.1: Effect on Representative Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
	between Cullen and Portnockie. The Moray Coastal Trail LDR runs along the coast below. View is also representative of views from attractive, historic settlement, its beaches, golf course and caravan park. The majority of the houses close to the sea do not face towards it in order reduce their exposure to the elements. Views out to sea are mainly from external areas. Coast characterised by sandy Cullen Bay enclosed on either side by rocky headlands of Old Red Sandstone cliffs. Focus of the view is the harbour area and surrounding development with sea forming a simple, large scale, background feature which contrasts with the complexity of the settled coast. Views west take in the viaduct and the sandstone cliffs that back the raised beach on which the golf course is located and extend out to sea to Bow Fiddle Rock. The settlement of Portknockie is visible above on the promontory. The Beatrice Demonstrator Turbines and the BOWL turbines are theoretically visible at ranges of 47.5 km and 55 km as blades and some hubs above the horizon, due to the curvature of the earth, However, these are unlikely to be visible to the naked eye except in excellent weather conditions. The BOWL wind farm extends across approximately 12.5 degrees of the wide panoramic view. **Value of views: medium** There are no scenic landscape designations. Views locally valued as open, undeveloped, sea outlook from settlement and its facilities. **Susceptibility to change: medium- high** Seascape contained by headlands visible to the west and east, which reduces the expansiveness of the view out to sea. This combined with the position of the viewpoint and coastal parts of	The increased separation of the viewpoint and the more distant turbines means that they are likely to be less visible than the closest. The distance to the most distant turbine of the WCS is 53.5 km. This distance results in the turbines theoretically appearing as small scale, vertical, moving features visible in 'excellent visibility' conditions. The vertical angle of view occupied by the Development theoretically takes up 0-0.5 degrees of the field of view. This is reduced due to the curvature of the earth, which screens the lower extents of the turbine towers. The ZTVs illustrate that parts of 51-62 turbines are theoretically visible with all of these visible to below hub level. The Development would be located on the skyline within a part of the broad but partially constrained, largely undeveloped, sea views that lie approximately north of north north west of the viewpoint. At this distance the curvature of the earth would reduce the apparent height of all of the turbines with those furthest away having hubs and a small section of their towers theoretically visible. The view direction to the centre of the Development is approximately north of north north west. This means that the sun may strike the turbines on their east round to their west sides and this may be apparent from this direction from morning to late afternoon. This could potentially increase contrast, making them more noticeable when the visibility is excellent. Due to the prevailing wind the turbines would most usually be seen so that the rotor faces are aligned at an angle to the viewpoint, slightly reducing the influence of the blade movement and also the overall dimension of the part of the view affected by each turbine. The rotating blades of the most northerly turbines of	narrow vertical and horizontal fields of view affected. Also, the strength of character of the existing view and the apparent separation of the Development from the coastal features. **Construction and decommissioning** Not-significant, negative, short term, reversible. **Likelihood of effect** Excellent visibility required for the Development to be visible at 41.2 km to closest turbine.

Table 14.7.1: Effect on Representative Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
	the settlement within the bay promotes the views north to north west as the main focus. View representative of views gained by locals and visitors using viaduct cycle path and visiting the harbour, and Cullen residents who gain coastal / sea views. Undeveloped seascape contrasts with settled, developed coastline. View has a strong character with main features being where the land and coast interact around the bay/beach and harbour in the context of the cliff landform, viaduct and village. Development located at a considerable distance from the viewpoint. **Sensitivity: medium-high**	the wind farm would be most apparent due to the prevalent angle of view. Due to the distance between the viewpoint and the OSPs combined with the curvature of the earth these would only just be theoretically visible above the skyline. The Development would introduce offshore wind farm visibility across a moderate extent of the partially constrained sea views from this location. The alignment of the turbines of the WCS is apparent within parts of this view. The large turbine spacing is made more noticeable by the outlying turbines on the south western extents of the Development. The Development would be apparent out in the open sea rather than encroaching above or near to land. There is a wide stretch of intervening, open sea visible from this section of coast. However, it would occur in the direction of the view that is towards Bow Fiddle Rock, which is the focus of views from this location. ***Magnitude of change: medium-low*** **Construction and decommissioning** The worst case scenario of both the construction and decommissioning will be when large numbers of turbines are in place in addition to concentrations of activity in the form of marine vessels and cranes. These activities associated with the Development turbines and OSPs will be distant. The construction of the offshore cable route may introduce visibility of further vessels to the south and east of the wind farm, and this would occur at closer proximity to the viewpoint. However, this would involve relatively few vessels. ***Magnitude of change: medium-low***	
21: Findlater Castle	Located in RCCA Sandend Bay and within The Coast LCT. View taken from formal viewpoint and information point for Findlater Castle, where access track meets cliff top path.	**Operation** Field of view affected by the Development is approximately 31.5 degrees.	**Operation** Not significant, negative, long term, reversible.

Table 14.7.1: Effect on Representative Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
Volume 3b – Figures 14.7.31a to 14.7.31b	View projects out from cliff top location across the immediate enclosed rocky bay to an open and expansive seascape which characterises view. Elevated position and low cover of vegetation accentuates openness of view. Remains of Findlater Castle form an existing focal point in the foreground view (although it is only partially visible in the viewpoint photograph due to its low-lying position). Visibility of coastal headland to left (Logie Head) and right (Crathie Point) of view tempers the influence of the seascape and draws attention to these features. However, the headlands do diminish the extent of sea view to some degree, although wide views remain. Irregular and rocky coastline of Old Red Sandstone cliffs with shore of pebbly raised beach obscured from view. The Beatrice Demonstrator Turbines and the BOWL turbines are theoretically visible at ranges of 48.5 km and 55.5 km as blades and some hubs above the horizon, due to the curvature of the earth, However, these are unlikely to be visible to the naked eye except in excellent weather conditions. The BOWL wind farm extends across approximately 13 degrees of the panoramic view. **Value of views – medium- high** Lies within locally designated SLA – North Aberdeenshire Coast. Locally valued as outlook from path and as setting to Castle. Importance of viewpoint denoted by formal recognition on OS map data. **Susceptibility to change – medium - high** View will be experienced by transient walkers with heightened sensitivity of scenic views towards the Castle. **Sensitivity: medium- high**	Distance from the Development (closest turbine of WCS) 42.3 km. The increased separation of the viewpoint and the more distant turbines means that they are likely to be less visible than the closest. The distance to the most distant turbine of the WCS is 53.5 km. This distance results in the turbines theoretically appearing as small scale, vertical, moving features visible in 'excellent visibility' conditions. The vertical angle of view occupied by the Development theoretically takes up 0-0.5 degrees of the field of view. This is reduced due to the curvature of the earth, which screens the lower extents of the turbine towers. The ZTVs illustrate that parts of 51-62 turbines are theoretically visible with all of these visible to below hub level. The Development would be located on the skyline within a part of the broad, panoramic, largely undeveloped, sea views that lie approximately north of north north west of the viewpoint. At this distance the curvature of the earth would reduce the apparent height of all of the turbines with those furthest away having hubs and a small section of their towers theoretically visible. The view direction to the centre of the Development is approximately north of north north west. This means that the sun may strike the turbines on their east round to their west sides and this may be apparent from this direction from morning to late afternoon. This could potentially increase contrast, making them more noticeable when the visibility is excellent. Due to the prevailing wind the turbines would most usually be seen so that the rotor faces are aligned at an angle to the viewpoint, slightly reducing the influence of the blade movement and also the overall dimension of the part of the view affected by	This is largely due distance and the narrow vertical and horizontal fields of view affected. **Construction and decommissioning** Not significant, negative, short term, reversible. **Likelihood of effect** Excellent visibility required for the Development to be visible at 42.3 km to closest turbine.

Table 14.7.1: Effect on Representative Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
		each turbine. The rotating blades of the most northerly turbines of the wind farm would be most apparent due to the prevalent angle of view. Due to the distance between the viewpoint and the OSPs combined with the curvature of the earth these would only just be theoretically visible above the skyline.. The Development would introduce offshore wind farm visibility across a moderate extent of the partially constrained but wide sea views from this location. The layout of the WCS turbines appears regular and legible within this view. The large turbine spacing is made more noticeable by the outlying turbines on the south western extents of the Development. The Development would be apparent out in the open sea rather than encroaching above or near to land. There is a wide stretch of intervening, open sea visible from this section of coast. The south westerly turbines would potentially be partially backclothed by the distant Caithness coast. However, at a range of over 60 km this would require very clear conditions. The direction of the Development would lie within the distant backdrop of the view towards Findlater Castle (just visible in the viewpoint photo) which is the key focus of views from this location. There is, however, a broad stretch of sea between the Castle and the Development. ***Magnitude of change: medium-low*** **Construction and decommissioning** The worst case scenario of both the construction and decommissioning will be when large numbers of turbines are in place in addition to concentrations of activity in the form of marine vessels and cranes. These activities associated with the Development turbines and OSPs will be distant. The construction of the offshore cable route may introduce visibility of further	

Table 14.7.1: Effect on Representative Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
		vessels to the south and east of the wind farm, and this would occur at closer proximity to the viewpoint. However, this would involve relatively few vessels. ***Magnitude of change: medium-low***	
22: Sandend Volume 3b – Figures 14.7.32a to 14.7.32c	Located within RCCA 21 Sandend Bay and The Coast LCT. Viewpoint is located at Sandend, where the wide curving beach is backdropped by the sand dunes on which this viewpoint is located. The dunes provide some screening and also vantage points to look out across the simple form of the beach to the sea. A small watercourse runs into the bay on its west side adding an attractive and permanent stream of reflective water to the views across the sands. The historic part of Sandend can be seen extending along the western edge of the bay out to where there is a small harbour with the houses clustered around it. Their layout follows the traditional arrangement of gables towards the sea in order to reduce exposure. The harbour area has a number of benches which provide locations from where the views are directed primarily to the north north east by landform. Higher ground is seen rising above the settled coast. To the south and west of the hamlet there are residential properties generally set out along two perpendicular roads. One running perpendicular to the coast with the other set back and running parallel so that these houses face out to sea. Between the residences and the beach there is a caravan park. This is laid out with the most northerly mobile homes positioned to gain views out to sea along the lower ground created by the stream, which runs around it.	**Operation** Field of view affected by the Development is approximately 4.5 degrees. Distance from the Development (closest turbine of WCS) 43.7 km. The increased separation of the viewpoint and the more distant turbines means that they are likely to be less visible than the closest. The distance to the most distant turbine of the WCS is 55 km. This distance results in the turbines theoretically appearing as small scale, vertical, moving features visible in 'excellent visibility' conditions. Analysis of the 10 year Met Office 'visibility' data for Lossiemouth suggests that 'visibility' at distances of over 40 km occurs 39 % of the time, which equates to an average of 143 days per year. The vertical angle of view occupied by the Development theoretically takes up 0-0.5 degrees of the field of view. This is reduced due to the curvature of the earth, which screens the lower extents of the turbine towers. The Development would theoretically span across approximately 4.5 degrees of the panoramic, open sea views. The ZTVs illustrate that parts of 11-20 turbines are theoretically visible with all of these visible to below hub level. The Development would be located on the skyline within a part of the broad, panoramic, largely undeveloped, sea views that lie approximately north of north north west of the viewpoint.	**Operation** Not significant, negative, long term, reversible. **Construction and decommissioning** Significant, negative, short term, reversible. This is a precautionary assessment of the effects due to the potential options for short term works located close to this viewpoint or short term views of large vessels/riggs located relatively close to the shore. **Likelihood of effect** Excellent visibility required for the Development to be visible at 43.7 km to closest turbine. '

Table 14.7.1: Effect on Representative Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
	The rear of the beach has a series of large, concrete blocks, a relic of World War II, sited to prevent invasion by tanks up the shallow profile. The beach and sea is popular for surfing as well as walks and other beach activities. There is a small car park at its western end to facilitate access but little in the way of other permanent facilities to encourage visitors. There is some information about the area near the parking. The view out to sea is constrained by the promontories forming each side of the bay. These are Garon Point and the cliffs between Sandend and West Head. To the east a distillery and several other buildings are seen on the headland. Views out of the bay are focused approximately north to north east. Viewpoint is representative of views gained from properties, from the beach and sea and by visitors, some of who may be resident in the caravan park. The blade tips of BOWL are unlikely to be visible at a range of 57 km. **Value of views – medium - high** Lies within locally designated SLA – North Aberdeenshire Coast. Locally valued as open sea outlook from hamlet and beach. **Susceptibility to change – medium- high** View is not representative views from houses or the caravan park, which would not gain visibility of the turbines or their	At this distance the curvature of the earth would reduce the apparent height of all of the turbines with those furthest away having hubs and a small section of their towers theoretically visible. The view direction to the centre of the Development is approximately north of north north west. This means that the sun may strike the turbines on their east round to their west sides and this may be apparent from this direction from morning to late afternoon. This could potentially increase contrast, making them more noticeable when the visibility is excellent. Due to the prevailing wind the turbines would most usually be seen so that the rotor faces are aligned at an angle to the viewpoint, slightly reducing the influence of the blade movement and also the overall dimension of the part of the view affected by each turbine. The rotating blades of the most northerly turbines of the wind farm would be most apparent due to the prevalent angle of view. The OSPs would not be visible within this view. The Development would introduce offshore wind farm visibility across a relatively narrow extent of the partially constrained sea views from this location. The layout of the WCS turbines appears regular and legible within this view. The Development would be apparent extending out to sea from behind the craggy, settled shoreline which may result in some visual confusion between the built form and the more distant turbines. ***Magnitude of change: low*** **Construction and decommissioning** The worst case scenario of both the construction and decommissioning will be when the majority of turbines are in place in addition to concentrations of activity in the form of marine	

Table 14.7.1: Effect on Representative Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
	construction but would gain visibility of the temporary works associated with the offshore cable route installation. Views are available towards the Development from the beach where people visit as part of their recreation and, in part, to enjoy the sea views. Such people are transient. View direction towards Development is not the main direction of views from the settlement. **Sensitivity – medium - high**	vessels and cranes. These activities associated with the Development turbines and OSPs will be distant. The construction of the offshore cable route would introduce visibility of further vessels and activity particularly during the laying of the near shore cables to the landfall which would occur within or near to this bay. This may include a large cable lay vessel. A support vessel(s) and offshore HDD rig if using HDD. The support vessel and HDD rig may be visible from the shore at relatively close range for a few weeks. If alternative trenching tecchniques used there would be visibility of a plough or jet trenching tool on the beach/nearshore waters. Depending on the conditions at the coast there may be a requirement for a coffer dam (steel sheeting to hold the trench open while the cable is pulled ashore). This would be temporary, lasting a small number of days. Such changes to this view would be short or medium in duration ***Magnitude of change: medium-low***	
23: Portsoy Volume 3b – Figures 14.7.33a to 14.7.33b	Located within RCCA Sandend Bay and The Coast LCT. View taken from grassy area between Shore Street and Schoolhendry Street in Portsoy. The settlement sits on a raised headland with rocky shoreline and harbour visible in the foreground. Benches are sited nearby and encourage appreciation of the views across the harbour and out to sea. The viewpoint is representative of views obtainable from residential properties as well as visitors. However, the majority of the coastal houses follow the traditional pattern of facing away from the sea in order to limit exposure to the elements. More modern housing is orientated to gain sea views. View presents open and uninterrupted seascape which extends across wide panorama and which has no specific focus.	**Operation** Field of view affected by the Development is approximately 29.5 degrees. Distance from the Development (closest turbine of WCS) 44.7 km. The increased separation of the viewpoint and the more distant turbines means that they are likely to be less visible than the closest. The distance to the most distant turbine of the WCS is 55 km. This distance results in the turbines theoretically appearing as small scale, vertical, moving features visible in ‘excellent visibility’ conditions. Analysis of the 10 year Met Office ‘visibility’ data for Lossiemouth suggests that ‘visibility’ at distances of over 40 km	**Operation** Not significant, negative, long term, reversible. **Construction and decommissioning** Not significant, negative, short term, reversible. **Likelihood of effect** Excellent visibility required for the Development to be visible at

Table 14.7.1: Effect on Representative Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
	Developed context of Portsoy visible within the remainder of panorama and characterised by harbour and other traditional coastal developments. Hard coastal shore characterised by Old Red Sandstone Cliffs and irregular coastal edge of pebbly raised beaches. The blades of BOWL are unlikely to be noticeable across this view except in very clear conditions. **Value of views – medium - high** Lies within locally designated SLA – North Aberdeenshire Coast. Views locally valued as views from properties and gained from around the settlement and harbour. **Susceptibility to change – medium-high** View representative of views gained by residents along Portsoy's coastal edge and visitors to the harbour and coastal area. Susceptability reduced due to long distance between viewpoint and Development. **Sensitivity – medium-high**	occurs 39 % of the time, which equates to an average of 143 days per year. The vertical angle of view occupied by the Development theoretically takes up 0-0.5 degrees of the field of view. This is reduced due to the curvature of the earth, which screens the lower extents of the turbine towers. The ZTVs illustrate that parts of 51-62 turbines are theoretically visible with all of these visible to below hub level. The Development would be located on the skyline within a part of the broad, panoramic, largely undeveloped, sea views that lie approximately north north west of the viewpoint. At this distance the curvature of the earth would markedly reduce the apparent height of all of the turbines with those furthest away having only hubs theoretically visible. The view direction to the centre of the Development is approximately north of north north west. This means that the sun may strike the turbines on their east round to their west sides and this may be apparent from this direction from morning to late afternoon. This could potentially increase contrast, making them more noticeable when the visibility is excellent. Due to the prevailing wind the turbines would most usually be seen so that the rotor faces are aligned at an angle to the viewpoint, reducing the influence of the blade movement and also the overall dimension of the part of the view affected by each turbine. The rotating blades of the most northerly turbines of the wind farm would be most apparent due to the prevalent angle of view. Due to the distance between the viewpoint and the OSPs combined with the curvature of the earth these would not be visible within this view.	44.7 km to closest turbine.

Table 14.7.1: Effect on Representative Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
		The Development would introduce offshore wind farm visibility across a moderate extent of the wide sea views from this location. The layout of the WCS turbines appears regular and legible within this view. The large turbine spacing is made more noticeable by the outlying turbines on the south western extents of the Development. The Development would be apparent out in the open sea rather than encroaching above or near to land. There is a wide stretch of intervening, open sea visible from this section of coast. The south westerly turbine would potentially be partially backclothed by the distant Caithness coast. However, at a range of over 65 km this would require very clear conditions. ***Magnitude of change: medium-low*** **Construction and decommissioning** The worst case scenario of both the construction and decommissioning will be when large numbers of turbines are in place in addition to concentrations of activity in the form of marine vessels and cranes. These activities associated with the Development turbines and OSPs will be distant. The construction of the offshore cable route may introduce visibility of further vessels to the south and east of the wind farm, and this would occur at closer proximity to the viewpoint. However, this would involve relatively few vessels. ***Magnitude of change: medium-low***	

Visual Effect on Views from Concentrations of Visual Receptors

Settlements

14.7.3.12 There are a number of settlements located along the coast and people living and moving around within these areas may gain views of the Development. Figure 14.7.7 illustrates the blade tip ZTV with settlements. A preliminary assessment of the effects on Visual Receptors was undertaken in Section 14.5.4. This scoped out a number of settlements where it was assessed that significant effects would not occur during operation, construction or decommissioning. Where settlements were not scoped out they are included in Table 14.7.2, which sets out the assessment of the effects on views from these settlements.

Table 14.7.2: Effect on Views from Settlements

Settlement	Baseline Condition and Sensitivity	Magnitude of Change	Significance of Effect
Wick (Volume 3b - Figure 14.7.11 Viewpoint 3: Wick)	Wick is the largest town in the Highland part of the Study Area. It has grown up around the confluence of the River Wick where it reaches Wick Bay. The bay is orientated so that its open 'mouth' is towards the south east. The town centre is around the river crossing and the land slopes up from there with the majority of the settlement located on the southern side. The urban area extends along the edges of the bay and onto higher land to the south. The harbour area of Wick has been important for its development with a high concentration of commercial uses clustered around it. There are several onshore wind farms visible from parts of the settlement as shown in Viewpoint 3. **Value of views: medium** The value of views from Wick is not formally recognised or inclusive of designated landscapes. Areas of amenity land, footpaths and the harbour facilitate informal enjoyment of sea views over Wick Bay. These have some local scenic qualities associated with the foreground view contained by the points of North and South Head, towards large scale, open seas beyond. **Susceptibility to change: medium- high** Residents are the main receptor, although there is some tourist / visitor activity in Wick, associated with pleasure craft at the marina and the nearby Castle of Old Wick. Residents have static, long-term views from their primary	**Operation** The ZTV (Figure 14.7.11) shows that it is theoretically possible to see the Development from limited parts of Wick. These include the residential areas on the north side of the bay including parts of Proudfoot, Broadside, Papigoe and Staxigoe as well as areas to the south of the airport. Parts of Old Wick may also have visibility. In reality the visibility from these areas will primarily be from south facing facades and garden areas on the edges of these areas. Tall buildings and locations where there are open foregrounds immediately to the south may also gain views from within the urban areas although these would have less open views characterized by an urban foreground so that the magnitude of change as a result of the Development would be less. Viewpoint 3 illustrates the highest levels of visibility from Wick as described in Table 14.7.1 above. The Development would be seen as an extension to BOWL, which extends across the more northerly seascape views out of Wick Bay. Such visibility would occur in views gained from the south facing aspects and gardens of the properties on the south eastern extents of Proudfoot, Papigoe and Staxigoe: east of Proudfoot Road; South View and Murray Avenue; Broadhaven Road; Mowat Place; Cormack Crescent; Cliff Cottages; and from the south eastern extents of Old	**Operation** ***Significant, negative, long term, reversible -*** in views gained from the south facing aspects and gardens of the properties on the south eastern extents of Proudfoot, Papigoe and Staxigoe: east of Proudfoot Road; South View and Murray Avenue; Broadhaven Road; Mowat Place; Cormack Crescent; Cliff Cottages; and from the south eastern extents of Old Wick: Kennedy Terrace; Roxburgh Road; and Battery Road. Core Paths out to North Head and South Head as well as coastal path to the Castle of Old Wick. ***Not significant, negative, long term, reversible -*** elsewhere within Wick.

Table 14.7.2: Effect on Views from Settlements			
Settlement	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
	place of residence, and dynamic views coming and going from their residence. Sea views to the south/south-east are a focus of views from residences on the northern side of Wick Bay; but less so from residences on the southern side of Wick Bay, where sea views from residences are confined by the landform of South Head. The Development may relate to some of the main characteristics of views from the settlement. Views include the broad expansive scale of the wide, open sea and BOWL. **Sensitivity: Medium-high**	Wick: Kennedy Terrace; Roxburgh Road; and Battery Road. Also, in views gained from Core Paths out to North Head and South Head as well as coastal path to the Castle of Old Wick. The Development would become screened by south head from locations further to the west so that its full extent would not be visible. ***Magnitude of change: medium- low*** Other locations within Wick. ***Magnitude of change: low or negligible*** **Construction and decommissioning** The worst case scenario of both the construction and decommissioning will be when large numbers of turbines are in place in addition to concentrations of activity in the form of marine vessels and cranes. These activities associated with the Development turbines and OSPs will be distant with the construction of the cable route occurring at even greater distances, beyond the wind farm. From the south facing aspects and gardens of the properties on the south eastern extents of Proudfoot, Papigoe and Staxigoe: east of Proudfoot Road; South View and Murray Avenue; Broadhaven Road; Mowat Place; Cormack Crescent; Cliff Cottages; and from the south eastern extents of Old Wick: Kennedy Terrace; Roxburgh Road; and Battery Road. Core Paths out to North Head and South Head as well as coastal path to the Castle of Old Wick. ***Magnitude of change: medium – low***	**Construction and decommissioning** ***Significant, negative, short term, reversible-*** in views gained from the south facing aspects and gardens of the properties on the south eastern extents of Proudfoot, Papigoe and Staxigoe: east of Proudfoot Road; South View and Murray Avenue; Broadhaven Road; Mowat Place; Cormack Crescent; Cliff Cottages; and from the south eastern extents of Old Wick: Kennedy Terrace; Roxburgh Road; and Battery Road. Core Paths out to North Head and South Head as well as coastal path to the Castle of Old Wick. ***Not significant, negative, short term, reversible*** - elsewhere within Wick. **Likelihood of effect** Excellent visibility required for the Development to be visible at 53.35 km to closest turbine.

Table 14.7.2: Effect on Views from Settlements			
Settlement	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
		Other locations within Wick. ***Magnitude of change: low or negligible***	
Thrumster (Closest viewpoint is Volume 3b Figure 14.7.12 Viewpoint 4: Sarclet)	Thrumster is located approximately 2km from the coast. It has a nucleated layout around a central amenity greenspace, with a combination of the housing/built form and surrounding landform limiting views of the coast and sea beyond. BOWL is a component of the wide sea views to the south east. **Value of views: medium** The value of views from Thrumster is not formally recognised or inclusive of designated landscapes. The settlement is set-back at around 2 km from the coast, such that views out to sea have limited influence on the scenic qualities of views from Thrumster, which are most influenced by the immediate rural landscape. **Susceptibility to change: medium** Residents are the main receptor. Residents have static, long-term views from their primary place of residence, and dynamic views coming and going from their residence. The coast and sea are not a key focus in views from residences in the settlement. The Development may relate to some of the main characteristics of views from the settlement, including the large scale of the context as well as its openness and the perceived exposure. BOWL is a component of wide sea views. **Sensitivity: medium**	**Operation** The ZTV on Figure 14.7.7b indicates that would be theoretically possible to see parts of 51-62 turbines from parts of Thrumster. In reality the intervening landscape and settlement would influence and reduce actual visibility of the Development to the south from Thrumster and the Core Paths. Where the seascape is visible to the south the Development would be seen as an extension to BOWL. The Burn of Whilk onshore wind farm is visible to the south west. ***Magnitude of change: low*** **Construction and decommissioning** The worst case scenario of both the construction and decommissioning will be when large numbers of turbines are in place in addition to concentrations of activity in the form of marine vessels and cranes. These activities associated with the Development turbines and OSPs will be distant with the construction of the cable route occurring at even greater distances, beyond the wind farm. ***Magnitude of change: low***	**Operation** ***Not significant, negative, long term, reversible.*** **Construction and decommissioning** ***Not significant, negative, long term, reversible.*** **Likelihood of effect** Very Good visibility required for the Development to be visible at 25 km to closest turbine.

Table 14.7.2: Effect on Views from Settlements			
Settlement	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
Lybster (Volume 3b - Figure 14.7.15 Viewpoint 7: Lybster)	The settlement is linear and is oriented north-south along one main street off the A99. The sea is the focus of views from the rears of residences on Main Street and from the south end of the settlement near the coast. There are several Core Paths, mostly providing links from the village to the coast and harbour, which was once the focus of the important herring fishing industry. **Value of views: medium** The value of views from Lybster is not formally recognised or inclusive of designated landscapes. The orientation of residences, side roads of Main Street and the harbour facilitate informal enjoyment of sea views over Lybster Bay to the wider seascape, which have locally valued scenic qualities associated with the exposure, openness and wide horizons of the sea. **Susceptibility to change: medium-high** Residents are the main receptor, although there is some limited tourist/visitor activity at the harbour, where there is a café and small beach. Residents have static, long-term views from their primary place of residence, and dynamic views coming and going from their residence. Views from residences on the western side of Main Street are restricted by houses directly opposite. The Development may relate to some of the main characteristics of views from the settlement, including BOWL, the broad expansive scale of the wide, open sea and the perceived exposure. **Sensitivity: medium-high**	**Operation** The ZTV shown on Figure 14.7.7b illustrates that it would be theoretically possible to see parts of 51-62 turbines from all but the westernmost extents of the settlement. In reality the visibility from many of the properties in the ZTV is restricted or influenced by other intervening buildings so that there are few properties that would gain views such as those illustrated by Viewpoint 7: Lybster. The Development would be seen in views towards the south round to the south east, which includes views along Main Street itself. Areas with open views in this direction from the edge of the settlement include those from properties on Southend, Shelligoe Road, Golf View Place, Golf View Drive, Gray's Place/Main Street, the golf course and the Core Paths that lead to the coast. Taller buildings and locations where there are open foregrounds immediately to the south to south east may also gain views from within the village although these would have less open views, characterised by a developed foreground so that the magnitude of change as a result of the Development would be less. The open, sea views would include the Development as an apparent extension to BOWL, across a wide expanse of the sea skyline. The change in views would be greatest from those places, described above, from where there would be clear views from Lybster. ***Magnitude of change: medium*** Other locations within Lybster where intermediate landform and buildings reduce visibility and influence.	**Operation** ***Significant, negative, long term, reversible.*** In open sea views to the south round to the south east from the end of Main Street and properties on Southend, Shelligoe Road, Golf View Place, Golf View Drive, Gray's Place/Main Street, the golf course and the Core Paths that lead to the coast. ***Not significant, negative, long term, reversible*** – elsewhere within Lybster. **Construction and decommissioning** ***Significant, negative, short term, reversible.*** In open sea views to the south round to the south east from the end of Main Street and properties on Southend, Shelligoe Road, Golf View Place, Golf View Drive, Gray's Place/Main Street, the golf course and the Core Paths that lead to the coast.

Table 14.7.2: Effect on Views from Settlements			
Settlement	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
		Magnitude of change: low or negligible **Construction and decommissioning** The worst case scenario of both the construction and decommissioning will be when large numbers of turbines are in place in addition to concentrations of activity in the form of marine vessels and cranes. These activities associated with the Development turbines and OSPs will be distant with the construction of the cable route occurring at even greater distances, beyond the wind farm. The change in views would be greatest from those places, described above, from where there would be clear views from Lybster. ***Magnitude of change: medium*** Other locations within Lybster where intermediate landform and buildings reduce visibility and influence. ***Magnitude of change: low or negligible***	***Not significant, negative, short term, reversible*** – elsewhere within Lybster. **Likelihood of effect** Very Good visibility required for the Development to be visible at 24.6 km to closest turbine.
Latheronwheel (Closest viewpoint is Volume 3b - Figure 14.7.16 Viewpoint 8: Latheron)	This is a small settlement to the south west of the A9-A99 junction. It is a linear settlement running parallel to and above the Burn of Latheronwheel between the A9 and the coast. The land slopes down across the hamlet so that properties on the northeast side of the road sit slightly higher than those on the other side providing more opportunity for views over and between the properties on the south west. There are Core Paths near the Burn/woods and the A9. BOWL is visible across 32 degrees of the views eastwards at a distance of 23 km. The Beatrice Demonstrator Turbines and the associated oil platforms are visible to the south east at a distance of 26 km.	**Operation** The ZTV shown on Figure 14.7.7c illustrates that it would be theoretically possible to see parts of 51-62 turbines from all of the settlement. In reality the visibility from many of the properties in the ZTV is restricted or influenced by other intervening buildings so that there are few properties that would gain views such as those illustrated by Viewpoint 8. The Development would be seen in views towards the east south east round to the south south east (extending wind farm views across a further 50 degrees). Views directly along the main street, Sinclair Terrace are partially obscured by intervening trees and buildings.	**Operation** ***Significant, negative, long term, reversible.*** In open sea views to the east south east round to the south south east from a small number of properties in Sinclair Terrace and Parkview Terrace and from the nearby Core Paths. **Construction and decommissioning**

Table 14.7.2: Effect on Views from Settlements			
Settlement	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
	Value of views: medium- high The value of views from Latheronwheel is not formally recognised, but do include the Berridale Coast SLA, which covers the dramatic coastal cliffs between Berriedale and Helmsdale that are visible in views south from Latheronwheel. The orientation of residences along the main street facilitate enjoyment of sea views along the coast towards Dunbeath and Berriedale Braes, which have scenic qualities associated with the drama of the sheer cliffs at the coast edge, exposure, openness and wide horizons of the sea. **Susceptibility to change: medium-high** Residents are the main receptor, although there is some limited tourist/visitor activity at the harbour. Residents have static, long-term views from their primary place of residence, and dynamic views coming and going from their residence. The settlement is linear and is oriented north-west to south-east along one main street off the A99. Sea views are a focus of views from residences along the Main Street, particularly those nearest the coast. The Development may relate to some of the main characteristics of views from the settlement, including BOWL, the broad expansive scale of the wide, open sea and the perceived exposure. **Sensitivity: Medium-high**	Small numbers of properties along Sinclair Terrace and Parkview Terrace have clear views out to sea. Where sea views are possible out the south-east the open, sea views would include the Development as an apparent extension to BOWL, across a wide expanse of the sea skyline. Such visibility would also occur when moving around the settlement. The Core Path running alongside the Burn of Latheronwheel may gain some visibility from its more elevated sections, as will the route along the A9. ***Magnitude of change: medium*** **Construction and decommissioning** The worst case scenario of both the construction and decommissioning will be when large numbers of turbines are in place in addition to concentrations of activity in the form of marine vessels and cranes. These activities associated with the Development turbines and OSPs will be distant with the construction of the cable route occurring at even greater distances, beyond the wind farm. ***Magnitude of change: medium***	***Significant, negative, short term, reversible.*** In open sea views to the east south east round to the south south east from a small number of properties in Sinclair Terrace and Parkview Terrace and from the nearby Core Paths. **Likelihood of effect** Very Good visibility required for the Development to be visible at 24 km to closest turbine.
Dunbeath (Volume 3b - Figure 14.7.17 Viewpoint 9a: Dunbeath (nr. Heritage Centre) and Figure 14.7.18 Viewpoint 9b: Dunbeath (by harbour)	Dunbeath is a small, dispersed settlement that is set around and above the valley of the Dunbeath Water. The curving, modern structure of the A9 bridge is a key feature of the village as well as offering views out across it. There are roads leading to residential properties on the north east and south west sides of the river. The	**Operation** The ZTV shown on Figure 14.7.7c illustrates that it would be theoretically possible to see parts of 51-62 turbines from most locations within Dunbeath. In addition, views from the A9 around the bridge and in the approaches and several Core Paths are also shown to be possible.	**Operation** ***Significant, negative, long term, reversible*** - in open views gained from the south to east facing aspects of a small number of properties and gardens near the mouth

Table 14.7.2: Effect on Views from Settlements			
Settlement	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
	northerly, Portormin Road leads to the harbour and a small car park and visitor area to the east. There is a small row of houses and isolated properties near the confluence of the river as well as properties further up the valley. There are also groups of properties on the higher ground to the west and east of the river and on either side of the A9, which runs through the settled area. Viewpoint 9a represents open seaward views from the upper area of the village, whilst Viewpoint 9b shows views from the near the harbour jetty at the end of the river. The wider views include a broad expanse of open sea. BOWL is visible across a part (26 degree) of the view to the east from the upper part of the settlement location at a range of 25.7 km (Viewpoint 9a). The Beatrice Demonstrator turbines and the associated oil platforms are visible as point features on the skyline at a distance of approximately 26 km. Dunbeath Castle would also gain such visibility, however the effect on this designated GDL is considered in Section 14.7.4. **Value of views: medium** The value of views from Dunbeath is not formally recognised or inclusive of designated landscapes. Views will be locally valued as the seaward views from this small settlement. **Susceptibility to change: medium- high** Residents are the main receptor, although there is some limited tourist/visitor activity. Residents have static, long-term views from their primary place of residence, and	The Development would be located in views from the south south east round to the east so that properties, gardens and routes with their main direction of view towards this, would be most affected. Views from parts of the village and the A9 are restricted by intervening woodland, buildings and the bridge structure. VP 9b illustrates the degree of visibility of the Development from the lower shores where there is screening of BOWL and part of the Development by intervening landform. Viewpoint 9a illustrates the degree of visibility from open, high level locations with a clear view towards the sea and the Development seen as an extension to BOWL. There is the possibility of such views from the houses around the Heritage Centre, Dunbeath Castle and on the east side of the river near to the A9, however, intervening properties, landform and vegetation will often partially screen or filter views. Many of the properties also do not face towards the Development particularly on the east side of the river, e.g. the Hotel and Knockglass Road, but instead have their aspects more to the south west so that views towards the Development would be oblique. The change in views would be greatest from those places, described above, from where there would be clear views from Dunbeath. ***Magnitude of change: medium*** Other locations within Dunbeath where intermediate landform and buildings reduce visibility and influence. ***Magnitude of change: low or negligible*** **Construction and decommissioning**	of the Dunbeath Water and on high ground near the Heritage Centre and to the north and south of the A9, east of the bridge as well as the coastal Core Paths. ***Not significant, negative, long term, reversible -*** elsewhere within Dunbeath. **Construction and decommissioning** ***Significant, negative, short term, reversible***-in open views gained from the south to east facing aspects of a small number of properties and gardens near the mouth of the Dunbeath Water and on high ground near the Heritage Centre and to the north and south of the A9, east of the bridge as well as the coastal Core Paths. ***Not significant, negative, short term, reversible -*** elsewhere within Dunbeath. **Likelihood of effect** Very Good visibility required for the Development to be visible at 24.5 km to closest turbine.

Table 14.7.2: Effect on Views from Settlements			
Settlement	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
	dynamic views coming and going from their residence. The settlement is dispersed, so the scenic qualities experienced vary, with areas to the north of the A9 afforded a more elevated aspect over Dunbeath Bay, influenced by the A9 corridor. Residence on the elevated area to the west of the river may have open views Residences along Dunbeath Water near the harbour are contained by the steep backdrop, but some afford open views south to the open sea, with scenic qualities associated with the exposure, openness and wide horizons. The proposed wind farm may relate to some of the main characteristics of views from the settlement, including BOWL, the broad expansive scale of the wide, open sea and the perceived exposure. **Sensitivity: medium-high**	The worst case scenario of both the construction and decommissioning will be when large numbers of turbines are in place in addition to concentrations of activity in the form of marine vessels and cranes. These activities associated with the Development turbines and OSPs will be distant with the construction of the cable route occurring at even greater distances, beyond the wind farm. The change in views would be greatest from those places, described above, from where there would be clear views from Dunbeath. ***Magnitude of change: medium*** Other locations within Dunbeath where intermediate landform and buildings reduce visibility and influence. ***Magnitude of change: low or negligible***	
Helmsdale (Closest viewpoint is Volume 3b - Figure 14.7.21 Viewpoint 12: Navidale)	Helmsdale is a coastal village located at the mouth and bridge crossing point of the River Helmsdale. There are older properties clustered around the harbour area and a planned 'newer' part set out in a grid pattern, on the side slopes of the river valley, to re-settle people at the time of the Highland Clearances. A cluster of more modern housing extends out along the coast to the east. There are also houses strung out along the A9 and the A897 into Strath Ullie. There are Core Paths located along the valley and the coast. **Value of views: medium- high** The value of views in Helmsdale is not formally recognised, but views out of parts of the settlement do	**Operation** The ZTV on Figure 14.7.7c illustrates that it would be theoretically possible to see the Development from the most easterly part of the settlement as well as from the A9 on the approaches. The view towards the Development is from the east south east round to the east north east. The headland to the east of the river prevents visibility from the main 'newer' part of the village and reduces visibility from the lower harbour area. Other parts of the village, such as around the church to the west of the river have their views screened or filtered by trees or intervening buildings. Some of the properties to the east of the village, within the more modern housing area on Dunrobin Street and	**Operation** ***Significant, negative, long term, reversible -*** In open views gained from some of the properties to the east of the village, within the more modern housing area on Dunrobin Street and Simpson Crescent and along the A9 where they have their aspects to the south east and east as well as from coastal core paths and the café. ***Not significant, negative, long term, reversible -***

Table 14.7.2: Effect on Views from Settlements			
Settlement	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
	include parts of the Berriedale Braes SLA to the north and Loch Fleet, Loch Brora and Glen Loth SLA to the south. Sea views are an important element in the setting and visual amenity of the settlement, with views inland contained by the steep upland backdrop and views to the sea being expansive, large scale with wide horizons. **Susceptibility to change: medium - high** Residents are the main receptor, although there is also some notable tourist / visitor activity in Helmsdale. Residents have static, long-term views from their primary place of residence, and dynamic views coming and going from their residence. Sea views from Helmsdale are oriented to the south/south-west, due to its position on rising ground on the northern side of the River Helmsdale, with the majority of residences having a south-westerly orientation (away from the Development) and contained to the east by the intervening headland. The Development may relate to some of the main characteristics of views from the settlement, including BOWL, the broad expansive scale of the wide, open sea and the perceived exposure. **Sensitivity: medium- high**	Simpson Crescent have their aspects to the south east and east and would gain open views of the Development similar to those shown and describe in Viewpoint 12: Navidale. The views would have a slightly greater extent of land within the foreground, which in some places influences visibility. There would also be similar open sea views from the coastal core paths and the Emigrants Monument, café and houses along the A9. The open, sea views would include the Development as an apparent extension to BOWL, across a wide expanse of the sea skyline. ***Magnitude of change: medium*** Other locations within Helmsdale where intermediate landform and buildings reduce visibility and influence. ***Magnitude of change: low or negligible*** **Construction and decommissioning** The worst case scenario of both the construction and decommissioning will be when large numbers of turbines are in place in addition to concentrations of activity in the form of marine vessels and cranes. These activities associated with the Development turbines and OSPs will be distant with the construction of the cable route occurring at even greater distances, beyond the wind farm. The change in views would greatest from those places, described above, from where there would be clear views from Helmsdale. ***Magnitude of change: medium*** Other locations within Helmsdale where intermediate landform and buildings reduce visibility and influence.	elsewhere within Helmsdale. **Construction and decommissioning** ***Significant, negative, short term, reversible-*** In open views gained from some of the properties to the east of the village, within the more modern housing area on Dunrobin Street and Simpson Crescent and along the A9 where they have their aspects to the south east and east as well as from coastal core paths and the café. ***Not significant, negative, short term, reversible -*** elsewhere within Helmsdale. **Likelihood of effect** Very Good visibility required for the Development to be visible at 27 km to closest turbine.

Table 14.7.2: Effect on Views from Settlements			
Settlement	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
		Magnitude of change: low or negligible	
Brora (Volume 3b - Figure 14.7.22 Viewpoint 13: Brora (picnic area off Salt Street)	Brora is a small, coastal, town located near the mouth and bridge crossing of the River Brora. It spans both sides of the river and evolved as a result of a variety of industrial and commercial industries, many of which are no longer in existence. There is a small harbour near the mouth of the river and both the A9 and the rail line pass through close to the centre. It is mostly set back from the beach by a broad, mainly grassy area which includes a car park/picnic site, dunes and a links golf course. There are several Core Paths along the coast and linking inland. **Value of views: medium- high** The value of views in Brora is not formally recognised, but views out of parts of the settlement to the north do include parts of the Loch Fleet, Loch Brora and Glen Loth SLA. Sea views are an important element in the setting and visual amenity of the sea facing parts of settlement, which are also a draw for visitors. Views out to the sea are expansive, large scale with wide horizons. However, views within the central parts of the village tend to be inward looking. **Susceptibility to change: medium - high** Residents and people using the beach/golf course are the main receptors, although there is also some notable tourist / visitor activity in Brora. Residents have static, long-term views from their primary place of residence,	**Operation** The ZTV on Figure 14.7.7c illustrates that it would be theoretically possible to see the Development from the majority of the settlement as well as from the A9 and rail line on the approaches to it. However, from locations within the settlement such visibility would actually be limited due to the screening effect of intervening buildings and vegetation. From locations where open sea views are gained to the east round to the east north east from the settlement it would be possible to gain visibility of the Development similar to those obtained from Viewpoint 13. However, such views would generally include a greater extent of fore and middle ground landscape/townscape which may decrease the influence of the sea views. Open sea views towards the Development are primarily available from houses in Uppat Place, Tarbat Crescent, Johnston Terrace and Moray Terrace across a broad area of dunes landscape. Views from the most southerly properties in Salt Street and George Street are most similar to those of Viewpoint 13 due to their location nearby. On the north side of the river properties on the edge of the settlement along Golf Road and Links View may have clear visibility towards the Development across the golf course, club house and beach, from where such visibility would also be gained. Visibility from properties along Victoria Road/A9 would also be possible although they are set beyond the rail	**Operation** ***Not significant, negative, long term, reversible.*** **Construction and decommissioning** ***Not significant, negative, long term, reversible.*** **Likelihood of effect** Very Good visibility required for the Development to be visible at 37 km to closest turbine.

Table 14.7.2: Effect on Views from Settlements			
Settlement	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
	and dynamic views coming and going from their residence. Sea views from Brora are generally oriented to the east south east and would include views of the Development, which lies to the east round to the east north east. The Development may relate to some of the main characteristics of views from the settlement, including BOWL, the broad expansive scale of the wide, open sea and the perceived exposure. It would not be located within the same part of the view as the landscape included in the SLA. **Sensitivity- medium- high**	line, a strip of agricultural land and the golf course, so that the open sea is less influential in these views. The coastal Core Paths/beaches would also gain open views towards the Development similar to those shown in Viewpoint 13. The change in views would be greatest from those places, described above, from where there would be clear views from Brora. ***Magnitude of change: medium-low*** Other locations within Brora where intermediate landform and buildings reduce visibility and influence of the Development. ***Magnitude of change: low or negligible*** **Construction and decommissioning** The worst case scenario of both the construction and decommissioning will be when large numbers of turbines are in place in addition to concentrations of activity in the form of marine vessels and cranes. These activities associated with the Development turbines and OSPs will be distant with the construction of the cable route occurring at even greater distances, beyond the wind farm. The change in views would be greatest from those places, described above, from where there would be clear views from Brora. ***Magnitude of change: medium- low*** Other locations within Brora where intermediate landform and buildings reduce visibility and influence of the Development. ***Magnitude of change: low or negligible***	

Table 14.7.2: Effect on Views from Settlements			
Settlement	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
Sandend Volume 3b – Figure 14.7.32 - Viewpoint 22: Sandend	Sandend is a hamlet spread across three disparate parts close to Sandend Bay on the Aberdeenshire coast. The historic part of Sandend extends along the western edge of the bay out to where there is a small harbour with the houses clustered around it. Their layout follows the traditional arrangement of gables towards the sea in order to reduce exposure. To the south and west of the hamlet there are residential properties generally set out along two perpendicular roads. One running perpendicular to the coast with the other set back and running parallel so that these houses face out to sea. Sandend has a wide curving beach, backdropped by sand dunes. The dunes provide some screening and also vantage points to look out across the simple form of the beach to the sea. Between the residences and the beach there is a caravan park. This is laid out with the most northerly mobile homes positioned to gain views out to sea along the lower ground created by a stream, which runs around it. Views out of the bay are focused approximately north to north east. **Value of views – medium - high** Lies within locally designated SLA – North Aberdeenshire Coast. Locally valued as open sea outlook from hamlet and the associated beach. **Susceptibility to change – medium-high** Houses within the settlement and the caravan park would not gain visibility of the turbines or their construction but would gain visibility of the temporary works associated with the OfTI.	**Operation** The ZTV shown on Figure 14.7.32a Viewpoint 22 Sandend - Viewpoint Location shows the limited theoretical visibility of the operational Development from the residential and caravan park areas of the settlement. Views from the beach/sand dunes area are assessed in Table 14.7.1 for Viewpoint 22. ***Magnitude of change: negligible*** **Construction and decommissioning** There would be very limited views of the decommissioning from Sandend. The worst case scenario of the construction will be when the construction of the offshore cable route would introduce visibility of further vessels and activity particularly during the laying of the near shore cables to the landfall which would occur within or near to this bay. This may include a large cable lay vessel. A support vessel and offshore HDD rig if using HDD. The support vessel and HDD rig may be visible from the shore at relatively close range for up to 18 months; If alternative trenching techniques used there would be visibility of a plough or jet trenching tool on the beach/nearshore waters. Depending on the conditions at the coast there may be a requirement for a coffer dam (steel sheeting to hold the trench open while the cable is pulled ashore). This would be temporary, lasting a small number of days. Such changes to this view would be short or medium in duration. **Magnitude of change: medium-low**	**Operation** ***Not significant, negative, long term, reversible.*** **Construction and decommissioning** ***Significant, negative, short term, reversible.*** This is a precautionary assessment of the effects due to the potential options for short term works located close to this settlement or short term views of large vessels/riggs located relatively close to the shore and visible from it.

Table 14.7.2: Effect on Views from Settlements			
Settlement	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
	Views are available towards the construction and operation of the Development from the beach where people visit as part of their recreation and, in part, to enjoy the sea views. Such people are transient. View direction towards the Moray West Wind Farm is not the main direction of views from the settlement. **Sensitivity – medium - high**		

Road users

14.7.3.13 There are numerous road corridors traversing the Study Area, some of which are associated with urban development while the majority provide access to the wider countryside or key links across it.

14.7.3.14 All of the major roads in the Study Area are shown in Figure 14.7.7 (Volume 3a), in relation to the ZTV. Based on the findings of the preliminary assessment, two sections of major roads are assessed further in Table 14.7.3 below. These are the A9 and the A99 where they run through the Study Area. These routes are shown at a larger scale in relation to the ZTV in Volume 3a - Figures 14.7.7 b and e.

Table 14.7.3: Effect on Views from Roads			
Route	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
A9 (Brora to Spittal)	The A9 is Scotland's longest road leading from Falkirk in the south to Thurso in the north of Scotland via Stirling, Perth and Inverness. In the south it is largely dual carriageway with further sections under construction between Perth and Inverness. By the point where the route enters the Study Area at Loch Fleet it is a much narrower, often winding, quieter road that predominantly follows the contours of the land near to the coast and demands slower speeds in places. At Latheron the road turns inland to strike a direct route north to Thurso. The A9 Berriedale Braes improvement scheme is due to proceed and will remove a hair pin bend and improve the alignment of the route where it ascends the steep valley side above Berriedale Water.	**Operation, construction and decommissioning** The route between Brora and Latheron runs generally in a north east or south westerly direction along the coast. At Brora the Development would be visible across the sea views from the east round to the east north east whilst at Latheron it would be visible across the sea views between east north east round to south of south south east.	**Operation** ***Not significant, negative, long term, reversible –*** on the views obtained from the A9 from Brora to east of Crakaig and between west of Ousedale and east of Berriedale. ***Significant, negative, long term, reversible –*** on the views obtained

Table 14.7.3: Effect on Views from Roads			
Route	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
	The route is generally described from south to north as it is travelers moving in this direction that would be most affected by visibility of the Development. This is due to the fact that the Development would mostly be seen ahead of or to the side of the route. Seaward views from Brora are restricted by intervening buildings. It then passes through an area of Small Farms and Crofts LCT before heading in a predominantly north north east direction, skirting close to the coast and running near to the beach alongside the rail line at Kintradwell. The route here passes along the inner edge of the coastal shelf LCT. From Lothbeg to Portgower the A9 runs in an east north east direction and is set back from the coast and characterised by scattered settlement the steep slopes of the Moorland Slopes and Hill LCT to the north. The open sea beyond forms a backdrop to the views but is often filtered and screened by intervening features. From north east of Crakaig through Portgower the slight elevation of the road above the coastal landscape means that the sea becomes a more pronounced and consistent component of the views from the road, which tend to be directed towards the east. There are several run off areas and laybys that facilitate stopping along this section of the route. North east of Portgower the landscape of the coastline changes so that more steeply sloping land reaches right to the coast and the character type changes to Small Farms and Crofts with the higher incidence of settlement. Here the road hugs the edge of the rocky coast with the rail line running parallel between. The sea views are the main component of views once past the intervening buildings around Portgower and until the road crosses the bridge at Helmsdale. Through Helmsdale the visibility out to sea is restricted by intervening buildings. Once outwith the town views out to sea are over the more coastal parts of the settlement with some roadside vegetation also restricting visibility in parts. The road climbs onto higher slopes north of East Helmsdale/Navidale (Viewpoint 12). At this point the open seascape also contains BOWL at a range of 38.6 km and spread across a part of the distant sea skyline. The Beatrice Demonstrator Turbines and the associated oil platforms are also visible as point features on the skyline at a range of approximately 32.8 km. Beyond this the route, whilst more elevated, also becomes more winding and visibility out to sea becomes more confined and less consistent. This is due to the route's changes in level and direction around the contours of the land formed by the Moorland Slopes and Hills	In the views from near Latheron (Viewpoint 8) the Development would be seen as an extension of BOWL. Due to the layout of these wind farms their longer dimensions are seen across the views so that together they fill a large part of the sea skyline with the Development making a more pronounced contribution to the wind farm views, than BOWL, due to its larger turbine size and wider spread. From nearer Brora (Viewpoint 13) the relationship of the Development to BOWL is such that BOWL's influence on the sea views is limited, whilst the layout of the Development is such that it's shorter dimension is closer to this part of the coast with the majority of turbines behind seen behind or to a lesser extent. Viewpoint 11: Berriedale and Viewpoint 12: Navidale illustrate the views of the Development between these locations, showing the transition between these two points along the route. The worst case scenario of both the construction and decommissioning will be when large numbers of turbines are in place in addition to concentrations of activity in the form of marine vessels and cranes. These activities associated with the Development turbines and OSPs will be distant with the	predominantly by north bound travelers from the A9 between east of Crakaig and west of Ousedale and between east of Berriedale and west of Latheron by both north and south bound travellers. **Construction and decommissioning** ***Not significant, negative, short term, reversible-*** on the views obtained from the A9 from Brora to east of Crakaig and between west of Ousedale and east of Berriedale. ***Significant, negative, short term, reversible –*** on the views obtained from the A9 by predominantly north bound travellers between east of Crakaig and west of Ousedale and by north and south bound travellers between east of Berriedale and west of Latheron. **Likelihood of effect** Very Good visibility required for the Development to be visible at 23 km to closest turbine.

Table 14.7.3: Effect on Views from Roads			
Route	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
	landscape. Views out to sea are across an increasingly more substantial strip of simple fore and middle ground landscape of sloping moorland, which conceals the high cliffs and sheltered bays that lie along the coast. There are several locations where vehicles can stop along this stretch. Around Ousdale the A9 moves further inland around the base of the steeper slopes. Here the views out to sea are screened by landform and forestry and this continues to be the case until Berriedale (a section of approximately 7km of the route). This is with the exception of a few small sections where lower intervening land allows visibility out to sea over moorland (e.g. east of Badbea). Once at approximately Lower Newport the landscape once again becomes characterised by Small Farms and Crofts below the more steeply sloping moorland further inland. The A9 runs above the lower slopes to the coast so that slightly elevated sea views are a key characteristic until the road passes Newport (Viewpoint 11). Along this stretch of the route views also include BOWL as part of the seascape at distances of approximately 28 km as well as the Beatrice Demonstrator Turbines and oil platforms at 26 km. The Burn of Whilk wind farm is also visible on the distant headland at a range of 22.7 km. Once north of Newport the A9 runs slightly further inland so that the shallow slopes to the coast intervene in sea views with their more settled characteristics of the Small Farms and Crofts LCT. The more steeply sloping Moorland Hills and Slopes LCT is set back from the road and together with the lower Sweeping Moorland in views north, this ensures that views are wider reaching and less focused out to sea. Intervening landform around the road to Rockhead prevents sea visibility for a short stretch. Thereafter, the A9 moves closer to the coast but maintains a higher elevation so that views over the sea are over the lower lying slopes to the sea. Scattered properties tend to be on the inland side of the route so that the wide sea views with BOWL and the Beatrice Demonstrator Turbines are a key characterising features. Coniferous forestry planted alongside the road in the vicinity of Dunbeath Mains and woodland around Dunbeath Castle until the A9 passes the junction with Acorn Road on the south side of Dunbeath restricts actual visibility. For a further short section of the route the buildings of Dunbeath prevent and filter visibility out to sea, however in the vicinity of the bridge views along the valley of the Dunbeath	construction of the cable route occurring at even greater distances, beyond the wind farm. **Magnitude of change: low-medium** - on the views obtained from the A9 from Brora to east of Crakaig. **Magnitude of change: medium –** on the views obtained predominantly by north bound travellers from the A9 between east of Crakaig and west of Ousedale at a maximum distance from the Development of 33.4 km. **Magnitude of change: low or none** - on the views obtained from the A9 between west of Ousedale and east of Berriedale due to a general lack of visibility out to sea. **Magnitude of change: medium** On the views obtained from the A9 between east of Berriedale and west of Latheron.	

Table 14.7.3: Effect on Views from Roads			
Route	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
	Water, across the village, to the open sea beyond, are possible in an east south easterly direction. Also from this stretch of the route there is visibility of several small, single turbines as well as Buolfruich wind farm to the north of the A9. From the bridge the A9 rises back up the slopes onto higher ground where views across the settled slopes to the sea are again more open until north of Toremore, where intervening landform restricts visibility out to sea for a short section of the route. At Knockinnon the land slopes steeply to the sea and the A9 runs slightly closer to the coast so that close range, unobstructed, open views out to sea are possible for much of the next 1km. North east of Upper Latheron farm the route of the A9 moves further inland, following the contours to the bridging point of the Burn of Latheronwheel. Here the substantial intervening landscape of Small Farms and Crofts, including some woodland, reduces the influence of the sea beyond, which, when visible, forms a narrow backdrop, with BOWL a feature of a wide extent of the sea skyline. From level with the Smerral junction intervening woodland, landform and the buildings of Latheronwheel restrict visibility out to sea until north of Latheronwheel. There, open and relatively consistent views out to sea over the sloping, partially settled landscape are available and such views continue to be possible until road turns northwards towards Latheron (Viewpoint 8: Latheron). There the intervening landscape widens out, however the elevated position of the A9 ensures that the open sea is a key characteristic of the views with BOWL visible across a large section of the skyline at a distance of 23.1 km and the Beatrice Demonstrator Turbines and oil platforms visible as features at a range of approximately 26 km. From Latheron itself views are restricted by intervening buildings and vegetation. Here the A9 leaves the coast and turns northwards. Visibility of the sea is screened and partially restricted by vegetation around Latheron and further north along the route. To the north the sloping landform on either side of the route channels views to the coast so that only a relatively narrow section of the sea skyline is visible above Latheron. North of Gillivoan the landscape changes to one of Sweeping Moorland and then ascends into a higher section of Moorland Slopes and Hills LCT to the north of Upper Latheron. From		

Table 14.7.3: Effect on Views from Roads			
Route	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
	there the sea views are a narrow component of the views forming a backdrop to the simple, partially settled landscape of the fore and middle ground. Sea views from the A9 are not possible from further north than the western flanks of Ben-a-chielt where the road descends from the Moorland Slopes and Hills through a further settled area to a large expanse of Sweeping Moorland and Flat Peatland LCT beyond. Within this area the Causeymire and Bad a' Cheo Wind Farms are seen ahead of the road, which passes alongside the turbines at relatively close proximity until just south of Spittal. **Value of views: medium – high between Brora and Latheron, medium Latheron to Spittal** Within the Study Area the A9 passes through two areas that have a recognised, heightened value due to their designation as SLAs within Highland. These are the Loch Fleet, Loch Brora and Glen Loth SLA and the Flow Country and Berriedale Coast SLA. The road passes through these areas for a short section where it passes along Loch Fleet, north east of Brora between approximately Kintradwell and Portgower, and north east of Ousdale between approximately Badbea and Newport. The view from the A9 north of Newport/Borgue is identified as a key view in THC (2017) Landscape Sensitivity Appraisal, which describes this as coastal views along east coast to Sarclet Head. Easily experienced by travelers heading north on A9 and significant because it allows an 'Unobstructed view along coastline from road. Eye is drawn to cliffs & inlets/bays. Views of open sky, experience of weather & waves.' The coastal section of the route between Brora and Latheron forms part of the North Coast 500 route, which is being promoted for its attractive scenery with numerous interesting places to visit. **Susceptibility to change: medium** Users of the A9 are transient and therefore their appreciation of the views would be shorter and more diverse than for residents. Their purpose for using the A9 may be varied. For example, they may be local, regular travelers, they may be delivery drivers using the route to transport goods or they may be visitors to the area taking in the scenery for the first time. People's attention to the scenery through which they are passing is likely to be varied depending on their purpose. Whilst people visiting the area are likely to give the views of it		

Table 14.7.3: Effect on Views from Roads			
Route	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
	a high degree of attention, this does not mean that local people or people working do not appreciate the scenery of the route's setting, particularly on a beautiful day. The views out to sea are often the focus of views from the A9, particularly where the landform restricts visibility inland as occurs for most of the route between Brora and Newport. The most susceptible parts of the route are where it passes close to the coast or where the intervening land is at a lower level so that it's influence on views is limited. From these locations the seascape is the key characteristic. **Sensitivity: medium- high Brora to Latheron, medium Latheron to Spittal**		
A99 (between Wick and Latheron)	The A99 is the coastal route between the A9 at Latheron and John O' Groats, the most northerly town in Scotland. Between Latheron and Wick it runs generally in a south west to north east alignment whilst north of Wick it runs predominantly north south. The route is generally described from north to south as it is travelers moving in this direction that would be most affected by visibility of the Development. This is due to the fact that the Development would mostly be seen ahead of or to the side of the route. North bound travelers are more influenced by views towards BOWL, due to its more northerly location. Viewpoint 3: Wick illustrate a view out to sea from the coast at Wick, however, views out to sea from the A99 within Wick are restricted by intervening buildings. To the south of Wick intervening landform screens views out to sea until south of Thrumster. There the A99 passes into an area of Small Farms and Crofts LCT which is studied with buildings and gently undulating. Whilst it is possible to gain views out to sea from sections of the route south of Thrumster, the sea does not become a consistent component of views until the A99 passes south of the Hill of Ulbster at Ulbster. The intervening undulating landscape and buildings ensure that visibility is, however, restricted to small parts of the view, where the low points on the intervening land allow views beyond to the sea and will often contain BOWL across the horizon. Viewpoint 5: Whaligoe Steps is nearby viewpoint illustrating a view from the coast. South of Whaligoe the views across the intervening landscape to the sea become more open whilst the distance to the sea decreases until near Bruan, where it moves slightly inland. When travelling north the short section of the route, where it is perpendicular to the coastline, has views directly east south east towards BOWL as the route turns the corner	**Operation, construction and decommissioning** BOWL is an apparent influence in views from the A99 from south of Thrumster with the Development extending the offshore wind farm characteristics further to the south across a further extent of the sea skyline. This means that in most instances, when travelling in a south westerly direction, and when a view out to sea occurs, in good visibility conditions, it would contain a wind farm. In addition, the shallow nature of the landform that often screens views of the sea itself, would result in both BOWL and the Development being visible above the land and in the context of its settlement features where the sea is not visible. From locations south west of Whaligoe the Development would become more	**Operation** ***Not significant, negative, long term, reversible*** – on the views obtained from the A99 from Wick to north of Ulbster. **Significant, negative, long term, reversible –** on the views obtained predominantly by south bound travelers from the A99 between north of Ulbster and Latheron. **Construction and decommissioning** ***Not significant, negative, short term, reversible***- – on the views obtained from the A99 from Wick to north of Ulbster. ***Significant, negative, short term, reversible*** – on the

Table 14.7.3: Effect on Views from Roads			
Route	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
	near the coast. The Beatrice Demonstrator Turbines and the oil platforms are apparent as features out at sea. The Burn of Whilk wind farm would be visible directly ahead of south bound travelers along this section at relatively close range and inland from sections of the route on either side of this, at greater distances. Continuing southwards along the A99 the route continues to be set back from the coast by a strip of Small Farms and Crofts land. This forms a substantial fore and mid-ground influence in the views so that the relatively small parts of the sea visible are part of the background where visible between and above the intervening fields and buildings. Once south of the Burn of Whilk wind farm access route, the views from the A99 include wider expanses of sea within the views as a backdrop to fields. The route also moves closer to the coast north of Mid Clyth. East of Occumster the depth of land between the sea and the A99 increases, as does the incidence of buildings. Views towards the sea are occasionally hidden by intervening landform as well as building along this section of the A99. Views from the A99 around Lybster have a substantial, settled foreground with views out to sea completely screened by buildings from within Lybster itself. Views out to sea tend to be of relatively narrow sections above dips in the landform and across further settled farmland to the south of Lybster. A more open view is available southwards from the A99 along the road to Achastle Shore. Such visibility occurs across this falling land until the A99 reaches Burrigill. The intervening settlement and landform at Burrigill and Forse create partial screening in views towards the sea in places with some houses set against an open sea backdrop. Further south to Latheron views of the sea become wider, although their vertical extent is often narrow due to the intervening landform. Views of the sea from within Latheron are either screened or form a backdrop to the settlement. **Value of views: medium** The A99 does not pass through any designated landscapes. The A99 between Wick and Latheron forms part of the North Coast 500 route, which is being promoted for its attractive scenery with numerous interesting places to visit. As such, the value of the views gained from the route is also heightened. **Susceptibility to change: medium**	apparent as a large, extension to BOWL, extending across the wide sea skyline visible from sections of the route. Viewpoints 5 and 7 illustrate more open views across the sea from the nearby coast. The worst case scenario of both the construction and decommissioning will be when large numbers of turbines are in place in addition to concentrations of activity in the form of marine vessels and cranes. These activities associated with the Development turbines and OSPs will be distant with the construction of the cable route occurring at even greater distances, beyond the wind farm. **Magnitude of change: low or negligible** - on the views obtained from the A99 from Wick to north of Ulbster. **Magnitude of change: medium -** on the views obtained from the A99 from north of Ulbster to Latheron.	views obtained predominantly by south bound travelers from the A99 between north of Ulbster and Latheron. **Likelihood of effect** Very Good visibility required for the Development to be visible at 25 km to closest turbine.

Table 14.7.3: Effect on Views from Roads			
Route	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
	Users of the A99 are transient and therefore their appreciation of the views would be shorter and more diverse than for residents. Their purpose for using the A99 may be varied. For example, they may be local, regular travelers, they may be delivery drivers using the route to transport goods or they may be visitors to the area taking in the scenery for the first time. People's attention to the scenery through which they are passing is likely to be varied depending on their purpose. Whilst people visiting the area are likely to give the views of it a high degree of attention, this does not mean that local people or people working do not appreciate the scenery of the route's setting, particularly on a beautiful day. The views out to sea are less of a focus for the majority of the A99 to the south of Wick than in views from the A9. This is largely as a result of the depth of the settled landscape that occurs between the route and the sea combined with its shallow incline so that the sea is less of a defining component. The most susceptible parts of the route are where it passes close to the coast or where the intervening land is at a lower level so that it's influence on views is more limited. The Development would be seen as an extension to BOWL in most views. **Sensitivity: medium**		

Rail users

14.7.3.15 The rail lines within the study are shown with the ZTV in Figure 14.7.7 (Volume 3a). The initial assessment of the effect on views gained by people travelling by train has assessed that there may be a significant effect on the views from the rail line where it runs between Brora and Helmsdale. The assessment of the visual effect on people using this route is included in Table 14.7.4 below. The nature of rail travel by the public is that views tend to be out to the side and slightly ahead or behind the direction of travel as people can be sitting facing or with their backs to the front of the train.

Table 14.7.4: Effect on Views from Rail Lines			
Route	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
Far North Line (Brora	This section of rail line is promoted by Scotrail and Visit Scotland as a scenic railway journey. It runs from Inverness via Beauly, Dingwall, Alness, Tain, Lairg, Golspie, Brora,	**Operation, construction and decommissioning** The route between Brora and Helmsdale runs generally in a north east or south westerly	**Operation** ***Not significant, negative, long term,***

Table 14.7.4: Effect on Views from Rail Lines			
Route	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
to Helmsdale)	Helmsdale and further north Thurso or Wick. There are also connections to the Orkney Ferry. It is promoted as a route through a diversity of Scotland's landscapes. This route is described from south to north. The southern section of the route from Inverness is inland although sections of it pass across and around a number of firths. The route emerges into the Study Area at Loch Fleet, south of Golspie, and it is from there that open sea views over the Moray Firth, become possible. From Golspie to Brora the route is aligned in a predominantly south west to north east orientation and views tend to be directed across to the Moray Coast in a south easterly or direction or south west towards Dornoch. Views out to sea would generally only occur from the windows on the southerly side of the train. Viewpoints 13 at Brora and Viewpoint 12: Navidale provide an indication of the baseline views including the range of visibility of the Beatrice Demonstrator Turbines and BOWL. The rail way line is set back from the shore within the settlement of Brora. Where it leaves the urban area, it is aligned in almost a north south direction. It is set back approximately 1 km from the coast at this point with the intervening coastal area characterised by views across the golf course a caravan and camping site and settlement. The rail route curves round the base of the hill slopes so that by the bay at Kintradwell it is adjacent to the coast, alongside the beach and rocky shoreline with the A9 immediately on its other side along this stretch. Here it passes along a narrow strip of Long Beaches Dunes and Links LCT with views out across the open Moray Firth and along the Highland and Moray Coast a key attractor, particularly due to the very coastal nature of the route and the fact that the hill slopes rise up on its other side. At Lothbeg Bay the landform on the north side of the route becomes more gently sloping and the route passes into a section of Small Farms and Crofts LCT and leaves the immediate coastline for a short section. Thereafter the route returns to snake along, close to the beach until west of Helmsdale, where it leaves the coast and turns north west along Strath Ullie from where it snakes far in land through valleys and out across vast peatlands and crofting landscapes where there are also onshore wind farms visible before returning to the coast at Wick or Thurso.	direction along the coast. The ZTV on Figure 14.7.7c illustrates that there would be theoretical visibility of the Development for much of the route. This is with the exception of the section east of Crakaig, around Lothbeg Point, where visibility is reduced/screened by the intervening landform and actual visibility would be further reduced where the line is in cutting. At Brora the Development would be visible across the sea views from the east round to the east north east whilst at Helmsdale it would be visible across the sea views between east north east round to the east south east. From nearer Brora (Viewpoint 13) the relationship of the Development to BOWL is such that BOWL's influence on the sea views is limited, whilst the layout of the Development is such that it's shorter dimension is closer to this part of the coast with the majority of turbines behind seen behind or to a lesser extent. In the views from near Helmsdale (Viewpoint 12; Navidale) the Development would be seen as an extension of BOWL. Due to the layout of these wind farms their longer dimensions are seen across the views so that together they fill a large part of the sea skyline with the Development making a more pronounced contribution to the wind farm views, than BOWL, due to its larger turbine size and wider spread. The worst case scenario of both the construction and decommissioning will be when large numbers of turbines are in place in addition to	***reversible –*** on the views obtained from the Far North Line from Brora to 1 km east of Crakaig. ***Significant, negative, long term, reversible –*** on the views obtained by passengers on the Far North Line between 1 km east of Crakaig and Helmsdale. **Construction and decommissioning** ***Not significant, negative, short term, reversible –*** on the views obtained from the Far North Line from Brora to 1 km east of Crakaig. ***Significant, negative, short term, reversible –*** on the views obtained by passengers on the Far North between 1 km east of Crakaig and Helmsdale. **Likelihood of effect**

Table 14.7.4: Effect on Views from Rail Lines			
Route	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
	Value of views: medium – high The rail route between Brora and Helmsdale passes through the Loch Fleet, Loch Brora and Glen Loth SLA. This is an area that has a recognised, heightened value due to its local designation within Highland. The rail line passes through this area for a short section where it passes north east of Brora between approximately Kintradwell and Portgower. The Far North Line is promoted as a scenic railway offering views across a range of landscapes as well as interesting stopping points. As such, the value of the views gained from the coastal section of the route is also heightened. **Susceptibility to change: medium** Users of the railway are transient and therefore their appreciation of the views would be shorter and more diverse than for residents. Their purpose for using the railway line may be varied. For example, they may be local, regular travelers. They may be travelling for work or with the sole purpose of getting from one place to another or they may be taking this journey with the expectation of appreciating the scenery along the route. People's attention to the scenery through which they are passing is likely to be varied depending on their purpose. Whilst people visiting the area as tourists are likely to give the views of it a high degree of attention, this does not mean that local people or people working/travelling do not appreciate the scenery of the route's setting, particularly on a beautiful day. The views out to sea are often the focus of views from this section of the Far North Line particularly where the landform restricts visibility inland as occurs for most of the route between Brora Helmsdale. The most susceptible parts of the route are where it passes close to the coast or where the intervening land is at a lower level so that it's influence on views is limited. From these locations the seascape is the key characteristic. **Sensitivity: medium- high**	concentrations of activity in the form of marine vessels and cranes. These activities associated with the Development turbines and OSPs will be distant with the construction of the cable route occurring at even greater distances, beyond the wind farm. **Magnitude of change: low-medium** - on the views obtained from the Far North Line from Brora to 1 km east of Crakaig. **Magnitude of change: medium –** on the views obtained by passengers on the south side of the train traveling along the Far North Line between 1 km east of Crakaig and Helmsdale at a maximum distance from the Development of 32.3 km. This is due to the following factors: visibility of the Development is almost continuous; the extent of the Development, in combination with views of BOWL is across a wide part of the sea views; its proximity to this stretch of the route; and the direction of the Development in relation to the orientation of the route.	Very Good visibility required for the Development to be visible at 28 km to closest turbine.

Night Time Visual Assessment

14.7.3.16 The perimeter turbines of the Development will be lit with medium intensity, flashing lights in accordance with Civil Aviation Authority (CAA) requirements. See Chapters 4: Description of the Development and 13: Aviation and MOD for descriptions of the lighting specifications. As such, there is potential for the Development to be visible at night.

14.7.3.17 The CAA has advised that the lighting of the turbines must take account of Article 223 of the UK ANO and changes to ICAO Annex 14 Volume 1, Chapter 6, paragraph 6.2.4 promulgated in November 2016. This requires that the turbines on the periphery of the group must be fitted with at least one medium intensity (2000 candela), flashing red light as close as reasonably practicable to the top of the fixed structure i.e. the turbine hub. The lights must be fitted so that they show when displayed in all directions without interruption.

14.7.3.18 Night time visual representations have been included in the assessment to predict and assess the possible effect of lighting of the Development. Lighting has been simulated using Resoft Windfarm software. The lighting on the Beatrice Demonstrator Turbines has been used as a basis for the lighting intensity shown with some adjustment for increased or decreased distance. Lights have been placed on the nacelle of the perimeter turbines as identified in Volume 3a - Figure 14.6.2.

14.7.3.19 The photographs have been taken so that where possible the flashing lights are shown 'on'. Existing lights shown in the photographs appear larger and more blurred than those seen to the naked eye. A term which seems to describe this effect is 'Bokeh' which has been defined as "the way the lens renders out-of-focus points of light'. This has proved difficult to avoid when taking photographs of light at varied distances across a view. The blurred nature of the lights is also exacerbated by their movement – particularly on vehicle headlights.

14.7.3.20 Where the lights of BOWL and the Development have been added to the night time views this effect has been emulated. Also seen in the baseline night time views is the Beatrice oil platforms and lighting of the vessels and platforms being used currently to erect the turbines and OSPs. Views of construction vessels are likely to be reduced once BOWL is operational but some may occur during operation.

14.7.3.21 The turbine blades when they intermittently pass in front of the lights would cause additional randomised flickering when the lights are 'on'. The turbines used in the night time visualisations have been positioned so that their blades face away from the viewpoint so that all the lights are visible and on within the visualisations.

14.7.3.22 The flickering effect caused by the blades interacting with the lights would be most usually apparent from a south westerly direction due to the prevailing south westerly wind.

14.7.3.23 The effect of the Development at night is assessed primarily from the viewpoints at Wick, Dunbeath and Navidale as representative locations from settlements and gateway views from the Highland and Moray coast. The assessment of the effects on these viewpoints is set out in Table 14.7.5. In the night time assessment, two potential night time WCS have been visualised and assessed as described in Section 14.6.1. These are the Model 2 layout and the Model 4f layout.

Table 14.7.5: Effect on Night Time Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
Viewpoint 3: Wick (path south of South View) Volume 3b - Figure 14.7.11	The immediate context of the views is the headland out to South Head where there are several buildings, street lights and a mast visible, all emitting light sources. There is also pole mounted lighting seen lower down the cliff face in an area that looks to have been quarried. Lighting by vehicle headlights is also apparent. The rocky coastline is in darkness whilst beyond and out to sea it is possible to see the flashing lights of the Beatrice Demonstrator Turbines and white lights of the associated oil platforms. Further out to sea the lights of the BOWL turbines are visible across approximately 38 degrees of the field of view, however, at this range the seascape remains an intrinsically dark place in contrast with the land. It is evident in the wider views across Wick Bay that is substantially lit by many features associated with the harbour and town of Wick, including lighting around the harbour, boat lighting, street lighting, lighting associated with houses and buildings in Wick and point features such as the lighthouse. The sea within the harbour area reflects the light from these sources, increasing the influence of lighting in the scene. There is a strong contrast between the developed and lit night time landscape around Wick Bay to the right of the view and the distant relatively 'dark' seascape to the left of the panorama. The overall impression of the night time view is of a settled, well-lit industrial	**Operation** The red turbine lights on the hubs of the perimeter turbines of the Development would be visible in the view. The lights would be visible on the skyline extending beyond the headland of the southern part of Wick Bay (South Head). The position of the Development in the view is such that they will introduce more red lights into the section of the sea skyline that lies between South Head and the lights of BOWL. These would initially be seen in the immediate context of the lit oil platforms, which would likely be in existence for part of the operational life of the Development. The turbine lights are at a higher level than these structures indicating their relative scale. The Development would appear as an extension to BOWL. The difference in height of the turbines would not be apparent in this view and there is some apparent clustering where the layouts overlap, although this is not immediately noticeable. The gap in the layout of the Development is apparent as there is a break in the rhythm of the lights across the view. This is more marked in the view of the model 4f layout than in the model 2 layout. The lights of both layouts appear randomly spaced across the view with the slightly lower height and higher density of lights in the model 2 layout noticeable when they are directly compared.	**Operation** ***Not significant, negative, long term, reversible*** **Construction and decommissioning** ***Not significant, negative, short term, reversible***

Table 14.7.5: Effect on Night Time Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
	harbour town in which lighting has a substantial influence on the existing night time view. The night time view from Wick Bay is likely to be experienced by residents on the north side of Wick Bay, around The Shore and Scalesburn, and by fishermen working or returning to Harbour. **Sensitivity to change: medium** This takes into account the slightly lower value and susceptibility levels attributed to such views at night as the seascape is less valued as part of the context of a place and people tend to look out over it less than they do during the day.	The lights of the Development would be likely to appear less intense than those of BOWL and would further reduce in apparent intensity with distance. The prevailing south westerly wind would mean that the lights on the hubs would mostly not be intermittently obscured by intervening blades so that they would not generally appear to flicker. The lights of the Development would also be seen in the context of the extensively lit night time landscape around Wick Bay. The appearance of the red turbine lights will appear substantially diminished in the context of the bright foreground lighting around Wick Bay, due to the long distance of the Development from this location (approximately 32 km to nearest turbine). Although the lighting introduces lights into a section of dark seascape, the lights are not considered to be obtrusive and due to their relatively low position on the distant skyline, do not impede the view of the night sky. The additional lights occupy a relatively small portion of the view in comparison to the existing portion of view which is lit up around Wick and Wick Harbour, however, a greater extent of the sea skyline would have lighting across it. The lights are likely to be viewed with the dark silhouette of the wind turbines and OSPs during the hours around dusk and as point features of light during the darker hours of the night. It is considered that the level of the magnitude of change would not differ for the two layouts. This	

Table 14.7.5: Effect on Night Time Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
		is largely due to similarity of the distance from the viewpoint to the lights and also the horizontal extent of the view they extend across. **Magnitude of change: low** **Construction and decommissioning** During this period the maximum levels of change in the views would be when there are large numbers of vessels and jack-up barges visible in the view, potentially in addition to lit turbines. The light levels and point source nature of these vessels would be similar to those currently constructing BOWL or the oil platforms seen within the view. **Magnitude of change: low**	
Viewpoint 9a: Dunbeath (nr Heritage Centre) Volume 3b - Figure 14.7.17	The view is somewhat channeled out to sea by the landform around Dunbeath Water. The harbour area is not lit but there are street lights adjacent to the residential properties. To the right of the view there are lights from the scattered dwellings and properties on higher ground at the northern edges of Dunbeath as well as street lights. Visibility of the open sea beyond is limited by landform so that a lesser extent is visible than from some coastal areas. The lighting on the Beatrice oil platforms and Beatrice Demonstrator turbines is visible on the horizon. The red CAA lighting on the hubs of the Beatrice demonstrator turbines is visible, with a short flash sequence. The navigational lighting on the	**Operation** The red turbine lights on the hubs of the perimeter turbines of the Development would be visible in the view. The lights would be visible across much of the skyline beyond Dunbeath Bay. The position of the Development in the view is such that they will introduce more red lights into the section of the sea skyline that lies between the lights of BOWL and the near headland. These would initially be seen in the immediate context of the lit oil platforms, which would likely be in existence for part of the operational life of the Development. The turbine lights are at a higher level than these structures indicating their relative scale. The Development would appear as an extension to BOWL. The difference in height of the	**Operation** ***Significant, negative, long term, reversible*** **Construction and decommissioning** ***Significant, negative, short term, reversible***

Table 14.7.5: Effect on Night Time Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
	Beatrice Demonstrator Turbines is not visible from this range (26.23 km). In the more distant part of the sea, and extending out beyond Portormin Head, lights of the BOWL turbines are visible across approximately 26 degrees of the field of view, however, at this range the seascape remains an intrinsically dark place in contrast with the land. The overall impression of the night time view is of a rural landscape with scattered onshore lighting and an intrinsically dark seascape with some offshore lighting. The night time view from Dunbeath is likely to mostly be experienced by residents and travelers on the A9. **Sensitivity to change: medium** This takes into account the slightly lower value and susceptibility levels attributed to such views at night as the seascape is less valued as part of the context of a place and people tend to look out over it less than they do during the day.	turbines would not be immediately apparent and the range of apparent light intensity similar. The prevailing south westerly wind would mean that the lights on the hubs would mostly not be intermittently obscured by intervening blades so that they would not generally appear to flicker. The appearance of the red turbine lights will be of similar intensity to the lights on the Beatrice Demonstrator Turbines, with the effect extended over a larger portion of the sea skyline, such that all of the sea skyline in the view would be occupied by a loose smattering of red turbine lights. The red turbine lights will be substantially diminished due to the distance of the Development offshore (24.8 km- layout 4f). Although the lighting introduces further lights into the seascape, the lights are an extension of an existing light characteristic of the baseline view and due to their relatively low position on the distant skyline, do not impede the view of the night sky. The lights are likely to be viewed with the dark silhouette of the wind turbines during the hours around dusk and as point features of light during the darker hours of the night. It is considered that the level of the magnitude of change would not differ for the two layouts. This is largely due to similarity of the distance from the viewpoint to the lights and also the horizontal extent of the view they extend across. **Magnitude of change: medium**	

Table 14.7.5: Effect on Night Time Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
		Construction and decommissioning During this period the maximum levels of change in the views would be when there are large numbers of vessels and jack-up barges visible in the view, potentially in addition to lit turbines. The light levels and point source nature of these vessels would be similar to those currently constructing BOWL or the oil platforms seen within the view. **Magnitude of change: medium**	
Viewpoint 12: Navidale Volume 3b - Figure 14.7.1	The viewpoint is elevated just over the A9 and the limited settlement that runs along it in this section. The view illustrates a relatively dark location, however there are houses behind and in the wider settled landscape. These have point sources of light as well as emitting light from windows. The light emitted by vehicle headlights on the roads visible is also part of the wider views. The view out to sea is across a low-lying shoreline looking down on an expansive area of sea beyond. The lighting on the Beatrice oil platforms and Beatrice Demonstrator turbines is visible on the horizon. The red CAA lighting on the hubs of the Beatrice demonstrator turbines is visible, with a short flash sequence. The navigational lighting on the Beatrice Demonstrator Turbines is not visible from this range (32.8 km). There are other lights of passing vessels apparent. In the more distant part of the sea, and extending to the north, lights of the BOWL	**Operation** The red turbine lights on the hubs of the perimeter turbines of the Development would be visible in the view. The lights would be visible across much of the sea skyline. The Development would appear as an extension to BOWL and extend lights across the area currently affected by the lights of the Beatrice Demonstrator Turbines and the oil platforms and beyond across an area that is unaffected by static light sources. The lights of the Development would initially be seen in the context of the lit oil platforms, which would likely be in existence for part of the operational life of the Development. The turbine lights are higher than these structures. The difference in height of the turbines of the Development compared to those of BOWL would not be immediately noticeable. The apparent intensity of the lights would be slightly stronger	**Operation** ***Significant, negative, long term, reversible*** **Construction and decommissioning** ***Significant, negative, short term, reversible***

Table 14.7.5: Effect on Night Time Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
	turbines are visible across approximately 17 degrees of the field of view, however, at this range the seascape remains an intrinsically dark place. The overall impression of the night time view is of a rural landscape with scattered onshore lighting and vehicles and an intrinsically dark seascape with some offshore lighting. Such views would be obtained by the residents within the nearby houses and settlements and by travelers on the A9 and minor roads within the area. **Sensitivity to change: medium** This takes into account the slightly lower value and susceptibility levels attributed to such views at night as the seascape is less valued as part of the context of a place and people tend to look out over it less than they do during the day.	than those of BOWL due to the closer range of the Development at 26.7 km (model 4f layout). The lights of both the model 2 and model 4f layouts appear randomly spaced across the view with the slightly lower height and higher density of lights in the model 2 layout noticeable when they are directly compared. The prevailing south westerly wind would mean that the lights on the hubs would mostly be intermittently obscured by intervening blades so that they would generally appear to flicker slightly. The appearance of the red turbine lights will be of similar intensity to the lights on the Beatrice Demonstrator Turbines, with the effect extended over a larger portion of the sea skyline, such that a large proportion of the sea skyline in the view would be occupied by a loose smattering of red turbine lights. The red turbine lights will be substantially diminished due to the distance of the Development offshore. Although the lighting introduces further lights into the seascape, the lights are an extension/increase in intensity of an existing light characteristic of the baseline view and due to their relatively low position on the distant skyline, do not impede the view of the night sky. The lights are likely to be viewed with the dark silhouette of the wind turbines during the hours around dusk and as point features of light during the darker hours of the night.	

Table 14.7.5: Effect on Night Time Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
		It is considered that the level of the magnitude of change would not differ for the two layouts. This is largely due to similarity of the distance from the viewpoint to the lights and also the horizontal extent of the view they extend across. ***Magnitude of change: medium*** **Construction and decommissioning** During this period the maximum levels of change in the views would be when there are large numbers of vessels and jack-up barges visible in the view, potentially in addition to lit turbines. The light levels and point source nature of these vessels would be similar to those currently constructing BOWL or the oil platforms seen within the view. ***Magnitude of change: medium***	
Viewpoint 16: Lossiemouth Harbour Volume 3b - Figure 14.7.26	The night time view from Lossiemouth is out across the open sea which extends across almost 180 degrees. It contains some navigational markers with flashing lights as well as the passing lights of vessels. The lighting along the coast and around the harbour is emitted by point sources of outdoor lights mounted on buildings as well as street lights. Light is also emitted from the windows of buildings and by the headlights of passing cars. The harbour itself has areas of darkness over the water and large hard standings as well as buildings in darkness. The susceptibility of residents, visitors or road users within Lossiemouth to night time views is	**Operation** The red turbine lights on the hubs of the perimeter turbines of the Development would be visible in the view. The lights would be visible above a relatively narrow part of the wide sea view (22.4 degrees). The prevailing south westerly wind would mean that the lights on the hubs would mostly be intermittently obscured by intervening blades so that they may appear to flicker slightly. The red turbine lights will be substantially diminished due to the distance of the Development offshore (31.7 km – Model 4f layout). This would increase with distance with the turbines on the far perimeter appearing	**Operation** ***Not significant, negative, long term, reversible*** **Construction and decommissioning** ***Not significant, negative, short term, reversible***

Table 14.7.5: Effect on Night Time Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
	lower than during the day since the draw of the open sea views is reduced. The darkness of the sea from the lit coastline does provide contrast and dark skies for clearer viewing the night sky, which may be valued. **Sensitivity to change: medium** This takes into account the slightly lower value and susceptibility levels attributed to such views at night as the seascape is less valued as part of the context of a place and people tend to look out over it less than they do during the day.	lower above the skyline and often much less intense than those nearer. The lights of both the model 2 and model 4f layouts appear randomly spaced across the view with the slightly lower height and higher density of lights in the model 2 layout noticeable when they are directly compared. Some of the lights of the most distant turbines in the Model 2 layout view would appear close to or on the distant horizon (when it is also visible). The perimeter turbine lighting introduces static light sources into a wide seascape which otherwise has few the lights and is a large expanse of darkness. Due to their relatively low position on the distant skyline, the lights do not impede the view of the night sky. The lights of the Development would be seen at a great distance so that the lit point sources would appear very small. Whilst they may be apparent in clear atmospheric conditions they would not be sufficiently prominent to materially diminish the otherwise dark seascape. The lights are likely to be viewed with the dark silhouette of the wind turbines during the hours around dusk and as point features of light during the darker hours of the night. It is considered that the level of the magnitude of change would not differ for the two layouts. This is largely due to similarity of the distance from the viewpoint to the lights and also the horizontal extent of the view they extend across.	

Table 14.7.5: Effect on Night Time Viewpoints			
Viewpoint	**Baseline Condition and Sensitivity**	**Magnitude of Change**	**Significance of Effect**
		Magnitude of change: medium- low **Construction and decommissioning** During this period the maximum levels of change in the views would be when there are large numbers of vessels and jack-up barges visible in the view, potentially in addition to lit turbines. ***Magnitude of change: medium-low***	

Summary of Night Time Effects

14.7.3.24 The effect of the Development at night results from the red CAA lighting located on the nacelle of turbines on the peripheral turbines of the Model 4f and Model 2 WCS layouts. The effect of the Development is assessed as not significant from Viewpoint 3: Wick (south of South View) and not significant from Viewpoint 16: Lossiemouth. Significant night time effects have been identified at Viewpoint 9a: Dunbeath and Viewpoint 12: Navidale. The effect on the views from Wick Bay and Lossiemouth are assessed as not significant largely due to the long distance and low intensity of the lights at this range and the existing lit environment around the viewpoints.

14.7.3.25 The significant effects on the views from Dunbeath and Navidale are largely due to the relatively dark coastal landscape and sea skyline in the existing views from these locations views, combined with the proximity and horizontal spread of the Development which will extend the effect of offshore lighting over a substantial proportion of the sea skyline in the view. Such a finding corresponds with the findings of the daytime assessment. It is considered that significant effects of the Development at night are limited in extent, concentrated to the coastal areas between Wick and Navidale, in areas where the baseline views are intrinsically dark but also often contain widespread visibility of the BOWL lights. Such views may be obtained relatively frequently by local people, visitors and motorists as they travel along this section of the coast.

14.7.3.26 In general, lighting is a secondary effect of the Development. Where the effects have been assessed as not significant during the day, when the wind turbines are fully visible, they would not have significant effects at night as a result of lighting, when the wind turbines are not visible. Due to the slightly lower levels of sensitivity at night/dusk locations the distance from, and extent of, views affected by the Development may be slightly higher before the threshold for significant effects is triggered.

14.7.3.27 The duration of the effect of the lights on receptors is likely to be over a relatively short period, more commonly experienced during evening and morning hours of darkness, around dusk and sunrise. The visual effects of the Development at night are also limited by the activity of receptors at night. Receptors that experience views at night are generally limited to residents of settlements, rural properties and motorists using the road network. Views from within properties are likely to be restricted by the use of window coverings, particularly in winter. Views from remote rural / coastal locations, beaches, mountains and footpaths etc. are visited infrequently at night.

14.7.3.28 The assessment of night time effects is also based on clear night time viewing conditions. At dusk and sunrise it may be possible to identify the formation of the turbines with the red CAA lighting, but only in conditions of good and excellent visibility.

14.7.3.29 At sunrise it may also be possible, in views from the west, to see the turbines lit and backlit by the rising sun.

14.7.4 Landscape / Seascape Character Effects

14.7.4.1 The landscape / seascape character effects of the Development are assessed in this section. The change resulting from the Development to the landscape / seascape resource is assessed during construction, operation and decommissioning stages.

14.7.4.2 Effects on landscape / seascape character are manifested where the pattern of elements that characterises the landscape / seascape will be altered by the addition of the Development to the seascape and where visibility of the Development may alter the way in which this pattern of elements is perceived.

14.7.4.3 Landscape / seascape character receptors fall into three groups:

- Landscape Character Types (LCTs) (as defined by SNH Terrestrial LCAs);
- Regional Coastal Character Areas (RCCAs) (as defined by coastal character assessment); and

- Landscape designations e.g. SLAs, NSAs.

14.7.4.4 The assessment for each of these groups is described in the following sections of this chapter.

Landscape Character Types

14.7.4.5 The first group of receptors covered in the assessment of effects on landscape / seascape character are the terrestrial landscape character types, shown in Volume 3a - Figure 14.4.4 and in conjunction with the ZTV in Volume 3a - Figure 14.7.4. The assessment considers the likely significant effects of the Development on the LCTs in the Study Area.

14.7.4.6 A preliminary assessment was carried out through a desk study and site survey which examined the characteristics of the LCTs and the visibility of the Development using the ZTV and wirelines. This initial assessment has identified which LCTs within the Study Area may be subject to significant effects through the introduction of the Development and therefore require to be considered in more detail.

14.7.4.7 The preliminary assessment of the effects of the Development on the character of the LCTs has identified that significant effects on landscape character may arise within the LCTs included in Table 14.7.6 below and where they are located within the Study Area to the north and east of the River/Strath Brora and south of Sarclet Head. The baseline characteristics of these Landscape Character Receptors are described in Volume 4 - Technical Appendix 14.2: Baseline Landscape Character, Table 2.1. This assessment has taken account of relevant aspects of the THC (2017) Landscape Sensitivity Appraisal: Caithness.

Table 14.7.6: Effect on Character of LCTs

LCT	Baseline Sensitivity	Magnitude of Change	Significance of Effect
Sweeping Moorland - 25	**Value – Medium-high within SLA areas medium elsewhere** Parts of the inland areas of the Sweeping Moorland LCT are designated as part of the Berriedale and Flow Country SLA with further and corresponding inland areas contained within the Causeymire, Knockfin Flows WLA indicating their higher recognised value. The condition and quality of parts of the LCT is reduced through the influence of coniferous forestry plantations and infrastructure, pylon lines and wind turbines.	**Operation, construction and decommissioning** The Development would not alter the character of the LCT through physical change to it but through changing views within its wider context from within it. This may indirectly change the way in which the pattern of elements in the LCT is perceived. The Development would be seen as an extension to BOWL apparent out in the open sea and separated from the LCT by an expanse of sea. The ZTV on Figure 14.7.4 illustrates that it is theoretically possible to gain views of up to 62 turbines from limited parts of the LCT. The seaward facing slopes are shown to have widespread theoretical visibility although this is restricted in places due to intervening landform. Further inland it is the hill tops and south east and east facing hill slopes of the moorland hills located near to the lone mountains that would gain visibility at distances of over 35 km. It is not anticipated that these hills will be well visited with game keepers and deer stalkers being the most likely receptors.	**Operation** **Not-significant, negative, long term, reversible –** on the character of the Sweeping Moorland LCT. **Construction and decommissioning** ***Not significant, negative, short term, reversible*** – on the character of the Sweeping Moorland LCT.

Table 14.7.6: Effect on Character of LCTs			
LCT	**Baseline Sensitivity**	**Magnitude of Change**	**Significance of Effect**
	Qualities of perceived wildness are reduced near the coast due to the visibility of the settled coast and BOWL in the sea beyond. **Susceptibility to change –medium** Landscape is most influenced by other adjoining landscapes rather than the sea which is set beyond the intervening settled coast, moorland hills or forestry. BOWL, Beatrice Demonstrator Turbines/Oil Platforms and onshore wind farms visible as part of the baseline views. **Sensitivity- medium- high in SLA, medium elsewhere.**	These areas are separated from the Development by intervening landscape of varied character influences, including the A9, considerable level changes and an extensive area of open sea. The Development would add further wind farm development to the sea horizon across less than 60 degrees of the field of view in the part of the views that are currently partially affected by the Beatrice Demonstrator Turbines and the associated oil platforms. The worst case scenario of both the construction and decommissioning will be when large numbers of turbines are in place in addition to concentrations of activity in the form of marine vessels and cranes. These activities associated with the Development will be distant with the construction of the cable route occurring at even greater distances, beyond the wind farm. **Magnitude of change – medium-low** on areas within 30-35 km of the Development. Low or negligible elsewhere.	
Small Farms and Crofts - 23 Viewpoints 5: Sarclet, 6: Minor Road South of Osclay, 7: Lybster, 8: Latheron, 9 a and b: Dunbeath,	**Value – medium overall** A very small extent of this LCT at Berriedale is designated as part of the Berriedale and Knockfin Flows SLA. The Dunbeath Castle GDL is located within this LCT. It is relatively small and has a localised effect on the quality of this landscape. The relatively high numbers of people that live scattered across this LCT are likely to consider it to be of local value as the setting to their dwellings. The effect on their views is considered in the visual assessment.	**Operation, construction and decommissioning** The Development would not alter the character of the LCT through physical change to it but through changing views within its wider context. This may indirectly change the way in which the pattern of elements in the LCT is perceived. The Development would be seen as an extension to BOWL apparent out in the open sea and separated from the LCT by an expanse of sea of more than 22.6 km. The close range views of the coast (where possible) and opportunities for interaction with the sea would not be altered. The Development would not affect the activity and sounds of the waves and wildlife characteristic at the coast. The characteristic views along the coast would not be affected by the Development. Coastal light may influence clarity of views to the Development, whilst characteristic strong winds provide a rationale for offshore wind farm development. The ZTV on Figure 14.7.4 illustrates that it is theoretically possible to gain views of up to 62 turbines from limited parts of the LCT.	**Operation** **Significant, negative, long term, reversible –**on the character of the Small Farms and Crofts LCT where it lies between Berriedale and Sarclet Head and the coast and the A9/A99. **Not-significant, negative, long term, reversible –** elsewhere on the character of the Small Farms and Crofts LCT.

Table 14.7.6: Effect on Character of LCTs			
LCT	**Baseline Sensitivity**	**Magnitude of Change**	**Significance of Effect**
11: Berriedale	The LCT is not particularly scenic although as seen in the various viewpoint the views out to sea and along the coast offer attractive views. **Susceptibility to change –medium** Seascape / coastal characteristics have external influence on character. Development seen as part of sea views and as an extension of BOWL at a range of 22.6 km. Visibility of Development may increase visual complexity and influence the perception of land division and human scale at the coastal edge, but also relates to the characteristic activity and development. Character influenced by development components including Burn of Whilk wind farm. **Sensitivity - medium**	The gently sloping seaward facing slopes are shown to have widespread theoretical visibility although this is restricted in places due to intervening landform and buildings/vegetation. The Development would add further wind farm development to the sea horizon across less than 60 degrees of the field of view in the part of the views that are currently partially affected by the Beatrice Demonstrator Turbines and the associated oil platforms. The interaction of the views of the turbines as a backdrop to the settled landscape may create some odd juxtapositions and scale comparisons. The worst case scenario of both the construction and decommissioning will be when large numbers of turbines are in place in addition to concentrations of activity in the form of marine vessels and cranes. These activities associated with the Development turbines and OSPs will be distant with the construction of the cable route occurring at even greater distances, beyond the wind farm. **Magnitude of change – medium** on the small farms and crofts LCT between Berriedale and Sarclet Head and between the coast and approximately the A9. **Medium-low** elsewhere.	**Construction and decommissioning** **Significant, negative, short term, reversible** –on the character of the Small Farms and Crofts LCT where it lies between Berriedale and Sarclet Head and the coast and the A9. ***Not significant, negative, short term, reversible*** – elsewhere on the character of the Small Farms and Crofts LCT.
Moorland Slopes and Hills - 18	**Value – medium-high** Partly located in the Flow Country and Berriedale Coast SLA, the Loch Fleet, Loch Brora and Glen Loth SLA and the Causeymire-Knockfin Flows WLA. **Susceptibility to change – medium-low** Seascape / coastal characteristics have external influence on character. Visibility of the Development may change	**Operation, construction and decommissioning** The Development would not alter the character of the LCT through physical change to it but through changing views within its wider context. This may indirectly change the way in which the pattern of elements in the LCT is perceived. The Development would be seen as an extension to BOWL apparent out in the open sea and separated from the LCT by an expanse of sea of more than 22.8 km. The ZTV on Figure 14.7.4 illustrates that it is theoretically possible to gain views of up to 62 turbines from limited parts of the LCT. The highest levels of theoretical visibility are across the seaward facing slopes and hills.	**Operation** **Significant, negative, long term, reversible –** on the character of the Moorland Hills and slopes in the vicinity of Badbea and the south east facing slopes of Cnoc na Croiche.

Table 14.7.6: Effect on Character of LCTs			
LCT	**Baseline Sensitivity**	**Magnitude of Change**	**Significance of Effect**
	perception of scale and add visual foci, but may also relate to the sense of exposure and broad scale of the landscape. **Sensitivity - medium**	The Development would add further wind farm development to the sea horizon across generally less than 50 degrees of the field of view in the part of the views that are currently partially affected by the Beatrice Demonstrator Turbines and the associated oil platforms. Orientation of landform generally prevents views of the coastline, but allows distant views of the Development out at sea. Large scale and simplicity of landscape is able to accommodate change in contextual views created by the Development without being materially altered. The worst case scenario of both the construction and decommissioning will be when large numbers of turbines are in place in addition to concentrations of activity in the form of marine vessels and cranes. These activities associated with the Development turbines and OSPs will be distant with the construction of the cable route occurring at even greater distances, beyond the wind farm. **Magnitude of change – medium** in the vicinity of Badbea and the south east facing slopes of Cnoc na Croiche, **medium-low elsewhere within the LCT.**	**Not-significant, negative, long term, reversible –** on the character of the other areas of the Moorland Slopes and Hills LCT. **Construction and decommissioning** **Significant, negative, short term, reversible –** on the character of the Moorland Hills and slopes in the vicinity of Badbea and the south east facing slopes of Cnoc na Croiche. ***Not significant, negative, short term, reversible*** – on the character of the other areas of the Moorland Slopes and Hills LCT.
Coastal Shelf - 6 Viewpoint 12: Navidale	**Value – medium-high in SLA, medium elsewhere** Coastal strip between Kintradwell and Portgower located in the Loch Fleet, Loch Brora and Glen Loth SLA. **Susceptibility to change – medium** Seascape / coastal characteristics have a defining influence on character.	**Operation, construction and decommissioning** The Development would not alter the character of the LCT through physical change to it but through changing views within its wider context. This may indirectly change the way in which the pattern of elements in the LCT is perceived. The Development would be seen as an extension to BOWL apparent out in the open sea and separated from the LCT by an expanse of sea of more than 24.6 km. The ZTV on Figure 14.7.4 illustrates that it is theoretically possible to gain views of up to 62 turbines from the majority of the LCT, except for at Ousdale and across areas at Kilmote and south of Crakaig.	**Operation** **Not-significant, negative, long term, reversible –** on the character of the Coastal Shelf LCT. **Construction and decommissioning** ***Not significant, negative, short term, reversible*** – on

Table 14.7.6: Effect on Character of LCTs			
LCT	**Baseline Sensitivity**	**Magnitude of Change**	**Significance of Effect**
	Visibility of the Development may change the way in which land / sea edge is perceived and the direct relationship of the sea with the coastal shelf, but may also relate to the sense of exposure and linear land use pattern. **Sensitivity: medium-high in SLA, medium elsewhere**	The highest levels and most consistent areas of theoretical visibility are across the seaward facing slopes and across the low lying areas where landform allows. The Development would add further wind farm development to the sea horizon across less than 50 degrees of the field of view in the part of the views that are currently partially affected by the Beatrice Demonstrator Turbines and the associated oil platforms. Elevated platform and enclosure by inland hills directs views to the Development out to sea which will include a skyline of offshore wind turbines, however the Development would be set back from the coast so that the views of the Caithness coast itself from the various routes that run through this type would not be changed. The worst case scenario of both the construction and decommissioning will be when large numbers of turbines are in place in addition to concentrations of activity in the form of marine vessels and cranes. These activities associated with the Development turbines and OSPs will be distant with the construction of the cable route occurring at even greater distances, beyond the wind farm. **Magnitude of change – medium-low**	the character of the Coastal Shelf LCT.
Coastal High Cliffs and Sheltered Bays - 11	**Value – medium- high in SLA, medium elsewhere** LCT area between Berriedale and The Needle is part of Flow Country and Berriedale Coast SLA. **Susceptibility to change – medium** Seascape / coastal characteristics have a defining influence on character. Visibility of the Development may change the way in which land / sea edge is perceived and the sense of exposure and perceived remoteness.	**Operation, construction and decommissioning** The Development would not alter the character of the LCT through physical change to it but through changing views within its wider context. This may indirectly change the way in which the pattern of elements in the LCT is perceived. The Development would be seen as an extension to BOWL apparent out in the open sea and separated from the LCT by an expanse of sea of more than 22.7 km. The ZTV on Figure 14.7.4 illustrates that it is theoretically possible to gain views of up to 62 turbines from the majority of the LCT, except for small patches where cliffs and steep slopes shield views from localised locations. The Development would add further wind farm development to the sea horizon across less than 50 degrees of the field of view in the part of the views that are currently	**Operation** **Significant, negative, long term, reversible –** on the character of the Coastal High Cliffs and Sheltered Bays LCT. **Construction and decommissioning** ***Significant, negative, short term, reversible*** – on the character of the Coastal High Cliffs and Sheltered Bays LCT.

Table 14.7.6: Effect on Character of LCTs			
LCT	**Baseline Sensitivity**	**Magnitude of Change**	**Significance of Effect**
	Sensitivity – medium- high in SLA, medium elsewhere	partially affected by the Beatrice Demonstrator Turbines and the associated oil platforms. The Development would form a new but visually separate focus out to sea, in addition to the stacks, caves and collapsed cliffs views along coast. The LCT would retain its exposed character. Perception of the character is experienced infrequently due to the limited access to the cliffs, gained mainly by walkers on foot. The worst case scenario of both the construction and decommissioning will be when large numbers of turbines are in place in addition to concentrations of activity in the form of marine vessels and cranes. These activities associated with the Development turbines and OSPs will be distant with the construction of the cable route occurring at even greater distances, beyond the wind farm. **Magnitude of change – medium**	
Long Beaches Dunes and Links	**Value – medium-high between Kintradwell and south of Lothbeg, medium around Brora and** The sections of the LCT between Kintradwell and Lothbeg Point lie within the Loch Fleet, Loch Brora and Glen Loth SLA. **Susceptibility to change – medium** Seascape / coastal characteristics have a defining influence on character. Visibility of the Development may change simple visual composition of low lying bays, but may also relate to the sense of exposure and existing offshore influences. **Sensitivity- medium-high in SLA, medium elsewhere**	**Operation, construction and decommissioning** The Development would not alter the character of the LCT through physical change to it but through changing views within its wider context. This may indirectly change the way in which the pattern of elements in the LCT is perceived. The Development would be seen as an extension of the more distant BOWL apparent out in the open sea and separated from the LCT by an expanse of sea of more than 33 km. The ZTV on Figure 14.7.4 illustrates that it is theoretically possible to gain views of up to 62 turbines from the majority of the LCT, except for an area around Lothbeg where the landform screens visibility. The Development would add further wind farm development to the wide sea horizon across less than 30 degrees of the field of view in the part of the views that are currently partially affected by the Beatrice Demonstrator Turbines and the associated oil platforms. Much of the expansive open sea view would be retained.	**Operation** **Not-significant, negative, long term, reversible –** on the character of the Long Beaches and Dunes LCT. **Construction and decommissioning** ***Not significant, negative, short term, reversible*** – on the character of the Long Beaches and Dunes LCT.

Table 14.7.6: Effect on Character of LCTs			
LCT	**Baseline Sensitivity**	**Magnitude of Change**	**Significance of Effect**
		The views along the beach and dunes would not be affected by the Development. It would retain its exposed character. The direct interaction of the waves with the beach would not be altered. The Development would not affect the characteristics of the soft linear edge to the coast of this LCT. The worst case scenario of both the construction and decommissioning will be when large numbers of turbines are in place in addition to concentrations of activity in the form of marine vessels and cranes. These activities associated with the Development turbines and OSPs will be distant with the construction of the cable route occurring at even greater distances, beyond the wind farm. **Magnitude of change – low**	

Regional Coastal Character Areas

14.7.4.8 The second group of receptors covered in the assessment of effects on landscape / seascape character are the Regional Coastal Character Areas, shown in Volume 3a - Figure 14.4.6 and in conjunction with the ZTV in Volume 3a - Figure 14.7.5a-f. The assessment considers the likely significant effects of the Development on the Regional Coastal Character Areas in the Study Area.

14.7.4.9 A preliminary assessment was carried out through a desk study and site survey which examined the characteristics of the Regional Coastal Character Areas and the visibility of the Development using the ZTV and wirelines. This initial assessment has identified which Regional Coastal Character Areas within the Study Area may be subject to significant effects through the introduction of the Development and therefore require to be considered in more detail.

14.7.4.10 The preliminary assessment of the effects of the Development on the character of the Regional Coastal Character Areas has identified that significant effects on landscape character may arise within those included in Table 14.7.7 below. The baseline characteristics of these Landscape Character Receptors are described in Volume 4 - Technical Appendix 14.2: Baseline Landscape Character, Table 3.1. This assessment has taken account of relevant aspects of the THC (2017) Landscape Sensitivity Appraisal: Caithness and has drawn upon the coastal characterisation set out in the Moray East ES (2012).

Table 14.7.7: Effect on Character of Regional Coastal Character Areas			
Regional Coastal Character Area	**Baseline Sensitivity**	**Magnitude of Change**	**Significance of Effect**
Sarclet Head - G Viewpoint 4: Sarclet and Viewpoint 5: Whaligoe Steps	**Value – medium** The RCCA does not lie within or look over any landscapes covered by a landscape planning designation. **Susceptibility to change - medium** Visibility of the Development may increase visual complexity and influence the perception of land division and human scale at the coastal edge, but may also relate to the sense of exposure and characteristic activity of people which has shaped the landscape. Existing views include on and offshore wind farms, which both increase and decrease factors of susceptibility to further offshore wind farm influence. The RCCA is located some 23.4 km from the Development and would affect views rather than physically altering it. **Sensitivity – medium**	**Operation, construction and decommissioning** Closest section of Caithness coastline is located approximately 23.4 km from the Development. Figure 14.7.5c illustrates the theoretical visibility of the Development from the majority of coastal edge and hinterland. The characteristics and scale of the Development would be an external influence on areas that lie adjacent to the coast. Development would be seen as an extension to BOWL across less than 60 degrees of the wide sea views and in the views south east round to the south. East south east/south east orientation of coast and linear plots aligned out to sea and the closer proximity of BOWL means it would be more prominent with the larger turbines of the Development seen across the more distant seascape at an oblique angle to the coast but more aligned with the direction of travel along routes inland. Turbines would not affect the appreciation of the physical influences which shape the coastal edge, but add to the wind farm seascape as a visually separate focus at a distance out to sea. Large parts of the sea horizon would remain free of wind farm development, however the Development is likely to become a prevailing influence on views out of the RCCA from south west of Sarclet Head. Clear light is likely to increase the perceived effect of the Development. The Development could relate well to the expansiveness and exposure of the open sea. Development would introduce collection of vertical features, but distance offshore reduces vertical impact and wide footprint of site relates to existing horizontal emphasis. The worst case scenario of both the construction and decommissioning will be when large numbers of turbines are in place in addition to concentrations of activity in the form of marine vessels and cranes. These activities associated with the Development turbines and OSPs will be distant with the construction of the cable route occurring at even greater distances, beyond the wind farm. **Magnitude of change – medium** south of Sarclet. **Medium- low or lower** elsewhere.	**Operation** ***Significant, negative, long term, reversible –*** on the character of the Sarclet Head RCCA to the south west of Sarclet Head itself. ***Not significant, negative, long term, reversible –*** on the character of the Sarclet Head RCCA to the north east of Sarclet Head itself. **Construction and decommissioning** ***Significant, negative, short term, reversible*** - on the character of the Sarclet Head RCCA to the south west of Sarclet Head itself. ***Not significant, negative, short term, reversible –*** on the character of the Sarclet Head RCCA to the north east of Sarclet Head itself.

Table 14.7.7: Effect on Character of Regional Coastal Character Areas			
Regional Coastal Character Area	**Baseline Sensitivity**	**Magnitude of Change**	**Significance of Effect**
Lybster Bay - H Viewpoint 7: Lybster	**Value – medium** The RCCA does not lie within or look over any landscapes covered by a landscape planning designation. **Susceptibility to change – medium** Visibility of the Development may change visual focus of bay and the way in which land / sea edge is perceived, the impression of scale and visual foci, but may also relate to the sense of exposure and sea based activity. Existing views include on and offshore wind farms, which both increase and decrease factors of susceptibility to further offshore wind farm influence. The RCCA is located some 24 km from the Development and would affect views rather than physically altering it. **Sensitivity – medium**	**Operation, construction and decommissioning** Closest section of Caithness coastline is located approximately 24 km from the Development. Figure 14.7.5c illustrates the theoretical visibility of the Development from the majority of coastal edge and hinterland. The characteristics and scale of the Development would be an external influence on areas that lie adjacent to the coast. Development would be seen as an extension to BOWL across less than 60 degrees of the wide sea views and in the views south east round to south. Some localised enclosure/screening provided in small bays and incised coastal features. Southerly orientation of coast likely to increase the effect of the Development which is aligned with the main orientation of the pattern and features of the landscape. This is with the exception of the A99, which runs along the coast. Turbines would not affect the appreciation of the physical influences which shape the coastal edge, but add to the wind farm seascape as a visually separate focus at a distance out to sea. The characteristics and scale of the Development could relate well to the expansiveness and exposure of the open sea. Character is experienced frequently from main road and settlements along the coastal edge. Views of Development as part of distant offshore wind farm seascape on skyline would reinforce this as a characteristic element of the wider context to the RCCA becoming a prevailing characteristic. However, other characteristics, such as this being a local, shallowly concave bay with fishing villages amongst rocky coastline will continue to provide other prevailing characteristics. The worst case scenario of both the construction and decommissioning will be when large numbers of turbines are in place in addition to concentrations of activity in the form of marine vessels and cranes. These activities associated with the Development turbines and OSPs will be distant with the construction of the cable route occurring at even greater distances, beyond the wind farm. **Magnitude of change: medium**	**Operation** ***Significant, negative, long term, reversible*** **Construction and decommissioning** ***Significant, negative, short term, reversible***

Table 14.7.7: Effect on Character of Regional Coastal Character Areas			
Regional Coastal Character Area	**Baseline Sensitivity**	**Magnitude of Change**	**Significance of Effect**
Dunbeath Bay - I Viewpoints 8: Latheron, 9a and b: Dunbeath and 11: Berrydale.	**Value – medium overall** A very small extent to the south of this RCCA at Berriedale is designated as part of the Berriedale and Knockfin Flows SLA. The Dunbeath Castle GDL is located along this RCCA. It is relatively small and has a localised effect on the quality of this landscape, with the Castle a notable feature in views across Dunbeath Bay. **Susceptibility to change – medium** Visibility of the Development may change visual focus of bay and the way in which land / sea edge is perceived, the impression of scale and visual foci, but may also relate to the sense of exposure and sea based activity. Existing views include on and offshore wind farms, which both increase and decrease factors of susceptibility to further offshore wind farm influence.	**Operation, construction and decommissioning** Closest section of Caithness coastline is located approximately 22.5 km from the Development. Figure 14.7.5c illustrates the theoretical visibility of the Development from the majority of coastal edge and hinterland. The characteristics and scale of the Development would be an external influence on areas that lie adjacent to the coast. Development would be seen as an extension to BOWL across less than 60 degrees of the wide sea views and in the views south east round to south. Some localised enclosure provided in small bays and incised coastal features would reduce visibility. South east orientation of coast and land division of linear plots aligned out to sea likely to increase effect of Development. Large parts of the open sea views to the south would remain open. Turbines would not affect the appreciation of the physical influences which shape the coastal edge, but add to the wind farm seascape as a visually separate focus at a distance out to sea. The characteristics and scale of the Development could relate well to the expansiveness and exposure of the open sea. Character is experienced frequently from main road and settlements along the coastal edge. Views of Development as part of distant offshore wind farm seascape on skyline would reinforce this as a characteristic element of the wider context to the RCCA becoming a prevailing characteristic. However, other characteristics, such as this being a broad, rocky, concave bay with strong fishing and cultural interest will continue to provide other prevailing characteristics. The worst case scenario of both the construction and decommissioning will be when large numbers of turbines are in place in addition to concentrations of activity in the form of marine vessels and cranes. These activities associated with the Development turbines and OSPs will be distant with the construction of the cable route occurring at even greater distances, beyond the wind farm.	**Operation** ***Significant, negative, long term, reversible*** **Construction and decommissioning** ***Significant, negative, short term, reversible***

Table 14.7.7: Effect on Character of Regional Coastal Character Areas			
Regional Coastal Character Area	**Baseline Sensitivity**	**Magnitude of Change**	**Significance of Effect**
	The RCCA is located some 22.5 km from the Development and would affect views rather than physically altering it. **Sensitivity - medium**	**Magnitude of change: medium**	
Helmsdale to Berriedale Coastal Shelf - J Viewpoint 12: Navidale	**Value – medium - high** The northern section of this RCCA between Berriedale and Badbea is designated as part of the Berriedale and Knockfin Flows SLA. **Susceptibility to change – medium** Visibility of the Development may change the way in which land / sea edge is perceived and the direct relationship of the sea with the coastal shelf, but may also relate to the sense of exposure, linear land use pattern and energy transmission features. Existing views include offshore wind farms, which both increase and decrease factors of susceptibility to further offshore wind farm influence.	**Operation, construction and decommissioning** Closest section of Caithness coastline is located approximately 22.6 km from the Development. Figure 14.7.5d illustrates the theoretical visibility of the Development from the majority of coastal edge and hinterland. Some localised enclosure provided in small bays and incised coastal features. Bay at Helmsdale is orientated south. The characteristics and scale of the Development would be an external influence on areas that lie adjacent to the coast. Development would be seen as an extension to BOWL across less than 50 degrees of the wide sea views and in the views south east round to south. Narrow character of coastline restricts visibility of the Development to narrow stretch at the immediate coastal edge. Exposure of coastline and direct relationship with the sea, with views inland screened by steep hills, increases the perceived effect of the Development. Turbines would not affect the appreciation of the physical influences which shape the coastal edge, but add to the wind farm seascape as a visually separate focus at a distance out to sea. The Development is likely to have an external influence due to direct relationship of the coastal shelf with the adjacent open sea. Perception of the character is experienced infrequently due to the limited access to the cliffs, gained mainly by walkers and visitors to the deserted village of Badbea. Views of Development as part of distant offshore wind farm seascape on skyline would reinforce this as a characteristic element of the wider context to the RCCA becoming a prevailing characteristic. However, other characteristics, such as the linear coastal shelf	**Operation** ***Significant, negative, long term, reversible –*** to the north east of Helmsdale. ***Not -significant, negative, long term, reversible –*** elsewhere within this RCCA. **Construction and decommissioning** ***Significant, negative, short term, reversible*** – to the north east of Helmsdale. ***Not -significant, negative, short term, reversible –*** elsewhere within this RCCA.

Table 14.7.7: Effect on Character of Regional Coastal Character Areas

Regional Coastal Character Area	Baseline Sensitivity	Magnitude of Change	Significance of Effect
	The RCCA is located some 22.6 km from the Development and would affect views rather than physically altering it. **Sensitivity: medium-high**	constricted by inland hills and open sea will continue to provide other prevailing characteristics. Large parts of the open sea views to the south would remain open, and this would particularly be the case to the south of Helmsdale. The worst case scenario of both the construction and decommissioning will be when large numbers of turbines are in place in addition to concentrations of activity in the form of marine vessels and cranes. These activities associated with the Development turbines and OSPs will be distant with the construction of the cable route occurring at even greater distances, beyond the wind farm. **Magnitude of change: medium** to the north east of Helmsdale. **Medium-low** elsewhere.	
Brora to Helmsdale Deposition Coast - K Viewpoint 13: Brora	**Value – medium - high** The section of the RCCA between Portgower in the north east and Kintradwell in the south west is located within the Loch Fleet, Loch Brora and Glen Loth SLA. **Susceptibility to change – medium** Visibility of the Development may change the way in which land / sea edge is perceived and the direct relationship of the sea with the coastal shelf, but may also relate to the sense of exposure and linear land use pattern and energy transmission features.	**Operation, construction and decommissioning** Closest section of Caithness coastline is located approximately 29 km from the Development. Figure 14.7.5d illustrates the theoretical visibility of the Development from the majority of coastal edge and hinterland. However, there is some screening provided by landform between Lothbeg and West Garty so that visibility is not continuous. The characteristics and scale of the Development would be an external influence on areas that lie adjacent to the coast. Development would be seen as an extension to BOWL across less than 30 degrees of the wide sea views and in the views south east round to south, although with distance, BOWL becomes less apparent. Elevated platform and enclosure by inland hills directs views out to sea. Perception of the character is experienced frequently by road users along main A9 transport corridor and passengers on the Far North Line. Turbines would not affect the appreciation of the physical influences which shape the coastal edge, but add to the wind farm seascape as a visually separate focus at a distance out to sea. Views of distant offshore wind farm seascape on skyline likely to become a characteristic element, However, large parts of the open sea views, perpendicular to the coast and from the south west round to the south east, and across the Moray coast, would remain open.	**Operation** ***Not -significant, negative, long term, reversible*** **Construction and decommissioning** ***Not -significant, negative, short term, reversible***

Table 14.7.7: Effect on Character of Regional Coastal Character Areas			
Regional Coastal Character Area	**Baseline Sensitivity**	**Magnitude of Change**	**Significance of Effect**
	Existing views include offshore wind farms, which both increase and decrease factors of susceptibility to further offshore wind farm influence. The RCCA is located some 29 km from the Development and would affect views rather than physically altering it. Main views across to the Moray Coast would not be affected. **Sensitivity: medium-high** in SLA, **medium** elsewhere.	Key characteristic as a linear deposition coast constricted by inland hills and open sea would continue to provide defining characteristic. The worst case scenario of both the construction and decommissioning will be when large numbers of turbines are in place in addition to concentrations of activity in the form of marine vessels and cranes. These activities associated with the Development turbines and OSPs will be distant with the construction of the cable route occurring at even greater distances, beyond the wind farm. **Magnitude of change: medium-low**	

Landscape Planning Designations

14.7.4.11 The third group of receptors covered in the assessment of effects on landscape / seascape character are the Landscape Planning Designations, shown in Volume 3a - Figure 14.4.7 and in conjunction with the ZTV in Volume 3a -Figure 14.7.1b. The assessment considers the likely significant effects of the Development on the Landscape Planning Designations in the Study Area.

14.7.4.12 A preliminary assessment was carried out through a desk study and site survey which examined the characteristics of the Landscape Planning Designations and the visibility of the Development using the ZTV and wirelines. This initial assessment has identified which Landscape Planning Designations within the Study Area may be subject to significant effects through the introduction of the Development and therefore require to be considered in more detail.

14.7.4.13 The preliminary assessment of the effects of the Development on the character of the Landscape Planning Designations has identified that significant effects on landscape character may arise within those included in Table 14.16 below. The baseline characteristics of these Landscape Character Receptors are described in Technical Appendix 14.2: Baseline Landscape Character, Table 4.1. This assessment has taken account of relevant aspects of the THC (2017) Landscape Sensitivity Appraisal: Caithness and has drawn upon the coastal characterisation set out in the Moray East ES (2012).

Table 14.7.8: Effect on Character of Landscape Planning Designations			
Landscape Planning Designation	**Baseline Sensitivity**	**Magnitude of Change**	**Significance of Effect**
Gardens and Designed Landscapes (GDL)			
Dunbeath Castle 23.9 km Nearest viewpoint 9a (Dunbeath nr. Heritage Centre) – Figure 14.7.17	**Value of Landscape Character Receptor - high** As a GDL contained in the HES Inventory this landscape has amongst the highest levels of protection from harm through national and development plan policy (Section 14.2). It has been attributed an outstanding level of scenic value and the landscape is noted specifically as comprising a dramatic landmark on the bleak coastal cliffs of Caithness. The GDL is classified as also having 'outstanding' historical, architectural and scenic value, with high value for work of art, horticultural and archaeological elements with 'some' nature conservation value. **Susceptibility to change – medium-high** The Development would not alter the character of the GDL through physical change to it but by through changing views from it through the introduction of medium scale, moving structures on part of the largely undeveloped skyline. The Development is proposed at a distance of approximately 24 km out to sea within the views directly out from the south easterly aspect of the Castle and within the distant, sea backdrop of the Castle when viewed from the approach road/main axis of the designed	**Operation, construction and decommissioning** The Development would not alter the character of the GDL through physical change to it but through changing views from within it. The ZTV on Figure 14.7.1b illustrates that it is theoretically possible to gain views of up to 62 turbines from most of the designated area. The distance to the Development is approximately 24 km and therefore it could be visible in very good visibility conditions. Actual visibility from some locations within the GDL would be restricted by intervening woodland, buildings and walls. The sloping nature of the GDL does mean that views from the more elevated parts of the gardens and 'parks' may still gain visibility of the Development. The Development would be seen as medium scale, moving structures that would extend offshore wind farm visibility across a further 50 degrees (approximately) of the sea views. Views towards the Castle along the main access and alignment would be altered from locations where the sea skyline is visible as a backdrop to the Castle. In views from higher ground the Castle is seen more against the open sea backdrop rather than against the skyline. However, it would be possible to gain views of the Castle from a number of locations with turbines located across the sea on either side of it. The worst case scenario of both the construction and decommissioning will be when large numbers of turbines are in place in addition to concentrations of activity in the form of marine vessels and cranes. These activities associated with the Development turbines and OSPs will be distant with the construction of the cable route occurring at even greater distances, beyond the wind farm. **Magnitude of change - medium**	**Operation** ***Significant, negative, long term, reversible –*** on the character of the Dunbeath Castle GDL. **Construction and decommissioning** ***Significant, negative, short term, reversible*** – on the character of the Dunbeath Castle GDL.

Table 14.7.8: Effect on Character of Landscape Planning Designations			
Landscape Planning Designation	**Baseline Sensitivity**	**Magnitude of Change**	**Significance of Effect**
	landscape. There is a large expanse of open sea between the Development and the Castle. Views out over the sea will also be available from the large open areas around the Castle and the cliff top areas. The sea views from within other parts of the GDL are likely to be constrained by the woodland and other planting as well as the garden walls. However, the gardens slope down towards the Castle so that locations higher in the grounds or within the open fields may gain views out over the Castle and woodland. There are existing views of offshore wind and oil platform development. **Sensitivity - high**		
Dunrobin Castle 40.2 km Nearest viewpoint 13: Brora – Picnic Area off Salt Street Figure 14.7.22	**Value of Landscape Character Receptor - high** As a GDL contained in the HES Inventory this landscape has amongst the highest levels of protection from harm through national and development plan policy (Section 14.2). The GDL has been attributed with an 'Outstanding' level for: work of art, historical, architectural, scenic and nature conservation: "The designed landscape makes a major contribution to the surrounding scenery". **Susceptibility to change – medium** The Development would not alter the character of the GDL through physical change to it but by	**Operation, construction and decommissioning** The Development would not alter the character of the GDL through physical change to it but through changing views from within it. The ZTV on Figure 14.7.1b illustrates that it is theoretically possible to gain views of up to 62 turbines from limited parts of the designated area. Theoretical visibility would be restricted by the intervening landform on which Dunrobin Woods is located. The distance to the Development is approximately 40 km and therefore it could be visible in excellent visibility conditions. Actual visibility from some locations within the GDL would be restricted by intervening woodland, buildings and walls. The sloping nature of the GDL does mean that views from the more elevated open parts of the GDL may still gain	**Operation** ***Not significant, negative, long term, reversible –*** on the character of the Dunrobin Castle GDL. **Construction and decommissioning** ***Not significant, negative, short term, reversible*** – on the character of the Dunrobin Castle GDL.

Table 14.7.8: Effect on Character of Landscape Planning Designations			
Landscape Planning Designation	**Baseline Sensitivity**	**Magnitude of Change**	**Significance of Effect**
	through changing views from it through the introduction of medium scale, moving structures on part of the largely undeveloped skyline. Large numbers of people visit the Castle and gardens with their main focus on these elements themselves with the open sea forming part of the wider setting. The Development is proposed at a distance of approximately 40 km out to sea within the views seen to the east from parts of the GDL. It would not occur in the direct axial views from the formal gardens. There is a large expanse of open sea between the Development and the Castle/GDL. Views out over the sea will be available from the coastal paths and open areas within the GDL. The sea views from within other parts of the GDL are likely to be constrained by the woodland and other planting as well as the garden walls. **Sensitivity – medium- high**	visibility of the Development, however most of these open areas would have their visibility of the Development restricted by woodland. The Development would be seen as small scale, moving structures that would extend offshore wind farm visibility across less than 20 degrees of the sea views approximately to the east round to the east north east. This is not in the direction of key views from the Castle or the gardens which are aligned to the south-east and with their main views focused towards the Moray coast. Views of the Development may be visible from parts of the GDL but it would be seen as peripheral to main views across a relatively small extent of the open sea views. Views towards the Castle from the A9 when travelling west would not be altered. The worst case scenario of both the construction and decommissioning will be when large numbers of turbines are in place in addition to concentrations of activity in the form of marine vessels and cranes. These activities associated with the Development turbines and OSPs will be distant with the construction of the cable route occurring at even greater distances, beyond the wind farm. **Magnitude of change – low**	
Special Landscape Areas			
Flow Country and Berriedale Coast	**Value – medium- high** This area is locally designated for its scenic landscape and due to this recognition it has a heighted value. The inland area of the SLA is	**Operation, construction and decommissioning** The Development would not alter the character of the SLA through physical change to it but through changing views from within it. Viewpoint 10: Morven (Figure 14.7.19) provides a view from a key vantage point within the SLA.	**Operation** ***Significant, negative, long term, reversible*** **–** on the areas to the south east of the A9.

Table 14.7.8: Effect on Character of Landscape Planning Designations			
Landscape Planning Designation	**Baseline Sensitivity**	**Magnitude of Change**	**Significance of Effect**
	recognised for its wildness qualities and defined as a Wild Land Area by SNH. It is a relatively intact area of landscape quality. The area is accessible to varying degrees with the settled coastal area and glens providing access for walkers to climb Morven (the highest hill in Caithness) and Scaraben. Otherwise there are few opportunities for people to access this area. There are particular cultural associations with the area around Badbea and Berriedale with a variety of buildings and ruins of historical interest. There is some access to the coast here along a core path, however other access to the coastal area of the SLA is not encouraged by roads or tracks leading to the coastal edge. There is a farm track that would facilitate walking closer to the shore, however there is nothing to encourage this. **Susceptibility to change - medium** The Development is located some 22 km from this SLA and as such it would not be physically altered by it but may obtain views towards it in the context of views of BOWL. The existing wind farm influence on the land and out at sea does increase the susceptibility of the SLA to further wind farm development where it is not consistent with those existing.	The Development would be seen as an extension to BOWL apparent out in the open sea and separated from the designated SLA by an expanse of sea. The ZTV on Figure 14.7.1b illustrates that it is theoretically possible to gain views of up to 62 turbines from limited parts of the designated area. The coastal area is shown to have theoretical visibility across its full extents. The seaward facing slopes are shown to have some theoretical visibility although this is restricted due to the alignment of the intervening landform with further screening of actual visibility afforded by intervening woodland within this area. Further inland it is the hill tops and south east and east facing hill slopes of the moorland hills and lone mountains that would gain visibility. Viewpoint 10: Morven, illustrates the view from the highest of these. Scaraben and other peaks of the Lone Mountains LCT are closer to the coast. The views from these is appreciated by walkers who are most likely to approach from Braemore so that visibility of the Development is from the summits and some adjoining ridges rather than from the slopes to the south where visibility would be more continuous. The Scarabens and Sron Gharbh themselves screen much of the visibility of the Development from the areas further north. This limits the influence of the Development on the core of the Wild Land Area and on the Flow Country beyond. Where visible from the Lone Mountains of Ben Alisky and Beinn Glas-choire beyond the Development would be seen at a range of around 40 km and its influence on landscape character would be limited also by the more defining influence of the intervening landscape. These areas are separated from the Development by intervening landscape of varied character influences, including the A9, considerable level changes and an extensive area of open sea. The Development will have an external influence on limited parts of SLA where there is a direct relationship with the adjacent open sea. The Development would not alter views towards the distinctive profile of Morven from the north coast or the Moray coast. From east of Portsoy, it may	**Not significant, negative, long term, reversible –** elsewhere on the character of the Flow Country and Berriedale Coast SLA. **Construction and decommissioning** ***Significant, negative, short term, reversible –*** on the areas to the south east of the A9. ***Not significant, negative, short term, reversible*** – on the character of the Flow Country and Berriedale Coast SLA.

Table 14.7.8: Effect on Character of Landscape Planning Designations			
Landscape Planning Designation	**Baseline Sensitivity**	**Magnitude of Change**	**Significance of Effect**
	There is a large separation by open sea between the Development and the SLA and it is seen as a separate entity far out to sea. The SLA has a strong inherent character so that it is less likely to be influenced materially by something occurring beyond its boundaries. Much of the interest in the sea from the coast occurs where the sea interacts with the coast. At close range this includes the waves and how they ebb and flow onto the small beach at Berriedale and the otherwise rocky/cliff shoreline and the water they leave behind. This also brings with it experience of the exposure and power of the sea that such proximity engenders. Views where the sea joins the coastal landscape to the north east and south west are also attractors. Such views are a focus here due to the linearity of the coastal landscape and its constraint by the higher landform inland. They also tend to make attractive scenic compositions. **Sensitivity to change – medium - high**	be seen in the same part of the views. However, at a range of over 85 km the profile of the Caithness coast is difficult to distinguish. Special qualities make no reference to coastal qualities, although overview describes Berriedale coast as having a 'series of vantage points from which to enjoy panoramic views out to the North Sea'. A key characteristic of the Berriedale Coast is that it is a linear coastal shelf constricted by inland hills with open sea views. Viewpoint 11: Berriedale (Figure 14.7.20) illustrates visibility from just outwith the boundary of the SLA, at slightly closer proximity to the Development. Reference should be made to the description of the proposed change in the view in Table 14.7.1. This illustrates that from the Berriedale coast the Development would add further wind farm development to the sea horizon across approximately 50 degrees of the field of view in the part of the views that are currently partially affected by the Beatrice Demonstrator Turbines and the associated oil platforms. From this coastal area sea views are available across approximately 180 degrees. The position of the Development in relation to the designated coast is such that open sea views are still available across the views from the south east round to the south west. This includes open views that include the Tarbat Ness and the inner firths beyond, and uninterrupted views to the Moray coast as far as Bin Hill. From the coastal areas to the south east of the A9 the orientation and extent of the views of the Development, as part of the seascape, coupled with their greater sense of relative wildness/remoteness would reinforce the Development as a prevailing characteristic element of the wider context to the SLA. The separation of the Berriedale Coast by a distance of approximately 22 km of open sea, along with the fact that the Development (and BOWL) are set back	

Table 14.7.8: Effect on Character of Landscape Planning Designations			
Landscape Planning Designation	**Baseline Sensitivity**	**Magnitude of Change**	**Significance of Effect**
		from the coastal areas so that views north and south along the coastline are not affected. The experiential qualities of being close to the sea would not be altered. There would be visibility from the monument and settlement at Badbea as well as from the castle ruins and beach at Berriedale. The visibility of the Development from one of the key locations where this landscape is experienced, the A9, is shown to have limited opportunities for visibility of the Development. See Table 14.7.1. The worst case scenario of both the construction and decommissioning will be when large numbers of turbines are in place in addition to concentrations of activity in the form of marine vessels and cranes. These activities associated with the Development turbines and OSPs will be distant with the construction of the cable route occurring at even greater distances, beyond the wind farm. **Magnitude of change – medium** within the coastal areas to the south of the A9. **Lower - elsewhere**	
Loch Fleet, Loch Brora and Glen Loth Nearest Representative Viewpoints – Viewpoint 12: Navidale, Viewpoint 13a – Brora and Viewpoint 13b- Dornoch	**Value – medium- high** This area is locally designated for its scenic landscape and due to this recognition it has a heighted value. It is a relatively intact area of landscape quality. The area is accessible to varying degrees with the settled coastal area and glens providing access. Beinn Dhorain is categorised as a Graham and is the highest summit in the SLA. It is most likely to be visited via Strath Ullie to the north, by local people. Otherwise there are few opportunities for people to access this	**Operation, construction and decommissioning** The Development would not alter the character of the SLA through physical change to it but through changing views from within it. The Development will have an external influence on limited parts of SLA where there is a direct relationship with the adjacent open sea. The Development would be seen as an extension to BOWL apparent out in the open sea and separated from the designated SLA by an expanse of sea. The ZTV on Figure 14.7.1b illustrates that it is theoretically possible to gain views of up to 62 turbines from limited parts of the designated area. The coastal area is shown to have theoretical visibility across its full extents. The seaward facing slopes are shown to have some theoretical visibility although this is restricted due to the alignment of the intervening landform with further	**Operation** ***Not significant, negative, long term, reversible*** – on the character of the Loch Fleet, Loch Brora and Glen Loth SLA. **Construction and decommissioning** ***Not significant, negative, short term, reversible*** – on the

Table 14.7.8: Effect on Character of Landscape Planning Designations			
Landscape Planning Designation	**Baseline Sensitivity**	**Magnitude of Change**	**Significance of Effect**
	area. Ben Bhraggie is the location for the Duke of Sutherland Monument and a vantage point visited for its historic importance and to gain the far-reaching views over the area, including Golspie and out to sea. A series of mountain bike routes, the Highland Wildcat Trails, has been built on side of Ben Bhraggie from the summit down to the village of Golspie. The views out to sea from the summit are partially framed by the bay encompassing Dunrobin Castle policies and the edge of Loch Fleet round to Tarbat Ness with the wider Moray and Caithness coasts extending beyond. Core Paths promote access across the hills between East Clyne and Gordonbush and along the shores of Loch Brora. **Susceptibility to change - medium** The Development is located some 29 km from the closest coastal point of this SLA and as such it would not be physically altered by it but may obtain views towards it in the context of views of BOWL. The existing wind farm influence on the land and out at sea does increase the susceptibility of the SLA to further wind farm development where it is not consistent with those existing. There is a large separation by open sea between the Development and the SLA and it is seen as a separate entity far out to sea to the	screening of actual visibility afforded by some limited intervening forestry within both these areas e.g. around Loch Fleet. Such areas include the Ben Bhraggie and the Sutherland Monument/ mountain bike trails near the summit. Further inland it is the hill tops and south east and east facing hill slopes of the moorland hills, such as Beinn Dhorain that would gain visibility. These areas are separated from the Development by intervening landscape of varied character influences, including the A9, considerable level changes and an extensive area of open sea. There would be no actual visibility of the Developmet from the Mound/bridge at Loch Fleet where the A9 crosses due the intervening Balblair Wood. There would be some visibility of the Development as part of the sea views from the linear settlements lying to the north west of the A9. However, visibility from these properties tends to be directed across the A9 to the south-east whilst the Development lies further round to the east south east so views would be oblique with open sea views still possible across the views to the south east and round to the south west. Whilst there would be visibility of the Development to the east south east extensive sea views across to the Moray coast would be maintained and would continue to contrast with the more intimate areas. The Development would not interfere with the views towards the local landmark of the Sutherland Monument. The Development would add to the large scale features visible from the SLA, however its distance from the Development and its restricted visibility from the more remote interior ensures that the scale of the hills and their qualities of wildness and tranquility are not materially changed. The views of the Development would introduce further focal features that would impinge on panoramic sea views. However, the location of the Development, extending away from the SLA and with its narrowest dimension closest to the	character of the Loch Fleet, Loch Brora and Glen Loth SLA.

Table 14.7.8: Effect on Character of Landscape Planning Designations			
Landscape Planning Designation	**Baseline Sensitivity**	**Magnitude of Change**	**Significance of Effect**
	east whilst the key orientation of the open sea views tends to be towards the south and south east, due to the south east orientation of the landform and its south east running glens, or north east along the Sutherland/Caithness coast. The SLA has a strong inherent character so that it is less likely to be influenced materially by something occurring beyond its boundaries. Much of the interest in the sea from the coast occurs where the sea interacts with the coast. At close range this includes the waves and how they ebb and flow onto the small beaches at and the otherwise rocky shoreline and the water they leave behind. This also brings with it experience of the exposure and power of the sea that such proximity engenders. Access to the shore on foot is relatively restricted within the SLA, however fossil hunting is promoted along the beaches accessible from near Crakaig and there is access promoted at Loch Fleet near Skelbo Castle and Little Ferry although views from there tend to be more focused on Loch Fleet. Views where the sea joins the coastal landscape to the north east and south west are also attractors. Such views are a focus on the stretch of coast between Kintradwell and Portgower due to the linearity of the coastal	designated area along with the large expanse of the panoramic sea views that remain open ensures that this remains the case. The open sea views are also retained in the most direct orientation of the views from the coastal and hill areas, which is to the south east. A key characteristic of the coastal area between Kintradwell and Portgower Berriedale Coast is that it is narrow area of Coastal Shelf LCT constricted by inland hills with open sea views. Viewpoint 12: Navidale illustrates visibility from outwith the boundary of the SLA, at slightly closer proximity to the Development. Reference should be made to the description of the proposed change in the view in Table 14.7.1. This illustrates that from the Kintradwell to Portgower coast the Development would add further wind farm development to the sea horizon across less than 37 degrees of the field of view in the part of the views that are currently partially affected by the Beatrice Demonstrator Turbines and the associated oil platforms. From this coastal area sea views are available across approximately 180 degrees. The position of the Development in relation to the designated coast is such that open sea views are still available across the views from the east south east round to the south west. This includes open views that include the Tarbat Ness and the inner firths beyond, and uninterrupted views to the Moray coast as further east than Bin Hill. The separation of the Kintradwell to Portgower coast by a distance of approximately 29 km of open sea, along with the fact that the Development (and BOWL) are set back from the coastal areas so that views north east and south west along the coastline are not affected, ensures that its strong coastal characteristics are not materially changed by views of the Development. The experiential qualities of being close to the sea would not be altered. The visibility of the Development from two of the key locations where this landscape is experienced, the A9 and the Far North Line, is shown to have	

Table 14.7.8: Effect on Character of Landscape Planning Designations			
Landscape Planning Designation	**Baseline Sensitivity**	**Magnitude of Change**	**Significance of Effect**
	landscape and its constraint by the higher landform inland. They also tend to make attractive scenic compositions. **Sensitivity to change – medium - high**	opportunities for visibility of the Development along much of its length. See Table 14.7.3 and Table 14.7.4 for descriptions of this visibility. Views of distant offshore wind farm seascape on skyline are likely to become a characteristic element of views. The worst case scenario of both the construction and decommissioning will be when large numbers of turbines are in place in addition to concentrations of activity in the form of marine vessels and cranes. These activities associated with the Development turbines and OSPs will be distant with the construction of the cable route occurring at even greater distances, beyond the wind farm. **Magnitude of change – medium-low** near to the coast or lower.	

14.7.5 Summary of Development Specific Effects

Table 14.7.9 summarises the findings of the development specific assessment contained in Section 14.7 where effects have been considered in detail.

Table 14.7.9: Summary of Development Specific Effects					
Receptor	**Sensitivity of Receptor**	**Impact Magnitude - Operation**	**Effect Significance Operation**	**Impact Magnitude - Construction/ Decommissioning**	**Effect Significance Construction/ Decommissioning**
Visual – Representative Viewpoints (Day)					
Viewpoint 1: Duncansby Head	Medium-high	Low	Not-significant, negative, long term, reversible	Low	Not-significant, negative, short term, reversible
Viewpoint 2: Keiss (A99)	Medium-high	Negligible	Not-significant, negative, long term, reversible	Low	Not-significant, negative, short term, reversible
Viewpoint 3: Wick (path south of South View)	Medium-high	Medium-low	Significant, negative, long term, reversible	Medium-low	Significant, negative, short term, reversible
Viewpoint 4: Sarclet (Sarclet Haven Info Board)	Medium-high	Medium	Significant, negative, long term, reversible	Medium	Significant, negative, short term, reversible
Viewpoint 5: Whaligoe Steps	Medium-high	Medium	Significant, negative, long term, reversible	Medium	Significant, negative, short term, reversible
Viewpoint 6: Minor Road (south east of Oslcay)	medium	Medium	Significant, negative, long term, reversible	Medium	Significant, negative, short term, reversible
Viewpoint 7: Lybster (end of Main Street)	Medium-high	Medium	Significant, negative, long term, reversible	Medium	Significant, negative, short term, reversible
Viewpoint 8: Latheron (A9)	Medium-high	Medium	Significant, negative, long term, reversible	Medium	Significant, negative, short term, reversible

Table 14.7.9: Summary of Development Specific Effects					
Receptor	**Sensitivity of Receptor**	**Impact Magnitude - Operation**	**Effect Significance Operation**	**Impact Magnitude - Construction/ Decommissioning**	**Effect Significance Construction/ Decommissioning**
Viewpoint 9a: Dunbeath (nr Heritage Centre)	Medium-high	Medium	Significant, negative, long term, reversible	Medium	Significant, negative, short term, reversible
Viewpoint 9b: Dunbeath (by harbour)	Medium-high	Medium-high	Significant, negative, long term, reversible	Medium-high	Significant, negative, short term, reversible
Viewpoint 10: Morven	Medium-high	Medium-low	Not-significant, negative, long term, reversible	Medium-low	Not-significant, negative, short term, reversible
Viewpoint 11: Berriedale (A9)	Medium-high	Medium	Significant, negative, long term, reversible	Medium	Significant, negative, short term, reversible
Viewpoint 12: Navidale	Medium-high	Medium	Significant, negative, long term, reversible	Medium	Significant, negative, short term, reversible
Viewpoint 13a: Brora (picnic area off Salt Street)	Medium-high	Medium-low	Not-significant, negative, long term, reversible	Medium-low	Not-significant, negative, short term, reversible
Viewpoint 13b: Dornoch (beach parking)	Medium-high	Low	Not-significant, negative, long term, reversible	Low	Not-significant, negative, short term, reversible
Viewpoint 14: Tarbat Ness Lighthouse	Medium-high	Medium-low	Not-significant, negative, long term, reversible	Medium-low	Not-significant, negative, short term, reversible
Viewpoint 15: Burghead Visitor Centre	Medium-high	Medium-low	Not-significant, negative, long term, reversible	Medium-low	Not-significant, negative, short term, reversible
Viewpoint 16: Lossiemouth Harbour	Medium-high	Medium-low	Not-significant, negative, long term, reversible	Medium-low	Not-significant, negative, short term, reversible

Table 14.7.9: Summary of Development Specific Effects					
Receptor	**Sensitivity of Receptor**	**Impact Magnitude - Operation**	**Effect Significance Operation**	**Impact Magnitude - Construction/ Decommissioning**	**Effect Significance Construction/ Decommissioning**
Viewpoint 17: Buckie (Cliff Terrace)	Medium-high	Medium-low	Not-significant, negative, long term, reversible	Medium-low	Not-significant, negative, short term, reversible
Viewpoint 18: Bin Hill	Medium	Low	Not-significant, negative, long term, reversible	Low	Not-significant, negative, short term, reversible
Viewpoint 19 Portnockie (Bow Fiddle Rock Info Point):	Medium-high	Medium-low	Not-significant, negative, long term, reversible	Medium-low	Not-significant, negative, short term, reversible
Viewpoint 20: Cullen (viaduct)	Medium-high	Medium-low	Not-significant, negative, long term, reversible	Medium-low	Not-significant, negative, short term, reversible
Viewpoint 21: Findlater Castle	Medium-high	Medium-low	Not-significant, negative, long term, reversible	Medium-low	Not-significant, negative, short term, reversible
Viewpoint 22: Sandend	Medium-high	low	Not-significant, negative, long term, reversible	Medium-low	Significant, negative, short term reversible
Viewpoint 23: Portsoy	Medium-high	Medium-low	Not-significant, negative, long term, reversible	Medium-low	Not-significant, negative, short term, reversible
Visual – People in Settlements					
Wick	Medium-high	South facing aspects and gardens of the properties on the south eastern extents of Proudfoot, Papigoe and Staxigoe: east of Proudfoot Road; South View and Murray Avenue; Broadhaven Road; Mowat Place; Cormack Crescent; Cliff Cottages; and from	South facing aspects and gardens of the properties on the south eastern extents of Proudfoot, Papigoe and Staxigoe: east of Proudfoot Road; South View and Murray Avenue; Broadhaven Road; Mowat Place; Cormack Crescent; Cliff Cottages; and from the south eastern	South facing aspects and gardens of the properties on the south eastern extents of Proudfoot, Papigoe and Staxigoe: east of Proudfoot Road; South View and Murray Avenue; Broadhaven Road; Mowat Place; Cormack Crescent; Cliff Cottages; and from the south eastern	South facing aspects and gardens of the properties on the south eastern extents of Proudfoot, Papigoe and Staxigoe: east of Proudfoot Road; South View and Murray Avenue; Broadhaven Road; Mowat Place; Cormack Crescent; Cliff Cottages; and from the south eastern

Table 14.7.9: Summary of Development Specific Effects					
Receptor	**Sensitivity of Receptor**	**Impact Magnitude - Operation**	**Effect Significance Operation**	**Impact Magnitude - Construction/ Decommissioning**	**Effect Significance Construction/ Decommissioning**
		the south eastern extents of Old Wick: Kennedy Terrace; Roxburgh Road; and Battery Road. Core Paths out to North Head and South Head as well as coastal path to the Castle of Old Wick. **Medium-low** Other locations in Wick. **Low or negligible**	extents of Old Wick: Kennedy Terrace; Roxburgh Road; and Battery Road. Core Paths out to North Head and South Head as well as coastal path to the Castle of Old Wick. **Significant, negative, long term, reversible** Other locations in Wick. **Not-significant, negative, long term, reversible**	extents of Old Wick: Kennedy Terrace; Roxburgh Road; and Battery Road. Core Paths out to North Head and South Head as well as coastal path to the Castle of Old Wick. **Medium-low** Other locations in Wick. **Low or negligible**	extents of Old Wick: Kennedy Terrace; Roxburgh Road; and Battery Road. Core Paths out to North Head and South Head as well as coastal path to the Castle of Old Wick. **Significant, negative, short term, reversible** Other locations in Wick. **Not-significant, negative, short term, reversible**
Thrumster	Medium	Low	Not-significant, negative, long term, reversible	Low	Not-significant, negative, short term, reversible
Lybster	Medium-high	In open sea views to the south round to the south east from the end of Main Street and properties on Southend, Shelligoe Road, Golf View Place, Golf View Drive, Gray's Place/Main Street, the golf course and the Core Paths that lead to the coast. **Medium** Other locations in Lybster. **Low or negligible**	In open sea views to the south round to the south east from the end of Main Street and properties on Southend, Shelligoe Road, Golf View Place, Golf View Drive, Gray's Place/Main Street, the golf course and the Core Paths that lead to the coast. **Significant, negative, long term, reversible.** Other locations in Lybster.	In open sea views to the south round to the south east from the end of Main Street and properties on Southend, Shelligoe Road, Golf View Place, Golf View Drive, Gray's Place/Main Street, the golf course and the Core Paths that lead to the coast. **Medium** Other locations in Lybster. **Low or negligible**	In open sea views to the south round to the south east from the end of Main Street and properties on Southend, Shelligoe Road, Golf View Place, Golf View Drive, Gray's Place/Main Street, the golf course and the Core Paths that lead to the coast. **Significant, negative, short term, reversible** Other locations in Lybster.

Table 14.7.9: Summary of Development Specific Effects					
Receptor	**Sensitivity of Receptor**	**Impact Magnitude - Operation**	**Effect Significance Operation**	**Impact Magnitude - Construction/ Decommissioning**	**Effect Significance Construction/ Decommissioning**
			Not-significant, negative, long term, reversible		**Not-significant, negative, short term, reversible**
Latheronwheel	Medium-high	In open sea views to the east south east round to the south south east from a small number of properties in Sinclair Terrace and Parkview Terrace and from the nearby Core Paths. **Medium**	In open sea views to the east south east round to the south south east from a small number of properties in Sinclair Terrace and Parkview Terrace and from the nearby Core Paths. **Significant, negative, long term, reversible**.	In open sea views to the east south east round to the south south east from a small number of properties in Sinclair Terrace and Parkview Terrace and from the nearby Core Paths. **Medium**	In open sea views to the east south east round to the south south east from a small number of properties in Sinclair Terrace and Parkview Terrace and from the nearby Core Paths. **Significant, negative, short term, reversible**.
Dunbeath	Medium-high	In open views gained from the south to east facing aspects of a small number of properties and gardens near the mouth of the Dunbeath Water and on high ground near the Heritage Centre and to the north and south of the A9, east of the bridge as well as the coastal Core Paths. **Magnitude of change: medium** Other locations within Dunbeath where intermediate landform	In open views gained from the south to east facing aspects of a small number of properties and gardens near the mouth of the Dunbeath Water and on high ground near the Heritage Centre and to the north and south of the A9, east of the bridge as well as the coastal Core Paths. **Significant, negative, long term, reversible.** Other locations within Dunbeath where intermediate landform and buildings reduce visibility and influence.	In open views gained from the south to east facing aspects of a small number of properties and gardens near the mouth of the Dunbeath Water and on high ground near the Heritage Centre and to the north and south of the A9, east of the bridge as well as the coastal Core Paths. **Magnitude of change: medium** Other locations within Dunbeath where intermediate landform and buildings reduce visibility and influence.	In open views gained from the south to east facing aspects of a small number of properties and gardens near the mouth of the Dunbeath Water and on high ground near the Heritage Centre and to the north and south of the A9, east of the bridge as well as the coastal Core Paths. **Significant, negative, short term, reversible.** Other locations within Dunbeath where intermediate landform and buildings reduce visibility and influence.

Table 14.7.9: Summary of Development Specific Effects					
Receptor	**Sensitivity of Receptor**	**Impact Magnitude - Operation**	**Effect Significance Operation**	**Impact Magnitude - Construction/ Decommissioning**	**Effect Significance Construction/ Decommissioning**
		and buildings reduce visibility and influence. **Magnitude of change: low or negligible**	**Not-significant, negative, long term, reversible**	**Magnitude of change: low or negligible**	**Not-significant, negative, short term, reversible**
Helmsdale	Medium-high	In open views gained from some of the properties to the east of the village, within the more modern housing area on Dunrobin Street and Simpson Crescent and along the A9 where they have their aspects to the south east and east as well as from coastal core paths and the café. **Medium** Elsewhere within Helmsdale. **Low or negligible**	In open views gained from some of the properties to the east of the village, within the more modern housing area on Dunrobin Street and Simpson Crescent and along the A9 where they have their aspects to the south east and east as well as from coastal core paths and the café. **Significant, negative, long term, reversible.** Elsewhere within Helmsdale. **Not-significant, negative, long term, reversible**	In open views gained from some of the properties to the east of the village, within the more modern housing area on Dunrobin Street and Simpson Crescent and along the A9 where they have their aspects to the south east and east as well as from coastal core paths and the café. **Medium** Elsewhere within Helmsdale. **Low or negligible**	In open views gained from some of the properties to the east of the village, within the more modern housing area on Dunrobin Street and Simpson Crescent and along the A9 where they have their aspects to the south east and east as well as from coastal core paths and the café. **Significant, negative, short term, reversible.** Elsewhere within Helmsdale. **Not-significant, negative, short term, reversible**
Brora	Medium-high	Medium- low or lower	Not-significant, negative, long term, reversible	Medium- low or lower	Not-significant, negative, short term, reversible
Sandend	Medium-high	Negligible	Not-significant, negative, long term, reversible	Medium-low	Significant, negative, short term, reversible.
Visual – People Using Routes					

Table 14.7.9: Summary of Development Specific Effects					
Receptor	**Sensitivity of Receptor**	**Impact Magnitude - Operation**	**Effect Significance Operation**	**Impact Magnitude - Construction/ Decommissioning**	**Effect Significance Construction/ Decommissioning**
A9 (Brora to Spittal)	Brora to Latheron **Medium-high** Latheron to Spittal **Medium**	On the views obtained from the A9 from Brora to east of Crakaig. **Low-medium** On the views obtained predominantly by north bound travellers from the A9 between east of Crakaig and west of Ousedale at a maximum distance from the Development of 33.4 km. **Medium** On the views obtained from the A9 between west of Ousedale and east of Berriedale due to a general lack of visibility out to sea. **Low or none** On the views obtained from the A9 between east of Berriedale and west of Latheron. **medium**	On the views obtained from the A9 from Brora to east of Crakaig and between west of Ousedale and east of Berriedale. **Not significant, negative, long term, reversible** On the views obtained predominantly by north bound travelers from the A9 between east of Crakaig and west of Ousedale and by north and south bound travellers between east of Berriedale and west of Latheron. **Significant, negative, long term, reversible**	On the views obtained from the A9 from Brora to east of Crakaig. **Low-medium** On the views obtained predominantly by north bound travellers from the A9 between east of Crakaig and west of Ousedale at a maximum distance from the Development of 33.4 km. **Medium** On the views obtained from the A9 between west of Ousedale and east of Berriedale due to a general lack of visibility out to sea. **Low or none** On the views obtained from the A9 between east of Berriedale and west of Latheron. **medium**	On the views obtained from the A9 from Brora to east of Crakaig and between west of Ousedale and east of Berriedale. **Not significant, negative, short term, reversible** On the views obtained predominantly by north bound travellers from the A9 between east of Crakaig and west of Ousedale and by north and south bound travellers between east of Berriedale and west of Latheron. **Significant, negative, short term, reversible**

Table 14.7.9: Summary of Development Specific Effects					
Receptor	**Sensitivity of Receptor**	**Impact Magnitude - Operation**	**Effect Significance Operation**	**Impact Magnitude - Construction/ Decommissioning**	**Effect Significance Construction/ Decommissioning**
A99 (Latheron to Wick)	Medium	On the views obtained from the A99 from north of Ulbster to Latheron **medium** On the views obtained from the A99 from Wick to north of Ulbster **Low or negligible**	On the views obtained predominantly by south bound travelers from the A99 between north of Ulbster and Latheron. **Significant, negative, long term, reversible** On the views obtained from the A99 from Wick to north of Ulbster. **Not significant, negative, long term, reversible**	On the views obtained from the A99 from north of Ulbster to Latheron **medium** On the views obtained from the A99 from Wick to north of Ulbster **Low or negligible**	On the views obtained predominantly by south bound travelers from the A99 between north of Ulbster and Latheron. **Significant, negative, short term, reversible** On the views obtained from the A99 from Wick to north of Ulbster. **Not significant, negative, short term, reversible**
Far North Line (Brora to Helmsdale)	Medium-high	On the views obtained from the Far North Line from Brora to 1 km east of Crakaig. **Low-medium** On the views obtained by passengers on the Far North Line between 1 km east of Crakaig and Helmsdale. **Medium**	On the views obtained from the Far North Line from Brora to 1 km east of Crakaig. **Not significant, negative, long term, reversible** On the views obtained by passengers on the Far North Line between 1 km east of Crakaig and Helmsdale. **Significant, negative, long term, reversible**	On the views obtained from the Far North Line from Brora to 1 km east of Crakaig. **Low-medium** On the views obtained by passengers on the Far North Line between 1 km east of Crakaig and Helmsdale. **Medium**	On the views obtained from the Far North Line from Brora to 1 km east of Crakaig. **Not significant, negative, short term, reversible** On the views obtained by passengers on the Far North Line between 1 km east of Crakaig and Helmsdale. **Significant, negative, short term, reversible**
Visual – Representative Viewpoints (Night)					
Viewpoint 3: Wick (path south of South View)	Medium	Low	**Not significant, negative, long term, reversible**	Low	**Not significant, negative, short term, reversible**

Table 14.7.9: Summary of Development Specific Effects					
Receptor	**Sensitivity of Receptor**	**Impact Magnitude - Operation**	**Effect Significance Operation**	**Impact Magnitude - Construction/ Decommissioning**	**Effect Significance Construction/ Decommissioning**
Viewpoint 9a: Dunbeath (nr Heritage Centre)	Medium	Medium	**Significant, negative, long term, reversible**	Medium	**Significant, negative, short term, reversible**
Viewpoint 12: Navidale	Medium	Medium	**Significant, negative, long term, reversible**	Medium	**Significant, negative, short term, reversible**
Viewpoint 16: Lossiemouth Harbour	Medium	Medium-low	**Not significant, negative, long term, reversible**	Medium-low	**Not significant, negative, short term, reversible**
Landscape / Seascape Receptors - LCTs					
Sweeping Moorland - 25	Medium-high in SLA, medium elsewhere	Medium-low or lower	Not significant	Medium-low or lower	Not significant
Small Farms and Crofts -23	Medium	Medium between Berriedale and Sarclet Head and the coast and the A9. Elsewhere low	**Significant, negative, long term, reversible –**between Berriedale and Sarclet Head and the coast and the A9. **Not-significant, negative, long term, reversible –** elsewhere	Medium between Berriedale and Sarclet Head and the coast and the A9. Elsewhere low	**Significant, negative, short term, reversible –**between Berriedale and Sarclet Head and the coast and the A9/A99. **Not-significant, negative, short term, reversible –** elsewhere
Moorland Slopes and Hills - 18	Medium	Medium in the vicinity of Badbea and the south east facing slopes of Cnoc na Croiche. Elsewhere lower.	**Significant, negative, long term, reversible –** in the vicinity of Badbea and the south east facing slopes of Cnoc na Croiche. **Not-significant, negative, long term, reversible –** elsewhere	Medium in the vicinity of Badbea and the south east facing slopes of Cnoc na Croiche. Elsewhere lower.	**Significant, negative, short term, reversible –** in the vicinity of Badbea and the south east facing slopes of Cnoc na Croiche. **Not-significant, negative, short term, reversible –** elsewhere

Table 14.7.9: Summary of Development Specific Effects					
Receptor	**Sensitivity of Receptor**	**Impact Magnitude - Operation**	**Effect Significance Operation**	**Impact Magnitude - Construction/ Decommissioning**	**Effect Significance Construction/ Decommissioning**
Coastal Shelf -6	Medium- high in SLA, medium elsewhere	Medium-low	Not significant, negative, long term, reversible	Medium-low	Not significant, negative, short term, reversible
Coastal High Cliffs and Sheltered Bays - 11	Medium- high in SLA, medium elsewhere	Medium	**Significant, negative, long term, reversible**	Medium	**Significant, negative, short term, reversible**
Long Beaches Dunes and Links - 16	Medium-high in SLA, medium elsewhere	Low	Not significant, negative, long term, reversible	Low	Not significant, negative, short term, reversible
Regional Coastal Character Areas					
Sarclet Head - G	Medium	Medium south of Sarclet. Lower elsewhere.	**Significant, negative, long term, reversible –**to the south west of Sarclet Head itself. **Not significant, negative, long term, reversible –**to the north east of Sarclet Head itself.	Medium south of Sarclet. Lower elsewhere.	**Significant, negative, short term, reversible –**to the south west of Sarclet Head itself. **Not significant, negative, short term, reversible –**to the north east of Sarclet Head itself.
Lybster Bay - H	Medium	Medium	***Significant, negative, long term, reversible***	Medium	***Significant, negative, short term, reversible***
Dunbeath Bay - I	Medium	Medium	***Significant, negative, long term, reversible***	Medium	***Significant, negative, short term, reversible***
Helmsdale to Berriedale Coastal Shelf - J	Medium-high	**Magnitude of change: medium** to the north east of Helmsdale. **Medium-low** elsewhere.	***Significant, negative, long term, reversible –*** to the north east of Helmsdale.	**Magnitude of change: medium** to the north east of Helmsdale. **Medium-low** elsewhere.	***Significant, negative, short term, reversible*** – to the north east of Helmsdale.

Table 14.7.9: Summary of Development Specific Effects					
Receptor	**Sensitivity of Receptor**	**Impact Magnitude - Operation**	**Effect Significance Operation**	**Impact Magnitude - Construction/ Decommissioning**	**Effect Significance Construction/ Decommissioning**
			Not -significant, negative, long term, reversible – elsewhere within this RCCA.		***Not -significant, negative, short term, reversible –*** elsewhere within this RCCA.
Brora to Helmsdale Deposition Coast - K	Medium-high in SLA, medium elsewhere	Medium-low	***Not -significant, negative, long term, reversible***	Medium-low	***Not -significant, negative, short term, reversible***
Landscape Planning Designations					
Dunbeath Castle GDL	High	Medium	***Significant, negative, long term, reversible***	Medium	***Significant, negative, short term, reversible***
Dunrobin Castle GDL	Medium-high	Low	***Not -significant, negative, long term, reversible***	Low	***Not -significant, negative, short term, reversible***
Flow Country and Berriedale Coast SLA	Medium-high	Medium to the south east of the A9. Lower elsewhere.	***Significant, negative, long term, reversible –*** on the areas to the south east of the A9. **Not significant, negative, long term, reversible –** elsewhere on the character of the Flow Country and Berriedale Coast SLA.	Medium to the south east of the A9. Lower elsewhere.	***Significant, negative, short term, reversible –*** on the areas to the south east of the A9. ***Not significant, negative, short term, reversible*** – on the character of the Flow Country and Berriedale Coast SLA.
Loch Fleet, Loch Brora and Glen Loth SLA	Medium-high	Medium-low near to the coast. Lower elsewhere.	***Not -significant, negative, long term, reversible***	Medium-low near to the coast or lower.	***Not -significant, negative, short term, reversible***

14.7.5.1 The significant visual effects identified in Table 14.7.9 above occur largely along the coastal area of Caithness and north east Sutherland in Highland between the A9 at Crakaig in the west of the Study Area and Wick in the north. These locations, which include views from settlements and routes represent the outer limits of significant visual effects on this coast lie at distances of approximately 33.5 km and 32.3 km from the nearest turbine of the WCS respectively. The identified concentrations of receptors span a section of coast that is roughly 60 km in length. The views from this stretch of coast are represented by ten of the 24 viewpoints assessed.

14.7.5.2 The stretch of coast that lies between these two points would be closer to the Development with a minimum distance to the closest turbine of the WCS of approximately 23 km with the closest representative viewpoint being Viewpoint 11: Berriedale and other close range sections of the coast being at Dunbeath and Lybster.

14.7.5.3 A significant visual effect has also been assessed for Viewpoint 6: Minor Road South of Osclay, which is slightly inland of Lybster at a range of 28.4 km and represents an area of scattered properties.

14.7.5.4 Within this largely coastal area the visual receptors are relatively limited and would be confined largely to within the coastal area where the Far North Line (railway), the A9 and the A99 run and provide access to the, mostly small, settlements as well as the scattered properties that are often linked to the main roads by minor routes, tracks and paths. Within this section of the coastline and within localised areas inland significant effects on people living, visiting and moving through this area may occur. Not all locations within this coastal strip would be significantly affected as noted in Table 14.7.9 and assessed in Section 14.7.

14.7.5.5 The most distant locations where significant visual effects would potentially arise along this coast occur for specific reasons so that it may be that the Development would not give rise to significant visual effects at similar distances. The specific reason for the representative viewpoint and people within the small areas of Wick having the potential to be significantly affected is due to the confined nature of Wick Bay and the fact that the Development would both infill part of the remaining seascape horizon with offshore wind farm – extending this influence across much of the views from these locations – and also due to the fact that the Development would be seen to link to the coast so that the offshore wind farm influence extends from there out to sea.

14.7.5.6 At Crakaig, and the coastal area nearby, the A9 and the Far North Line run close to the coast with views confined and channelled towards the Development by the steeply rising slopes inland and are located within an area that is locally designated as part of the Loch Fleet, Loch Brora and Glen Loth SLA.

14.7.5.7 The Development would mostly be seen in the context of BOWL and Moray East. Its more south-westerly location and its longer length aligning with the coastline of Caithness and north east Sutherland means that it extends and increases the offshore wind farm influence rather than introducing new effects along this stretch of coast and also in many other parts of the Study Area. Importantly, significant visual and cumulative effects were assessed as being likely to arise as a result of BOWL and Moray East wind farms within their respective ES's along the (approximately 40 km) stretch of coast between Wick and Berriedale. This indicates that the Development would add to the coastal area where significant effects may arise through views of offshore wind farm development between Berriedale and Crakaig.

14.7.5.8 Whilst the Development would be noticeable at greater distances in very good or excellent visibility conditions it is considered that its distance, vertical scale and location within wide expansive seas, which would remain the predominant characteristic, would ensure that such effects are not significant. This applies to views and effects on visual receptors in Moray, Aberdeenshire and other parts of Caithness and Sutherland.

14.7.5.9 It has been assessed that significant visual effects of the Development at night are limited in extent, concentrated to the coastal areas between Wick and Navidale, in areas where the baseline views are intrinsically dark but also often contain widespread visibility of the BOWL lights. Such views may be obtained relatively frequently by local people, visitors and motorists as they travel along this section of the coast.

14.7.5.10 Significant effects on landscape/seascape character receptors are less widespread and are concentrated along the coast between north-east of Helmsdale and Sarclet Head and between the A9/A99 and the coast. The affected area includes a small part of the area designated as the Flow Country and Berriedale Coast SLA as well as the Dunbeath Castle GDL. This is largely as a result of the change to their character through the increased extent of the open sea views that would be affected by offshore wind farms as a result of the introduction of the Development and the scale of the proposed turbines. It has been assessed that there would be no significant effects on the NSA, WLAs or other designated parts of the Study Area.

14.8 Assessment of Cumulative Effects

14.8.1.1 The following section presents the results of assessment of the likely significant cumulative effects upon seascape, landscape and visual receptors arising from the proposed Development in conjunction with other onshore and offshore wind farm developments and their associated offshore grid infrastructure.

14.8.1.2 The Development is likely to give rise to potential cumulative effects as an addition to other wind energy developments that are operational (including those under construction), consented and at application stage.

14.8.1.3 The operation of the Development will occur in the context of BOWL but may also occur in the context of the consented Moray East Offshore Wind Farm (Moray East). There are a number of different layouts for Moray East, however, due to the timing of this submission and no further proposals having been confirmed the worst case project envelope from the Moray East ES (2012) is considered in the cumulative assessment of the Development. Volume 3b – Technical Appendix 14.4 also includes cumulative wirelines for each of the viewpoints that illustrate an alternative and more likely scenario for the Moray East layout and wind turbine generator (WTG) dimensions. This is described as the Moray East Current Base Case Layout. Further changes to this may be required following site investigation and analysis and through the planning process. An assessment of the difference this potential layout would make to the cumulative assessment of the Development from these viewpoint locations is also included.

14.8.1.4 The cumulative effect of the Development also considers the addition of the Development to consented and application stage onshore wind farms.

14.8.1.5 It is assumed that the BOWL and Moray East will be operational prior to the construction of the Development and therefore construction effects of the developments would not overlap but would occur sequentially. Potential cumulative construction stage effects of the Development are therefore scoped out of the SLVIA.

14.8.1.6 The decommissioning of the Beatrice Demonstrator Turbines is likely to occur within the first few years of operation of the Development. The cumulative effect of operation and subsequent decommissioning the Beatrice Demonstrator Turbines would be limited due to their distance offshore and the relatively short timescale of their concurrent operation/decommissioning compared with the operational life of the Development, which is shown in the visualisations and assessed. Therefore, such effects have been scoped out of the assessment, as agreed with SNH.

14.8.1.7 Table 14.8.1, sets out the list of cumulative schemes as agreed with Marine Scotland Licencing (MS-LOT), THC, MC and AC as well as their relevance to the cumulative assessment.

Table 14.8.1: Cumulative Wind Farms in the Study Area				
Wind Farm	**Number of turbines**	**Height to blade tip (m)**	**Distance to Moray West wcs turbine (km)**	**Relevant to cumulative assessment?**
Operational/ Under Construction				
Beatrice Offshore Demonstrator	2	151	Located within Moray West site.	No. Would be removed within the first few years of operation of the Development.
BOWL	84	187	1.86	Yes
Burn of Whilk	9	116	26.25	Yes
Buolfruich	15	75	29.12	Yes
Camster	25	121.2	31.91	Yes
Achairn	3	100	33.19	Yes
Wathegar	5	100	34.48	Yes
Flex Hill/Bilbster	3	93	35.52	Yes
Bad a Cheo/Mybster	13	112	39.3	Yes
Causeymire	21	100	40.66	Yes
Gordonbush	35	110	42.32	Yes
Achlachan	5	110	43.07	Yes
Ley Farm	1	74	45.20	No – due to scale and influence of wind farm and distance from the Development.
Boyndie	7	100.5	47.41	Yes
Badentoul	1	67	47.40	No – due to scale and influence of wind farm and distance from the Development.
Stroupster	13	113/110	45.07	Yes
Braeside	1	79	48.11	No – due to scale and influence of wind farm and distance from the Development.
Cairnton Road	1	98.14	48.3	No – due to scale and influence of wind farm and distance from the Development.
Kilbraur	27	115	47.73	Yes
Boyndie Extension	1	100.5	48.64	No – due to scale and influence of wind farm and distance from the Development.
Followsters Newmill	1	77	49.48	No – due to scale and influence of wind farm and distance from the Development.
Netherton of Windyhills	2	92	49.89	No – due to scale and influence of wind farm and distance from the Development.

Table 14.8.1: Cumulative Wind Farms in the Study Area				
Wind Farm	**Number of turbines**	**Height to blade tip (m)**	**Distance to Moray West wcs turbine (km)**	**Relevant to cumulative assessment?**
Balnamoon	1	70	50.40	No – due to scale and influence of wind farm and distance from the Development.
Bognie Farm	1	60.98	50.27	No – due to scale and influence of wind farm and distance from the Development.
Consented				
Moray East Offshore Wind Farm	216	204	adjacent	Yes
Osclay Quarry	1	80	28.28	Yes, in views from A99 and Viewpoint 6: Minor Road (south-east of Osclay)
Rumster	3	75	31.02	Yes
Wathegar 2	9	110	33.41	Yes
Cogle Moss	12	99.5	38.83	Yes
Halsary (and Resubmission)	15	112	40.16	Yes
Gordonbush Extension	16	115/130	43.83	Yes
Achlachan 2	3	110	43.23	Yes
Aultmore	13	110	46.97	Yes
Lochend Farm	4	99.5	50.08	Yes
Application				
Navidale	5	125	27.27	Yes
Golticlay	19	130	29.53	Yes
West Garty	17	110 / 100	32.27	Yes
East Kirk	1	79.6	41.35	No – due to scale and influence of wind farm and distance from the Development.
Lurg Hill	5	130	49.18	Yes
Scoping				
Torranreach	4	77	24.65	No – due to scoping status, scale and distance from Development.
Lynton Cottage	2	77	25.27	
Red Moss	7	148.5	25.54	
Tofts of Tain	3	84	48.42	
Brabster	10	120	48.78	
Camster II	55	126.5	29.33	

Table 14.8.1: Cumulative Wind Farms in the Study Area				
Wind Farm	**Number of turbines**	**Height to blade tip (m)**	**Distance to Moray West wcs turbine (km)**	**Relevant to cumulative assessment?**
Durran Mains / Stemster Hill	4	92.5	49.58	

14.8.1.8 The cumulative situation changes frequently as applications are made or withdrawn, and the layouts of submitted application wind farms are changed. The 9th November 2017 has been used as a cut-off for this cumulative assessment - any changes in the cumulative situation after that date are not incorporated in the assessment.

14.8.1.9 The following assessment includes the consented Moray East as part of the main cumulative assessment. In the cumulative SLVIA this is assessed as being the WCS included in the Moray East ES (2012), which included the three consented wind farm sites (Telford, Stevenson and MacColl) in Layout 4c with 216 turbines of 204 m to tip.

14.8.1.10 The consented Moray East now has CfD funding and is moving towards a revised layout based on further investigations and technical/economic factors. It is intended that the actual layout will be confirmed via Moray East DSLP in Q2 2018. However, at this stage it is known that the changes to the layout are likely to include development of the Moray East as a single development, with reduced turbine numbers and turbines of 197 m to tip above HAT. Until the DSLP submission is made there is no certainty over what this layout will be, however, Moray East has issued an interim, more likely Moray East Current Base Case Layout, which provides the basis for a secondary assessment of the effect of the Development included in this SLVIA, in the context of BOWL and Moray East Offshore. Wirelines illustrating this more likely layout are contained in Volume 3b - Technical Appendix 14.4: Assessment and Cumulative Wirelines Illustrating Moray East Current Base Case Layout.

14.8.1.11 The methodology for the Cumulative Seascape, Landscape and Visual Impact Assessment (CSLVIA) is set out in Volume 4 - Technical Appendix 14.1: SLVIA Methodology.

14.8.1.12 GLVIA Version 3 (2013) advises the following:

14.8.1.13 'The most significant cumulative landscape effects are likely to be those that would give rise to changes in the landscape character of the study area of such and extent as to have major effects on its key characteristics and even, in some cases, to transform it into a different landscape type. This may be the case where the project being considered itself tips the balance through its additional effects. The emphasis must always remain on the main project being assessed and how or whether it adds to or combines with the others being considered to create a significant cumulative effect.'

14.8.1.14 GLVIA Version 3 also advises that:

14.8.1.15 'Higher levels of significance may arise from cumulative visual effects related to:

- *Developments that are in close proximity to the main project and are clearly visible together in views from the selected viewpoints; and*
- *Developments that are highly inter-visible, with overlapping ZTVs – even though the individual developments may be at some distance from the main project and from individual viewpoints, and when viewed individually not particularly significant, the overall combined cumulative effect on a viewer at a particular viewpoint may be more significant.'*

14.8.1.16 The CSLVIA describes, illustrates and assesses the ways in which the Development will have additional effects when considered together with other existing/under construction, consented or proposed (application stage) wind farms and identifies any related significant cumulative effects arising from the Development. The CSLVIA does not assess the total effect arising from all of these wind farms, but assesses the additional effects arising from the Development in relation to the other wind farms assumed to be part of the landscape in each scenario.

14.8.1.17 The addition of the Development to the operational/under construction wind farm context has been assessed in the main assessment contained in Section 14.7. This included the assessment of the effects of the Development in the context of BOWL.

14.8.1.18 The CSLVIA section assesses the effect of the Development in two further scenarios as follows:

- Consented scenario – operational/under construction wind farms plus consented wind farms; and
- Application scenario – operational/under construction and consented wind farms plus application stage wind farms.

14.8.1.19 The key consideration in the CSLVIA is the addition of Moray East Offshore Wind Farm in the consented scenario.

14.8.1.20 The ultimate scenario that may arise (i.e. the total number of wind farms that are built) is uncertain and therefore speculative, as the scenarios include wind farms which are in the process of being determined by the relevant planning authority, and those which have not yet been built. Not all proposals will necessarily gain planning approval or be built. Judgements made from the conclusions of this theoretical assessment therefore need to be weighed up and balanced according to the likelihood of the effect arising.

14.8.1.21 The CSLVIA is supported by figures contained in Volume 3a, which includes a cumulative wind farm map (Figure 14.8.1) Cumulative Zone of Theoretical Visibility (CZTV) mapping (Volume 3a - Figures 14.8.2 – 14.8.24) and cumulative wireline views within the assessment viewpoints (Volume 3b - Figures 14.7.9 to 14.7.34). Cumulative wind farms are also shown on the A0 ZTV Figure 14.7.1b (Volume 3a).

14.8.1.22 Visual representations for the cumulative assessment are produced in accordance with SNH (2017) guidance. Single frame viewer images showing the cumulative effects have been prepared for certain viewpoints as agreed with THC.

14.8.2 Cumulative Assessment Scope

14.8.2.1 Scoping stage wind farms are shown on the plan figures but they are not assessed in any detail. This accords with SNH (2012) guidance and is generally as a result of the uncertainty of their future status and insufficient information being available for pre-application stage wind farms. Domestic and feed in tariff scale single wind turbines, with a height less than 50 m to blade tip, have been scoped out of the assessment as agreed with SNH, THC, MC, and AC. It is considered that these small turbines would not have a material effect on the cumulative wind farm context to which the Development would be added.

14.8.2.2 An initial assessment of the relationship and intervisibility of other wind farms with the Development has been undertaken, in order to determine which wind farms have the potential to contribute to a significant cumulative effect arising from the addition of the Development. The assessment focuses on the wind energy developments with potential for significant cumulative effects with Development.

14.8.2.3 It is understood that the Beatrice Demonstrator Turbines would only exist at the same time as the Development for a relatively short time so that although they are part of the existing baseline and have an existing influence (Volume 3a - Figure 14.8.5) they have been scoped out of the CSLVIA.

14.8.2.4 The CSLVIA focuses on the cumulative effect of the Development with the two offshore wind farms BOWL and Moray East and the closest onshore wind farms in Caithness where they affect views from the coast or sequentially along the A9/A99.

14.8.2.5 A summary of the worst case parameters of wind farm design for the Moray East Offshore Wind Farm is provided in Table 14.8.2 below.

Table 14.8.2: Moray East Offshore Wind Farm Worst Case Scenario for Cumulative SLVIA

Layout 4c	
Rating	7MW
Layout type	The tallest and most numerous turbine for all sites (the 8 MW is of the same dimensions but will be less numerous). Aligned so that turbine rows are perpendicular to the Caithness coast.
Number of turbines	216
Approximate hub Height	118
Rotor Diameter	172
Maximum Tip Height	204

14.8.2.6 For comparison Table 14.8.3 illustrates the details of the Moray East Current Base Case Layout.

Table 14.8.3: Moray East Offshore Wind Farm Layout for Cumulative SLVIA in Volume 3b - Technical Appendix: 14.4

Current Base Case Layout	
Rating	10 MW
Layout Type	North - south / west – east turbine rows.
Number of Turbines	100
Maximum Hub Height	118 m
Rotor Diameter	164 m
Maximum Tip Height	204 m

14.8.3 Cumulative ZTV

14.8.3.1 Cumulative Zones of Theoretical Visibility (CZTV) have been produced to identify the cumulative visibility of the Development with the other wind farms in the Study Area. The CZTV show that the Development would have the following broad patterns of combined visibility with other wind farms:

- Combined visibility with **BOWL** (Volume 3a - Figure 14.8.6) from much of coastal edge and immediate hinterland between Brora and Duncansby Head, with the Development set further to the south. Combined visibility extends inland across elevated moorlands and hills in southern part of Caithness, forming a view-shed which screens views from the flat peatlands. Scattered visibility filtering inland at long distances in northern part of Caithness in the Study Area. Theoretical combined visibility from Moray coast is shown to occur, however, in reality, with BOWL located over 50 km from Moray coast combined effects would be difficult to perceive;
- Combined visibility with **Moray East** (Volume 3a - Figure 14.8.7) from much of coastal edge and immediate hinterland between Brora and Duncansby Head, with the Development set further to the south. Combined visibility extends inland across elevated moorlands and hills in southern part of Caithness, forming a view-shed which screens views from the flat peatlands. Scattered visibility filtering inland at long distances in northern part of Caithness in the Study Area. Theoretical combined visibility from Moray coast is shown to occur, however, in reality, with Moray East Offshore Wind Farm located over 40 km from Moray and Aberdeenshire coast combined effects would be less noticeable than from Caithness and Sutherland;
- Combined visibility with **Burn of Whilk** (Volume 3a - Figure 14.8.8) scattered over coastal edge of east Caithness between Berriedale and Wick, extending inland to high ground in central / southern parts of Study Area and scattered locations in the northern part of the Study Area;
- Combined visibility with **Buolfruich** (Volume 3a - Figure 14.8.9) contained to area of higher sweeping moorland to the west of Buolfruich and from limited parts of the coastal edge near Dunbeath, including part of the A9 on approach to Dunbeath;
- Combined visibility with **Achairn, Flex Hill** and **Wathegar** (Volume 3a - Figure 14.8.10) from limited areas around and to the west of Wick; scattered visibility from the inland areas of mixed agriculture and settlement to the north of Wick and from the A99 to the north of Wick. Limited combined visibility from areas to the south of Wick including A99;
- Combined visibility with **Camster** (Volume 3a - Figure 14.8.11) from limited areas around and to the west of Wick; scattered visibility from the inland areas of mixed agriculture and settlement to the north of Wick and from the A99 to the north of Wick. Limited combined visibility from areas to the south of Wick including A99;
- Combined visibility with **Causeymire, Halsary, Achlachan 1 & 2** and **Bad a'Cheo** (Volume 3a - Figure 14.8.12) is contained to scattered visibility from the inland areas of mixed agriculture and settlement to the north of Wick / A882 and from lone mountains to the south of the Caithness part of the Study Area. Limited / no combined visibility from coastal areas to the south of Wick including A9, with inland hills forming clear viewshed;
- Combined visibility with **Gordonbush** and **Gordonbush Extension** (Volume 3a - Figure 14.8.13), limited west of Brora and high areas of lone mountains inland of Berriedale. Combined visibility around Dornoch Firth, Tarbat Ness and western Moray coast;
- Combined visibility with **Stroupster** (Volume 3a - Figure 14.8.14) largely across north east corner of Caithness and coastal areas around Wick including along the A99 between Wick and John o'Groats. Limited combined visibility from areas to the south of Wick, including coastal edge and A99;
- Combined visibility with **Kilbraur** (Volume 3a - Figure 14.8.15) limited within Caithness and Sutherland and across point of Tarbet Ness. Small section of Kilbraur visibility on A9 and around Brora. Widespread combined visibility in Moray.

- Combined visibility with **Rumster** (Volume 3a - Figure 14.8.16) across sweeping moorland and moorland slopes and hills to the west and east and down to coast to the south of Rumster site, including sections of the A99. Scattered combined visibility from the inland areas of mixed agriculture and settlement to the north of Wick. Distant visibility shown across Moray;
- Combined visibility with **Cogle Moss** (Volume 3a - Figure 14.8.17) largely across north east corner of Caithness and coastal areas around Wick including along the A99 between Wick and John o'Groats. Limited combined visibility from areas to the south of Wick, including coastal edge and A99;
- Combined visibility with **Lochend Farm** (Volume 3a - Figure 14.8.18) largely across north east corner of Caithness and coastal areas around Wick including along the A99 between Wick and John o'Groats. Limited combined visibility from areas to the south of Wick, including coastal edge and A99;
- Combined visibility with **Navidale** (Volume 3a - Figure 14.8.19) across moorland slopes and hills around the site and including areas close to shore and the A9, Far North Line rail route around Navidale. High tops of lone mountains. From Brora and Dornoch and around the Dornoch Firth and on the sweeping moorland and coastal areas east of Latheron and along the A99 and A9 road corridors in the vicinity;
- Combined visibility with **Golticlay** (Volume 3a - Figure 14.8.20) across the sweeping moorland and small farms and crofts landscape down to the coast around Latheron, including the A9 and A99 corridors. Scattered combined visibility across the sweeping moorland the west of the site and across the inland areas of mixed agriculture and settlement to the north and west of Wick;
- Combined visibility with **West Garty** (Volume 3a - Figure 14.8.21) across moorland slopes and hills around the site and including areas close to shore and the A9, Far North Line rail route around Navidale. High tops of lone mountains. From Brora and Dornoch and around the Dornoch Firth and on the sweeping moorland and coastal areas east of Latheron and along the A99 and A9 road corridors in the vicinity;
- Combined visibility with **Boyndie** (Volume 3a - Figure 14.8.22) and its extension across limited areas of Aberdeenshire and eastern Moray including sections of the coast around Portnockie and Portsoy. Scattered combined visibility across areas inland from Lossiemouth including coastal areas to the east;
- Combined visibility with **Aultmore** (Volume 3a - Figure 14.8.23) across limited areas of Aberdeenshire and eastern Moray including sections of the coast around Portnockie and Portsoy. Scattered combined visibility across areas inland from Lossiemouth including coastal areas to the east; and
- Combined visibility with **Lurg Hill** and **Netherton of Windyhill** (Volume 3a - Figure 14.8.24) across limited areas of Aberdeenshire and eastern Moray including sections of the coast around Portnockie and Portsoy. Scattered combined visibility across areas inland from Lossiemouth including coastal areas to the east.

14.8.4 Key Issues for Cumulative Assessment

14.8.4.1 The pattern of wind energy development and inter-visibility identified in the Study Area and the CZTVs raises several key issues for the CLVIA, as follows:

- The combination of BOWL and Moray East along with the onshore wind farms creates high levels of effect and cumulative effect, particularly along the northern Caithness coast where these wind farms would be seen in combination and sequentially. Such effects have been identified in the BOWL ES (2012) and the Moray East ES (2012);

- Cumulative effect of the Development as a southerly extension to BOWL and Moray East, as the closest offshore wind farms, to which the Development will directly relate and be viewed, generally in combination;
- In general, the potential for cumulative effects is limited by the location of the Development which is visually separate from onshore wind farms, such that onshore and offshore wind farms are rarely seen in combination in the same portion of view. Coastal viewpoints are particularly focused towards the sea, or contained by coastal landforms, with limited inland visibility. The Development is generally seen in succession or in sequence with onshore wind farms, visually separated from the pattern of onshore wind farm development;
- Cumulative landscape and visual effect of the Development on the coastal edge and hinterland of east Caithness with BOWL, Moray East and onshore wind farms near the coast (Buolfruich, Rumster, Burn of Whilk, Stroupster);
- Simultaneous and sequential cumulative visual effects on views experienced by motorists on the A9 and A99 road corridors with BOWL and Moray East Offshore Wind Farm and onshore wind farms visible from coastal edge and in the peatlands, moorland and coniferous plantations to the south of the A822 and south of Spittal on the A9 (Causeymire, Halsary, Bad a'Cheo, Achlachan 1&2, Flex Hill, Achairn, Wathegar and Camster), in views from the inland area of mixed agriculture and settlement to the north of the Study Area; and
- Extent to which the addition of the Development may increase the influence of wind farms as a characteristic element or create a character change to a 'wind farm seascape / landscape'.

14.8.4.2 These aspects are assessed in the following assessment of cumulative effects on seascape / landscape character and views and a series of conclusions are drawn which address these key issues. The cumulative assessment is undertaken for the landscape and visual receptors assessed in Section 14.7. The range of viewpoints is representative and adequate for cumulative assessment purposes.

14.8.5 Cumulative Visual Effects – with Operational, Consented and Application Wind Farms

14.8.5.1 The assessment of cumulative effects on views is carried out with consideration of the same visual receptors and viewpoints assessed in Section 14.7.3. The methodology for the assessment of cumulative effects on views is described in Volume 4 - Technical Appendix 14.1.

14.8.5.2 The assessment of cumulative effects on views assesses the additional effects arising from the addition of the Development to the other wind farms assumed to be part of the landscape in two scenarios: consented and application. The sensitivity of each viewpoint is repeated from the viewpoint assessment in and the cumulative magnitude of change is described further for each viewpoint in each scenario.

14.8.5.3 Onshore wind farms where they are located at distances of greater than 50 km are not shown in the wirelines or included in the cumulative assessment as they are unlikely to materially contribute to significant effects arising from the Development due to their distance and the smaller scale of the onshore wind farms.

Cumulative Visual Effects Scoped Out of the Assessment

14.8.5.4 The main assessment has considered the effect of the addition of the Development to BOWL and the other operational and under construction wind farms and therefore this assessment is not repeated.

14.8.5.5 As set out in Section 14.8.4 above the operational and consented wind farm scenarios will create high levels of cumulative effect through their interaction and relationship to the visual receptors and viewpoints even without the introduction of the Development. This will particularly be the case along the northern Caithness coast. Therefore, the introduction of the Development to the views from viewpoints and receptors there would not give rise to significant cumulative effects, as these would, in effect, already exist i.e. views are already defined by the presence of wind farm development.

14.8.5.6 The additional effect that would occur through the addition of the Development would be that it would increase the turbine density in the parts of the views where it appears to overlap with BOWL and Moray East and extend the turbine extents to the south with taller, less dense, turbine spacing.

14.8.5.7 Aspects of the effects of the addition of the Development have already been accounted for in the main assessment in Section 14.7 so that the key difference is that the receiving seascape has, in the consented scenario, a larger number of turbines offshore to the north to which the Development is then added.

14.8.5.8 Further development onshore in northern Caithness that is to be considered in the consented and application scenarios would add to the wind farm development through the addition of Wathegar 2 as part of an existing group of wind farms and Cogle Moss would add a further onshore wind farm to sequential views from the A99 and would appear as part of a group in views from Keiss. The addition of these sites does not have a material influence on the cumulative context in considering the cumulative effect of the Development, where its main additional influence is on receptors further to the south.

14.8.5.9 In considering these factors there would be an increased level of cumulative effect as a result of the Development in northern Caithness. However, such effects would not be significant. Such a finding applies to the following viewpoints and receptors:

- Viewpoint 1: Duncansby Head;
- Viewpoint 2: Keiss (A99);
- Viewpoint 3: Wick (path south of South View);
- Wick;
- Keiss;
- Thrumster; and
- A99 between Wick and Ulbster.

Cumulative Effects on Representative Viewpoints

14.8.5.10 The assessment of cumulative effects on viewpoints not scoped out is presented in Table 14.8.4 below.

Table 14.8.4: Assessment of Cumulative Effects on Representative Viewpoints

Viewpoint	Sensitivity	Cumulative Scenario	Wind Farms Visible	Cumulative Magnitude of Change	Significance of Cumulative Effect
4 Sarclet (Sarclet Haven Info Board) Volume 3b - Figure 14.7.12	Medium-high	Consented	BOWL Moray East Burn of Whilk	Increased density and number of moderately sized offshore turbines in sea to north resulting from BOWL and Moray East. Development seen to increase density in part and as a further extension to BOWL and Moray East to the south with taller moving turbines with, less dense turbine spacing. The difference is turbine scale is less apparent here due to the closer proximity of BOWL. Development occurs in vicinity of Beatrice oil platforms and in the vicinity of the operational Beatrice Demonstrator Turbines. Combined visibility with Burn of Whilk inland in separate part of landscape. **Cumulative magnitude of change - medium**	Significant, negative, long term, reversible
		Application	None	None	None
5 Whaligoe Steps Volume 3b - Figure 14.7.13	Medium-high	Consented	BOWL Moray East	Increased density and number of moderately sized offshore turbines in sea to north resulting from BOWL and Moray East. Development seen to increase density in part and as a further extension to BOWL and Moray East to the south with taller moving turbines with, less dense turbine spacing. The difference is turbine scale is less apparent here due to the closer proximity of BOWL. Development occurs in vicinity of Beatrice oil platforms and in the vicinity of the operational Beatrice Demonstrator Turbines. **Cumulative magnitude of change - medium**	Significant, negative, long term, reversible
		Application	None	None	None
6 Minor Road (south east of Osclay)	Medium	Consented	BOWL Moray East	Influence on view by BOWL and Moray East relatively limited due to intervening landform. Development seen to increase density in part and as a further extension to BOWL and Moray East to the south with taller moving turbines with, less dense turbine spacing	Not significant, negative, long

Table 14.8.4: Assessment of Cumulative Effects on Representative Viewpoints					
Viewpoint	**Sensitivity**	**Cumulative Scenario**	**Wind Farms Visible**	**Cumulative Magnitude of Change**	**Significance of Cumulative Effect**
Volume 3b - Figure 14.7.14			Burn of Whilk Osclay Quarry Rumster	Development occurs in vicinity of Beatrice oil platforms and in the vicinity of the operational Beatrice Demonstrator Turbines. Combined, in combination, turbine visibility with Osclay Quarry single turbine close to viewpoint. Combined, in succession visibility with the three relatively small turbines of Rumster. **Cumulative magnitude of change -low-medium**	term, reversible
		Application	As consented plus: Navidale Golticlay	Additional influences: Combined, in succession visibility with Navidale in the distance, may be screened by intervening woodland from this location. Combined, in succession visibility of close range Golticlay. **Cumulative magnitude of change - medium**	Significant, negative, long term, reversible
7 Lybster (end of Main Street) Volume 3b - Figure 14.7.17	Medium-high	Consented	BOWL Moray East Burn of Whilk Buolfruich Osclay Quarry Rumster	Increased density and number of apparently small/medium sized offshore turbines in sea to north resulting from BOWL and Moray East. Development seen to increase density in part and as a further extension to BOWL and Moray East to the south with taller moving turbines with, less dense turbine spacing. Development occurs in vicinity of Beatrice oil platforms and in the vicinity of the operational Beatrice Demonstrator Turbines. Theoretical combined, in succession visibility with Burn of Whilk, Rumster and Osclay Quarry inland in separate part of landscape – not visible from this location but from other parts of the village/rears of houses. Buolfruich not readily noticeable due to limited extents visible and range. **Cumulative magnitude of change - medium**	Significant, negative, long term, reversible
		Application	As above plus: Golticlay Navidale West Garty	Combined, in succession visibility with distant Navidale and West Garty set back from coast and in the same part of the view. Theoretical, combined, in succession visibility with Golticlay inland although not visible from this location. **Cumulative magnitude of change - medium**	Significant, negative, long term, reversible

Table 14.8.4: Assessment of Cumulative Effects on Representative Viewpoints

Viewpoint	Sensitivity	Cumulative Scenario	Wind Farms Visible	Cumulative Magnitude of Change	Significance of Cumulative Effect
8 Latheron (A9) Volume 3b - Figure 14.7.16	Medium-high	Consented	BOWL Moray East	Increased density and number of apparently small offshore turbines in sea to north resulting from BOWL and Moray East. Development seen to increase density in part and as a further extension to BOWL and Moray East to the south with taller moving turbines with, less dense turbine spacing. Development occurs in vicinity of Beatrice oil platforms and in the vicinity of the operational Beatrice Demonstrator Turbines. **Cumulative magnitude of change: medium**	Significant, negative, long term, reversible
		Application	None	None	None
9a Dunbeath (nr Heritage Centre) Volume 3b - Figure 14.7.17	Medium-high	Consented	Moray East BOWL	Increased density and number of apparently small sized offshore turbines in sea to north resulting from BOWL and Moray East. Moray East extends offshore wind farm influence across substantial additional section of open sea view from this location where the sea views are constrained by landform. Development seen to increase density across centre of view and as a further extension to BOWL and Moray East to the south with taller moving turbines with, less dense turbine spacing Development occurs in vicinity of Beatrice oil platforms and in the vicinity of the operational Beatrice Demonstrator Turbines. Development fills remaining part of open sea view. **Cumulative magnitude of change: medium**	Significant, negative, long term, reversible
		Application	None	None	None
9b Dunbeath (by harbour) Volume 3b - Figure 14.7.18	Medium-high	Consented	Moray East	Moray East extends offshore wind farm influence across a relatively small section of open sea view from this location where the sea views are constrained by landform so that BOWL is hidden. Development seen to increase density across part of view and as a further extension to Moray East to the south with taller turbines and less dense, turbine spacing.	Significant, negative, long term, reversible

Table 14.8.4: Assessment of Cumulative Effects on Representative Viewpoints

Viewpoint	Sensitivity	Cumulative Scenario	Wind Farms Visible	Cumulative Magnitude of Change	Significance of Cumulative Effect
				Development occurs in vicinity of Beatrice oil platforms and in the vicinity of the operational Beatrice Demonstrator Turbines. Development fills a large proportion of the open sea views. **Cumulative magnitude of change: medium**	
		Application	None	None	None
10 Morven Volume 3b - Figure 14.7.19	Medium-high	Consented	BOWL Moray East Causeymire Achlachan 1&2 Lochend Farm Stroupster Bad a'Cheo Halsary Cogle Moss Flex Hill/Bilbster Whathegar 1&2 Camster Achairn Rumster Buolfruich	Increased density and number of offshore turbines in sea to north resulting from BOWL and Moray East. Moray East extends offshore wind farm influence across additional section of open sea view from this location. This extends the offshore wind farm influence across the sea views above the notable hill formations of the Scarabens and Sron Gharbh. This occurs at a range of 49.3 km and therefore would only be visible in excellent conditions. Development seen to increase density across a section of the skyline affected by BOWL (41 km distant) and Moray East and as a further extension to BOWL and Moray East to the south with taller turbines and less dense, turbine spacing. The vertical extent of the field of view affected by the Development (and the other offshore wind farms) is greater from here as the elevation allows the turbine bases to be visible in very good or excellent conditions. The larger comparative height and closer proximity of the Development to the viewpoint means that the turbines would appear larger than those of the other offshore wind farms. Theoretical combined, in succession visibility with Causeymire, Achlachan 1&2, Lochend Farm, Stroupster, Bad a'Cheo, Halsary, Cogle Moss, Flex Hill/Bilbster, Whathegar 1&2, Camster, Achairn, Rumster, Buolfruich, Burn of Whilk, Osclay Quarry, Kilbraur, Gordonbush & Extension inland in separate part of landscape. Kilbraur and Gordonbush (and its consented extension) occur within a small field of view to the south west. A substantial section of the views across the most valued landscape (across the Fens to the lone mountains) remains undeveloped.	Not significant, negative, long term, reversible

Table 14.8.4: Assessment of Cumulative Effects on Representative Viewpoints					
Viewpoint	**Sensitivity**	**Cumulative Scenario**	**Wind Farms Visible**	**Cumulative Magnitude of Change**	**Significance of Cumulative Effect**
			Burn of Whilk Osclay Quarry Kilbraur Gordonbush & Extension	A loose cluster of the other onshore wind farms occurs across approximately 40 degrees of the field of view to the north east. It is set back slightly from the coast and at a range of greater than 16.7 km from this viewpoint and extending into the distance. Development occurs in vicinity of Beatrice oil platforms and in the vicinity of the operational Beatrice Demonstrator Turbines. As the Development appears as an extension to other substantial offshore wind farms this ensures that additional effects occur within a similar part of the wide panoramic views so that further parts of the view are not affected. **Cumulative magnitude of change: medium-low**	
		Application	As consented plus: East Kirk Golticlay Navidale West Garty	East Kirk and Golticlay will add further turbines and density of wind farms to the loose cluster to the north east. Navidale adds an onshore wind farm close to the coast and visible on the skyline at a range of 9.8 km. The Development would be seen simultaneously with Navidale. West Garty would also add an onshore wind farm close to the coast and visible against a sea backdrop and the Moray coast. The Development would be seen in succession with West Garty. These two wind farms extend wind farm influence across the currently undeveloped panoramic view between the Kilbraur/Gordonbush incidence of visibility and the coast and closer to the Development. The addition of the Development would mean that the separation between wind farms out at sea and on the land, would be reduced and that incidences of wind farm views would extend across a much further field of view simultaneously and in succession.	Significant, negative, long term, reversible
11 Berriedale (A9) Volume 3b - Figure 14.7.20	Medium-high	Consented	BOWL Moray East Osclay Quarry Burn of Whilk	Increased density and number of apparently small offshore turbines in sea to north resulting from BOWL and Moray East. Development seen to increase density in part and as a further extension to BOWL and Moray East to the south with taller moving turbines and less dense, turbine spacing. This extends the field of view affected by turbine visibility across a wide part of the open sea views. Development occurs in vicinity of Beatrice oil platforms and in the vicinity of the operational Beatrice Demonstrator Turbines.	Significant, negative, long term, reversible

Table 14.8.4: Assessment of Cumulative Effects on Representative Viewpoints					
Viewpoint	**Sensitivity**	**Cumulative Scenario**	**Wind Farms Visible**	**Cumulative Magnitude of Change**	**Significance of Cumulative Effect**
				Theoretical combined, in succession visibility with Burn of Whilk and Osclay Quarry in separate part of landscape. **Cumulative magnitude of change: medium**	
		Application	As consented plus: Golticlay	Golticlay adds to the onshore wind farm effects in the views to the north east but does not markedly alter the cumulative effect of adding the Development.	No further cumulative effect as a result of the addition of the Development.
12 Navidale Volume 3b - Figure 14.7.21	Medium-high	Consented	BOWL Moray East	Increased density and number of apparently small offshore turbines in sea to north resulting from BOWL and Moray East. Moray East extends offshore wind farm influence across substantial additional section of open sea view from this location where the sea views are constrained by landform. Development seen to increase density across centre of view and as a further extension to BOWL and Moray East to the south with taller, moving turbines and less dense, turbine spacing. Development occurs in vicinity of Beatrice oil platforms and in the vicinity of the operational Beatrice Demonstrator Turbines. Development extends offshore wind farm across a further large part of the of open sea view. **Cumulative magnitude of change: medium**	Significant, negative, long term, reversible
		Application	As consented plus: Navidale	One blade and one blade tip (not shown on wireline) visible of Navidale at relatively close range inland from the coast.	No further cumulative effect as a result of the addition of the Development.

Table 14.8.4: Assessment of Cumulative Effects on Representative Viewpoints

Viewpoint	Sensitivity	Cumulative Scenario	Wind Farms Visible	Cumulative Magnitude of Change	Significance of Cumulative Effect
13a Brora (picnic area off Salt Street) Volume 3b - Figure 14.7.22	Medium-high	Consented	BOWL Moray East	Although the turbines of BOWL and Moray East are shown in the wirelines and CZTVs to be theoretically visible the extent of this visibility and the distance means that this is unlikely to be noticeable in most conditions with the naked eye. **Cumulative magnitude of change: low**	Not significant, negative, long term, reversible
		Application	As consented plus: Navidale West Garty	Navidale adds an onshore wind farm close to the coast and visible on the skyline at a range of 10.8 km. The Development would be seen simultaneously with Navidale. West Garty would also add an onshore wind farm close to the coast. The Development would be seen simultaneously with West Garty. The Development would be seen in a different part of the view and within the seascape rather than within a landscape setting. **Cumulative magnitude of change: medium-low**	Not significant, negative, long term, reversible
13b Dornoch (beach parking) Volume 3b - Figure 14.7.23	Medium-high	Consented	BOWL Moray East	None	None
		Application	As consented plus: Navidale West Garty	Navidale adds an onshore wind farm close to the coast and visible on the skyline at a range of 37.6 km. The Development would be seen simultaneously with Navidale. West Garty would also add an onshore wind farm close to the coast at a range of 28.2 km. The Development would be seen simultaneously with West Garty. The Development would be seen in the distance across a small part of the of the view and within the seascape rather than within a landscape setting. **Cumulative magnitude of change: low**	Not significant, negative, long term, reversible
14 Tarbat Ness Lighthouse Volume 3b - Figure 14.7.24	Medium-high	Consented	BOWL Moray East Gordonbush Extension Kilbraur	Although the turbines of BOWL and Moray East are shown in the wirelines and CZTVs to be theoretically visible the extent of this visibility and the distance means that this is unlikely to be noticeable in most conditions with the naked eye. The Kilbraur and Gordonbush Extension wind farms are shown to be theoretically visible in succession as blades and blade tips. At distances of around 25 km these are unlikely to be readily noticeable.	Not significant, negative, long term, reversible

Table 14.8.4: Assessment of Cumulative Effects on Representative Viewpoints

Viewpoint	Sensitivity	Cumulative Scenario	Wind Farms Visible	Cumulative Magnitude of Change	Significance of Cumulative Effect
				Cumulative magnitude of change: low	
		Application	As consented plus: Navidale West Garty	Navidale adds an onshore wind farm close to the coast and visible on the skyline at a range of 32.6 km. The Development would be seen simultaneously with Navidale. West Garty would also add an onshore wind farm close to the coast at a range of 25.8 km. The Development would be seen simultaneously with West Garty. The Development would be seen in the distance of 36.8 km across a relatively small part of the of the view and within the seascape rather than within a landscape setting. **Cumulative magnitude of change: low**	Not significant, negative, long term, reversible
15 Burghead Visitor Centre Volume 3b - Figure 14.7.25	Medium-high	Consented	BOWL Moray East Kilbraur	Although the turbines of BOWL and Moray East are shown in the wirelines and CZTVs to be theoretically visible the extent of this visibility and the distance means that this is unlikely to be noticeable in most conditions with the naked eye. There are some turbines of Moray East that are visible down to hub height and these may be visible at a range of 55. 3 km only in excellent weather conditions. The Development would be seen simultaneously in a similar part of the view to these turbine blades. The Kilbraur wind farm is shown to be theoretically visible in succession as blade tips. At a distance of around 49 km these are unlikely to be readily noticeable. **Cumulative magnitude of change: low**	Not significant, negative, long term, reversible
		Application	As consented plus: Navidale West Garty	Navidale adds an onshore wind farm close to the coast and visible on the skyline at a range of 49.9 km. The Development would be seen simultaneously with Navidale in excellent weather conditions. West Garty would also add an onshore wind farm close to the coast at a range of 46.6 km. The Development would be seen simultaneously with West Garty. The Development would be seen in the distance of 37.7 km across a relatively small part of the view and within the seascape rather than within a landscape setting. **Cumulative magnitude of change: low**	Not significant, negative, long term, reversible

Table 14.8.4: Assessment of Cumulative Effects on Representative Viewpoints					
Viewpoint	**Sensitivity**	**Cumulative Scenario**	**Wind Farms Visible**	**Cumulative Magnitude of Change**	**Significance of Cumulative Effect**
16 Lossiemouth Harbour Volume 3b - Figure 14.7.26	Medium-high	Consented	BOWL Moray East Boyndie Cairnton Road Ley Farm Aultmore Followsters Newmill	Although the turbines of BOWL and Moray East are shown in the wirelines and CZTVs to be theoretically visible the extent of this visibility and the distance means that this is unlikely to be noticeable in most conditions with the naked eye. There are some turbines of Moray East that are visible down to hub height and these may be visible at a range of 45.8 km only in excellent weather conditions. The Development would be seen simultaneously in a similar part of the view to these turbine blades. Boynde, Cairnton Road and Followsters Newmill are unlikely to be noticeable due to the extent of their visibility and their distance to the viewpoint. Ley Farm single turbine, at 31 km, may be visible in very good weather conditions but makes only a minimal contribution to the cumulative context. The Aultmore wind farm is shown to be theoretically visible in succession at a distance of around 25.8 km. This may be more visible from other parts of Lossiemouth and is set back in the landscape from the coast. It affects a small part of the field of view. The Development would be seen in succession with Aultmore, located within a separate part of the view in the seascape. **Cumulative magnitude of change: low**	Not significant, negative, long term, reversible
		Application	As consented plus: West Garty Lurg Hill	West Garty would also add an onshore wind farm close to the coast at a range of 50 km. The Development would be seen simultaneously with West Garty only in excellent weather conditions. Lurg Hill would be seen in a similar part of the view to Aultmore from this location so that its addition would add little to the cumulative context to which the Development would be added.	Not significant, negative, long term, reversible
17 Buckie (Cliff Terrace) Volume 3b - Figure 14.7.27	Medium-high	Consented	BOWL Moray East	Although the turbines of BOWL are shown in the wireline and CZTV to be theoretically visible the distance of 57.6 km means that it is unlikely to be noticeable in most conditions with the naked eye. There are some of the closest turbines of Moray East that are visible to almost their full extent and may be visible at a range of 44.38 km in excellent weather conditions. The more distant turbines are substantially screened due to the curvature of the earth. The Development would be seen simultaneously in a similar part of the view to the closest of these turbines.	Significant, negative, long term, reversible

Table 14.8.4: Assessment of Cumulative Effects on Representative Viewpoints					
Viewpoint	**Sensitivity**	**Cumulative Scenario**	**Wind Farms Visible**	**Cumulative Magnitude of Change**	**Significance of Cumulative Effect**
				In such conditions the Development would be seen to extend moving offshore wind farms across 29 degrees of the extent of the open sea views at a range of 39.7 km in excellent conditions. The divergence in the scale and density of the Development when compared with Moray East increases the cumulative magnitude of change, however, at their distant range these will not often be visible and would appear as small scale features. **Cumulative magnitude of change: medium-low**	
		Application	None	None	None
18 Bin Hill Volume 3b - Figure 14.7.28	Medium-high	Consented	BOWL Moray East Boyndie Cairnton Road Badentoul Braeside Netherton of Windyhills Balnamoon Aultmore Followsters Newmill Bognie Farm	Although the turbines of BOWL are shown in the wireline and CZTV to be theoretically visible the extent of this visibility and the distance means that this is unlikely to be noticeable in most conditions with the naked eye. There are some turbines of Moray East that are visible as parts of towers and down to hub height and these may be visible at a range of 45.64 km in excellent weather conditions. The Development would be seen simultaneously in a similar part of the view and as an extension to it, visible generally within the same excellent weather conditions as moving turbines at a range of 43 km. In such conditions the Development would be seen to extend offshore wind farms across a wide extent of the open sea views and across the distant landform of the Caithness coast. The divergence in the scale and density of the Development when compared with Moray East increases the cumulative magnitude of change Boynde, Cairnton Road and Ley Farm, Badentoul, Braeside, Netherton of Windyhills, Balnamoon and Aultmore are shown to be theoretically visible in succession across the landscape at relatively close to moderate distances from the viewpoint. Together they add wind farm characteristics to the views of the landscape to the east and south of the viewpoint. Aultmore, due to its scale and proximity will have the most prominent onshore wind farm influence. The Development would be seen in succession with these wind farms located within a separate part of the panoramic views in the seascape.	Not significant, negative, long term, reversible

Table 14.8.4: Assessment of Cumulative Effects on Representative Viewpoints					
Viewpoint	**Sensitivity**	**Cumulative Scenario**	**Wind Farms Visible**	**Cumulative Magnitude of Change**	**Significance of Cumulative Effect**
				Bognie Farm and Followsters Newmill add little to the cumulative context to which the Development would be added. **Cumulative magnitude of change: medium-low**	
		Application	As consented plus: Lurg Hill	Lurg Hill would be seen across a relatively small section of the field of view at a range of 6.4 km. This would add to the wind farm context inland. The Development would be seen in succession with the onshore wind farms located within a separate part of the panoramic views in the seascape and in a similar part of the sea view to Moray East.	Not significant, negative, long term, reversible
19 Portnockie (Bow Fiddle Rock Info Point) Volume 3b - Figure 14.7.29	Medium-high	Consented	BOWL Moray East	Although the turbines of BOWL are shown in the wireline and CZTV to be theoretically visible the distance of 53.3 km means that it is unlikely to be noticeable in most conditions with the naked eye. There are some turbines of Moray East that are visible to almost their full extent and may be visible at a range of 41.2 km in excellent weather conditions. The Development would be seen simultaneously in a similar part of the view to these turbines. In such conditions the Development would be seen to extend moving offshore wind farms across a wide extent of the open sea views at a range of 39.11 km. The Development would be seen to extend close to the distant landform of the Caithness coast. The divergence in the scale and density of the Development when compared with Moray East increases the cumulative magnitude of change. **Cumulative magnitude of change: medium-low**	Significant, negative, long term, reversible
		Application	None	None	None
20 Cullen (viaduct) Volume 3b - Figure 14.7.30	Medium-high	Consented	BOWL Moray East	Although the turbines of BOWL are shown in the wireline and CZTV to be theoretically visible the distance of 55 km means that it is unlikely to be noticeable in most conditions with the naked eye. There are some turbines of Moray East that are visible to almost their full extent and may be visible at a range of 42.9 km in excellent weather conditions. The Development would be seen simultaneously in a similar part of the view to these turbines.	Significant, negative, long term, reversible

Table 14.8.4: Assessment of Cumulative Effects on Representative Viewpoints					
Viewpoint	**Sensitivity**	**Cumulative Scenario**	**Wind Farms Visible**	**Cumulative Magnitude of Change**	**Significance of Cumulative Effect**
				In such conditions the Development would be seen to extend moving offshore wind farms across a wide extent of the open sea views at a range of 41.2 km. The divergence in the scale and density of the Development when compared with Moray East increases the cumulative magnitude of change. The Development would be seen to extend close to the apparent distant landform of the Caithness coast. **Cumulative magnitude of change: medium-low**	
		Application	None	None	None
21 Findlater Castle Volume 3b - Figure 14.7.31	Medium-high	Consented	BOWL Moray East	Although the turbines of BOWL are shown in the wireline and CZTV to be theoretically visible the distance of 55.5 km means that it is unlikely to be noticeable in most conditions with the naked eye. There are some turbines of Moray East that are visible to almost their full extent and may be visible at a range of 43.2 km in excellent weather conditions. The Development would be seen simultaneously in a similar part of the view to these turbines. In such conditions the Development would be seen to extend moving offshore wind farms across a wide extent of the open sea views at a range of 42.3 km. The divergence in the scale and density of the Development when compared with Moray East increases the cumulative magnitude of change. The Development would be seen to extend across the distant landform of the Caithness coast. **Cumulative magnitude of change: medium-low**	Significant, negative, long term, reversible
		Application	None	None	None
22 Sandend Volume 3b - Figure 14.7.32	Medium-high	Consented	BOWL Moray East Cairnton Road	Although the turbines of BOWL are shown in the wireline and CZTV to be theoretically visible the distance of 56.7 km and limited extent of visibility means that it is unlikely to be noticeable in most conditions with the naked eye.	Not significant, negative, long term, reversible

Table 14.8.4: Assessment of Cumulative Effects on Representative Viewpoints					
Viewpoint	**Sensitivity**	**Cumulative Scenario**	**Wind Farms Visible**	**Cumulative Magnitude of Change**	**Significance of Cumulative Effect**
				There are some turbines of Moray East that are theoretically visible to below hub height and may be visible at a range of 44.4 km in excellent weather conditions. The Development would be seen simultaneously in a similar part of the view to these turbines. In excellent weather conditions the Development would be seen to extend moving offshore wind farms across a narrow extent of the wide sea views at a range of 43.7 km. The scale of the turbines at this range would be relatively small. Cairnton Road adds little to the cumulative context of the Development due to its limited theoretical visibility and screening by intervening woodland. **Cumulative magnitude of change: low**	
		Application	None	None	None
23 Portsoy Volume 3b - Figure 14.7.33	Medium-high	Consented	BOWL Moray East	Although the turbines of BOWL are shown in the wireline and CZTV to be theoretically visible the distance of 57.2 km and limited extent of visibility means that it is unlikely to be noticeable in most conditions with the naked eye. There are some turbines of Moray East that are theoretically visible to below hub height and may be visible at a range of 44.8 km in excellent weather conditions. The Development would be seen simultaneously in a similar part of the view to these turbines. In excellent visibility conditions the Development would be seen to extend moving offshore wind farms across approximately 29.5 degrees of the wide, panoramic sea views at a range of 44.7 km. The Development turbines would be seen as relatively small scale features at this range and would not be seen to their full extent due to the curvature of the earth, further reducing their vertical scale. The Development would be seen to partially extend across very the distant landform of the Caithness coast. **Cumulative magnitude of change: medium-low**	Not significant, negative, long term, reversible
		Application	None	None	None

Cumulative Effects on Principal Visual Receptors

14.8.5.11 From an analysis of the pattern of significant cumulative effects on the representative viewpoints it is possible to extrapolate the potential for significant cumulative effects on the concentrations of visual receptors along the coasts of Caithness, Sutherland and Moray, where it is considered there may also be significant cumulative effects due to the combination of sensitivity and cumulative magnitude of change.

14.8.5.12 Reference has also been made to the findings of the visual receptor assessments in Section 14.7.3 and the Cumulative ZTVs on Volume 3a - Figures 14.8.1– 14.8.24 to provide an indication of the extent of the routes and settlements that may be affected in this way.

14.8.5.13 It is assessed that no significant cumulative effects would arise in Aberdeenshire and that significant cumulative effects may arise on the following coastal receptors within Highland and Moray:

Highland – in the Consented Scenario

- When visibility is very good or excellent – parts of the settlements of Lybster, Latheronwheel, Dunbeath and East Helmsdale where they have open sea views towards the Development and BOWL and Moray East from the east round to the south or north east depending on the location of the settlement;
- When visibility is very good or excellent - on the views obtained predominantly by north bound travellers from the A9 between east of Crakaig and west of Ousedale and by north and south bound travellers between east of Berriedale and west of Latheron where they have open sea views towards the Development and BOWL/Moray East;
- When visibility is very good or excellent - on the views obtained from the A99 between Latheron and north of Ulbster where they have open sea views towards the Development and BOWL and Moray East as well as sequential/successive visibility of Burn of Whilk, Osclay Quarry and Rumster onshore wind farms inland; and
- When visibility is very good or excellent – on the views obtained from the Far North Line from between 1 km east of Crakaig and Helmsdale where they have open sea views towards the Development and BOWL and Moray East.

Highland - in the Application Scenario

- When visibility is very good or excellent – parts of the settlements of Lybster where there may also be visibility of the Development in the context of successive views of Golticlay, West Garty and Navidale in addition to views of the operational wind farms; and
- When visibility is very good or excellent – from the A99 approximately between Latheron and Clyth where successive and sequential relatively close range views of Golticlay and more distant views of Navidale and West Garty occur along with other operational wind farms (Burn of Whilk).

Moray – in the Consented Scenario

- When visibility is excellent - parts of the settlements of Kingston, Portgordon, Buckie, Findochty, Portnockie and Cullen where open sea views towards the Development and Moray East in the north are possible;
- When visibility is excellent - Moray Coastal Trail – where it runs along the coast between Lossiemouth and Kingston, in the vicinity of the Scottish Dolphin Centre at Spey Bay, where it runs along the edge of the Spey Bay Golf Course, where it crosses the open fields to Portannachy and thereafter where it follows the coast to Cullen Bay where open sea views towards the Development and Moray East in the north are possible. This is with the

exception of the section running along the western part of the beach at Cullen where the effect would be not significant due to the lack of visibility of the Development; and

- When visibility is excellent NCR 1 – Portgordon to Buckie, east of Findochty to Portknockie and the southern section of the route along the viaduct in Cullen where open sea views towards the Development and Moray East in the north are possible.

Moray - in the application scenario

- No further significant cumulative effects would arise on the principal visual receptor concentrations.

14.8.6 Cumulative Operational Seascape/Landscape Effects – with Operational, Consented and Application Wind Farms

14.8.6.1 From fieldwork, review of further wirelines and an analysis of the pattern of significant cumulative effects on the representative viewpoints it is possible to extrapolate the potential for significant cumulative effects on the seascape/landscape receptors along the coasts of Caithness, Sutherland and Moray, where it is considered there may also be significant cumulative effects due to the combination of sensitivity and cumulative magnitude of change, particularly where onshore wind farms may be located within or close to the character receptor itself. This is possible because the cumulative effect on each of these receptors where significant seascape/landscape character effects may arise as a result of the addition of the Development is through visibility and not through any physical alteration to the receptor itself.

14.8.6.2 Reference has also been made to the findings of the seascape/landscape assessment in Section 14.7.4 and CZTVs in Section 14.8.1 to 14.8.24 to provide an indication of the extent of the seascape/landscape receptors that may be affected in this way.

14.8.6.3 It is assessed that no significant cumulative seascape/landscape character effects would arise on the coast of Moray or Aberdeenshire. This is due largely to the distance and separation between the coast and the Development/Moray East.

14.8.6.4 Significant cumulative effects may arise on the following coastal seascape/landscape receptors in Highland:

<u>In the Consented Scenario</u>

14.8.6.5 The Dunbeath Castle GDL;

- Coastal areas of the Flow Country and Berriedale Coast SLA between the A9 and the coast, which includes a section of the High Cliffs and Sheltered Bays LCT and the Moorland Slopes and Hills LCT, along with a section of the Helmsdale to Berriedale Coastal Shelf RCCA ;
- The RCCAs from the north of Helmsdale to the south of Sarclet Head including: part of the Helmsdale to Berriedale Coastal Shelf; Dunbeath Bay, Lybster Bay and Sarclet Head to the south west of Sarclet; and
- The coastal LCTs including: Coastal High Cliffs and Sheltered Bays north east of Helmsdale; the Moorland Slopes and Hills in the vicinity of Badbea and the south east facing slopes of Cnoc na Croiche; the Small Farms and Crofts LCT between Berriedale and Sarclet Head to the south of the A9.

14.8.6.6 It should be noted that all of these significant cumulative effects would arise as a result open sea views towards the Development in the context of BOWL and Moray East. All of these character receptors have been assessed in Section 14.7 as having the potential to experience significant effects as a result of the Development being added to the baseline context including BOWL.

In the Application Scenario

- The Coastal Shelf area of the Loch Fleet, Loch Brora and Glen Loth SLA, where the Development would also be seen in succession and sequentially with the West Garty onshore wind farm which would be seen at relatively close range;
- Coastal High Cliffs and Sheltered Bays and the Moorland Slopes and Hills LCTs north east of Helmsdale and in the vicinity of Badbea and Cnoc na Croiche where the Development would also be seen successively in the context Navidale, which would be visible at relatively close range. The north eastern part of this area, around Badbea is also concurrent with the Flow Country and Berriedale Coast SLA; and
- The Small Farms and Crofts LCT to the east of the A9 and approximately west of Upper Clyth due to the successive and sequential visibility of the Development in the context of Golticlay, which would be seen at relatively close range.

14.8.7 Summary of Cumulative Effects

14.8.7.1 The effect of the Development in the context of the baseline onshore and offshore wind farms was assessed in the project assessment.

14.8.7.2 The cumulative assessment considers the addition of the Development to two further scenarios. The first is described as the consented scenario and the second the application scenario.

14.8.7.3 Within Highland, in the consented scenario it has been assessed that when visibility is very good or excellent significant cumulative visual effects would arise on the representative viewpoints that are located between Viewpoint 4: Sarclet and Viewpoint 12: Navidale along the Highland coastline. This is with the exception of Viewpoint 6: Minor Road (south east of Osclay) and Viewpoint 10: Morven where it is assessed that the addition of the Development to the consented scenario would be not significant. There may also be significant cumulative effects on parts of the settlements of Lybster, Latheronwheel, Dunbeath and East Helmsdale and sections of the A9, the A99 and the Far North Line. These occur largely as a result of the Development being seen in the context of BOWL/Moray East but in some instances (A99) such effects arise due to sequential/successive visibility of Burn of Whilk, Osclay Quarry and Rumster onshore wind farms.

14.8.7.4 In the consented scenario the addition of the Development results in significant seascape/landscape cumulative effects arising at the Dunbeath Castle GDL; coastal areas of the Flow Country and Berriedale Coast SLA between the A9 and the coast, which includes a section of the High Cliffs and Sheltered Bays LCT and the Moorland Slopes and Hills LCT, along with a section of the Helmsdale to Berriedale Coastal Shelf RCCA; the RCCAs from the north of Helmsdale to the south of Sarclet Head including: part of the Helmsdale to Berriedale Coastal Shelf; Dunbeath Bay, Lybster Bay and Sarclet Head to the south west of Sarclet; and the coastal LCTs including: Coastal High Cliffs and Sheltered Bays north east of Helmsdale; the Moorland Slopes and Hills in the vicinity of Badbea and the south east facing slopes of Cnoc na Croiche; the Small Farms and Crofts LCT between Berriedale and Sarclet Head to the south of the A9.

14.8.7.5 Along the Moray coast, in the consented scenario, it has been assessed that when visibility is excellent, significant cumulative visual effects would arise on the representative viewpoints that are located between Viewpoint 17: Buckie (Cliff Terrace) and Viewpoint 21: Findlater Castle. This is with the exception of Viewpoint 18: Bin Hill where it is assessed that the addition of the Development to the consented scenario would be not significant. There may also be significant cumulative effects on parts of the settlements of Kingston, Portgordon, Buckie, Findochty, Portnockie and Cullen and sections of the Moray Coastal Trail and NCR 1. These occur as a result of the Development being seen in the context of Moray East.

14.8.7.6 It is assessed that the cumulative effects on the landscape/seascape receptors in the Moray/Aberdeenshire would be not significant in either the consented or the application scenario.

14.8.7.7 Within Highland, in the application scenario, it has been assessed that when visibility is very good or excellent further significant cumulative visual effects would arise on the representative viewpoints at Viewpoint 6: Minor Road (south east of Osclay) and Viewpoint 10: Morven. There may also be significant cumulative effects on parts of the settlement of Lybster and a section of the A99. This is a result of the Development also being seen in the context of Golticlay, West Garty and Navidale in addition to views of the operational wind farms.

14.8.7.8 In the application scenario the addition of the Development results in significant seascape/landscape cumulative effects arising within Highland within the Coastal Shelf area of the Loch Fleet, Loch Brora and Glen Loth SLA, where the Development would also be seen in succession and sequentially with the West Garty wind farm; the Coastal High Cliffs and Sheltered Bays and the Moorland Slopes and Hills LCTs north east of Helmsdale and in the vicinity of Badbea and Cnoc na Croiche where the Development would also be seen successively in the context Navidale wind farm. The north eastern part of this area, around Badbea is also concurrent with the Flow Country and Berriedale Coast SLA; and the Small Farms and Crofts LCT to the east of the A9 and approximately west of Upper Clyth due to the successive and sequential visibility of the Development in the context of Golticlay wind farm.

14.9 References

EDPR. (2012). Moray East Environmental Statement;

BOWL (2012). Environmental Statement;

DTI. (2005). Guidance on the Assessment of the Impact of Offshore Wind farms: Seascape and Visual Impact Report;

Landscape Institute and IEMA. (2013). Guidelines for Landscape and Visual Impact Assessment: Third Edition;

Landscape Institute. (2011) Use of Photography and Photomontage in Landscape and Visual Impact Assessment, Note 01/11;

Landscape Institute. (2017). Visual representation of development proposals LI Technical Guidance Note 02/2017;

SNH. (2012). Assessing the Cumulative Impact of Onshore Wind Energy Developments;

SNH. (2012) Offshore Renewables – guidance on assessing the impact on coastal landscape and seascape. Guidance for Scoping an Environmental Statement;

SNH. (2017). Visual Representation of Wind Farms (Version 2.2);

SNH. (2017). Siting and designing wind farms in the landscape - Version 3;

SNH. (2017). Guidance on Coastal Character Assessment Prepared by Carol Anderson Landscape Associates;

SNH. (2017) Scottish Natural Heritage consultation on draft guidance: Assessing impacts on Wild Land Areas – technical guidance;

SNH (2017). Wild Land Areas descriptions and maps. https://www.nature.scot/wild-land-area-descriptions;

The Highland Council (2016). Visualisation Standards for Wind Energy Developments;

The Highland Council in partnership with Scottish Natural Heritage (2011). Assessment of Highland Special Landscape Areas produced by Horner + Maclennan with Mike Wood, Landscape Architect;

The Highland Council (2017). Landscape Sensitivity Appraisal: Black Isle, Surrounding Hills and Moray Firth Coast Caithness – Version for Committee August 2017;

Moray Council (2012). Moray Wind Energy Landscape Capacity Study Final Main Study Report prepared by Alison Grant and Carol Anderson, Landscape Architects;

Moray Council (2012). Moray Onshore Wind Energy Supplementary Planning Policy Guidance;

Aberdeenshire Council (2017). Aberdeenshire Local Development Plan 2017 Supplementary Guidance 9 – Aberdeenshire Special Landscape Areas;

Aberdeenshire Council (2014). Strategic Landscape Capacity Assessment for Wind Energy;

Met Office. (2012). Met Office Visibility Frequency Analysis report from Wick Airport weather station, based on hourly data from 01/01/2002 to 31/12/2011;

Met Office. (2018). Met Office Visibility Frequency Analysis report from Lossiemouth weather station, based on hourly data from 01/01/2008 to 31/12/2017; and

Met Office. (2010). National Meteorological Library and Archive Fact sheet 17 – Weather Observations Over Land.

The Highland Council (2011). Assessment of Highland Special Landscape Areas.

Historic Environment Scotland: Inventory Garden and Designed Landscape (GDL00150) http://portal.historicenvironment.scot/designation/GDL00150

Historic Environment Scotland: Inventory Garden and Designed Landscape (GDL00160) http://portal.historicenvironment.scot/designation/GDL00160

Scottish Natural Heritage (2010). The special qualities of the National Scenic Areas. SNH Commissioned Report No.374.

BOWL (Jan 2016). Beatrice Offshore Wind Farm Consent Plan, Lighting and Marking Plan

BOWL (Nov 2016). Beatrice Offshore Wind Farm Consent Plan, Development Specification and Layout Plan

MORAY WEST
OFFSHORE WINDFARM

Offshore EIA Report

Moray Offshore Windfarm (West) Limited

Chapter 15 Socio-economics, Tourism and Recreation

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Acronyms	
Acronyms	**Expanded Term**
BEIS	Department of Business, Energy & Industrial Strategy
CfD	Contracts for Difference
FID	Final Investment Decision
FTE	Full Time Equivalent
GVA	Gross Value Added
LCOE	Levelised Cost of Energy
LQ	Location Quotient
NPF3	Third National Planning Framework for Scotland
O&M	Operation and Maintenance
ONS	Office for National Statistics
SIC	Standard Industrial Classification
SCA	Scottish Canoeing Association
SPP	Scottish Planning Policy
SSF	Scottish Surfing Federation
WAP	Working age population

Glossary of Terms	
Term	**Definition**
Direct Economic Impact	Increases in economic output and/or employment generated by The Applicant/operator of the project as a result of the project going ahead, plus increases in economic output and employment among suppliers who provide goods and services directly to the project.
Direct Gross Value Added	The contribution of individual businesses, industries or sectors to the economy as a result of the direct expenditure associated with the proposed Development.
Economic Activity Rate	The proportion of an area's working age population who are either in employment or actively seeking work. This includes self-employed people and part time workers.
Full Time Equivalent (FTE)	A unit for measuring employment which indicates the workload associated with each post. One FTE is the equivalent of a full time post. An FTE of 0.5 indicates that a post is half time.
Gross Value Added (GVA)	The value to the economy of activity generated through construction and O&M of the scheme. Gross Value Added is effectively a measure of the additional profits generated in businesses benefiting from the activity plus additional salaries that are paid to their employees.
Indirect Economic Impact	As suppliers to the project increase output to meet the additional demand for their goods and services associated with the project, there will also be a corresponding increase in demand on their own suppliers and down their

Glossary of Terms	
Term	**Definition**
	supply chains - the resulting increase in economic output and employment is termed the "indirect effect".
Location Quotient	Location quotient is a measure of industry employment concentration in a given area relative to the national level (the value for the UK equals one, so a value of greater than one represents a higher than average industry concentration).
Person Years	A unit of measurement used to capture temporary employment impact. One person year is the equivalent of one Full Time Equivalent post, but may in practice be made up of a number of temporary posts which sum to a person year.
Working Age Population	People aged 16 to 64.

15 Socio-economics, Tourism and Recreation

15.1 Introduction

15.1.1.1 This chapter presents an assessment of the likely significant effects of the construction, operation and maintenance and decommissioning of the Moray West Offshore Windfarm and associated Offshore Transmission Infrastructure (OfTI) ("the Development") on local, regional and national socio-economic characteristics, along with proposed mitigation measures, where considered necessary.

15.1.1.2 The specific objectives of the chapter are to:

- Define the legislation, policy and guidance framework that is of relevance to socio-economics;
- Detail the consultation activities and responses that are relevant to, and have informed, this socio-economic impact assessment;
- Describe the socio-economic baseline;
- Describe the assessment methodology and significance criteria used in completing the impact assessment;
- Describe the potential effects, including direct, indirect and cumulative effects;
- Describe the mitigation measures proposed to address likely significant effects; and
- Assess the residual effects remaining following the implementation of mitigation.

15.1.1.3 The assessment has been carried out by appropriately qualified specialists, with experience in economic development and economic impact assessment, employed by Regeneris Consulting ltd. Authors have good knowledge of the relevant economic appraisal guidance from UK Government, including Green Book (HM Treasury, 2011).

15.1.1.4 This chapter is supported by:

- Volume 4 - Technical Appendix 15.1: Socio-economics.

15.2 Legislation, Policy and Guidance Framework

15.2.1.1 This section sets out the relevant policy and legislation context for the Development. While the Development occurs offshore, the socio-economic impacts and those associated with recreation value occur onshore. Therefore, the relevant documents covered in this section are mostly onshore focused.

15.2.2 Scottish Planning Policy and Third National Planning Framework, 2014

15.2.2.1 The Scottish Planning Policy (SPP) (Scottish Government, 2014) and Scotland's Third National Planning Framework (NPF3) (Scottish Government, 2014) are two policy documents underpinning the Scottish Government's planning policy. NPF3 and SPP share a single vision for Scotland to achieve sustainable, distributable and fair growth without compromise on the quality of environment, place and life, with emphasis on reduced emissions.

15.2.2.2 One of the core values of the Scottish Planning Policy (SPP) (Scottish Government, 2014) is for it to play a key role in facilitating sustainable economic growth, particularly the creation of new jobs and the strengthening of economic capacity and resilience within communities.

15.2.2.3 Within the SPP document, there are four planning outcomes which support the vision, two of which are of direct relevance to this chapter:

- **Outcome 1:** A successful, sustainable place - Supporting sustainable economic growth and regeneration, and the creation of well-designed, sustainable places; and

- **Outcome 2**: A low carbon place – reducing our carbon emissions and adapting to climate change.

15.2.2.4 The NPF3 is a spatial expression of Scottish Government's economic strategy for Scotland (Scottish Government, 2014). The document recognizes the new opportunities for the economy from the energy sector which can help to deliver economic growth, attract and retain population and support local services. It aims to support the diversification of the energy sector. The spatial strategy aims to reduce greenhouse gas emission and assist in adapting to climate change. This is in line with the Climate Change Act (Scotland) 2009 which states Scotland's endeavors to reduce emissions by 42% by 2020 and 80% by 2050.

15.2.2.5 Developments such as the Moray West offshore wind farm can contribute to delivering the ambitions set out within SPP and NPF3 by providing economic benefits while supporting climate change mitigation and adaptation.

15.2.3 Local Planning Policy

15.2.3.1 The planning policy context in the local study area is summarised briefly below:

- Highland-wide Local Development Plan (Highland Council, 2012). The Plan outlines the vision for the Highlands up to 2030, including a diverse economy and sectors, increasing the population, promoting tourism and providing employment opportunities. The Plan outlines that renewable energy developments will be assessed against the Renewable Energy Policies and the non-statutory Highland Renewable Energy Strategy. The Plan recognises the significant potential of renewable energy developments for the Highlands and for Scotland. Policy 67: Renewable Energy Developments states the proposed developments will be considered in terms of their contribution towards meeting renewable energy generation targets, and their effect on the local and national economy.

- Moray Local Development Plan (Moray Council, 2015). The Plan outlines Sustainable Economic Growth as one of its Primary Policies, identifying sustainable economic growth and high value employment creation as main objectives. It outlines its commitment to supporting renewable energy generation through a diverse range of technologies and all scales of development. The Plan is supported by the Moray Economic Strategy (Moray Community Planning Partnership, 2012) which sets out the objectives in more detail. The core targets within the strategy are the creation of 5,000 high quality jobs with a focus on engineering, science and technology sectors; increasing average earnings above regional and Scottish averages by an emphasis on higher value activities; and growing the population by attracting new residents to the local authority.

- Aberdeenshire Local Development Plan (Aberdeenshire Council, 2017). The Plan's strategic aims are to increase and diversify the economy while supporting sustainable development. Under Policy C2 Renewable Energy, Aberdeenshire Council will support renewable developments, including wind, which are in appropriate sites and of the right design. The Plan is supported by the Aberdeenshire Economic Development Strategy (Aberdeenshire Council, 2012). The Strategy outlines the strategic objectives which focus on making a positive impact on the local and regional economy. These include making Aberdeenshire a location of choice for renewable energy businesses, promoting it as a location for tourism, as well as a place to live and work.

- Aberdeen City Local Development Plan (Aberdeen City Council, 2017). The Plan outlines the ambition to increase population of the city region to 500,000 people by 2035, while growing and diversifying the regional economy and providing jobs and homes to support maintain and improve quality of life. The Council outlines its support for all types of renewable energy, in principle.

15.2.4 Economic Development Policy

15.2.4.1 Table 15.2.1 provides a summary of economic development policy in Scotland focused on the development of the renewable energy sector and offshore wind in particular.

Table 15.2.1: Summary of Socio-Economic Development Policy

Policy Document	Overview
Scottish Energy Strategy: The future of energy in Scotland (Scottish Government, 2017)	The vision set out in the strategy is one that places emphasis on the development of renewable energy to secure socio-economic benefits for Scotland. A strong low carbon economy – sharing the benefits across our communities, reducing social inequalities, and creating a vibrant climate for innovation, investment and high value jobs. A key part of the vision is inclusive growth which is to be delivered from secure, reliable, and affordable energy. Specifically to offshore wind, there is a commitment to continue to grow and support the sector in Scotland, creating opportunities for manufacturers and the supply chain.
A Low Carbon Economic Strategy for Scotland (Scottish Government, 2011)	Similar to the Scottish Energy Strategy, the 2011 Low Carbon Economic Strategy aims to deliver on the promises made in the Climate Change Act (Scotland) 2009. It further echoes the sentiment, found in the literature policy review, to attain sustainable growth and a transition to a low carbon Scotland. Offshore wind is highlighted as an area of strong potential to attract large investment and create jobs. To enable the sector, the government will aim to reduce barriers, change regulation, outline route maps, advocate innovation, and market the sector.
National Renewables Infrastructure Plan (N-RIP) 1 - 2 (Scottish Enterprise & Highlands and Islands Enterprise, 2013)	N-RIP aims to develop an actionable framework to deliver on the growing offshore renewables sector. The first report (Scottish Enterprise & Highlands and Islands Enterprise, 2013a) maps out the existing and potential locations and renewable infrastructure, highlighting spatial areas of expertise. The second plan (Scottish Enterprise & Highlands and Islands Enterprise, 2013b) builds on this and explores an investment plan to deliver on the first phase, involving local community, enterprise and planning authority engagement, investment propositions, and identification of funding streams.
2020 Routemap for Renewable Energy in Scotland (Scottish Government, 2011) and Electricity Generation Policy Statement (Scottish Government, 2013)	The Routemap, an update on the Scottish Renewables Action Plan 2009, sets out a set of actions to meet 100% demand for electricity from renewable energy by 2020. Both papers note that over the period 2010-20, renewables in Scotland could provide: - up to 40,000 jobs (Skills Development Scotland, 2011) and £30 bn investment to the Scottish economy; and - a transformational opportunity for local ownership and benefits amongst communities. The 2020 Routemap report also states offshore wind represents the biggest opportunity for sustainable economic growth in Scotland for a generation, potentially supporting up to 28,000 directly related jobs and a further 20,000 indirect jobs and generating up to £7 bn for the Scottish economy by 2020.
Low Carbon Scotland: Meeting the Emissions Reduction Targets 2010-2022 (Scottish Government, 2011)	The report outlines actions that can be taken to achieve greenhouse gas emission targets as set out in the Climate Change Act 2009. It draws together existing policies and interventions that exist and those that will continue to drive Scotland to its carbon reduction target.

Table 15.2.1: Summary of Socio-Economic Development Policy	
Policy Document	**Overview**
	The potential economic benefits are huge, ranging from motorist and farmer savings to energy exports: - In 2008-09, Scotland's low carbon market was worth around £8.8 bn and is forecast to rise to around £12 bn by 2015-16; - Jobs in the low carbon sector in Scotland could grow by 4% a year to 2020, rising from around 70,000 to 130,000, over 5% of the Scottish workforce. From a social and community perspective, a low carbon society will improve quality of life, reduce pollution and improve air and water quality, lower fuel poverty, and improve health outcomes and lifestyles.
2015-2018 Business Plan: Building Scotland's International Competitiveness (Scottish Enterprise, 2015)	The business plan contains a framework built around creating sustainable growth, the purpose of which is to create opportunities for all and by doing so reduce inequality. Scottish Enterprise will seek to assist key sectors, including offshore wind, in taking advantage of global opportunities.
Oil and Gas 'Seize the Opportunity' Guides – Offshore Wind (Scottish Enterprise, 2016)	The guide's aim is to encourage diversification within the oil and gas industry to the offshore wind sector. Both industries share a lot in common. Many of the infrastructures and resources used in oil and gas are similar to that used in offshore wind, whilst the skills developed are also transferrable.

15.3 Consultation

15.3.1.1 Moray West has framed its assessment of potential effects on socio-economics and recreation and tourism activities through consultation with key stakeholders.

15.3.1.2 Table 15.3.1 details the key issues raised in relation to socio-economics in the Moray West Offshore Wind Farm Scoping Opinion (August 2016) and the OfTI Scoping Opinion (August 2017) and summarises other issues / concerns that have been raised during additional consultation activities undertaken as part of the EIA process and how these have been addressed in the preparation of this EIA Report.

Table 15.3.1: Consultation		
Consultee and Date	**Issue Raised**	**Moray West Approach**
Scottish Ministers Moray West Offshore Transmission Infrastructure (OfTI) Scoping Opinion August 2017	The Scottish Ministers agree with the potential effects that have been scoped in or out as noted in the Scoping Report. The Scottish Ministers draw Moray West's attention to a Marine Scotland publication on licensing guidance for socio-economic applications with a particular case study focus on offshore wind that will be available soon as this may be helpful.	The issue has been addressed in Section 15.5: Assessment Methodology
Moray Council Moray West Offshore Wind Farm Scoping Opinion August 2016	Moray Council is also the harbour authority and would wish early engagement about what facilities are available to MORL and on any likely impact if Moray harbours are to be used. If the anticipated use of harbours	The issue has been addressed by the use of two scenarios which assume different levels of harbor use in the local study area (see Section 15.5: Assessment Methodology)

Table 15.3.1: Consultation		
Consultee and Date	**Issue Raised**	**Moray West Approach**
	are known this would be relevant to assessing the infrastructure and socio-economic impact of the proposal.	
Marine Scotland Science (MSS) Moray West Offshore Wind Farm Scoping Opinion August 2016	MSS is content with the proposals for the Human Environment part of the assessment for WDA. MSS welcomes the commitment to update the baseline information from MORL ES 2012	The issue has been addressed in Section 15.4.2: Current Baseline and Section 15.5: Assessment Methodology
Aberdeenshire Council Moray West Onshore Transmission Infrastructure Scoping Opinion August 2017	Agree that operational effects of the export cable circuits and landfall can be scoped out, along with housing demand associated with labour. With regard to recreation, note that Sandend beach is very well used by walkers, surfers, kayakers, paddle boarders and families. If cable landfall is to be in this location, consideration will need to be given to mitigation of management of effects on these users.	Noted regarding scoping out. Recreational activity in the vicinity of the Landfall Area is described in Section 15.4.2. Potential effects on coastal and marine recreation are assessed in Section 15.7.2.
Deveron Canoe Club (by email, January 2018)	Provided information on the use of Sandend Bay by the club. Noted that should the export cable circuits be routed via Sandend Bay, the club would ask that the beach is returned to its original condition after installation.	Watersports activity in the vicinity of the Landfall Area is described in Section 15.4.2. Potential effects on marine recreation, including kayaking, are assessed in Section 15.7.2. In Chapter 4: Description of Development, it is confirmed that the export cable circuits will be buried.
Suds Surf School (by phone, January 2018)	Provided information on the use of Sandend Bay by the school and surf community. Identified concerns about noise and visual impact of cable installation, and potential effects of infrastructure on surf conditions. Stated desire for cable to be buried and for any jointing bays to be beyond the beach.	Watersports activity in the vicinity of the Landfall Area is described in Section 15.4.2. Potential effects on marine recreation, including surfing and paddle boarding, are assessed in Section 15.7.2. In Chapter 4: Description of Development, it is confirmed that the export cable circuits will be buried.

15.4 Baseline Conditions

15.4.1 Baseline Characterisation Approach

15.4.1.1 For the purpose of this assessment, the socio-economic baseline comprises the following socio-economic indicators:

- Wealth creation as measured through Gross Value Added (GVA)[1];
- Employment creation;
- Measures of community vitality and viability (e.g. changes in demand for local housing, accommodation and services); and
- Access to and enjoyment of watersports activity and the associated economic value.

<u>Study Area</u>

15.4.1.2 Two study areas have been identified for socio-economic analysis of the Moray West Offshore Wind Farm. The primary local study area covers four local authority areas: the Highlands, Moray, Aberdeenshire, and Aberdeen City. This local study area is linked to the selection of construction and operation and maintenance ports and the supply of a range of inputs and services for Moray West Offshore Wind Farm, and therefore an area for potential socio-economic impacts associated with construction, O&M and decommissioning of the Development.

15.4.1.3 The second study area used in the analysis is Scotland. The study area has been included to reflect the wider reach of GVA and employment impacts that are likely to materialize through the supply chain and provision of labour. Where appropriate, UK level analysis will also be presented, however, this has not been formally defined as a study area for the receptors. For example, analysis of socio-economic indicators in the context of the UK provides a useful comparison for sector specialisms and contextualises the economic performance in the local study area and Scotland.

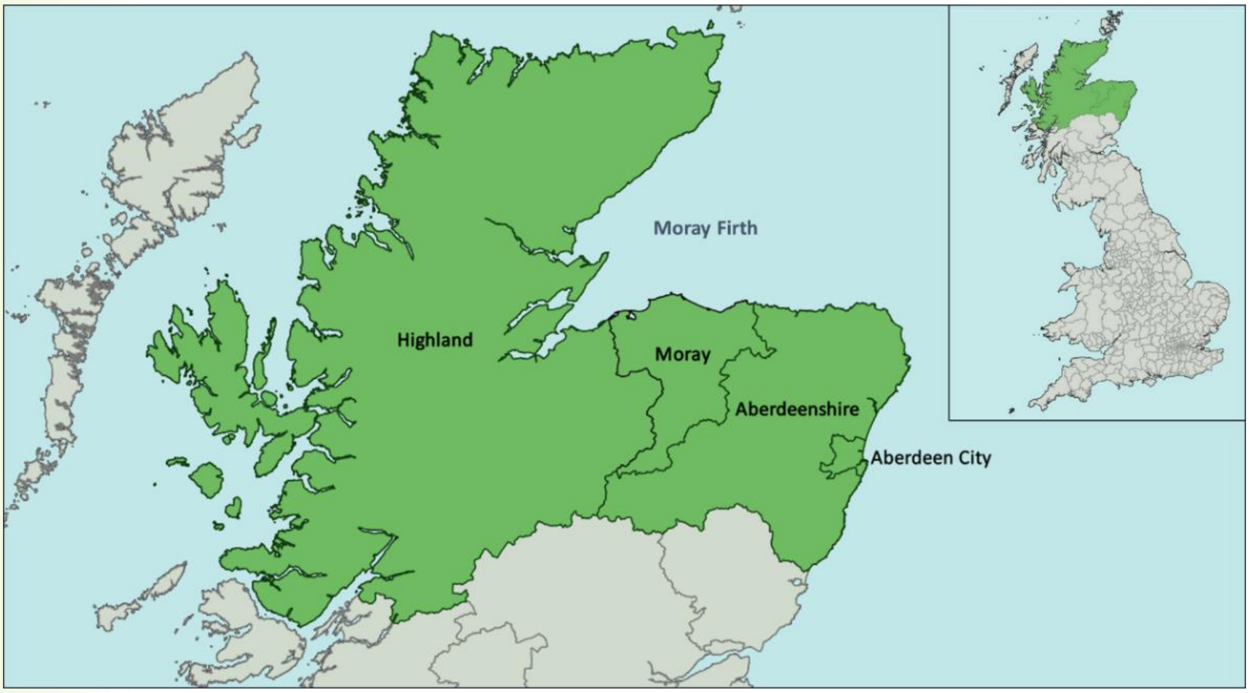

Image 15.4.1: Moray West Offshore Wind Farm Study Area

[1] GVA is a measure of wealth creation (i.e. additional profits generated in businesses benefiting from the activity plus additional salaries that are paid to their employees).

Desk Study / Field Survey

15.4.1.4 The socio-economic analysis has been informed by an overview of the key social and economic indicators within the study areas, and a review of relevant economic development policy.

15.4.1.5 The key sources of data used to assess the baseline environment include relevant national datasets from the Office of National Statistics (ONS) which provide data on population, labour market and employment base conditions at the national and local levels.

15.4.1.6 The analysis draws on the most up to date sources of data available at the time of submission for all key socio-economic indicators, although the year that the data relates to varies according to the release calendar for each dataset. The baseline year will therefore vary slightly across the indicators considered in the baseline. The data is considered as the best available representation of the baseline conditions for the purposes of the impact assessment. The baseline year for all indicators is referenced throughout the chapter but also included in Table 15.4.1.

Table 15.4.1: Summary of Key Socio-Economic Data Sources

Economic Indicator	Source	Year	Author
Population	ONS Mid-year population estimates	2017	ONS
Employment and economic activity	ONS Annual Population Survey	2017	ONS
Unemployment	ONS Annual Population Survey	2017	ONS
Job Seeker's Allowance	ONS Claimant Count	2017	ONS
Qualifications of residents	ONS Annual Population Survey	2017	ONS
Occupations of residents	ONS Annual Population Survey	2017	ONS
Sectoral and size band structure of the business base	ONS UK Business Counts	2016	ONS
Sectoral and size band structure of the employment base	ONS Business Register and Employment Survey	2016	ONS
Trends in GVA of main industrial sectors	ONS Regional GVA estimates	2016	ONS
Workplace and residence based earnings	ONS Annual Survey of Hours and Earnings	2017	ONS
Tourism volume and value	Tourism in Scotland	2017	Visit Scotland
Supply chain research	Renewable sector research studies	2015	Scottish Enterprise
Supply chain research	Renewable supply chain in Scotland	2016	Renewable UK

15.4.2 Current Baseline

Population Structure

15.4.2.1 As summarised in Table 15.4.2: Table 15.4.2 the local study area is home to a population of 822,870 people, of which 530,880 (around 65%) are of working age2. This is the same working age proportion as the Scotland average of 65% and higher than the United Kingdom proportion of 63%. Aberdeen City and Aberdeenshire are the two areas, in the local study area, with the largest absolute figure and proportion of working age population with 70% and 63% of the population being of working age in the respective areas. The proportion of working age population for Aberdeen City is significantly higher than the UK and Scottish averages due to its role as a significant economic center as well as the prominence of the energy sector.

Table 15.4.2: Total and Working Age Population (WAP), 2016

Geographical Area	Total Population (000s)	WAP (000s)	WAP as a % of Total.
Local Study Area	**822**	**531**	**65%**
Highland	235	145	**62%**
Aberdeenshire	262	166	**63%**
Aberdeen City	230	161	**70%**
Moray	96	60	**62%**
Scotland	5,405	3,490	**65%**
United Kingdom	65,648	41,444	**63%**

Source: ONS (2017), 'Mid-Year Population Estimates'.

15.4.2.2 Image 15.4.2 shows that the local study area has a one percentage point higher population aged 65+ than the Scotland and UK average of 18%. The 0-15 age cohort in both Scotland and the local study area represented 17% of their respective total population, which is two percentage points lower than the UK average of 19%. Overall, there are no considerable differences the age composition across the three comparator areas despite the local study area having a slightly older population structure. This suggests that the areas have a comparable pool of workers (as share of overall population) for the Development to potentially draw on.

[2] The working age population is calculated as the total population (men and women) who area aged between 16-64 years of age. Although current working age definitions refer to males aged 16 to 64 and females aged 16 to 62 this will change by November 2018, where men and women become eligible for state pension at the age of 65. Although this is set to further increase in 2020, 2028 and 2037.

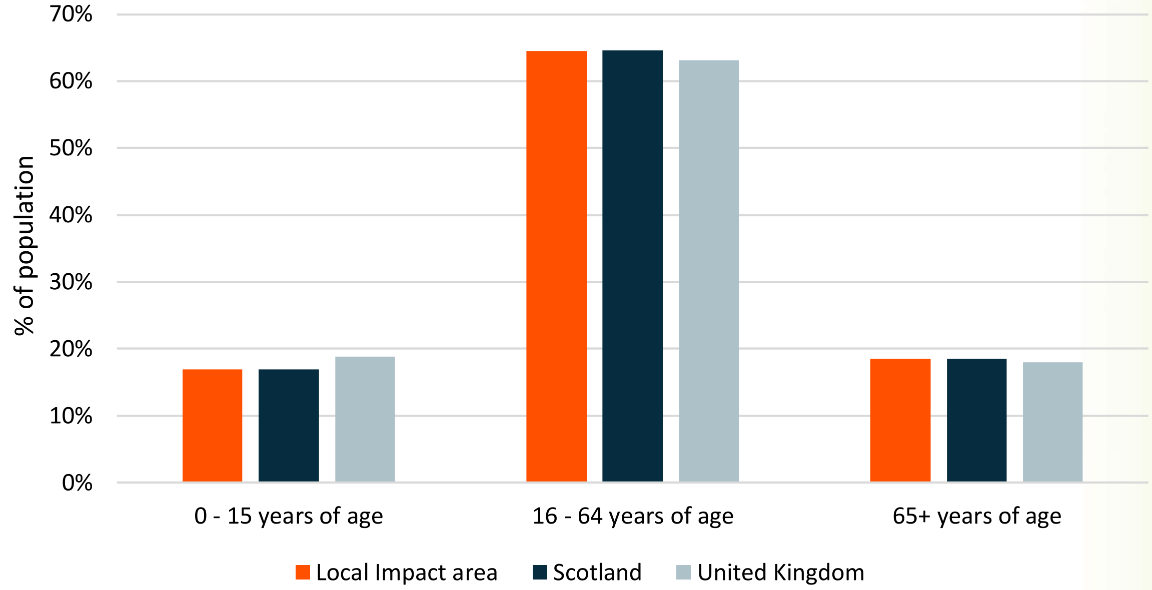

Image 15.4.2: Composition of the population in the Local Study Area, Scotland and UK by age, 2016 (Source: ONS (2017), 'Mid-Year Population Estimates')

15.4.2.3 Image 15.4.3 shows the variations in the broad composition of the population in each of the local authorities within the local study area. It shows that Aberdeen City, the most urban and densely populated area of the local study area, has a notably higher proportion of working age population (70%), and lower 65+ age (15%) and 0-15 age (15%) cohorts vis-à-vis the other local authorities. This contrasts with Moray and the Highlands which have the lowest proportion of working age population (62%), and highest proportion of the 65+ age cohort (21%). As Aberdeen City is a large employment center in the area, it draws in more working age residents compared to the more rural Highlands and Moray.

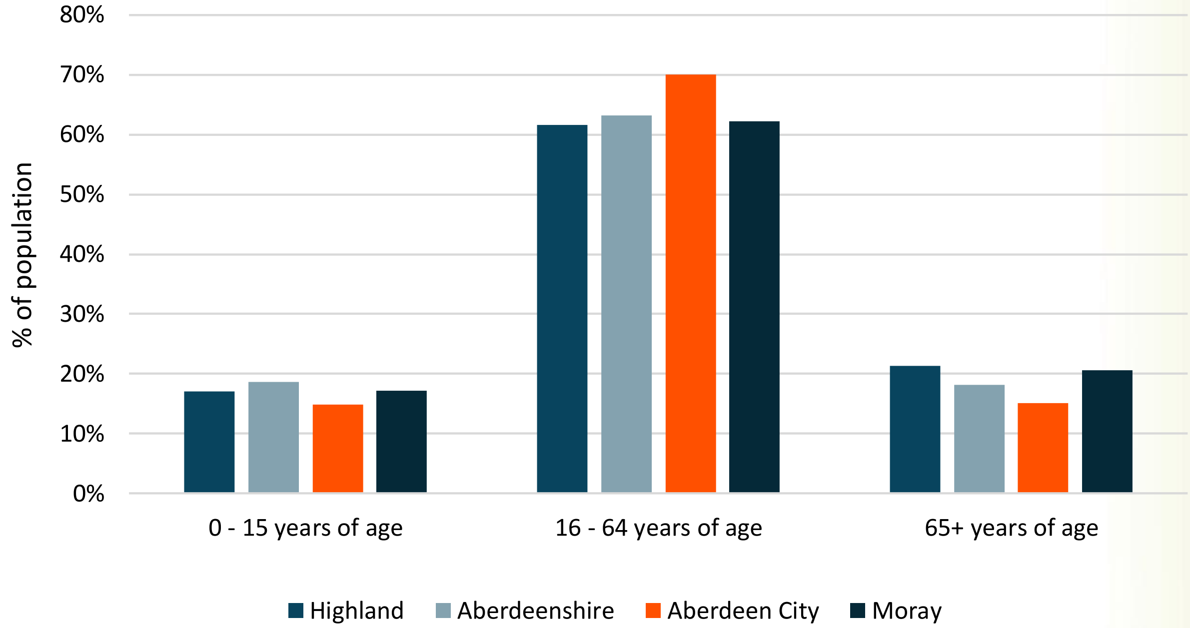

Image 15.4.3: Composition of the Population in the Local Study Area by Age and Local Authority, 2016 (Source: ONS (2017), 'Mid-Year Population Estimates')

Labour Market Indicators

15.4.2.4 Table 15.4.3 highlights the performance of the local study area's labour markets in comparison with Scotland and UK. Overall, the local study area compares well in terms of the proportion of working age residents who are economically active – i.e. either in employment or actively looking for work – at approximately 80% compared with 77% in Scotland and 78% in the UK. Within the local study area, economic activity rate varies from 78% in Moray to almost 83% in Aberdeenshire, the latter of which out-performs the overall local study area by 2.5 percentage points.

Table 15.4.3: Headline Performance on Key Labour Market Indicators, 2017. Rates Presented as a Proportion of Working Age Population (WAP)

Geographical Area	Economically Active		In Employment		Economically Inactive	
	No (000s)	% WAP	No (000s)	% WAP	No (000s)	% WAP
Local Study Area	**422**	**80.4**	**401**	**76.4**	**103**	**19.6**
Highland	115	81.9	112	79.8	26	18.1
Aberdeenshire	138	82.9	130	78.0	29	17.1
Aberdeen City	124	77.6	116	72.9	36	22.4
Moray	45	77.6	42	73.5	13	22.4
Scotland	2,626	76.9	2,505	73.4	787	23.1
United Kingdom	31,949	77.8	30,395	74.0	9,100	22.2

Source: ONS (2017), 'Annual Population Survey', Apr 2016 - Mar 2017.

15.4.2.5 The International Labour Organisation (ILO)3 unemployment data presented in Table 15.4.4 below indicates that there is some capacity within the labour market in the local study area. In total, there are around 21,000 unemployed residents across the local study area. This represents an overall unemployment rate of 4.9% in the local study area which is the same as the unemployment rate in the UK but slightly higher than the Scotland rate of 4.6%.

Table 15.4.4: Level and Rate of Unemployment, 2016

Geographical Area	Number Unemployed (000s)	% of Economically Active Population
Local Study Area	**21**	**4.9**
Highland	3	2.5
Aberdeenshire	8	5.8
Aberdeen City	8	6.1
Moray	2	5.3
Scotland	121	4.6
United Kingdom	1,554	4.9

Source: ONS (2017), 'Annual Population Survey'.

[3] The International Labour Organisation (ILO) measure of unemployment refers to people without a job who were able to start work in the 2 weeks following their Annual Population Survey (APS) interview and who had either looked for work in the 4 weeks prior to interview or were waiting to start a job they had already obtained (Source: ONS).

15.4.2.6 Recent changes brought about by the introduction of Universal Credit have meant that it is difficult to track how unemployment has changed over time. The evidence presented in Image 15.4.4 measures the number of people claiming benefits (principally for the reason of being unemployed), and includes all out of work Universal Credit claimants as well as all Job Seeker's Allowance claimants. It shows that overall, the claimant rate in the local study area has been consistently below the average rate in Scotland and the UK from January 2013 to April 2017, and up until January 2017 it has also been below UK rates. Furthermore, the diagram also shows that the claimant rate in Scotland and the UK has fallen steadily from around 4% in the beginning of 2013 to below 2.5% in April 2017. On the other hand, the local study area has fluctuated from 2.1% in the beginning of January 2013 to dipping to 1% in October 2014, and then rising to its previous rate of 2% in April 2017 and becoming in line with UK averages.

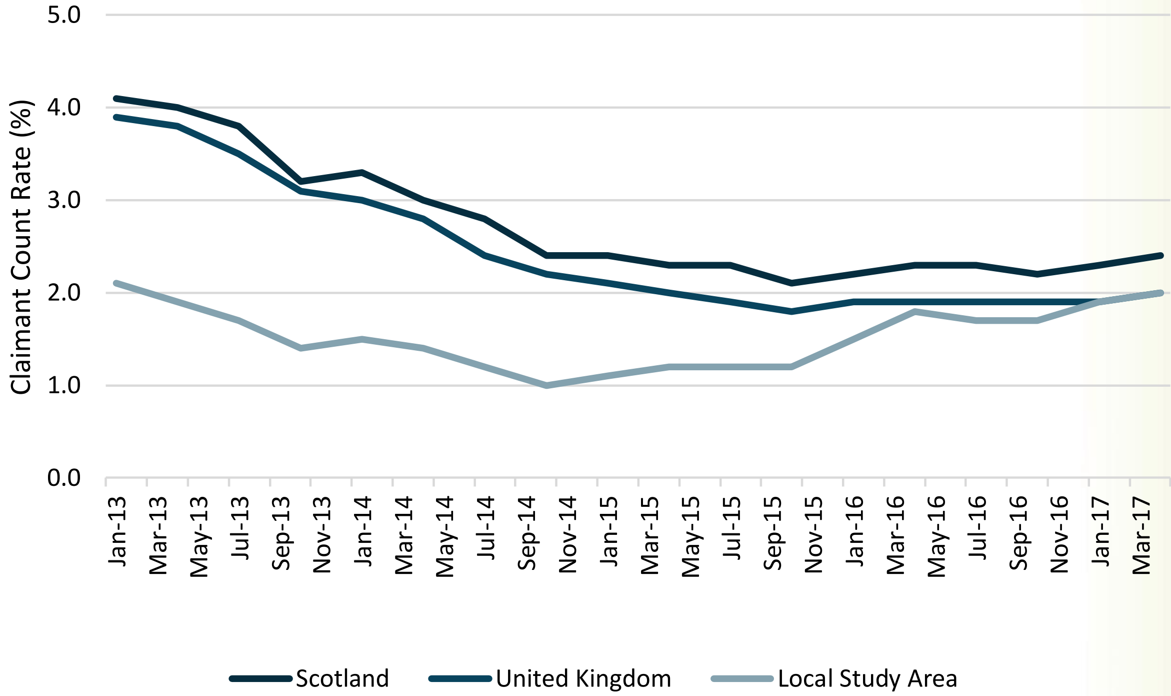

Image 15.4.4: Claimant Rate for the Local Study Area, Scotland and the UK (Source: ONS (2017) Claimant Count)

15.4.2.7 The skills profile of the local study area's residents compares favourably to the UK average. Table 15.4.5 below summarises the National Vocational Qualification (NVQ) level of working age residents. Approximately 47% of the local study area's working age population holds a NVQ level 4 and above (i.e. degree level or above), which is slightly above the UK average of almost 43%, although below the Scottish average of 48%.

15.4.2.8 However, the aggregate performance across the local study area masks some variations amongst the local authority areas which make up the local study area. Whilst over 55% of Aberdeen City's economically active working age population possess higher level skills, only approximately 37% have the equivalent skills in Moray.

15.4.2.9 Overall, the local study area has a slightly lower proportion of economically active working age individuals with no qualification (6%) compared to the Scotland average (6.5%), but above the UK average (5.2%).

Table 15.4.5: Qualifications of Working Age Adults by NVQ level, 2016												
Geographic Area	Qualifications											
	NVQ 4 and above		NVQ 3		Apprenticeships		NVQ 1 & 2		Other Qualifications		No Qualifications	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Local Study Area	**196**	**47.4**	**58**	**14.1**	**23**	**5.6**	**90**	**10.8**	**22**	**5.3**	**25**	**6.0**
Highland	51	45.7	17	14.9	4	3.8	26	11.5	6	5.0	8	7.5
Aberdeenshire	62	45.2	20	14.8	9	6.5	33	12.2	5	3.7	7	5.3
Aberdeen City	66	55.5	14	11.8	6	5.0	18	7.5	9	7.4	7	5.4
Moray	17	36.6	7	15.7	4	8.5	13	13.8	3	5.8	3	5.8
Scotland	1,264	48.4	359	13.8	121	4.6	540	10.3	159	6.1	169	6.5
United Kingdom	13,563	42.6	5,417	17.0	1,084	3.4	8,015	12.6	2,093	6.6	1,638	5.2

Source: ONS (2017), 'Annual Population Survey'.

15.4.2.10 The occupational structure of the employment base reflects the skills profile of the area. The local study area is comparable to Scotland and the UK on the proportion of workers in high skill occupations as well as low skill occupations (c. 15% and 9% respectively)4. Within the local study area there is some variation, as Aberdeen City and Aberdeenshire are leading in terms of high skill occupations (c. 17%), while Moray has the lowest proportion (11%).

Table 15.4.6: Employment by Standard Occupation Classification, 2016/17						
Geographic Area	Occupation Classification					
	High Skill Occupations		Medium Skill Occupations		Low Skill Occupations	
Number (000s) and %	Number (000s)	%	Number (000s)	%	Number (000s)	%
Local Study Area	126	30	144	35	140	34
Highland	31	27	40	34	44	38
Aberdeenshire	46	34	48	35	42	30
Aberdeen City	38	33	40	35	36	31
Moray	10	23	16	35	19	42
Scotland	758	29	884	34	926	36
United Kingdom	9,691	31	10,972	35	10,680	34

Source: ONS (2017), 'Annual Population Survey'.

[4] Occupations are defined as: **High skill** occupations are defined as managers, directors and senior officials; and professional occupations. **Medium skill** occupations are defined as associate professional and technical occupations; administrative and secretarial occupations; and skilled trades occupations. **Low skill** occupations are defined as caring, leisure and other service occupations; sales and customer service occupations; process, plant and machine operatives; and elementary occupations.

Sectoral Structure of Employment Base

15.4.2.11 Data from the ONS indicates that the total number of people employed within the local study area stood at 234,000 in 2015. Employment within local study area is concentrated in different centers which include Aberdeen City, Inverness, Eglin and Inverurie. The Aberdeenshire and Aberdeen City area contains around 156,000 jobs, which represents 66% of all jobs across the local study area.

15.4.2.12 Employment density (i.e. the number of jobs per 1,000 working age residents) can be used to compare overall performance with the national performance and across other comparator areas. At 818 jobs per 1,000 working age residents, jobs density in the local study area is above the Scotland average (at 731 jobs per 1,000 working age residents) and the Great Britain[5] average (at 737 jobs per 1,000 working age residents) (Table 15.4.7). This is c. 87 jobs per 1,000 more than the Scotland figure and c. 81 jobs per 1,000 more than the Great Britain figure. Performance within the local study area varies, with employment density ranging from c. 587 jobs per 1,000 working age residents in Moray to c. 1,117 jobs per 1,000 working age residents in Aberdeen City (which suggests in-commuting).

Table 15.4.7: Total Employment and Employment Density in the Local Study Area

Geographical Area	Employment Density		
	Total Employment (000s)	% of Employment in Local Study Area	Employment Density (Jobs per 1,000 WAP)
Local Study Area	**436**	**-**	**818**
Highland	113	25.9%	779
Aberdeenshire	107	24.5%	643
Aberdeen City	181	41.5%	1,117
Moray	35	8.0%	587
Scotland	2,541	-	731
Great Britain	29,546	-	737

Source: ONS (2016), 'Business Register and Employment Survey'. Please note –numbers are rounded to nearest 1,000 and percentage points are rounded to nearest decimal place so may not sum exactly.

15.4.2.13 Image 15.4.5 shows annual employment change across the local study area from 2009 onwards, and compares it with annual employment change nationally over the same period. It shows that the employment level in the local study area has varied significantly between 2009-2015, recording three years of a negative change in employment and three years of strong employment growth. In 2009-10, the local study area and Scotland witnessed a 3% decline in employment, which was worse than the UK's decline of 1%. However, from 2010-2014, the local study area overall performed better or similar to the UK's employment growth rates, where it mostly experienced strong growth (at +3.4%, -0.2%, +2% and +4.6% respectively) compared to the UK average (at 0.5%, 0.4%, 1.1% and 2.7% respectively) and the Scotland average (1.5%, -1.8%, 1.3%, 3.5%). The most recent data, from 2014-15, reveals that employment in the local study area shrank by 2.3%, which was worse than the no change in the Scotland average (0%) and growth in UK average (2.0%).

[5] BRES data is not available at a UK level, therefore for analysis of employment concentrations and sectors Great Britain is used as the national indicator.

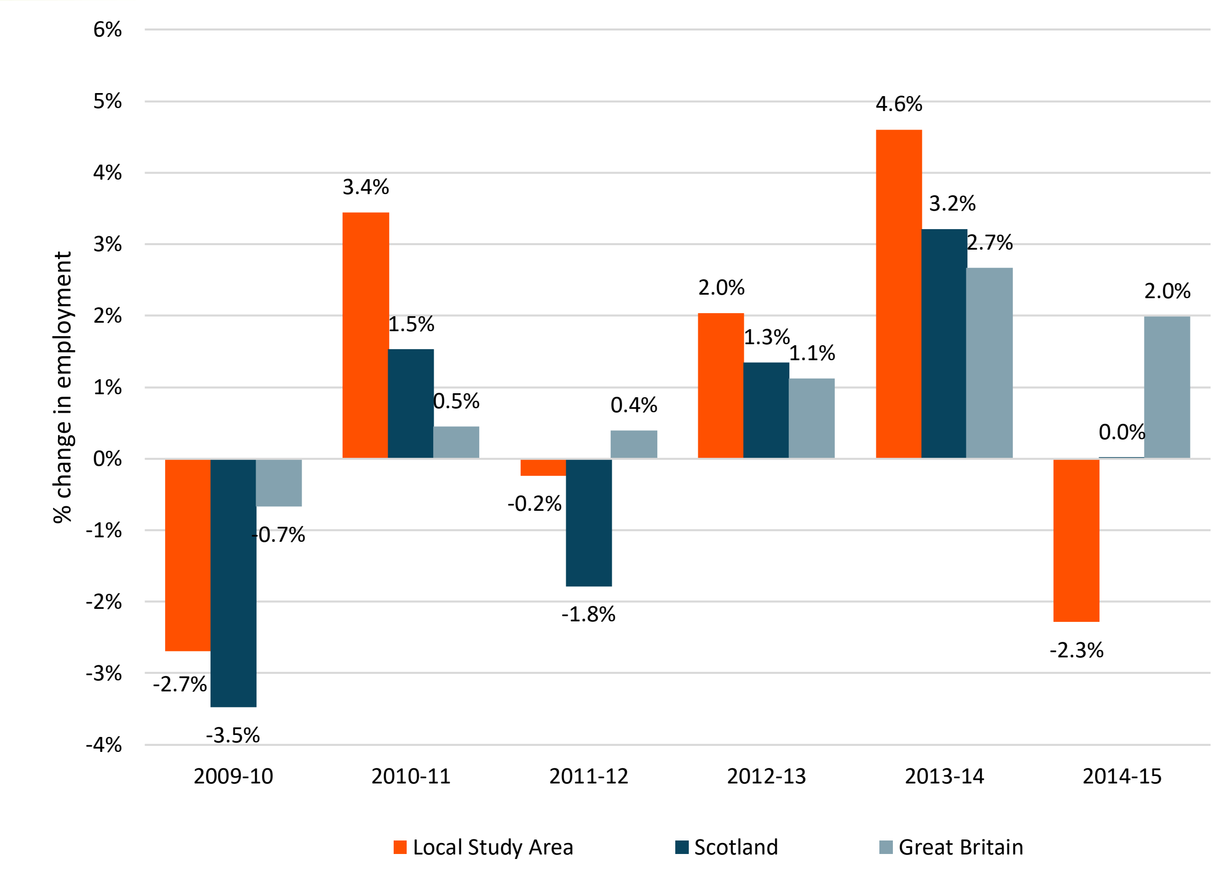

Image 15.4.5: Employment Trends, 2009-2015 (Source: ONS (2016) Business Register and Employment Survey)

15.4.2.14 Concentrations of employment in key sectors that exist in the local study area (compared with the Great Britain's employment base) are highlighted in Image 15.4.6 below. The local study area's employment base although heavily reliant on service sector activities, appears to also have a greater focus on lower value service activities. The prominence the mining and quarrying sector with a Location Quotient (LQ)[6] of 36.5 highlights the presence of the oil and gas sector and Aberdeen's status as the main center for UK North Sea oil and gas activities. Linked to this is the professional and technical services sector (LQ=1.26) providing support activities for the oil and gas sector (including design, installation, and technical services).

[6] Location quotient is a measure of industry employment concentration in a given area relative to the national level (the value for the UK equals one, so a value of greater than one represents a higher than average industry concentration).

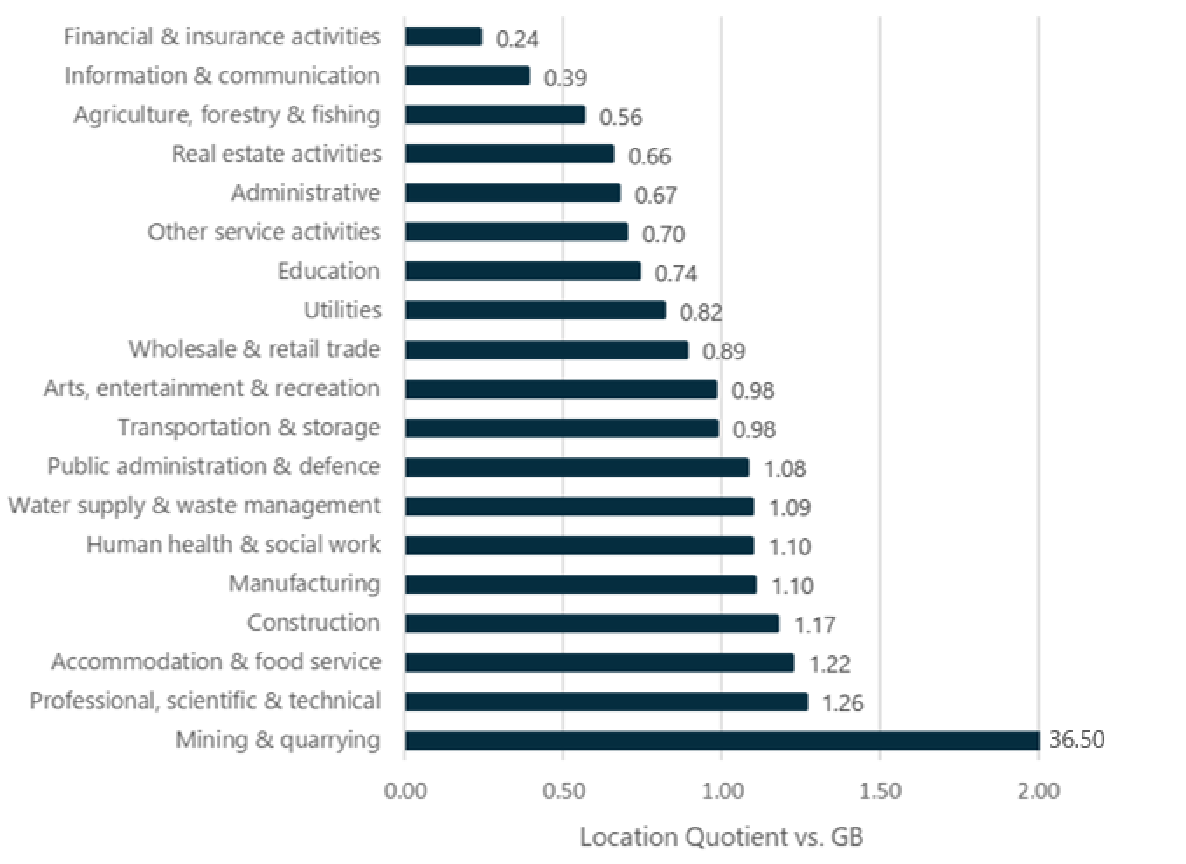

Image 15.4.6: Concentration of Employment in the Local Study Area by Sector, 2015 (Source: ONS (2016) Business Register and Employment Survey)

15.4.2.15 The oil and gas sector in the local study area is a vital part of the economy. It is part of the mining and quarrying sector, which accounts for 31,700 jobs in the local study area, representing 54% and 93% of all mining and quarrying employment in the Great Britain and Scotland respectively.

15.4.2.16 Accounting for approximately 62,000 jobs, the human health and social work activities is the largest sector across the local study area and represents just over 14% percent of all jobs locally which is a higher concentration than the national average (location quotient of 1.1). Other areas of concentration are the:

- *Professional, scientific and technical activities* (LQ of 1.26) accounting for 11% of all employment in the local study area;
- *Accommodation and food service activities* (LQ of 1.22) accounting for 9% of employment;
- *Construction* (LQ of 1.17) represents 5% of all employment; and
- *Manufacturing* (LQ of 1.10) accounts for 9% of all employment.

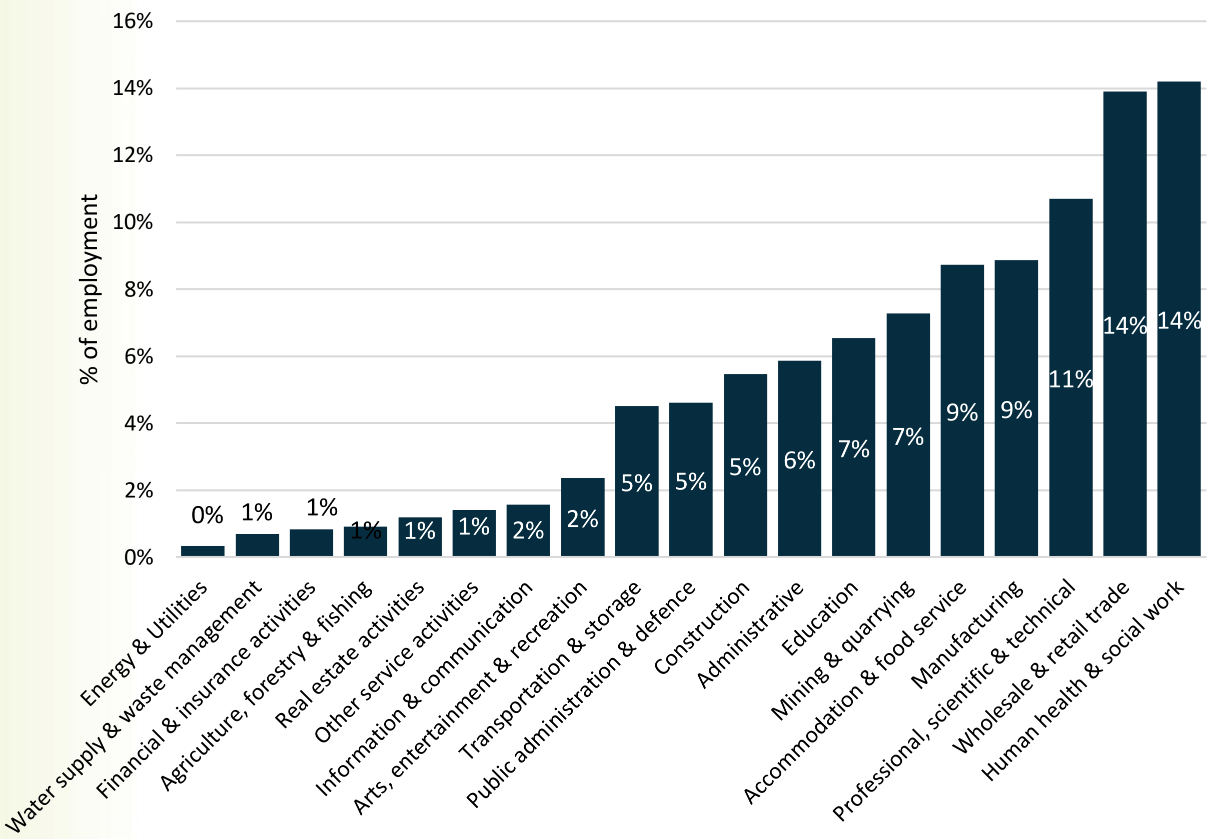

Image 15.4.7: Distribution of Employment in the Local Study Area by Sector, 2015 (Source: ONS (2016) Business Register and Employment Survey)

Earnings and Wealth Generation

15.4.2.17 Table 15.4.8 highlights the gap that exists between the earnings of those employed in the local authorities in the local study area, and the Scotland and UK average. The median annual salary for people working in the local study area varies from £25,106 in Moray to £32,013 in Aberdeen City. The Scotland and UK median workplace based salary is £27,953 and £28,213 respectively, which are c. £3800-4000 below the median salary in Aberdeen City but above the median of Highland, Aberdeenshire and Moray. Overall, the workplace based median salary of the local study area (£28,156) is slightly below the UK average (-£57 gap), but slightly above the Scotland average (+£203 gap).

Table 15.4.8: Annual Median Gross Pay for Full Time Employees and Residents for the Local Study Area and other Comparator Areas 2016

Geographical Area	Residence Based (£)	Workplace Based (£)
Local Study Area*	**27,935**	**28,156**
Highland	27,885	27,602
Aberdeenshire	29,918	27,903
Aberdeen City	29,249	32,013
Moray	24,687	25,106
Scotland	28,007	27,953
United Kingdom	28,213	28,213

Source: ONS (2017), 'Annual Survey of Hours and Earnings, Residence and Workplace Based'. *Residence and Workplace based median salary for the local study area are calculated as an average of the four local authority median salaries.

15.4.2.18 The local study area presents significant differences in the residence based[7] and workplace based[8] annual median salary between local authorities in the local study area. According to the data, Moray and Highland are the areas with a residence based and workplace based earning broadly similar, both of which are below UK median salaries.

15.4.2.19 In relative terms, data suggests that higher value jobs are located in Aberdeen City and are taken up by incoming workers from outside the City most likely from neighboring local authorities (highlighted by the £2,760 gap between workplace and resident earnings). The workplace based salary in Aberdeen City is the highest of the four local authorities which constitutes the local study area, whilst Moray has the lowest workplace based and residence based salaries. The wage levels reflect the economic composition of local authorities within the local study area. Aberdeen City host the high value oil and gas jobs, driving up the average wage levels directly and in related sectors, and attracting more workers from neighboring local authorities.

15.4.2.20 Overall, the median residence based annual pay is £27,935 in the local study area, which is slightly below Scottish and UK averages. The workplace based pay is slightly more than the residence based pay in the local study area, with a gap of around £221, suggesting incoming workers into the local study area.

Table 15.4.9: Total GVA and GVA per Head, 2015

Geographical Area	Total GVA (£ m)	GVA per Head
Local Study Area*	£25,324	£29,461
Highland	£5,273	£22,525
Aberdeenshire	£7,253	£27,687
Aberdeen City	£10,828	£47,006
Moray	£1,970	£20,624
Scotland	£127,260	£23,685
United Kingdom	£1,666,342	£25,601

Source: ONS (2016), 'Regional GVA (income approach) at current basic prices'. *The GVA per head for the local study area is calculated as the average GVA per head of the four local authorities in the area.

15.4.2.21 Table 15.4.9 shows that in 2015 the local study area had an overall GVA output of just over £25 bn. As evidenced in the table, this represents almost 20% of all the GVA output across Scotland in 2015.

15.4.2.22 Total GVA figures on their own are not useful, especially when comparing the local study area with the national average and other comparator areas. As such, a figure of GVA per head is used instead. Data from the ONS gives the local study area a GVA per head output of around £29,500 and Scotland a GVA per head output of £23,700.

15.4.2.23 However, the GVA per head for Moray and the Highlands, at £20,600 and £22,500 GVA per head respectively, is below the local study area's average. These figures are also below UK and Scotland averages. This reflects a range of socio-economic factors where Moray, in particular, performs below the UK and Scotland average, especially in terms of qualifications and employment density (per 1,000 working age residents) in addition to the concentration of lower value sectors (such as manufacturing and wholesale and retail). Therefore, the above average

[7] Residence-based earnings are defined and calculated by ONS as earnings of employees who live in an area (source: ONS Annual Survey of Hours and Earnings).
[8] Workplace-based earnings are defined and calculated by ONS as earnings of employees who work in an area (source: ONS Annual Survey of Hours and Earnings).

GVA per head in the local study area reflects the significantly higher than Scotland and UK average GVA per head in Aberdeen City (£47,000) and Aberdeenshire (£27,700).

15.4.2.24 A detailed look at GVA output and GVA per head within the local study area, shows that the local study area's output of almost £29,500 GVA per head is approximately £5,700 higher than the Scotland figure of £23,700 and almost £3,900 higher than the UK GVA per head figure of £25,600.

Supply Chain Capacity and Capability

15.4.2.25 An overview of the offshore wind supply chain by Renewable UK (2016) in the local study area has highlighted several businesses which provide key services across the different phases of the offshore wind farm life cycle from initial site surveys and investigations, through environmental and engineering consultancy and wind farm design, project management and procurement, construction and installation, through to operations and maintenance services.

15.4.2.26 Scotland, and especially the local study area, has a rich heritage in the oil and gas industry as highlighted earlier. Along with onshore wind energy, there are significant opportunities for the diversification of these industries into offshore wind energy. Indeed, a report by the Scottish Enterprise has identified nine areas of high potential for oil and gas industries to diversify into wind energy, including project management, the provision of various vital components; and installation, maintenance and inspection services (Scottish Enterprise, 2016).

15.4.2.27 Scottish Development International (2017) has identified several Scottish Energy Ports in the local study area which have the potential to contribute to the offshore wind farm construction and operations supply chain. These include:

- Port of Inverness: Has direct access to the Moray Firth and has been identified by Scottish Development International (2017) as the economic hub of the Highlands and gateway for import and export of goods;
- Port of Cromarty Firth: home to six marine facilities and provides a "one port" solution for a number of support services and capabilities, such as sheltered anchorage, local supply chain, warehouses and pilotage services;
- Nigg Energy Park: Current provider of storage and handling of large scale equipment services to the offshore renewables industry; and
- Wick Harbour: large structures and wind turbine components of various developers tend to be handled at this port which is of close proximity to Moray Firth (8 miles). It has also been identified as a port for providing O&M services the Beatrice offshore wind farm project (Scottish Energy Ports Capability Directory, 2017).

15.4.2.28 Table 15.4.10 shows a breakdown of sectors where there are supply chain opportunities for the Development, including supporting and peripheral activities. The analysis uses 3-digit Standard Industrial Classification (SIC) codes to map supply chain activities to the sectors related to offshore wind. The resulting SIC code definitions are used to identify employment and concentrations in the relevant sectors. These are presented on a full time equivalent (FTE) basis. The main activities which are analysed include:

- Manufacturing and engineering sectors: in particular the manufacture of fabricated metal products (for example as part of the supply chain for the turbine substructures and towers), manufacture of electric wires and cables required as part of the offshore transmission infrastructure and manufacture of electric motors and generators (for example to supply components for offshore sub stations);
- Construction sectors: the more specialist construction sectors and those relating to construction structures, ships and boats are most likely to be affected by the Development;

- Land and marine transport sectors: sea and coastal water transport and ancillary services will be key sectors along with other land-based forms of transport;
- Accommodation and food service: these sectors will be serving workers coming into the area from elsewhere, during the construction period in particular; and
- Professional services: a range of technical consultancy services will be required throughout the construction and O&M of the Development.

15.4.2.29 The analysis shows there are 64,900 FTE employees employed in sectors related to offshore wind in the local study area. There are a number of specialisms which show capability in these activities already, building on the servicing of the existing energy sector in the area:

- The construction sub-sectors employ around 3,000 FTEs, with civil engineering employment likely related to the construction of oil and gas projects in the local study area. There are several large-scale international construction companies based in the local study area (Aberdeen City in particular) already supplying services for offshore wind as well as the oil and gas sector given the synergies in marine construction services between the two sectors (Scottish Enterprise, 2015);
- There is a concentration of transport sectors, particularly marine transport (LQ=3.7). This reflects the presence of multiple ports as well as vessels currently engage in the oil and gas sector; and
- The relevant professional services sub-sectors employ over 25,100 FTE employees. These activities present a great opportunity to supply the offshore wind sector, with transferable skills from oil and gas as identified by the report for Scottish Enterprise (2016). The report suggests a number of project management companies are already supplying services for offshore wind projects, and this area does not require substantial investment for diversification.

Table 15.4.10: Employment in Sectors with Supply Chain Opportunities for Construction and O&M, 2016

Sector	Great Britain FTEs (000s)	Local Study Area FTEs (000s)	Local Study Area LQ vs Great Britain
Manufacturing			
Fabricated metal products	45.4	0.4	0.6
Motors, generators, transformers etc.	23.1	0.1	0.3
Wiring and wiring devices	13.0	0.1	0.4
General purpose machinery	48.4	0.6	0.8
Construction Sectors			
Building of ships and boats	31.5	0.9	1.9
Other civil engineering projects	134.0	2.1	1.1
Transport Sectors			
Freight transport by road	248.5	3.4	0.9
Sea and coastal freight water transport	5.3	0.3	3.7
Support activities for transportation	213.0	5.4	1.7
Professional Services			

Table 15.4.10: Employment in Sectors with Supply Chain Opportunities for Construction and O&M, 2016			
Sector	**Great Britain FTEs (000s)**	**Local Study Area FTEs (000s)**	**Local Study Area LQ vs Great Britain**
Management consultancies	443.3	4.0	0.6
Architectural, engineering consultancy	435.3	19.5	3.1
Other professional, scientific and technical	121.0	1.6	0.9
Accommodation and Food Services			
Accommodation	360.9	10.6	2.0
Food and beverage services	1194.8	14.6	0.8
Other Services			
Electric generation, transmission, distribution	76.0	1.5	1.3
TOTAL	3393.3	64.9	-

Source: ONS (2016), 'Business Register and Employment Survey.'

15.4.2.30 Table 15.4.11 shows how the FTE employment has performed across the key supply chain sectors (which are outlined in Table 15.4.10) in the Local Study area and Scotland. The FTE employment in the supply chain in the local study area has grown on average by 1,600 FTE jobs in these sectors over the seven years, equivalent to a 2% annual average growth rate. This growth rate is comparable to Scotland, with the absolute number of FTE jobs growing on average by 4,440 between 2009 and 2015.[9]

Table 15.4.11: FTE Employment in Key Supply Chain Sectors, 2009-2015						
Year	**Local Study Area**			**Scotland**		
	FTE Employment	**Annual Change**	**Annual % Change**	**FTE Employment**	**Annual Change**	**Annual % Change**
2009	61,600	-	-	258,600	-	-
2010	59,000	-2,600	-4%	251,600	-7,000	-3%
2011	60,600	1,600	3%	246,800	-4,800	-2%
2012	62,200	1,600	3%	246,800	0	0%
2013	67,600	5,400	9%	271,800	25,000	10%
2014	69,600	2,000	3%	276,300	4,500	2%
2015	71,000	1,400	2%	285,200	8,900	3%
Average Annual Change (2009-2015)	**-**	**1,600**	**2%**	**-**	**4,400**	**2%**

Source: ONS (2009-2016), 'Business Register and Employment Survey'.

[9] Please note: ONS has made methodological changes to the Business Register and Employment Survey in the 2016 release, which makes the 2016 data not directly comparable to previous years. For this reason, the historic analysis focuses on the period between 2009 and 2015 to provide an accurate representation of employment trends.

Serviced Accommodation

15.4.2.31 Analysis of capacity in the different types of temporary accommodation in the local study area can help to understand the ability of the area to respond to potential increase in demand from workers during the construction period for the Development. While the overall construction period is expected to be three years, some of the activities will be shorter term with different activities having shorter durations. The analysis therefore focuses on short term accommodation with a lease of up to six months, as it is unlikely that the Development will generate demand for long term accommodation and housing.

15.4.2.32 In addition to the two major settlements of Aberdeen and Inverness, a further three local centres have been identified within the study area as having a significant supply of visitor accommodation. Their selection was based on their size, all having a population greater than 15,000 people, along with their proximity to the Moray West Site or one of the four Scottish Energy Ports. These include:

- Wick (Highlands, pop. 7,155 (Census 2011));
- Peterhead (Aberdeenshire, pop. 18,537 (Census, 2011)); and
- Elgin (Moray, pop. 23,128 (Census, 2011)).

15.4.2.33 It is important to note that this is an assessment of the total supply of visitor accommodation. This has a pre-existing demand from Scotland's tourist economy which at a headline figure for 2016 there were 14.26m overnight tourist visitors to Scotland (Visit Scotland, 2016). Of these visits to Scotland, 17% were visits to the Highlands. Consequently, demand for tourism in these locations tends to have a seasonal element which peaks in the summer when occupancy rates reach 70% (Image 15.4.8). In other locations such as Peterhead and Aberdeen, demand for visitor accommodation is more reflective of business tourism associated with the oil and gas industry. Consequently, the demand is more consistently distributed throughout the year (Image 15.4.9).

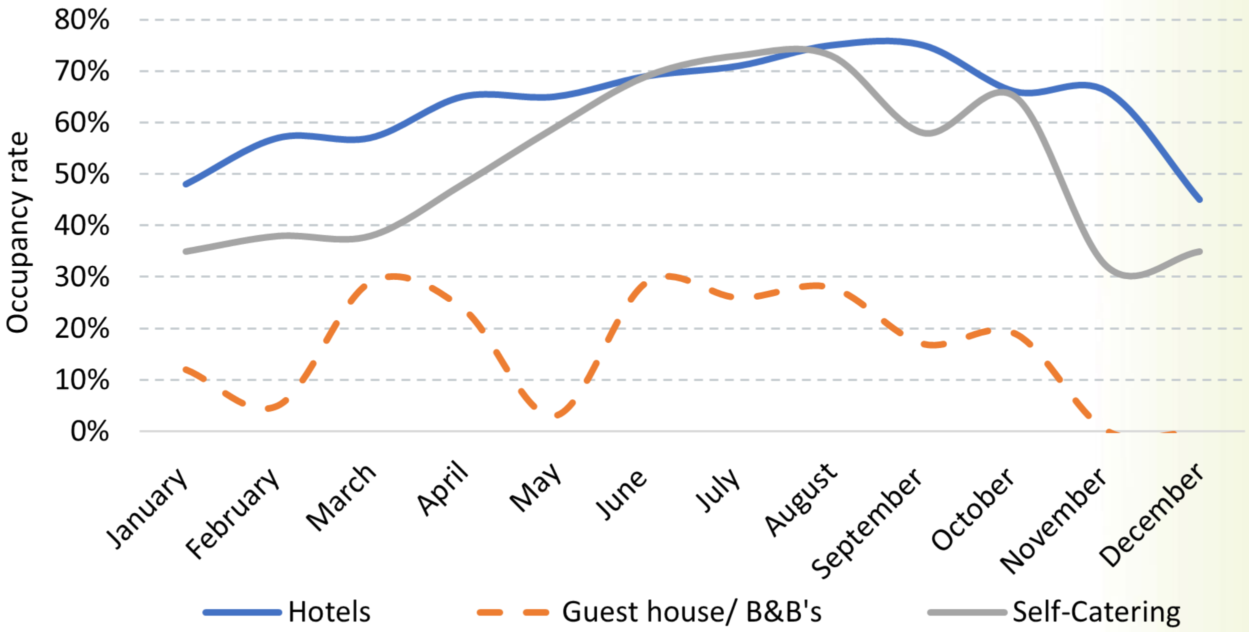

Image 15.4.8: Occupancy Rates in the Highlands, 2016 (Source: Scottish Occupancy Survey, 2016)

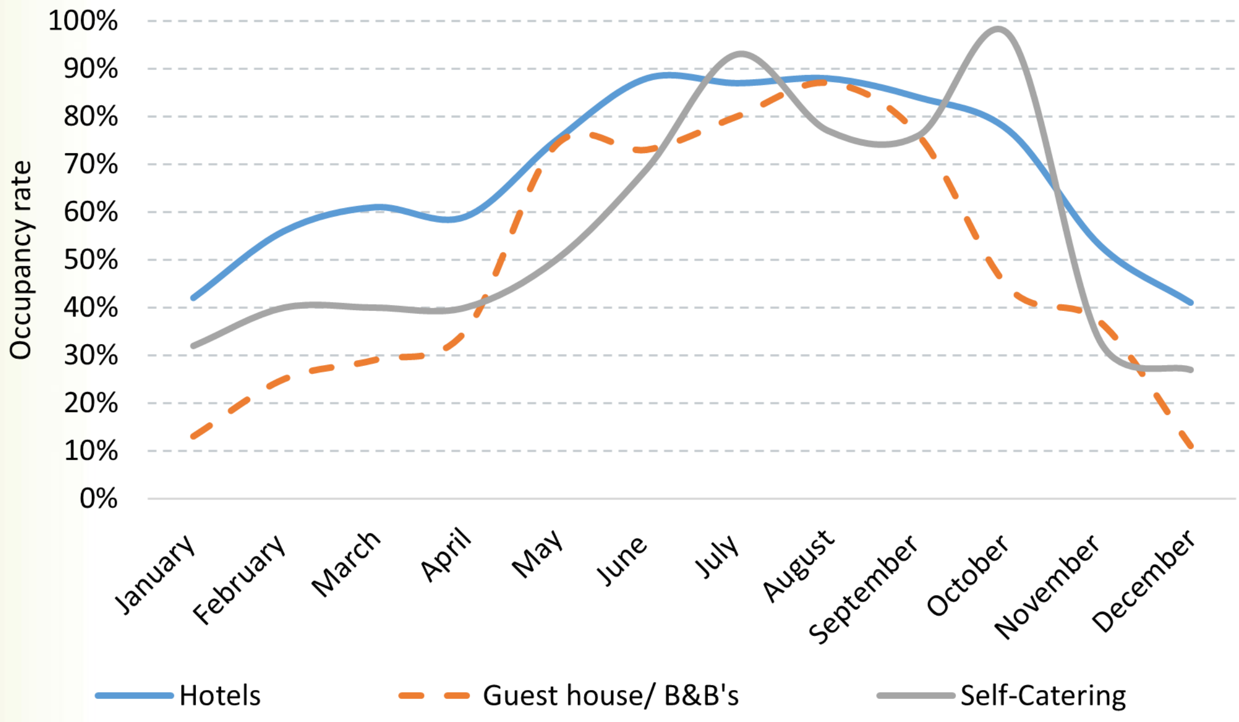

Image 15.4.9: Occupancy Rates in Aberdeen & Grampian, 2016 (Source: Scottish Occupancy Survey, 2016)

15.4.2.34 Aberdeen is one of the largest cities in Scotland and has a large and developed visitor accommodation hub stemming from its hospitality industry, in particular related to business tourism. It has a further requirement for overnight professionals visiting the city for its oil and gas hub. In 2014 Aberdeen was termed a 'Hotel Super City' due to its strong visitor accommodation infrastructure. There were approximately 5,095 three to five star hotel beds in September 2015, with a further 500 bedrooms being opened in 2015 and several large scale (100+ rooms) being at an advanced planning stage. Given the fall in the price of oil over the last few years, the demand for accommodation in Aberdeen may have subsided, releasing capacity in the short-term accommodation market which is not reflected in the available data. Aberdeen has the widest range of amenities of all the population centres in question.

15.4.2.35 Inverness is only city in the Highlands. It has approximately 50,000 inhabitants. A 2011 survey (Highlands and Islands Enterprise, 2011) found the Greater Inverness area to have 2,345 visitor bedrooms across all accommodation types. There has been an increase in supply since 2011 as a result of a number of large hotel developments. The tourism sector represents a large proportion of the Inverness economy.

15.4.2.36 Peterhead is the largest settlement in Aberdeenshire with a population of around 20,000. Its economy is centred around its port which primarily services the fishing, oil and gas industries. The town has some tourist industries but this is supplementary to its commercial port. The cost of accommodation in Peterhead is low compared to Aberdeen and Inverness and is generally consistent all year round due to a lack of seasonal tourism.

15.4.2.37 Elgin is the largest town in Moray, operating as the administrative and commercial centre for the county. It has a population of around 25,000 and an economy that is highly dependent on tourism. Consequently, the total supply of visitor accommodation along the Moray Coast from Kintessack to Sandend is relatively high, with 795 visitor bedrooms available in 2011. Most accommodation comprises small, independent hotels and bed and breakfasts.

Tourism and Recreation

15.4.2.38 The Tourism Scotland 2020 Strategy (Scottish Tourism Alliance, 2012) estimated that tourism generates in excess of £4.5bn annually in overnight visitors in Scotland, with day visitors generating a further £6.2bn, which in aggregate accounts for around £11bn in expenditure (2011 estimates) nationally. Indeed, the Scottish Government states that tourism generates around £6bn to Scottish GDP, with is around 5% of total Scottish GDP. The Government sets out objectives to enhance and support the tourism sector which is important to the national economy, attracting over 14.3 million visitors in 2016 and supporting around 217,000 jobs (Visit Scotland, 2017).

15.4.2.39 The two wider regions which constitute the local study area, Highlands & Islands and Grampian, constitute a significant percentage of the total visits to Scotland. Combined, they account for 27% of all tourist trips, individually Highlands & Islands accounts for 17% and Grampian 9%.

Table 15.4.12: Tourist Trips to Study Area (Thousands), 2016

	Highlands & Islands	% of Total Visits to Scotland	Grampian	% of Total Visits to Scotland	Scotland
Overseas tourist trips	596	22%	305	11%	2,747
Domestic tourist trips	1,855	16%	1,027	9%	11,514
Total	2,451	17%	1,332	9%	14,261

Source: Visit Scotland, 2016.

15.4.2.40 The Strategic Framework for Scotland's Marine Tourism Sector (Highlands and Islands Enterprise, 2015) sets out ambitions that by 2020 Scotland will be "a marine tourism destination of first choice for high quality, value for money and memorable customer experience". Its mission is to grow the sailing and tourism sector from £101m to £145m, and increase the overall economic value of marine tourism[10] from £360m to £450m by 2020.

15.4.2.41 Marine tourism plays a significant role in attracting tourists. A recent survey, commissioned by the Scottish Government, estimated that the expenditure from marine recreation and tourism activities (including around the shore in general) accounted for around £3.7bn to the Scottish economy, £2.4bn of which was related to general recreation and tourism and £1.3bn associated with more specialist activities such as wildlife watching sailing, kayaking, surfing and angling (Marine Scotland, 2016). As can be seen in Image 15.4.10, the most popular marine and tourism activities at the sea or around the Scottish coastline line are located on the western coast with some high activity areas in Forth and Tay, Moray Firth and the North East.

[10] Marine tourism here is defined as including "those recreational activities which involve travel away from one's place of residence and have the marine environment or inland waters/waterways as their host or focus." It includes activities such as cruising, sea angling, marine wildlife watching, boat trips, sailing and boating, sea kayaking, coastal rowing, surfing, diving, water skiing, kite surfing etc. (Highlands and Islands Enterprise, 2015)

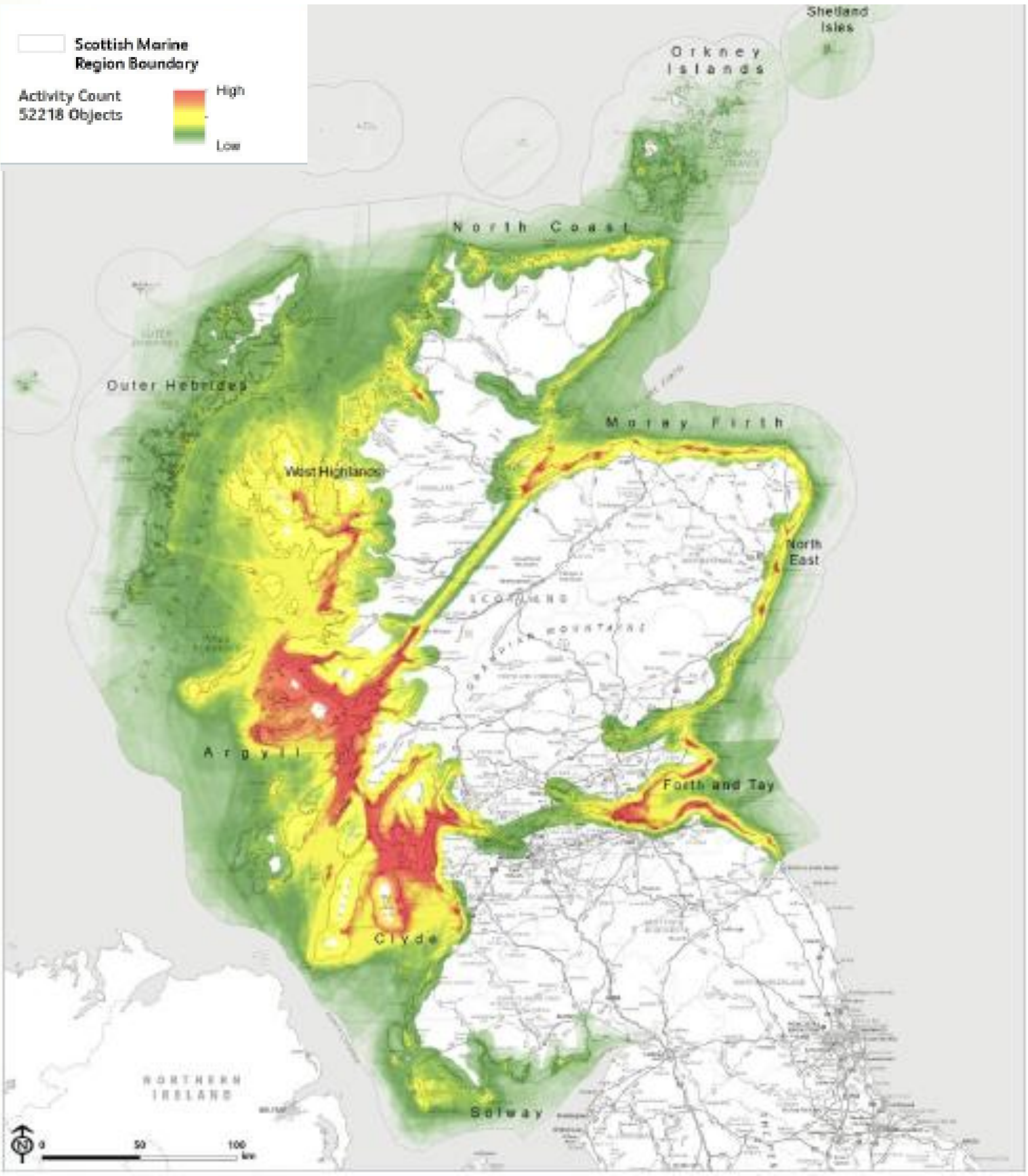

Image 15.4.10: Recreation and Tourism Activity Around Scottish Coastline, 2015 (Source: Marine Scotland, 2016)

Marine Tourism

Sailing and Yachting

15.4.2.42 Sailing and yachting is a prominent marine activity in Scotland. The East Coast is dotted with many small harbours and acts as a gateway for local sailors and visitors from Scandinavia and Northern Europe (Northern Isles and East Coast Marine Tourism Group, 2017). The Moray Firth offers easy access to Inverness, Loch Ness and the Caledonia Canal and links to West Coast Scotland. According to Sail Scotland (2017), there have been a number of recent developments which have improved the offer of marine facilities along the East Coast of Scotland, including nearby facilities in Aberdeen, Peterhead and Wick.

15.4.2.43 Data from the Royal Yachting Association (RYA, 2017) shows that the coastline from Lossiemouth to Fraserburgh is of moderate intensity for recreational boating, all close in proximity to the shoreline. The coast is home to 14 harbours or marinas which can facilitate yachting activities. The Royal Yachting Association has four registered associations within this area. Whitehills harbour is home to a popular marina which hosts an annual sailing regatta in August.

Wildlife Watching

15.4.2.44 The wildlife in the local study area is one of the major tourist attractions. The area has an abundance of wildlife, including at Dornoch Firth, as well as multiple estuaries of Scotland's major rivers such as the Ness, Findhorn and Spey. Part of the Moray Firth (Inner Moray Firth) is designated as a Special Area of Conservation (SAC) for its resident population of bottlenose dolphin. VisitScotland also promotes the area to visitors interested in wildlife for its grey and harbour seals, harbour porpoises and otters. A number of interesting birds are also present in the location such as ospreys, waders and various wildfowl.

15.4.2.45 A 2010 study estimated that there were around 63,000 overnight visitors to Moray Firth dolphin survey locations, with total direct expenditure related to bottlenose dolphins estimated to be in the region of £10m (Davies *et al.*, 2010). A study found that approximately 202 full-time jobs were created and approximately £4 m total income from direct tourism expenditure is generated solely based on the presence of the bottlenose dolphin population in the East of Scotland in 2009. The bulk of tourism expenditure received by tourist providers is centered around the Moray Firth region, with local authorities of the Highlands accounting for 61.3%, Moray for 14.2% and Aberdeenshire with 4.5% (Davies *et al.,* 2010).

15.4.2.46 There are a number of businesses and centers servicing the wildlife tourist market. The most prominent is the Scottish Dolphin Centre located in Spey Bay. This is open from March-October each year. The center offers guided walking tours to spot wildlife in the sea, along with a number of interactive exhibits within the center which require use of the sea (e.g. an under-water microphone to record dolphin calls). A number of private businesses also offer wildlife boat trips. One of the more popular trips is the Gemini Marine Tour from Buckie harbour which operates throughout the year. They generally make 2/3 trips per day lasting around two and a half hours.

Watersports

15.4.2.47 The export cables will be brought ashore at a location on the north Aberdeenshire coast between Findlater Castle and Redhythe Point. This stretch of coastline has been identified as being important for a number of watersports activities including surfing, kayaking, canoeing, windsurfing and kite surfing. Most of these activities occur within a few hundred meters from the coast and therefore will have limited interaction with the Development unless located within or immediately adjacent to the export cable corridor and landfall e.g. the coastline and adjacent waters in the vicinity of Sandend Bay.

15.4.2.48 The beach at Sandend is recognised as one of the prime surfing locations on the East Coast of Scotland. Home to the Moray Firth Surf Riders, the beach is surfed all year round by people learning to surf for the first time to professional surfers. There is a local surf school based in Sandend Village which offers surfing lessons all year round.

15.4.2.49 The Sandend Beach also attracts a number of visitors during the summer with accommodation provided at the beach side Sandend caravan park or local hotels in the nearby village of Portsoy. Sandend is also popular for other watersports such as kayaking, canoeing and standup paddle boarding.

Sea-angling and Scuba-diving

15.4.2.50 Sea angling/fishing is a popular sport throughout the Study Area, targeting species such as cod, ling and mackerel amongst others. Fishing is either conducted along the coastline with raised cliffs and local beaches providing casting spots. Alternatively, sea-angling can occur further offshore using specialists chartered fishing vessels.

15.4.2.51 Scuba diving can also occur further offshore and therefore could potentially interact with the Development in locations further from the coast. There are a number of areas of interest for scuba-diving in the area (see Image 15.4.11) and a number of businesses offering a variety of diving related services including diving lessons and charter boat hire for diving in the area. One company is North East Dive in Portsoy, which offers bi-monthly three to five-day diving expeditions throughout the summer. Dive clubs based in other areas also often visit the area, for example the Central Scotland Dive Club offer a regular dive at Lossiemouth.

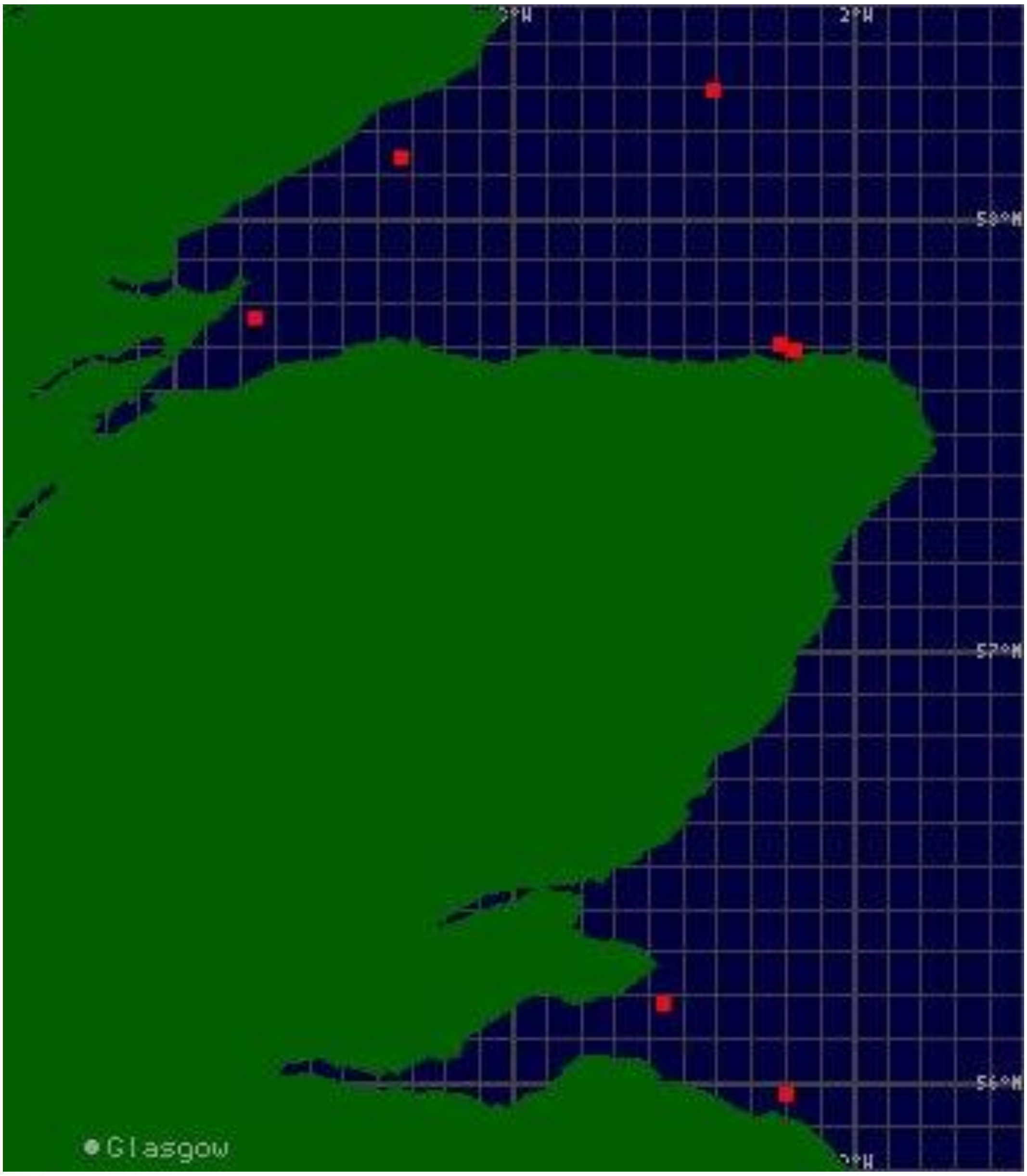

Image 15.4.11: Map of Wreck Diving Sites, 2006 (Source: ukdiving.co.uk, 2006)

15.5 Assessment Methodology

15.5.1 Assessment Approach

15.5.1.1 This assessment considers the potential effects associated with the construction, operation and decommissioning of the Development on socio-economic, recreation and tourism receptors in the local study area. The absolute scale of economic impacts was calculated using an approach which is consistent with the methods and principals for economic impact assessment and appraisal as set out in HM Treasury's Green Book (2011). The detailed assessment approach is set out in Volume 4, Appendix 15.1.

15.5.1.2 The analysis of employment and GVA effects focuses on direct and indirect economic impacts during construction, and operation and maintenance phases:

- Direct economic impact:
  - During construction, these measure the potential effects wholly related to construction of the Development. Direct impacts capture the jobs and GVA associated with the first round of capital expenditure (i.e. the one which Moray West will spend directly with its suppliers). Impacts are calculated based on the sourcing assumption for Scotland and local study area, and applying benchmarks[11] to additional output estimates in each sector; and
  - For O&M, the direct effects capture the jobs and GVA that are directly associated with O&M activity (i.e. employees engaged in activities relating to management, monitoring and maintenance). The jobs and GVA estimates have been based on sourcing assumptions for each study area.
- Indirect economic effect: indirect economic impact captures the FTE jobs and GVA generated in the local study area and Scotland in the supply chain:
  - For construction, the direct impacts are derived from the expenditure on goods and services that companies directly supplying the Development would spend on their own supply chains; and
  - For O&M, the indirect effects capture the jobs and GVA associated with all supply chain spend required during the O&M phase. The estimates are derived using cost and sourcing assumptions, and are calculated using Regeneris Consulting's in-house Input-Output model for Scotland.

15.5.1.3 In addition to direct and indirect effects, there will be additional employment and wealth which arise through personal expenditure of direct and indirect staff. However, compared with the direct and indirect economic effects, there is typically greater uncertainty about the scale, sectoral distribution, and geographical spread of these effects, these have therefore not been included in this assessment.

15.5.1.4 The employment and GVA impacts are driven by the expenditure on suppliers in the local study area and Scotland. This geographical sourcing is subject to various uncertainties:

- The location of the main tier one and tier two suppliers, their associated supply chains and the extent to which this influences the retention of supply chain expenditure in Scotland and the local study area;
- The likelihood of ports in the study areas being selected as construction and O&M bases and the range of functions they might serve;
- The capacity in the supply chain at the time the Development take place to tender for contracts and deliver the services and goods required, as well as the ability to secure contracts; and
- The potential for the range and expertise of suppliers and workers with relevant skills to be increased or enhanced prior to the procurement of the Development.

15.5.1.5 To reflect these uncertainties, two assessment scenarios have been developed which reflect the range of expenditure which could be captured in the study areas. The scenarios have been informed by the developer and their view of supply chain strengths in Scotland and the local study area and the likelihood that companies in the areas can capture parts of the supply chains. A detailed outline of the scenarios is set out in Volume 4, Appendix 15.1.

[11] Turnover per FTE job benchmarks in relevant sectors from the Annual Business Survey 2015.

Construction Phase Scenarios

15.5.1.6 The scenarios outline the sourcing assumptions for the development and construction of the Development.

- Under the low assessment scenario, it is assumed that very limited activity takes place at the ports in the local study area, with some use of vessels and limited installation activity. The scenario assumes 4% of the value is captured by the local study area and 14% in Scotland. The main construction ports are located outside of Scotland; and
- The high assessment scenario for construction assumes the use of local ports for some of the construction activity, providing more of the vessels and transportation, as well as the supply of some of the components and services required. It is assumed 21% is captured in the local study area and 49% in Scotland under the high scenario during construction.

Operation and Maintenance Phase Scenarios

15.5.1.7 Both scenarios for O&M assume a fairly significant local operational base, hence the extensive use of a local port and sourcing of local labour. Other assumptions include:

- Under the low assessment scenario, 25% of the expenditure is retained in the local study area and 26% in Scotland; and
- The high assessment scenario assumes 40% is retained in the local study area and 41% in Scotland.

15.5.1.8 In addition to quantitative operation and maintenance impacts, the chapter outlines the potential benefit of the Development on renewable electricity generation costs. This is an important benefit for the UK economy which is described qualitatively.

15.5.2 Impacts Identified as Requiring Assessment

15.5.2.1 Table 15.5.1 below lists all potential impacts on socio-economics and recreation and tourism identified as requiring consideration as part of the assessment. This list of impacts is based on expert judgement, reflects responses provided by statutory consultees and other stakeholders in the wind farm and OfTI Scoping Opinions and takes into account further comments received as part of ongoing community consultation activities.

Table 15.5.1: Impacts on Socio-Economics, Recreation and Tourism Requiring Assessment

Potential Impact	Nature of Impact (direct or indirect)	Inter-Relationships with Other EIA Topics / Receptors
Construction Impacts		
Development construction activities leading to an effect on employment.	Direct	None
Development construction activities leading to an effect on GVA.	Direct	None
Development construction activities leading to an effect on demand for housing, accommodation and local services.	Indirect	None
OfTI construction activities leading to an effect on access to, and enjoyment of watersports.	Indirect	None
OfTI construction activities leading to an effect on activity onshore supported by local watersports activities.	Indirect	None

Table 15.5.1: Impacts on Socio-Economics, Recreation and Tourism Requiring Assessment		
Operation and Maintenance (O&M) Impacts		
Development O&M activities leading to an effect on employment.	Direct	None
Development O&M activities leading to an effect on GVA.	Direct	None
Decommissioning Impacts		
Development decommissioning activities leading to an effect on employment.	Direct	None
Development decommissioning activities leading to an effect on GVA.	Direct	None
OfTI decommissioning activities leading to an effect on access to, and enjoyment of watersports.	Indirect	None
OfTI decommissioning activities leading to an effect on activity onshore supported by local watersports activities.	Indirect	None

15.5.3 Scoped Out Impacts

15.5.3.1 The following impacts on socio-economics, tourism and recreation have been scoped out of the assessment (Table 15.5.2).

Table 15.5.2: Scoped Out Impacts on Socio-Economics, Tourism and Recreation		
Potential Impact	**Phase**	**Justification**
Impact of offshore wind farm on tourism	Construction, Operation and Maintenance and Decommissioning	Given the distance of the wind farm for land, it is expected to have limited or no visibility from land or to interfere with onshore tourism or leisure activity. It should be noted that potential impacts on popular visitor destinations and individuals visiting the area in terms of the visuals impacts associated with the wind farm have assessed in the Seascape, Landscape and Visual Impact Assessment (SLVIA).
Impact of offshore wind farm on Surfing, Sea-Kayaking and Walking	Construction, Operation and Maintenance and Decommissioning	These activities are likely to take place near or on shore. Interactions between these activities and the wind farm are therefore highly unlikely due to the distance of the Moray West site offshore (22 km).
Impact of OfTI on access to and enjoyment of watersports activity	Operation and Decommissioning	Unlike the construction phase, the operations and maintenance activity will be relatively intermittent and spread across a large area. The OfTI will have no impact on surf conditions during O&M, with no cable exposure and no visible above ground infrastructure (see Chapter 6: Physical Processes and Water Quality). Therefore, it is not expected that there would be much potential for disruption of the limited offshore recreational watersports activity which currently

Table 15.5.2: Scoped Out Impacts on Socio-Economics, Tourism and Recreation		
Potential Impact	**Phase**	**Justification**
		occurs. This potential effect, and the associated visitor economy effect, have therefore been scoped out.
Impact of OfTI on economic activity onshore supported by local watersports activity	Operation and Decommissioning	As above, with limited disruption expected during operation and maintenance, the impact on economic activity is expected to be minimal.
Impact of wind farm and OfTI on the change in demand for housing and local services associated with influx of labour	Operation and Decommissioning	The scale of activity during operation and decommissioning phases is much more limited, and therefore is not expected to result in a large influx of labour from outside the area. This means there is limited scope to impact demand for housing and local services at these phases.

15.5.4 Assessment Criteria

15.5.4.1 The general approach to the assessment is detailed in Chapter 5 EIA Methodology. This is a two stage process involving the application of specific criteria to defining the sensitivity of the receptors and the magnitude of the potential impacts. Specific criteria developed to inform the assessment of impacts on socio-economics and recreation and tourism receptors associated with the construction, operation and maintenance and decommissioning of the Development is described below.

15.5.4.2 The absolute scale of economic impacts (i.e. the number of jobs which construction, O&M and decommissioning activity is expected to support under each scenario) was calculated using an approach consistent with methods for economic impact assessment set out in HM Treasury Green Book (2011).

Sensitivity Criteria

15.5.4.3 The sensitivities of the receptors are defined by both their potential vulnerability to, or benefit from, an impact of the Development, their recoverability and the value or importance of the receptor. The definitions of terms relating to the receptors are detailed in Table 15.5.3. The method for determining the sensitivity of each of the receptors takes account of the importance attached to each receptor in local and national economic development and regeneration policy, together with professional judgement relating to the scale of socio-economic challenges.

Table 15.5.3: Sensitivity Criteria	
Sensitivity	**Definition Used in this Chapter**
High	The receptor is identified as a policy priority (as a result of economic potential and/or need). There is evidence of major socioeconomic challenges or underperformance and vulnerability for the receptor in the study area.
Medium	The receptor is not identified as a policy priority (as a result of economic potential and/or need). There is evidence of considerable socioeconomic challenges or underperformance and vulnerability for the receptor in the study area.

Table 15.5.3: Sensitivity Criteria	
Sensitivity	**Definition Used in this Chapter**
Low	The receptor is not identified as a policy priority (as a result of economic potential and/or need). There is evidence that the receptor is resilient and no particular weaknesses or challenges for the receptor in the study area.
Negligible	The receptor is not identified as a policy priority (as a result of economic potential and/or need). There is evidence of good overall performance and no particular weaknesses or challenges for the receptor in the study area.

Magnitude of Impact

15.5.4.4 The magnitude of impact is defined by a series of factors including the spatial extent of any interaction, the likelihood, duration, frequency and reversibility of a potential impact. The definitions of the levels of magnitude used in this assessment in respect of the receptors are described in Table 15.5.4 below.

15.5.4.5 Further quantitative definitions of magnitude are included in Volume 4, Appendix 15.1. Due to the nature of socio-economic impacts, it is not always possible to define magnitude in a wholly quantitative way. The assessment considers the direct and indirect economic impacts measured against baseline measures in the areas in which these impacts are likely to occur. The assessment considers the historic baseline performance of the receptors where relevant (for example, historic employment growth in relevant sectors is taken into account when assessing the magnitude of impact). The assessment of magnitude therefore requires an element of professional judgement to conclude the assessment considering the several elements which are taken into account. For this reason the magnitude definitions provided in this chapter are in qualitative terms.

Table 15.5.4 : Magnitude Criteria	
Magnitude of Impact	**Definition Used in this Chapter**
High	Large change to baseline conditions in terms of absolute and/or percentage change
Moderate	Moderate change in baseline conditions which is noticeable in terms of absolute and/or percentage change
Low	Minor shift away from baseline which would be noticeable in terms of absolute and/or percentage change in baseline conditions
Negligible	Very slight change from baseline condition
No change	No change from baseline condition.

Significance Criteria

15.5.4.6 The significance of the effect upon socio-economics and recreation and tourism receptors is determined by correlating the magnitude of the impact and the sensitivity of the receptor. The particular method employed for this assessment is presented in Table 15.5.5.

15.5.4.7 For the purposes of this assessment, any effects with a significance level of minor or less have been concluded to be not significant in terms of the EIA Regulations.

Table 15.5.5: Significance Criteria					
Sensitivity of Receptor	**Magnitude of Impact**				
	No change	**Negligible**	**Low**	**Moderate**	**High**
Negligible	Negligible	Negligible	Negligible	Minor	Minor
Low	Negligible	Negligible	Minor	Minor	Moderate
Medium	Negligible	Negligible	Minor	Moderate	Major
High	Negligible	Minor	Minor	Moderate	Major

15.5.5 Data Limitations

15.5.5.1 The main areas of uncertainty in undertaking the assessment of socio-economic assessment effects are around costs, the construction and O&M port to be used, and geographic sourcing of goods and services. As the location of ports and supply chain contracts will be determined through a procurement process at a later stage (post consent), it is not possible to confidently predict the level of expenditure and where it is likely to take place. It is also difficult to measure with certainty the capacity within the supply chain businesses to compete for contracts.

15.5.5.2 The uncertainty has been dealt with using the scenario-based approach to assessment described previously to illustrate the likely range of potential impacts. A detailed description of these is provided in Volume 4 – Technical Appendix 15.1: Socio-Economics Technical Report.

15.6 Design Envelope Parameters

15.6.1 Realistic Worst Case Design Scenario for Impacts Requiring Assessment

15.6.1.1 As identified in Volume 2 - Chapter 4: Development Description, Moray West is considering a range of potential construction methods and design options for the Development. The Design Envelope presented in Chapter 4 (Volume 2) represents the maximum design parameters for each of the options under consideration e.g. substructure type or turbine model.

15.6.1.2 In order to determine potential impacts of the various options it is necessary to define the 'realistic worst case scenario'. The realistic worst case scenario represents, for any given receptor and potential impact on that receptor, various options in the Design Envelope that would result in the greatest potential for change to the receptor in question.

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

15.6.1.4 Table 15.6.1 presents the realistic worst case scenario for potential impacts on socio-economics and recreation and tourism during construction, operational and maintenance and decommissioning phases of the Development and provides justification as to why the options and design parameters identified are considered to be the realistic worst case scenario.

Table 15.6.1 : Worst Case Scenario Design Envelope Parameters Relevant to Socio-Economics, Recreation and Tourism		
Potential Impact	**Realistic Worst Case Scenario**	**Justification**
Construction		
Development construction activities leading to an effect on employment	Maximum design scenario does not in practice apply for employment and GVA related impacts. The scenario which results in lowest levels of benefits is associated with the lowest expenditure. For this reason, the assessment assumes the lowest maximum number of turbines (62 for Model 4 WTG) will be used and 275 km of inter-array cables.	Effects in relation to employment and GVA generated as a result of construction activity are all beneficial, so there is no maximum adverse scenario. Detailed aspects of scheme design do not have a substantial bearing on the economic impact assessment. Non-design factors (such as the selection of ports, procurement approach and the geography of the Development's supply chain) are much more important factors in determining the overall level of potential economic impact. Two construction scenarios are assessed, both of which are beneficial. The low assessment scenario could be thought of as a maximum adverse insofar as the local and Scotland-based benefits are at their lowest.
Development construction activities leading to an effect on GVA		
Development construction activities leading to an effect on demand for housing, accommodation and local services	Maximum design scenario does not apply.	Impacts on this receptor are driven by the geography of the Development's labour force and the extent to which workers come from outside of the local study area. This is not affected by detailed aspects of the scheme design. The maximum adverse scenario for this receptor would arise if low levels of sourcing of local goods and services applied, with the exception of ports. This would cause the employment generated during the construction phase to be filled by people from outside of the local study area. This is represents a cautious position.
OfTI construction activities leading to an effect on access to, and enjoyment of watersports and associated value	Construction works in close proximity to popular watersports activity areas nearshore which would exclude members of the public from engaging in water sports activities, or lead to temporary deterioration in recreational attributes and conditions. The scenario with maximum number of substructures and the longest cable route option would apply: • Interconnector cable of 15 km; • Inter array cable of 275 km;	This scenario represents maximum spatial and temporal disturbances to watersports users. It would result in loss of access to watersports activity and displacement of recreational users for the duration of construction. A temporary displacement of watersports activity could result in a short-term loss of economic value associated with these activities in the local study area.

Table 15.6.1 : Worst Case Scenario Design Envelope Parameters Relevant to Socio-Economics, Recreation and Tourism		
Potential Impact	**Realistic Worst Case Scenario**	**Justification**
	• 2 export cable circuits of 65 km each; and • Two OSPs.	
Operation and Maintenance		
Development O&M activities leading to an effect on employment	Maximum design scenario does not apply for employment and GVA related impacts. The scenario which results in lowest levels of benefits is associated with the lowest expenditure. For this reason, the assessment assumes the fewest number of turbines (62) will be used and 275km of inter array cables as these would require the least expenditure on operation and maintenance.	Effects in relation to employment and GVA generated as a result of O&M activity are all beneficial, so there is no maximum adverse scenario. Detailed aspects of scheme design do not have a substantial bearing on the economic impact assessment. Non-design factors (such as the selection of ports, procurement approach and the geography of the Development's supply chain) are much more important factors in determining the overall level of potential economic impact. Two O&M scenarios will be assessed. The low assessment scenario could be thought of as a maximum adverse insofar as the local and Scotland-based benefits are at their lowest.
Development O&M activities leading to an effect on GVA		
Decommissioning		
Development O&M activities leading to an effect on employment	Maximum design scenario does not apply for employment and GVA related impacts. The scenario which results in lowest levels of benefits is associated with the lowest expenditure. For this reason, the assessment assumes lowest maximum number of turbines (62 for Model 4 WTG) will be used and 275km of inter-array cables as these would require the least expenditure on decommissioning works.	Effects in relation to employment and GVA generated as a result of decommissioning activity are all beneficial, so there is no maximum adverse scenario. Detailed aspects of scheme design do not have a substantial bearing on the economic impact assessment. Non-design factors (such as the selection of ports, procurement approach and the geography of the Development's supply chain) are much more important factors in determining the overall level of potential economic impact. Two assessment scenarios will be assessed. The low assessment scenario could be thought of as a maximum adverse insofar as the local and Scotland-based benefits are at their lowest.
Development O&M activities leading to an effect on GVA		

15.6.2 Embedded Measures

15.6.2.1 In the context of socio-economics, most potential effects are beneficial and therefore do not require embedded measures.

15.6.2.2 With respect to recreation and tourism, where there is potential for effects on watersport activities as a result of disturbance or temporarily reduced access to specific watersport locations, proposals for reducing potential effects on these activities will be identified during selection of final design options (e.g. landfall location) and though on-going consultation with specific groups affected in order to identify appropriate detailed design and construction methods for reducing potential effects.

15.6.2.3 Embedding mitigation for reducing potential impacts on recreational sailing is provided in the Chapter 12: Shipping and Navigation.

15.6.2.4 Embedding mitigation relating to potential effects on the physical environment (e.g. seabed, coastal processes and water quality) are discussed in Chapter 6: Physical Processes.

15.7 Assessment of Potential Effects

15.7.1.1 Potential impacts resulting from the construction, operation and maintenance and decommissioning of the Development and the significance of the effect of those impacts on socio-economic receptors identified within the local study area and Scotland are discussed below.

15.7.2 Potential Construction Effects

Development Construction Activities Leading to an Effect on Employment

15.7.2.1 The following assessment focuses on the potential impacts of construction phase activities on direct and indirect employment in the construction supply chain in each study area.

Magnitude

15.7.2.2 Table 15.7.1 sets out the estimated levels of direct and indirect employment that the Development could support during the construction phase of the Development across the local study area and Scotland.

Table 15.7.1: Magnitude of Employment Impact Associated with Construction of the Development

Indicator	Impact type	Local Study Area		Scotland	
		Low Scenario	High Scenario	Low Scenario	High Scenario
Person years[12]	Direct	570	2230	1880	5400
	Indirect	80	290	1360	3860
	Direct + indirect	**650**	**2520**	**3250**	**9250**
Annual Full Time Equivalent jobs (during an assumed 3-year construction period)	Direct	190	740	630	1800
	Indirect	30	100	450	1290
	Direct + indirect	**220**	**840**	**1080**	**3080**

Source: Socio-economic impact calculations by Regeneris Consulting, 2017. Totals may not sum due to rounding.

[12] A unit of measurement used to capture temporary employment impact. One person year is the equivalent of one Full Time Equivalent post, but may in practice be made up of a number of temporary posts which sum to a person year.

15.7.2.3 The estimated number of jobs (direct and indirect) that could potentially be created during construction of the Development in the local study area ranges from 220 FTEs to 840 FTEs annually for the low and high scenarios respectively.

15.7.2.4 With respect to existing employment levels in the Local Study, the direct employment impact of 190 and 740 direct FTE jobs is equivalent to an uplift of 0.3% and 1.2% respectively in employment across relevant sectors. Between 2009 and 2015, the average annual change in employment in these sectors has been around 1,600 FTEs (or 2% annual average growth). In this context, the addition of 190 and 740 direct FTE jobs under each of the scenarios can represent a sizeable uplift in employment.

15.7.2.5 The nature of the direct jobs and the sectors which they are likely to be supported in mean that there will likely be a geographic clustering of activity, particularly in the location of chosen ports for the construction of the Development. The employment opportunities which could be created in these locations as a result of the Development could support a noticeable change in employment in the vicinity of ports, subject to residents accessing these opportunities.

15.7.2.6 Although the direct and indirect employment impact combined represents an uplift of 0.1% under the low and 0.2% of employment under the high scenarios respectively, the impact is primarily driven by direct job creation which is expected to be create a discernable change in baseline employment levels.

15.7.2.7 For this reason, the magnitude of impact in the in the local study area is considered to be **low** under the low impact scenario, and **high** under the high impact scenario.

15.7.2.8 In Scotland, the estimated number of jobs (direct and indirect) ranges from 1,080 to 3,080 FTEs annually under the low and high scenario respectively. With respect to existing employment levels across Scotland this equates to the following:

- Direct employment impact of 630 and 1,800 FTEs represents an uplift of 0.2% and 0.7% in employment in key supply chain sectors under the low and high scenarios respectively. Analysis of historic performance presented in the baseline section shows that between 2009 and 2015, employment in these sectors grew on average by 4,400 FTE jobs (equivalent to an average annual growth rate of 2%). The employment impact created by the Development could therefore contribute significantly to this growth rate, especially under the high impact scenario.
- In the context of total employment, the direct and indirect impact represents a change of 0.1% under both scenarios. The baseline section highlighted fluctuations in employment in the local study area, with average annual rate of change equivalent to +0.8% between 2009 and 2015. Therefore the potential uplift created by the Development would make an important contribution to resilience of the employment base.

15.7.2.9 The magnitude of impact for Scotland is therefore concluded as **low** under the low impact scenario and **moderate** under the high impact scenario.

Sensitivity

15.7.2.10 Job creation is a central strategic priority in national and local economic policies and strategies. It is a vital component in the government’s plan to create sustainable and equitable growth. As highlighted in the strategic policy review (Section 15.2.3) there is an emphasis on opportunity sectors, one of which is the renewable energy sector.

15.7.2.11 Sub-regionally the local authority strategies within the local study area all emphasise the ambition for new jobs to be created in their own local authority boundaries.

15.7.2.12 In light of the continued strategic importance attached to the creation of employment in economic development policy for the local study area and Scotland (see Section 15.2), this receptor is deemed to be of high value. The sensitivity of the receptor is therefore considered to be **high.**

Significance

15.7.2.13 The significance of effects on employment is driven by the high sensitivity of the receptor rather than the magnitude of change.

15.7.2.14 For the local study area, the effect would be of minor beneficial significance under the low assessment scenario, which is not significant in EIA terms. Under the high assessment scenario, the effect would be of **major beneficial significance,** which is **significant** in EIA terms.

15.7.2.15 For Scotland, the significance of the effect on employment is expected to be of **minor beneficial significance** for the low assessment scenario, which is not significant in EIA terms. For the high impact scenario, the effect is expected to be of **moderate beneficial significance**, which is **significant** in EIA terms.

<u>Development Construction Activities Leading to an Effect on GVA</u>

Magnitude

15.7.2.16 Table 15.7.2 sets out the estimated levels of direct and indirect GVA that the Development could support during the construction phase of the Development across the local study area and Scotland.

Table 15.7.2: Magnitude of GVA Impact Associated with Construction of the Development

		Local Study Area		Scotland	
Indicator	Impact type	Low Scenario	High Scenario	Low Scenario	High Scenario
Cumulative GVA (£m)	Direct	30	140	90	320
	Indirect	0	20	70	230
	Direct + indirect	**30**	**150**	**160**	**550**
Annual GVA (£m) during a 3-year construction period	Direct	10	50	30	110
	Indirect	0	10	20	80
	Direct + indirect	**10**	**50**	**50**	**180**

Source: Socio-economic impact calculations by Regeneris Consulting, 2017. Please note that totals might not sum due to rounding.

15.7.2.17 The potential GVA impact in the local study area ranges from £10m GVA annually over the construction period to £50m. In the context of the local economy which generated £25.3bn in 2015, the GVA uplift is less than 0.1% under the low scenario and 0.2% under the high scenario compared to baseline conditions.

15.7.2.18 As with employment, the direct GVA generated is likely to be concentrated in smaller areas driven by the location chosen port locations for the Development and hence the location of direct employment. This would lead to a sizeable increase in economic wealth in the vicinity of port location, although some of this will leak out of the local study area and indeed outside Scotland and the UK. Indirect GVA generated is likely to be spread more widely geographically across the local study area as it reflects the pattern of supply chain.

15.7.2.19 In Scotland, the annual GVA impact ranges from £50m to £180m annually under the low and high scenarios. Given the annual GVA in Scotland in 2015 was £127.3bn, this would represent an uplift of between less than 0.1% and just about 0.1% under the low and high scenarios respectively.

15.7.2.20 The magnitude of impact is therefore **low** under the low scenario and **high** under the high scenario.

Sensitivity

15.7.2.21 Nationally, GVA is an important measure of the amount of wealth that economic activity is creating and economic growth is a national priority. The latest evidence available shows that Scotland-wide GVA for 2015 was around £127.3bn.

15.7.2.22 At the local study area level, economic growth, and hence additional wealth creation, is identified as a key ambition (see Section 15.2).

15.7.2.23 In light of the strategic importance attached to the creation of wealth and economic growth as set out in the baseline section, the GVA receptor is deemed to be of high sensitivity. The sensitivity of the receptor is therefore considered to be **high.**

Significance

15.7.2.24 Similarly to employment impacts, the significance of effects on GVA is driven by the high sensitivity of the receptor rather than the magnitude of change.

15.7.2.25 For the local study area as a whole, the effect would be of **minor beneficial significance** for the low assessment scenarios (although the effect may be greater in the vicinity of the port itself), which is not significant in EIA terms. For the high assessment scenario, the effect would be of **major beneficial significance**, which is **significant** in EIA terms

15.7.2.26 Likewise for Scotland, the significance of the effect on GVA is expected to be of **minor beneficial significance** for the low assessment scenarios, which is not significant in EIA terms. For the high assessment scenario, the effect would be of **moderate beneficial significance**, which is **significant** in EIA terms.

<u>Development Construction Activities Leading to an Effect on Demand for Housing, Accommodation and Local Services</u>

Magnitude

15.7.2.27 During construction, the impact of the Development on demand for housing and other services is dependent on the number of direct and indirect jobs generated during the construction phase, and the extent to which the jobs are taken up by local workers. This is influenced by two key factors:

- The ability of local people to access employment created in local firms will determine whether or not local companies need to look outside of the local study area for their workforce on a large scale; and
- The wider geography of the construction supply chain will determine the extent to which temporary workers from outside of the local study area will be required. Due to their specialist nature, it is likely that many of the larger upper tier contracts will be delivered by companies from outside of the local study area. For example, it is likely that for some parts of the construction period, some of the workers from other parts of the UK or overseas will need to be on or close to the Development area.

15.7.2.28 The wind farm and OfTI construction period is expected to last around three years, with the longest element of construction works being installation of substructures (nine months). Given the phasing and timing of construction activities, there is likely to be some requirement for temporary accommodation as part of the construction phase. The focus of the assessment is therefore on temporary short-term accommodation for up to six months as opposed to housing.

15.7.2.29 It is very difficult to be definitive about the number of workers from outside of the area who would require temporary accommodation. The baseline section provided an overview of short-term accommodation in the main settlements within the local study area where the incoming workers are likely to get based. The analysis identified capacity in the short-term serviced accommodation, especially outside of summer months.

15.7.2.30 The assessment of the employment impact estimates that between 190 and 740 direct FTE jobs could be supported in the local study area annually during construction of the Development under the low and high scenarios respectively. The low scenario assumes some, but limited use of local ports for construction, so while the number of workers from within the local study area is modest, the incoming workers are likely to locate in the vicinity of the chosen port. Therefore, it is less likely that the low scenario will create a significant demand for accommodation and services in the local study area.

15.7.2.31 Under the high scenario, a more extensive use of local construction ports is assumed, as well as a higher sourcing of workers and services from within the local study area. While it is likely that the Development will create demand for temporary accommodation, it is difficult to be definitive about the scale of this demand due to uncertainty about how workers will be sourced from the local or Scottish study areas or from outside Scotland. Given capacity exists in the serviced accommodation throughout the year, especially outside of summer months, it is reasonable to expect the market to be able to absorb the additional requirement for accommodation.

15.7.2.32 It is also important to note that additional demand for accommodation and services will support positive impacts in the local economy as incoming workers spend their wages in the local study area, generating additional income.

15.7.2.33 The impact on housing, accommodation and local services is expected to be of local spatial extent and short term duration. Given the estimated scale of employment impacts and location of construction activities under each of the assessment scenarios, the magnitude of impact is expected to be **negligible** under both scenarios.

Sensitivity

15.7.2.34 Housing and local services are important locally, however, local policy has not identified any significant challenges with under or oversupply of services across the local study area (see Section 15.2). The receptor is therefore deemed to be of **medium** sensitivity.

Significance

15.7.2.35 While is it is difficult to predict the exact scale of additional demand for services and temporary accommodation, in the context of the wider economy and accommodation provision in the local study area the construction of the Development is not expected to create unserviceable demand. In addition, the positive impact generated through additional expenditure brought into the local economy to an extent counteracts some of the potential adverse effects. The magnitude of impact is expected to be **negligible**, which combined with **medium** sensitivity of the receptor would result in an effect of **negligible adverse significance**, which is **not significant** in EIA terms.

OfTI Construction Activities Leading to an Effect on Access to and Enjoyment of Watersports

Magnitude

15.7.2.36 There is potential for construction of the OfTI to have a direct effect on water sports activity as a result of restricted access to, and changes in conditions for surfing, kayaking, diving and other watersports. The assessment focuses on watersport activities occurring within the main OfTI export cable corridor and Landfall Area which covers a c. 50 km stretch of the Aberdeenshire coastline that encompasses Sandend Bay.

15.7.2.37 Sandend Bay is home to the Moray Firth Surf Riders surf club and is a popular, and recognised location for surfing on the East Coast of Scotland. There is also a local surf school located in Sandend village with direct access to the beach. Consequently, access to the beach and wave quality are both important considerations in this location with respect to the wider Landfall Area. Further information on wave quality and coastal processes is provided in Chapter 6 of this EIA Report (Physical Processes and Water Quality).

15.7.2.38 Locations for sea kayak / canoeing have been identified at Inverboydynie, located to the east of the Landfall Area and Sunnyside beach, to the west of the Landfall Area. The analysis did not identify significant kayaking and canoeing sites in close proximity to Sandend Bay or the offshore export cable route. Kayaking and canoeing activities are also generally less spatially restricted in terms of activity areas than other watersports such as surfing which is dependent on very specific wave and beach conditions. Other recreational activity, fishing and diving in the Landfall Area is also considered to be limited.

15.7.2.39 In terms of the wider context of the local study area, given the localised spatial extent, temporary nature and short term duration of construction activities along the offshore export cable corridor within the Landfall Area, impact magnitude is considered to be negligible.

15.7.2.40 With respect to potential effects on Moray Firth Surf Riders, given that Sandend Beach is located within in the wider Landfall Area, there is potential for temporary access restrictions to these surfing areas during construction, potentially displacing some of the surfing activity. The extent to which the activity will be affected will depend on the final location of the landfall in relation to the surfing areas, selected method of cable installation at the landfall and the duration and timing of the works. This will be determined through on-going consultation with the Moray Firth Surf Riders.

15.7.2.41 Although there is potential for disturbance to, and restricted access for, Sandend surfers during installation of the cable, these impacts will be temporary and short term. Impact magnitude is therefore considered to be **low**.

Sensitivity

15.7.2.42 Receptor sensitivity is driven by the importance of watersports locally, related to the quality and significance of resource and scale of its use. Based on the analysis of activities, the picture is mixed: while there are good assets for surfing within the Landfall Area, other watersports activities are less prominent. The sensitivity of the receptors when considered across the local study area are therefore considered be low. However, given the popularity and regional importance of Sandend Beach, located within the Landfall Area, for surfing, the sensitivity of this receptor is assessed as **medium**.

Significance

15.7.2.43 At a local study area level, given construction activities will be temporary, localised and of short term duration, impact magnitude is assessed as minor. Taking into account the low sensitivity of the receptors means the effect on the receptor is considered to be of **negligible significance**, which is **not significant** in EIA terms.

15.7.2.44 In terms of potential effects on the Moray Firth Surf Riders, based at Sandend, although there is potential for disturbance to, and restricted access for, surfers during installation of the export cable circuits, these impacts will be temporary, short term and of short duration (six months). Impact magnitude is therefore considered to be minor. Although the receptor is considered to be of medium sensitivity due to the regional importance of the Sandend Beach for surfing, the overall significance of the effect of cable installation activities on surfers is assessed to be **minor**, and therefore **not significant** in EIA terms.

<u>OfTI Construction Activities Leading to an Effect on Activity Onshore Supported by Local Watersports Activity at the Landfall</u>

Magnitude

15.7.2.45 As discussed previously the Moray Firth Surf Riders are based at Sandend Beach which is located within the Landfall Area. There is also a local surf school based in Sandend village which offers lessons to surfers throughout the year. As discussed previously the Sandend surfing asset and surfers using Sandend are considered to be of medium sensitivity to potential disruptions to, or restricted access to the main surfing area (Sandend Beach and adjacent waters).

15.7.2.46 The associated economic value of these receptors relates to the impact on businesses providing these activities and tourism spend by watersports users. While there is potential for the surf school to experience a reduction in economic activity during the construction period as a result of temporary restricted access for surfing (either at the beach or offshore depending on the final location of the landfall), the extent to which this affects the business depends on the volume of customers affected and the duration of the restricted access.

15.7.2.47 Given that any potential restricted access for surfing on the beach or offshore will be temporary and of short duration the potential impact magnitude is **low**.

Sensitivity

15.7.2.48 The surf club and school is focused specifically on surfing relating activities and the majority of its economic activity is generated through surfers. However, although surfing does occur throughout the year, the school is expected to experience some seasonal variations in economic activity when there is a lower demand for lessons and other related activities e.g. during winter. Any disruptions are to the surf school will be temporary and reversible. Although the school is used to experiencing seasonal fluctuations in activity, it is likely to be of **medium** sensitivity to any restrictions in surfing activities given surfers are its main customer base.

Significance

15.7.2.49 Given the temporary, short term nature of the cable installation activities, potential effects on the economic value on watersport providers in the area, specifically the Sandend Surf School are expected to be of **minor adverse significance**, which is **not significant** in EIA terms.

15.7.3 Potential Operational Effects

15.7.3.1 The potential effects during O&M phase of the Development on socio-economics and recreation and tourism receptors identified within the local and Scotland study areas are discussed below.

<u>Development Operation and Maintenance Activities Leading to an Effect on Employment</u>

Magnitude

15.7.3.2 Table 15.7.3 below sets out the estimated levels of direct and indirect employment that the Development could support during the O&M phase of the Development across the local study area and Scotland.

Table 15.7.3: Magnitude of Employment Impact During O&M Phase of the Development					
Indicator	**Impact Type**	**Local Study Area**		**Scotland**	
		Low	**High**	**Low**	**High**
Person years	Direct	450	890	460	1000
	Indirect	340	500	2030	3070
	Direct + indirect	**790**	**1390**	**2490**	**4070**
Annual FTEs (during a 25-year operational period)	Direct	20	40	20	40
	Indirect	10	20	80	120
	Direct + indirect	**30**	**60**	**100**	**160**

Source: Socio-economic impact calculations by Regeneris Consulting, 2017. Please note that totals might not add up due to rounding.

15.7.3.3 The estimated employment impact in the local study area ranges from 30 FTEs to 60 FTEs annually.

- Direct employment impact is considered in the context of electricity generation and distribution sector, which employs 1,500 FTEs in the local study area (out of total employment of 354,750 FTEs). Therefore, the direct employment impact would represent an uplift of 1.3% under the low and 2.7% under the high scenario; and
- The direct and indirect employment impact combined represents an uplift of less than 0.1% of total employment under both scenarios.

15.7.3.4 The absolute number of jobs that would be supported during the O&M phase are is comparatively smaller scale than the construction impact. It is important to emphasize that the O&M phase generates localised, high value, and long-term employment opportunities which will create a permanent employment uplift in the local study area. This is in contrast to construction impacts which are likely to be supported over the shorter construction period. There is therefore greater certainty that O&M employment opportunities can support a meaningful change in the local study area, and are more likely to be taken up by residents.

15.7.3.5 The absolute number of operation and maintenance jobs is likely to be concentrated in one sector and in fairly close proximity to the O&M base, therefore the magnitude is considered to be driven primarily by the direct impact. The magnitude of impact for the local study area is considered to be **moderate** under the low scenario and **high** under the high scenario.

15.7.3.6 In Scotland, the estimated annual levels of employment range from 100 FTEs to 160 FTEs under the low and high scenarios respectively:

- Direct employment is considered against the baseline level of 11,400 FTEs in the electricity generation and distribution sector. The impact is an uplift of 0.2% and 0.4% under the low and high scenarios; and
- The combined direct and indirect employment effects is less than 0.1% under both scenarios.

15.7.3.7 As outlined above, the O&M employment impacts are likely to be concentrated in one location, reflected in the result of the magnitude assessment for the local study area. At the level of Scotland, the impacts represent a smaller comparable change.

15.7.3.8 The magnitude of impact is therefore concluded as **negligible** for Scotland under both scenarios.

Sensitivity

15.7.3.9 The evidence underpinning the assessment of the sensitivity of the receptor is as for the construction phase. The sensitivity of the O&M employment receptor is therefore considered to be **high**.

Significance

15.7.3.10 For the local study area, the effect is considered to be of **moderate beneficial significance** for the low assessment scenario and **major beneficial significance** for the high assessment scenario, both of which are significant in EIA terms.

15.7.3.11 In light of the negligible magnitude of change for Scotland, the significance of effect is expected to be of **minor beneficial significance** under both assessment scenarios, which is not significant in EIA terms.

<u>Development Operation and Maintenance Activities Leading to an Effect on GVA</u>

Magnitude

15.7.3.12 Table 15.7.4 sets out the estimated levels of direct and indirect GVA that could potentially be generated across the local study area and Scotland during the O&M phase of the Development.

Table 15.7.4: Magnitude of GVA Impact During O&M Phase of the Development

Indicator	Impact Type	Local Study Area		Scotland	
		Low	High	Low	High
Cumulative GVA (£ms)	Direct	30	220	90	320
	Indirect	0	50	70	230
	Direct + indirect	30	270	160	550
Annual GVA (£ms) (during a 25-year operational period)	Direct	10	10	30	110
	Indirect	0	0	20	80
	Direct + indirect	10	10	50	180

Source: Socio-economic impact calculations by Regeneris Consulting, 2017. Please note that totals might not add up due to rounding.

15.7.3.13 The estimated GVA impact in the local study area is estimated as £10m annually under both scenarios. This impact will be generated in a comparable way to employment creation, and will be the wealth impact associated with the O&M jobs. The magnitude of the impact on the local study area is therefore expected to be **moderate** for the low scenario, and **high** for the high scenario**.**

15.7.3.14 In Scotland, the estimated GVA impact rages from £50m to £180m under the low and high scenarios respectively. The change under the low scenario represents a less than 0.1% change to baseline GVA, while the high scenario impact amounts to a 0.1% change

15.7.3.15 The magnitude of impact is therefore concluded as **negligible** for Scotland both scenarios.

Sensitivity

15.7.3.16 The evidence underpinning the assessment of the sensitivity of the receptor is as for the construction phase. The sensitivity of the O&M GVA receptor is therefore considered to be **high**.

Significance

15.7.3.17 The significance of effect in the local study area is expected to be of **moderate beneficial significance** under the low scenario and of **major beneficial significance** under the high scenario, both of which are significant in EIA terms.

15.7.3.18 In Scotland, the significance of the effect is expected to be of **minor beneficial** under both scenarios, which is **not significant** in EIA terms.

<u>Effect of Development Operations on UK Electricity Generation Costs</u>

15.7.3.19 The assessment considers the operational effects of the Development on the UK electricity market. Given the supply of electricity from the Development would be to the National Grid, the benefit is considered at a UK spatial level (note that this benefit is not assessed in terms of its significance in the same manner as the other receptors).

15.7.3.20 While it is not within the scope of this chapter provide a quantitative assessment of the effect of the Development on the supply and cost of electricity, there is potential for the Development to deliver benefits for the UK electricity market which can be assessed qualitatively. These benefits include:

- Reduced cost of electricity generated from renewable energy sources (offshore wind);
- Increased resilience of the UK energy market; and
- Increased security energy of supply.

15.7.3.21 Reducing the cost of renewable energy is a key priority for the UK Government. The Clean Growth Strategy (2017) published by the Government sets out the steps to ensure economic growth is achieved while ensuring decreased emissions. Meeting domestic commitments at the lowest net cost to consumers and businesses is one of the key objectives of the Strategy.

15.7.3.22 The offshore wind industry has experienced significant cost reduction in recent years. The Offshore Renewable Energy Catapult tracks this progress on behalf of Offshore Wind Programme Board and publishes annual Cost Reduction Monitoring Framework reports. Its most recent report was produced in 2016, showing that the Levelised Cost of Energy (LCOE)[13] fell by 32% from £142/MWh for projects reaching final investment decision (FID) in 2010/11, to £97/MWh for projects reaching FID in 2015/16. This level of cost reduction has exceeded the joint industry and UK Government target of £100/MWh by 2020.

15.7.3.23 Furthermore, the results of the recent Contracts for Difference (CfD) auction suggest even greater progress in the industry. The CfD mechanism was introduced by the UK Government in 2013 as part of the Electricity Market Reform (EMR). The CfD process replaces the Renewable Obligation Certification (ROCs) system, aiming to stimulate cost reduction of renewable electricity.

[13] Levelised cost of energy is the average cost of the lifetime of the plant per MWh of electricity generated (source: BEIS).

15.7.3.24 The CfD process works by offering to pay the energy generator the difference between the electricity strike price[14] and the reference price[15]. By doing so, generators are given certainty of revenues while consumers are protected from paying for higher support costs when electricity prices are high (BEIS, 2017).

15.7.3.25 Since the introduction of the CfD process, two auction rounds have taken place in 2015 and 2017 respectively. The results saw the strike price for offshore wind halve, dropping to £57.50/MWh for projects commencing delivery in 2022/23.

Table 15.7.5: Contracts for Difference Auction Results: Lowest Strike Price for Each Technology

Technology Type	Round 1	Round 2
Advanced conversion technologies	£114.39	£40.00
Energy from waste with CHP	£80.00	£74.75
Offshore wind	£114.39	£57.50
Onshore wind	£79.23	-
Solar PV	£50.00	-

Source: Department for Business, Energy & Industrial Strategy (2015,2017). Strike prices expressed in 2012 prices.

15.7.3.26 This evidence from the CfD auctions point to offshore wind driving down the costs of renewable energy, but also compared to other sources of energy. Indeed, the latest auction results show that offshore wind is now cheaper than energy from planned nuclear development. The Government contract awarded to Hinkley Point C guarantees a strike price of £92.50/MWh for 35 years.

15.7.3.27 Furthermore, the cost of new gas powered generation (Combined Cycle Gas Turbines) is estimated by BEIS at £66/MWh for projects commissioning in 2020, increasing thereafter (BEIS 2016). The implication is that the latest CfD auction results imply offshore wind is thought to be one of the most cost effective sources of electricity generation.

15.7.3.28 By the next auction, Moray West will be required to bid below the Government's ceiling price if it is to secure the contract to supply electricity to the National Grid. The maximum price has been set by the Government at £85/MWh.

15.7.3.29 Should Moray West Offshore Wind Farm be successful in the next round of the CfD auction, it will be a large source of renewable electricity generation for the UK. Moreover, it has the potential to drive down the cost of energy generation as a whole.

15.7.4 Potential Decommissioning Effects

15.7.4.1 The scope of decommissioning would comprise:

- Dismantling and removing the WTGs;
- Removal of foundations and substructures of the OPS(s), with piled foundations removed just below the seabed; and
- All cables being disconnected and left in situ, buried and/or protected.

[14] Strike price is a price for electricity reflecting the cost of investing in a particular low carbon technology (source: BEIS).
[15] Reference price is a measure of the average market price for electricity in the GB market (source: BEIS).

15.7.4.2 The turbines would be dismantled and removed from the site in a manner similar to that of their erection. The decommissioning phase may involve fewer transport trips on the network than the construction phase as elements of infrastructure such as piled foundations and electrical connections may be left in place. The approach to decommissioning is presented in the draft Decommissioning Programme (Volume 4 - Technical Appendix 4.2) which has been prepared in line with the requirements of the Energy Act 2004. This will be reviewed, updated and finalised prior to any decommissioning works commencing.

15.7.4.3 There is a lot of uncertainty concerning the potential socio-economic effects of the decommissioning of the Development. This is because the approach to decommissioning, the available technology which could be used and the associated costs are not known at this stage, and neither is the potential for local sourcing.

15.7.4.4 The decommissioning activities described above may draw on similar services and skills as the construction phase. For this reason, we would expect the effects during decommissioning (including effects of the Development decommissioning on employment, GVA, enjoyment of watersports and associated value) to follow the similar range of effects as for the construction phase.

15.7.5 Summary of Development Specific Effects

15.7.5.1 Table 15.7.6 below summarises the results of the Development specific assessment.

Table 15.7.6: Summary of Development Specific Effects

Potential Impacts	Receptor	Impact Magnitude	Sensitivity of Receptor	Effect Significance	Mitigation (in addition to embedded measures)	Residual Significance
Construction						
Direct and indirect construction employment	Construction employment	**Local study area**: Low under low and high under the high assessment scenario **Scotland**: Low under low and moderate under the high assessment scenario	High	**Local study area:** Minor beneficial significance for the low assessment scenario; major beneficial significance for the high assessment scenario. **Scotland**: Minor beneficial significance for the low assessment scenarios; moderate beneficial significance for the high assessment scenario.	N/A	N/A
Direct and indirect construction GVA	GVA	**Local study area:** Low under the low scenario and high under the high scenario. **Scotland**: Low under the low scenario and moderate under the high scenario.	High	**Local study area:** Minor beneficial significance for the low assessment scenario; major beneficial significance for the high assessment scenario. **Scotland:** Minor beneficial significance for the low assessment scenarios; moderate beneficial significance for the high assessment scenario.	N/A	N/A
Change in demand for housing and local services associated with influx of labour in the local study area	Housing and local services in local study area	Negligible	Medium	Negligible adverse significance	N/A	N/A
Access to and enjoyment of watersports activity	Watersports activity in local study area	Negligible	Low	Negligible adverse significance	N/A	N/A

Table 15.7.6: Summary of Development Specific Effects						
Potential Impacts	**Receptor**	**Impact Magnitude**	**Sensitivity of Receptor**	**Effect Significance**	**Mitigation (in addition to embedded measures)**	**Residual Significance**
	Moray Firth Surf Riders	Low	Medium	Minor adverse significance	N/A	N/A
Change in economic activity onshore supported by local watersports activity	Economic activity supported by local watersports activity in local study area	Low	Medium	Minor adverse significance	N/A	N/A
Operation and Maintenance						
Direct and indirect O&M employment: Scotland and local study area	O&M employment	local study area: medium under low, and high under high assessment scenario Scotland: negligible under both scenarios	High	**Local study area:** moderate beneficial significance for the low assessment scenario; major beneficial significance for the high assessment scenario. **Scotland:** minor beneficial significance for both assessment scenarios.	N/A	N/A
Direct and indirect O&M GVA: Scotland and local study area	GVA	local study area: medium under low, and high under high assessment scenario Scotland: negligible for Scotland under both scenarios.	High	**Local study area:** moderate beneficial significance for the low assessment scenario; major beneficial significance for the high assessment scenario. **Scotland:** minor beneficial significance for both assessment scenarios.	N/A	N/A
Decommissioning						
Considered to be equal to or less than impacts stated in construction.						

15.8 Assessment of Cumulative Effects

15.8.1.1 The assessment of cumulative effects for socio-economics, recreation and tourism draws on the methodology and the list of relevant projects outlined in Volume 2, Chapter 5: EIA Methodology. In line with the outlined methodology, the cumulative assessment distinguished between the in-combination effects and additive effects – that is, the total cumulative effect in a given area, and the part of the effect accounted for by the Development.

15.8.1.2 The potential cumulative effects for socio-economics depend on the extent to which the Development and other relevant projects draw on a similar supply chain and labour market within the study area. Based on this, the following factors have been considered in selecting the relevant projects for the cumulative assessment:

- For socio-economic receptors, overlap in construction and operation and maintenance with the Development. Contemporaneous activity may place competing demands on the supply chain, labour markets and services in the local study area, which can increase competition for a range of goods and services in the area. This increases the likelihood of these goods and services being sourced from outside the local study area. This in turn may have a cumulative effect on the demand for accommodation and local services; and
- For enjoyment of watersports and associated value receptors, projects in proximity to landfall location and export cable corridor route of the Development could have a cumulative effect on watersports if the construction activity is simultaneous or continuous. For example, access to larger sections of coastline being restricted.

15.8.1.3 It is important to note the timing dimension to cumulative assessment in relation to socio-economic receptors:

- If the construction phase for the Development and other projects were undertaken simultaneously, this could restrict the ability of the local supply chain and labour market to benefit – i.e., the cumulative effect for local socio-economics does not equal the sum of construction benefits for all cumulative projects. A supply-side constraint can make the benefits from the Development assessed in isolation less likely to occur; and
- On the other hand, consecutive construction of projects may lead to the temporary construction impact being sustained for longer, potentially leading to subsequent projects being able to secure higher local benefits. If there are a number of consecutive projects taking place which are drawing on the same labour market and supply chains, this can contribute to growth in capacity, increasing the confidence of businesses to make investments knowing there will be longer term demand for their products or services.

15.8.1.4 It is also important to recognize the uncertainties with regard to cumulative assessment, as follows:

- The assessment needs to consider the ability of supply chain and labour markets to adapt to increased demand. There are external factors which may influence this, and it is difficult for the cumulative assessment to predict what the dynamics of supply chains might be;
- There are uncertainties in timings of cumulative developments, particularly those which are at earlier stages in the planning process. The assessment cannot say with confidence which projects will proceed. Even projects which have been consented may change their design or apply for variations in consent. The assessment draws on the information which is available to date, however, it is not known with confidence what the timings of all projects might be; and
- A critical driver of cumulative socio-economic impact is the extent to which other projects are competing for the same local supply chains and workers as the Development or if the Development can benefit from the capacity and experience built from proceeding projects.

For example, selection of construction and O&M ports is an important consideration for the cumulative assessment. This information is not always available, particularly for projects which still in the planning phase. Since ports are a major driver of local economic benefit, the assessment considers the likelihood of other projects drawing on ports from within the local study area based on available information and location of wind farms.

15.8.1.5 Therefore, the schemes which are relevant to the cumulative assessment for socio-economic receptors have been selected based on the demands their construction and operation are likely to place on the same supply chains and labour markets as the Development. The projects which are scoped in for the cumulative assessment are confirmed below (see Table 15.8.1).

15.8.1.6 The assessment also notes that there may be other projects which are located further from the local study area which may eventually draw to some extent on the same ports, supply chains and labour market (namely wind farms off the Firth of Forth and Firth of Tay). However, in the absence of information on where the supply chains for these projects might be based, and given that there are a number of other east coast ports in much closer proximity to these wind farms, the assessment has not scoped these in as it would be unable to draw conclusions about the extent to which these projects may result in a cumulative impact with the Development.

Table 15.8.1: Projects Considered in Cumulative Effect Assessment for Socio-economics, Tourism and Recreation

Project	Construction Port	O&M Port	Overlap in Construction Period with the Development	Overlap in O&M with the Development	Project Location
Beatrice Offshore Wind Farm	Nigg Energy Park	Wick	No	Yes	Moray Firth
Moray East Offshore Wind Farm	Not available **	Not available**	No	Yes	Moray Firth
Beatrice Oil Field Decommissioning (P187 – Block 11/30a) P1031 – Block 11/25a P0982	n/a	n/a	Partial*	Yes	Moray Firth

*Main decommissioning activities are due to commence in 2024 when construction of the Moray West offshore wind farm is due to be completed.
**At the time of writing, Moray East has not yet selected construction or O&M ports, however the construction period (which would potentially be relevant to cumulative consideration of resource availability) will be not overlap with Moray West.

15.8.1.7 The types of impacts considered in this cumulative assessment are:

- Direct and indirect employment and GVA supported as a result of the Development and other projects during construction and operation and maintenance;
- Change in demand for housing and local services associated with influx of labour during construction; and
- Effect on access to and enjoyment of watersports activities and associated economic value onshore.

15.8.2 Cumulative Construction Effects

Direct and Indirect Employment and GVA

15.8.2.1 The driver of cumulative impact on labour market and supply chain demands in the local study area and Scotland will be driven by simultaneous construction activity of offshore wind farms. Projects with ongoing O&M activities at the time of construction of the Development will be contributing to the demand for workers, but to a much lesser extent. Instead, projects that have completed construction before the Development have the potential to contribute to the supply chain capabilities (provided goods and services had a similar geographical sourcing pattern). This would increase the likelihood of the high scenario for the Development being achieved.

Beatrice Offshore Wind Farm (BOWL)

15.8.2.2 BOWL has already commenced construction. However, the activity would not be captured by the socio-economic baseline yet due to time lags in activity being picked up in the published socio-economic datasets.

15.8.2.3 BOWL is being constructed from the Port of Nigg within the local study area and is expected to be operational in 2019. BOWL's location and local port use means the wind farm will be drawing on the similar workers and businesses as the Development. Given the timing of the two projects, BOWL can play a positive role in building the skills base and supply capacity in the local study area, which can make it a more attractive area for investment as the timing provides continuity of wind farm construction activity in the area.

15.8.2.4 Given that BOWL is still in construction, the extent to which the project contributes to capacity building will depend on the final project expenditure in the local study area and Scotland. Nevertheless, these activities may contribute to capacity and capability within the study areas. This could result in an increased likelihood of higher supply chain sourcing being achieved from the individual impact assessment of the Development.

15.8.2.5 The conclusion is that the two projects cumulatively may lead to a greater benefit locally, leading to higher local sourcing during Development construction. The assessment of significance would therefore follow the conclusion from the individual assessment of significance of the Development assuming higher sourcing.

15.8.2.6 It is worth noting that the in-combination cumulative impact and the additive impact of BOWL and the Development is equivalent in this assessment, as construction does not overlap. The magnitude of impact on employment and GVA is expected to be high. Sensitivity of the receptor would remain high for both, employment and GVA. The effect on employment and GVA is expected to be of **major beneficial significance** for employment and GVA, which is **significant** in EIA terms.

Moray East Offshore Wind Farm

15.8.2.7 Moray East Offshore Wind Farm is expected to be operational by 2022. Based on these indicative timings, the project would be expected to support cumulative impact with the Development in a similar way as BOWL.

15.8.2.8 Although Moray East has not yet selected a construction port, the potential use of Nigg in the local study area for construction activities can stimulate investment, however, the exact scale of local employment and supply chain sourcing is yet to be determined.

15.8.2.9 As mentioned earlier, it is difficult to predict how the supply chain dynamics may respond to ongoing activities, however, given the current expectations of sequencing in timing, the temporary construction impact may be maintained for longer. Another dimension to this is the ability of subsequent projects to achieve higher local benefit as capacity is being built.

15.8.2.10 As with BOWL, the cumulative impact of Moray East Offshore Wind Farms with the Development may result in an increased likelihood of the high sourcing scenario from the individual impact assessment of the Development.

15.8.2.11 As with BOWL, the cumulative in-combination impact and the additive cumulative impact of these two projects would be equivalent due to sequenced construction phases.

15.8.2.12 Therefore, we conclude that the magnitude of impact on employment is expected to be high. The magnitude of impact on GVA is expected to be high. Sensitivity of the receptor would remain high for both, employment and GVA. The impact on employment and GVA is expected to be of **major beneficial significance** for employment and GVA, which is **significant** in EIA terms.

Beatrice Oil Field Decommissioning

15.8.2.13 The Beatrice Oil Field is expected to be decommissioned between 2024 and 2027, which means that there is potential for some overlap (months) with the planned construction period for the Development (2022 to 2024). The decommissioning processes draw on similar elements of the supply chain as a wind farm construction, so there is potential overlap in the types of skills and services which are required, although not all the activity will be comparable. For example, the use of vessels, ports and logistics, professional and technical services have parallels between the two types of projects.

15.8.2.14 There are a number of scenarios of how the cumulative impacts of Beatrice Oil Field and the Development may occur. Should the Beatrice Field and the Development choose to use the same ports and vessels, the simultaneous activity could constrain the ability of businesses to be able to meet the service and labour market requirement for both projects due to limited capacity. This may restrict the economic benefits which the Development and project cumulatively may deliver.

15.8.2.15 Another possible scenario is that the two projects decide to use different locations from which the activity would be taking place, and different supply chains within the local study area. In this instance, the local benefits could be maximised, effectively doubling the potential benefits associated with required workers, vessels and ports (should the area be able to meet this demand). Under this more positive scenario, the simultaneous construction and decommissioning activities may cause a supply-side response and stimulate investment and increasing capacity as a result.

15.8.2.1 It is not possible to predict how the cumulative impacts will be generated with any confidence. The in-combination impact for the study areas can be expected to deliver benefits as stated before but also any potential impacts which are specific to oil field decommissioning and does not overlap with wind farm construction benefits (i.e. drawing on different services and skills). However, the potential additive benefits of the Development could be reduced under a more pessimistic view, as the concurrent construction and decommissioning activities may result in greater likelihood of impacts from the lower impacts from the Development materialising if capacity is taken up by other projects.

15.8.2.2 The assessment cannot say what the in-combination cumulative impact on employment and GVA may be for the study areas beyond the higher sourcing benefits from the Development assessed individually without knowing what the additional benefits are of decommissioning activity which does not overlap with the Development construction. The conclusion is therefore that the in-combination magnitude of cumulative employment and GVA impact would be high. The additive cumulative magnitude would be expected to be low for employment and GVA.

15.8.2.3 Sensitivity of the receptor would remain high for both, employment and GVA.

15.8.2.4 The in-combination impact on employment and GVA is expected to be of **major beneficial significance** for employment and GVA, which is significant in EIA terms. The additive cumulative impact on employment and GVA is also expected to be of **minor beneficial significance** for employment and GVA, which is **not significant** in EIA terms

<u>Change in Demand for Housing and Local Services Associated with Influx of Labour</u>

15.8.2.5 The cumulative impact on the demand for housing and local services will be determined by the scale of influx of non-resident workers to the local study area. This in turn is influenced by a number of factors including the timing of key activities and the balance between local workers and those recruited from outside the Local Impact Areas.

15.8.2.6 If the simultaneous construction and decommissioning activities result in capacity constraints in the local labour market, there is potential for more workers coming in from outside the local study area. As noted earlier, Beatrice Oil Field decommissioning is the only project with overlapping construction and decommissioning timing within the local study area. This may result in more workers being drawn in from outside the local study area to service activities for both projects. While there is a likelihood of this happening, it is not possible to estimate the scale of incoming workers as a result of these projects.

15.8.2.7 Overall, it is difficult to predict the level of impact on this receptor. The conclusion is that both the in-combination and additive cumulative magnitude of impact would be negligible. The sensitivity of the receptor remains medium. Therefore, the cumulative in-combination and additive impact would be of **minor adverse significance**, which is **not significant** in EIA terms.

<u>Access To and Enjoyment of Watersports Activity and Associated Economic Activity Onshore</u>

15.8.2.8 The current expectations on locations and timing of projects show no overlapping OfTI construction activity in the Landfall Area at the time of construction of the Development.

15.8.2.9 Therefore, it is expected that the cumulative impacts would be no different to the results of the impact assessment of the Development individually. With no concurrent construction activity, the in-combination and the additive cumulative impacts of the project are equivalent.

15.8.2.10 The expected magnitude of impact on access to and enjoyment of watersports is negligible, and sensitivity is low. The cumulative impact is therefore considered to be of **negligible adverse significance** which is not significant in EIA terms.

15.8.2.11 The magnitude of impact of impact on the Moray Firth Surf Riders is low, sensitivity is medium. The cumulative impact is therefore considered to be of **minor adverse significance** which is not significant in EIA terms.

15.8.2.12 The magnitude of impact on the activity supported onshore by local watersports is considered to be low, sensitivity medium. The cumulative impact is therefore considered to be of **minor adverse significance** which is **not significant** in EIA terms.

15.8.3 Cumulative Operational Effects

<u>Direct and Indirect O&M Employment and GVA</u>

15.8.3.1 O&M is a long-term activity expected to take place over a couple of decades. This would allow for any necessary supply-side adjustments to increase capacity in the supply chain and the labour market. Therefore, overlapping O&M phases for cumulative projects can be seen largely as beneficial as they encourage supply chain development.

15.8.3.2 As with the construction phase, some projects that are not yet operating are also subject to uncertainties around supply chain sourcing and port selection. The developer for this Development is not yet certain on which port is going to be used for O&M so the assessment should be considered with this in mind.

15.8.3.3 As with construction, the magnitude of impact will depend on port selection and supply chain and labour sourcing.

15.8.3.4 There are several ports in the local study area which the Development may be able to choose from. Of the projects which have been scoped into the cumulative assessment, information on O&M ports is available for BOWL and Moray East Offshore Wind Farm. The two projects are planning to use different ports for O&M. It should be noted that should the projects decide to share any non-port related element of O&M support for BOWL or Moray East Offshore Wind Farm, the potential scale of cumulative economic impact may be reduced due to lower spend associated with the projects.

15.8.3.5 The cumulative additive O&M impact on employment and GVA is considered to be of high magnitude for employment and GVA impact. The in-combination cumulative impact may be even higher for the study areas; however, the assessment cannot quantify any potential benefits as it is not yet known which port the Development will use for O&M and how the cumulative activity will happen in reality.

15.8.3.6 The sensitivity of the receptors is high, and therefore the effect is considered to be of **major beneficial significance**, which is **significant** in EIA terms.

15.8.4 Cumulative Decommissioning Effects

15.8.4.1 The same uncertainties apply during decommissioning phase assessment as outlined in the individual assessment of Development impacts. In addition, there are the uncertainties associated with the cumulative assessment which make it challenging to provide a meaningful assessment of impacts and determine effect significance.

15.8.4.2 As outlined before, the decommissioning activities may draw on similar services and skills as the construction phase. For this reason, we would expect the cumulative decommissioning phase impacts (effects on employment, GVA, enjoyment of watersports and associated value) to be similar to those assessed for the construction phase.

15.9 References

Aberdeen City Council (2017). Aberdeen local development plan 2017. Aberdeen, Aberdeen City Council [online]. Accessed at: https://www.aberdeencity.gov.uk/services/planning-and-building/local-development-plan/aberdeen-local-development-plan. [Accessed September 2017].

Aberdeenshire Council (2012). Economic Development Strategy 2011-2016. Aberdeenshire Council [online]. Accessed at: https://www.aberdeenshire.gov.uk/media/11581/econdev_strategy.pdf. [Accessed September 2017].

Aberdeenshire Council (2017). Aberdeenshire Local Development Plan 2017. Aberdeenshire Council [online]. Accessed at: https://www.aberdeenshire.gov.uk/planning/plans-and-policies/aberdeenshire-local-development-plan-2017. [Accessed September 2017].

Census (2011). Population and Household Estimates. Newport, Office for National Statistics. [online]. Accessed at: https://www.nomisweb.co.uk/query/select/getdatasetbytheme.asp?theme=75. [Accessed September 2017].

Davies, Pita, Lusseau (2010). The Value of Tourism Expenditure related to the East of Scotland Bottlenose Dolphin Population. Aberdeen, Aberdeen Centre for Environmental Sustainability.

Department of Business, Energy & Industrial Strategy (2015). Contracts for Difference First Allocation Round Results. [online]. Accessed at: https://www.gov.uk/government/publications/contracts-for-difference-cfd-allocation-round-one-outcome. [Accessed March 2018].

Department of Business, Energy & Industrial Strategy (2016). Electricity Generation Costs. London, HM Government. [online]. Accessed at: https://www.gov.uk/government/publications/beis-electricity-generation-costs-november-2016. [Accessed March 2018].

Department of Business, Energy & Industrial Strategy (2017). Contracts for Difference Second Allocation Round Results. [online]. Accessed at: https://www.gov.uk/government/publications/contracts-for-difference-cfd-second-allocation-round-results. [Accessed March 2018].

Department of Business, Energy & Industrial Strategy (2017). Clean Growth Strategy. London, HM Government. [online]. Accessed at: https://www.gov.uk/government/publications/clean-growth-strategy. [Accessed March 2018].

Ekos (2016). Sailing Tourism in Scotland. Highlands and Islands Enterprise. [online]. Accessed at: http://www.hie.co.uk/common/handlers/download-document.ashx?id=fabd59f1-9b63-4424-9ff5-3d380541a5ba. [Accessed December 2017].

Highlands and Islands Enterprise (2015). Awakening the Giant: A Strategic Framework for Scotland's Marine Tourism Sector. Highlands and Islands Enterprise [online]. Accessed at: http://www.hie.co.uk/common/handlers/download-document.ashx?id=e5ea1ab9-4d9c-4565-b03b-4148ff731d70. [Accessed December 2017].

Highland Council (2012). Highland-wide Local Development Plan. The Highland Council [online]. Accessed at: https://www.highland.gov.uk/info/178/local_and_statutory_development_plans/199/highland-wide_local_development_plan/1. [Accessed December 2017].

HM Treasury (2011). Green Book. London, HM Treasury. [online]. Accessed at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/685903/The_Green_Book.pdf [Accessed September 2017].

Magicseaweed (2017). Moray firth. [online]. Accessed at: http://www.surfschoolscotland.co.uk/locations/moray-firth. [Accessed November 2017].

Marine Scotland (2016). Scottish Marine Recreation and Tourism Survey 2015. [online]. Accessed at: http://www.gov.scot/Topics/marine/seamanagement/national/RecandTourism. [Accessed November 2017].

Moray Community Planning Partnership (2012). The Moray Economic Strategy. Elgin, Moray Council [online]. Accessed at: http://www.moray.gov.uk/moray_standard/page_96870.html. [Accessed September 2017].

Moray Council (2015). Moray Local Development Plan 2015. Elgin, Moray Council [online]. Accessed at: http://www.moray.gov.uk/moray_standard/page_100458.html. [Accessed September 2017].

Northern Isles and East Coast Marine Tourism Group (2017). [online]. Accessed at: http://northandeasternmarinetourism.com/.

Office for National Statistics (2013). Job Seeker's Allowance. Newport, Office for National Statistics. [online]. Accessed at: https://www.nomisweb.co.uk/query/select/getdatasetbytheme.asp?collapse=yes. [Accessed September 2017].

Office for National Statistics (2016). Business Register and Employment Survey. Newport, Office for National Statistics. [online]. Accessed at: https://www.nomisweb.co.uk/query/select/getdatasetbytheme.asp?collapse=yes. [Accessed September 2017].

Office for National Statistics (2016). Sub-regional Productivity Data. Newport, Office for National Statistics. [online]. Accessed at: https://www.nomisweb.co.uk/query/select/getdatasetbytheme.asp?collapse=yes. [Accessed September 2017].

Office for National Statistics (2017). Mid-Year Population Estimates. Newport, Office for National Statistics. [online]. Accessed at: https://www.nomisweb.co.uk/query/select/getdatasetbytheme.asp?collapse=yes. [Accessed September 2017].

Office for National Statistics (2017). Annual Population Survey. Newport, Office for National Statistics. https://www.nomisweb.co.uk/query/select/getdatasetbytheme.asp?collapse=yes. [Accessed September 2017].

Office for National Statistics (2017). Annual Survey of Hours and Earnings. Newport, Office for National Statistics. [online]. Accessed at: https://www.nomisweb.co.uk/query/select/getdatasetbytheme.asp?collapse=yes. [Accessed September 2017].

Office for National Statistics (2017). Claimant count. Newport, Office for National Statistics. [online]. Accessed at: https://www.nomisweb.co.uk/query/select/getdatasetbytheme.asp?collapse=yes. [Accessed September 2017].

Offshore Wind Programme Board (2016). Cost Reduction Monitoring Framework 2016. [online]. Accessed at: http://crmfreport.com/wp-content/uploads/2017/01/crmf-report-2016.pdf. [Accessed September 2017].

Offshore Wind Industry Group (2013). Scotland's Offshore Wind Route Map. Edinburgh, The Scottish Government [online]. Accessed at: http://www.gov.scot/Publications/2013/01/5856/0. [Accessed September 2017].

RenewableUK (2016). Offshore Wind in Scotland. London, RenewableUK. [online]. Accessed at: http://www.renewableuk.com/news/315310/Offshore-Wind-in-Scotland.htm. [Accessed September 2017].

Sail Scotland (2017). Sail. [online]. Accessed at: http://www.sailscotland.co.uk/sail/. [Accessed November 2017].

Scottish Development International (2017). Scottish Energy Ports. [online]. Accessed at: https://www.sdi.co.uk/knowledge-hub/articles/insight/scottish-energy-ports. [Accessed September 2017].

Scottish Energy Ports Capability Directory (2017). Wick Harbour. [online]. Accessed at: http://energy.scottishports.org.uk/ports/wick-harbour. [Accessed November 2017].

Scottish Enterprise & Highlands and Islands Enterprise (2013). National Renewables Infrastructure Plan (N-RIP) 1 - 2. Glasgow, Scottish Enterprise. [online]. Accessed at: https://www.scottish-enterprise.com/~/media/se/resources/documents/sectors/energy/energy-renewables-reports/national-renewables-infrastructure-plan.ashx. [Accessed September 2017].

Scottish Enterprise (2015). 2015-2018 Business Plan: Building Scotland's International Competitiveness. Glasgow, Scottish Enterprise. [online]. Accessed at: https://www.scottish-enterprise.com/knowledge-hub/articles/publication/business-plans. [Accessed September 2017].

Scottish Enterprise (2016). Oil and Gas 'Seize the Opportunity' Guides – Offshore Wind. Glasgow, Scottish Enterprise. [online]. Accessed at: https://www.scottish-enterprise.com/knowledge-hub/articles/guide/seize-the-opportunity-offshore-wind. [Accessed September 2017].

Scottish Government (2011). Low Carbon Scotland: Meeting the Emissions Reduction Targets 2010-2022. Edinburgh, The Scottish Government. [online]. Accessed at: http://www.gov.scot/Topics/Environment/climatechange/scotlands-action/lowcarbon/rpp. [Accessed September 2017].

Scottish Government (2011). 2020 Routemap for Renewable Energy in Scotland. Edinburgh, The Scottish Government. [online]. Accessed at: http://www.gov.scot/Publications/2011/08/04110353/0. [Accessed September 2017].

Scottish Government (2013). Electricity Generation Policy Statement. Edinburgh, The Scottish Government. [online]. Accessed at: http://www.gov.scot/Topics/Business-Industry/Energy/EGPSMain. [Accessed September 2017].

Scottish Government (2014). Scotland's Third National Planning Framework. Edinburgh, The Scottish Government. [online]. Accessed at: http://www.gov.scot/Resource/0045/00453683.pdf. [Accessed September 2017].

Scottish Government (2017). Scottish Energy Strategy: The future of energy in Scotland. Edinburgh, The Scottish Government. [online]. Accessed at: http://www.gov.scot/Publications/2017/12/5661. [Accessed September 2017].

Scottish Tourism Alliance (2012). Tourism Scotland 2020. The future of our industry, in our hands. Highlands and Islands Enterprise. Stirling, Scottish Tourism Alliance [online]. Accessed at: http://scottishtourismalliance.co.uk/uploads/TS2020/Tourism%20Scotland%202020%20final.pdf. [Accessed November 2017].

Scottish Surfing Association (2017). Affiliations. [online]. Accessed at: http://thessf.com/directory/affiliated-surf-schools/. [Accessed November 2017].

Trivago (2017). Median price data. [online]. Accessed at: https://www.trivago.co.uk/. [Accessed November 2017].

UK Diving (2006) UK wreck map. [online]. Accessed at: http://www.ukdiving.co.uk/wrecks/map.php. [Accessed November 2017].

Visit Scotland (2017). The key facts on tourism in 2016. Edinburgh, Visit Scotland. [online]. Accessed at: http://www.visitscotland.org/research_and_statistics/tourismstatistics/latest_statistics.aspx. [Accessed November 2017].

Visit Scotland (2017). Scottish Occupancy Survey 2016. Edinburgh, Visit Scotland. [online]. Accessed at: http://www.visitscotland.org/research_and_statistics/tourismstatistics/latest_statistics.aspx. [Accessed November 2017].

MORAY WEST
OFFSHORE WINDFARM

Offshore EIA Report

Moray Offshore Windfarm (West) Limited

Chapter 16 Archaeology and Cultural Heritage

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Acronyms	
Acronym	**Expanded Term**
AEZ	Archaeological Exclusion Zone
AC	Aberdeenshire Council
ASA	Archaeological Study Area
BGS	British Geological Society
BOWL	Beatrice Offshore Wind Farm Ltd.
CfD	Contract for Difference
CIfA	Chartered Institute for Archaeologists
COWRIE	Collaborative Offshore Wind Research into the Environment
DBA	Desk Based Assessment
DLSP	Design Layout and Specification Plan
EIA	Environment Impact Assessment
EMP	Environmental Management Plan
ES	Environmental Statement
GBS	Gravity Base Structure
HE	Historic England
HES	Historic Environment Scotland
HER	Historic Environment Record
HMPA	Historic Marine Protected Area
JNAPC	Joint Nautical Archaeology Policy Committee
MFV	Motor Fishing Vessel
MHWS	Mean High Water Springs
MLWS	Mean Low Water Springs
NMRS	National Monument Records of Scotland
MPS	Marine Planning Statement
MS-LOT	Marine Scotland Licensing Operations Team
NLB	Northern Lighthouse Board
NPF	National Planning Framework
OfTI	Offshore Transmission Infrastructure
OnTW	Onshore Transmission Works
OSP	Offshore Substation Platform
OWF	Offshore Wind Farm
PAD	Protocol for Archaeological Discoveries
PAN	Planning Advice Note
PMRA	Protection of Military Remains Act

Acronyms	
Acronym	**Expanded Term**
AEZ	Archaeological Exclusion Zone
AC	Aberdeenshire Council
SPP	Scottish Planning Policy
SLVIA	Seascape, Landscape and Visual Impact Assessment
THC	The Highland Council
UKHO	United Kingdom Hydrographic Office
WA	Wessex Archaeology
WSI	Written Scheme of Investigation
WTG	Wind Turbine Generator
ZTV	Zone of Theoretical Visibility

16 Archaeology and Cultural Heritage

16.1 Introduction

16.1.1.1 This chapter considers the likely significant effects associated with the construction, operation and maintenance and decommissioning of the Moray West Offshore Wind Farm and associated Offshore Transmission Infrastructure (OfTI) ("the Development") on marine archaeology and cultural heritage.

16.1.1.2 The specific objectives of the chapter are to:

- Identify the legislation, policy and guidance framework relevant to marine archaeology and cultural heritage;
- Detail the consultation activities and responses that are relevant to and have informed this marine archaeology and cultural heritage assessment;
- Describe the marine archaeology and cultural heritage baseline;
- Describe the assessment methodology and significance criteria used in completing the impact assessment;
- Describe the potential effects, including direct, indirect and cumulative effects;
- Describe the mitigation measures proposed to address potential significant effects; and,
- Assess the residual effects remaining following the implementation of mitigation.

16.1.1.3 The assessment has been carried out by appropriately qualified and experienced staff from Wessex Archaeology, following best practice professional guidance outlined by the Chartered Institute for Archaeologists' (CIfA) *Standard and Guidance for Historic Environment Desk-Based Assessment* (2014, updated 2017). Wessex Archaeology (Scotland) has produced cultural heritage assessment for numerous offshore wind farms and associated infrastructure. The Coastal & Marine and Heritage teams have a wealth of experience in interpreting, understanding, recording and protecting our vast maritime and terrestrial heritage.

16.1.1.4 This chapter is supported by:

- Volume 4 - Technical Appendix 16.1: Marine Archaeology Baseline Report.

16.2 Legislation, Policy and Guidance Framework

16.2.1 Relevant Legislation

16.2.1.1 In undertaking the assessment, the following legislation has been considered:

- Marine (Scotland) Act 2010 - this provides for the establishment of national and regional marine plans and for offshore sites of national importance to be designated as Historic Marine Protected Areas;
- Historic Environment Scotland Act 2014 – this sets out guidance for the implementation of Scottish Planning Policy 2014 in relation to the Historic Environment;
- Protection of Military Remains Act 1986 (PMRA 1986) – this provides protection for the wreckage of military aircraft and designated military vessels of any nationality;
- The Merchant Shipping Act 1995 – this defines the ownership of underwater finds considered to be 'wreck'; and
- The Planning (Listed Buildings and Conservation Areas) (Scotland) Act 1997 – this contains the bulk of built heritage conservation planning law for Scotland. It requires Scottish Ministers to compile lists of buildings of archaeological or historic importance and provides for the designation of conservation areas. This Act has been amended by The Historic

Environment (Amendment) (Scotland) Act 2011. This Act is specifically relevant for the designation of built heritage and informs the overall methodology for setting assessment of the onshore cultural heritage within this EIA.

16.2.2 Relevant Policy

16.2.2.1 The UK Marine Policy Statement (HM Government, 2011) sets out the framework for preparing marine plans and taking decisions affecting the marine environment. The Scottish Government has produced a National Marine Plan in accordance with these UK policies (Scottish Government, 2015). The plan covers the management of both Scottish inshore waters (out to 12 nm) and offshore waters (12 to 200 nm) and sets out the strategic policies for which management decisions will be made across the main marine sectors including general policies as well as specific policies for offshore wind and marine renewable energy.

16.2.2.2 The following policy applies to this archaeology and cultural heritage assessment:

- Scotland's National Marine Plan 2015 – this plan sets out a single framework for sustainable development within Scotland's marine area. Historic Environment Scotland (HES) states "development and use of the marine environment should protect and, where appropriate, enhance heritage assets in a manner proportionate to their significance" (GEN 6); and
- Additionally, Scottish Historic Environment Policy 2016 (Historic Environment Scotland, 2016a) sets out Scottish Ministers' policies, providing direction for HES and a policy framework that informs the work of a wide range of public sector organisations.

16.2.3 Relevant Guidance

16.2.3.1 The following publications have been used to inform both the onshore cultural heritage settings assessment and the offshore archaeology and cultural heritage impact assessment:

- Chartered Institute for Archaeologists Standard and guidance for historic environment desk-based assessment (2014, updated 2017);
- COWRIE Historic Environment Guidance for the Offshore Renewable Energy Sector (Wessex Archaeology, 2007);
- COWRIE Guidance for Assessment of Cumulative Impact on the Historic Environment from Offshore Renewable Energy (Oxford Archaeology, 2008);
- Historic Environment Guidance for Wave and Tidal Energy (HE, 2013);
- Joint Nautical Archaeology Policy Committee (JNAPC) Code for Practice for Seabed Development (2006);
- Model Clauses for Archaeological Written Schemes of Investigation, Offshore Renewables Project (Crown Estate, 2010);
- Managing Change in the Historic Environment: Setting (HES, 2016b);
- Marine Geophysics Data Acquisition, Processing and Interpretation Guidance Notes (English Heritage (now HE), 2013);
- Military Aircraft Crash Sites: Guidance on their significance and future management (English Heritage (now HE), 2002);
- Our Seas - A shared resource: High level marine objectives (DEFRA, 2009);
- Offshore Geotechnical Investigations and Historic Environment Analysis: Guidance for the Renewable Energy Sector (COWRIE, 2011);

- Planning Advice Note (PAN) 2/2011: Planning and Archaeology (Scottish Government, 2011b) – this provides advice to planning authorities and developers on dealing with archaeological remains with an emphasis which is proportionate to the relative value of the remains and of the developments under consideration; and
- Ships and Boats: Prehistory to Present: Designation Selection Guide (English Heritage (now Historic England), 2012).

16.3 Consultation

16.3.1.1 Moray West has framed its assessment of potential impacts on marine archaeology and cultural heritage through consultation with key stakeholders.

16.3.1.2 Table 16.3.1 details the key issues raised in relation to marine archaeology and cultural heritage in the Moray West Offshore Wind Farm Scoping Opinion (August 2016) and the OfTI Scoping Opinion (August 2017) and summarises other issues / concerns that have been raised during additional consultation activities undertaken during the EIA process and how these have been addressed in this EIA Report.

Table 16.3.1: Consultation Responses

Date and Consultee	Issue Raised	Moray West Approach
Historic Environment Scotland (HES) OfTI Scoping Opinion August 2017	HES are content with the information provided regarding the assessment of potential impacts of the proposed Development on marine archaeology (through both contamination, damage or loss of archaeological remains in or on the seabed and de-stabilisation of sites through changed sedimentary regimes). The proposed mitigation measures are likely to be adequate considering that further geophysical data would need to be undertaken post-consent.	Geophysical work on assessing recorded or potential wrecks and potential submerged palaeo-landscapes or prehistory has not extended to the export cable corridor and covered the full extents of Moray West Wind Farm area. Future assessment of this potential resource will be built in to pre-construction activities and developed as per any future Written Scheme of Investigation (WSI), agreed with relevant Stakeholders.
	The scoping report identifies that further geophysical survey, to provide data for the area of the wind farm site not already covered and the export cable route, will be undertaken post-consent. Best practice would allow for the surveys to be completed prior to a design being finalised and consent being granted and this would ensure that any potential assets of national importance are avoided. By proposing to undertake further survey work post-consent, there is a risk to the project of reaching an impasse where you can neither excavate nor avoid a significant historic environment asset, rendering your cable route or site unusable.	
	We welcome the identification of the charted wrecks, reported losses and other sites of potential archaeological value within the OfTI area that have been identified at this stage. We consider the identified methodologies for these potential impacts to be adequate. We consider that the mitigation measures proposed are likely to be adequate taking into account the information below.	Noted.
	Given that the exact locations of the offshore export cable landing point has not yet been identified it is not yet clear whether there will be any direct impacts on terrestrial	Potential for direct impacts on terrestrial assets has been considered in Section As identified in section

Table 16.3.1: Consultation Responses		
Date and Consultee	**Issue Raised**	**Moray West Approach**
	assets within our remit. The potential for direct impacts should therefore be considered within the assessment.	16.5.2 there is potential for the presence of WTGs to lead to changes in the setting of onshore cultural heritage assets which may affect the cultural heritage significance of individual assets. The assessment of effects on the setting of cultural heritage assets has been carried out in line with HSE guidance and considers both visual factors and the contributions of the surroundings to the experience, understanding and appreciation of a cultural heritage asset..
	We welcome that the potential impacts to the setting of terrestrial assets within our remit will be identified and that a ZTV analysis will be used to identify assets for assessment. We also welcome that our up to date Managing Change guidance note on Setting has been referenced and we strongly recommend its use in any setting impact assessment.	Setting impact assessment has been carried out in section 16.7.3.9.
Historic Environment Scotland (HES) OfTI Scoping Opinion August 2017	We consider the identified methodologies for these potential impacts to be adequate, however, we note that the baseline data for this section of the report refers only to marine archaeological receptors and there is no mention of any baseline data for terrestrial historic environment assets which may receive setting impacts. While we are content that there may be some crossover with the SLVIA section of the assessment, given that only Inventory GDLs are identified in the baseline data for that section it will be important to ensure that all setting impacts are addressed properly and that no historic environment assets are missed out of the assessment. Up to date information on all designated historic environment assets can be accessed from our website here.	Setting impact assessment has been carried out in section 16.7.3.9.
	There are no HMPAs in the vicinity of the site or in the wider area. However, we welcome that the assessment will consider direct disturbance, contamination and loss to historic environment assets and de-stabilisation of sites through changed sedimentary regimes.	Noted.
	We welcome the identification of the charted wrecks, reported losses and other sites of potential archaeological value within the OfTI area that have been identified at this stage. We consider the identified methodologies for these potential impacts to be adequate. We consider that the mitigation measures proposed are likely to be adequate taking into account the information below	Noted.

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Aberdeenshire Council (AC) OfTI Scoping Opinion August 2017	AC are broadly content and satisfied with the scope and approach taken towards the preparation of the EIA Report.	Noted.
	Aberdeenshire Council Archaeology Service agree with the identified potential effects as detailed in Table 7.5.3 on archaeological and cultural heritage assets, and for these three elements to be scoped in for further assessment within the EIA. There are no further considerations of potential or known impacts on archaeology and cultural heritage that require further assessment. There are no further recommendations for mitigation requirements or assessments other than those identified within Section 7.5.6 “Potential Mitigation Measures”.	This is included in the EIA (See Section0 & 16.7).
	Having reviewed the documentation, including Chapter 7.5 ‘Archaeology and Cultural Heritage’ of the submitted Scoping Report, I can make the following comments: 1) I agree with the identified potential effects as detailed in Table 7.5.3 on archaeological and cultural heritage assets, and for these three elements to be scoped in for further assessment within the EIA. 2) There are no further considerations of potential or known impacts on archaeology and cultural heritage from my perspective that require further assessment. 3) I have no further recommendations for mitigation requirements or assessments other than those identified within Section 7.5.6 ‘Potential Mitigation Measures’. Taking all of the above into consideration I can confirm that I have no additional requirements for the Scoping Request, and that those already scoped in for further assessment are appropriate.	Noted.
Marine Scotland OfTI Scoping Opinion August 2017	Stakeholders with a remit for archaeology and cultural heritage agree that effects scoped into the EIA, as noted in the Scoping Report, are appropriate. Moray West is to note the commentary provided by HES on the provision of geophysical data and setting impacts on terrestrial assets. Clarification should be provided to HES on these matters through the EIA assessment process	Please note comments addressed within this table.

Table 16.3.1: Consultation Responses		
Date and Consultee	**Issue Raised**	**Moray West Approach**
Historic Environment Scotland (HES) Offshore Wind Farm Scoping Opinion August 2016	General guidance and policy for marine cultural heritage assessments, and, sources of data and information.	Included in methodology (refer to Section 16.2.3).
	There are no HMPAs in the vicinity of the site or the wider area. However, we welcome that the assessment will consider direct disturbance and loss to known and unknown assets of historic importance and indirect impacts and indirect potential for impacts relating to disturbance and changes to the physical environment and coastal sediment dynamics of the area	Noted.
	We welcome the identification of the charted wreck of the vessel Sunbeam in the scoping report. We note that there are a number of other potential sites of archaeological value within the WDA that have been identified at this stage.	Noted.
Marine Scotland Offshore Wind Farm Scoping Opinion August 2016	The Crown Estate intends to launch in England and Wales a new cultural heritage reporting scheme for the seabed and intertidal zones. This scheme will be responsible for, and assist with, enhancing the environmental stewardship of underwater cultural heritage. The Marine Antiquities Scheme (“MAS”) will closely mirror the Portable Antiquities Scheme (“PAS”). The MAS will fit in with, and is designed to enhance and compliment, statutory reporting mechanisms that already exist, principally the Merchant Shipping Act 1995. It is important to note that reporting through the scheme does not devolve the finder from any other legal requirements that apply. It is designed to effectively capture data about the historic marine environment, return information to the finder and make that data available to the public for research in an accessible way – in much the same way that the PAS has been doing for some time. Although this is a document produced for England and Wales, the Company should be aware of this document and, as a matter of best practice, should be guided by the information contained therein.	N/A
The Highland Council (THC) Offshore Wind Farm Scoping Opinion August 2016	Cultural Heritage: - The ES needs to identify all designated sites which may be affected by the development either directly or indirectly. This will require you to identify: - - the architectural heritage (Conservation Areas, Listed Buildings) - the archaeological heritage (Scheduled Monuments), - the landscape (including designations such as National Parks, National Scenic Areas, Areas of Great Landscape Value, Gardens and Designed Landscapes and general setting of the development. - the inter-relationship between the above factors.	Direct and indirect impacts on all listed receptors have been assessed in Section 16.7.

16.4 Baseline Conditions

16.4.1 Baseline Characterisation Approach

16.4.1.1 The baseline characteristics for marine and coastal archaeology, which includes recorded wrecks and obstructions, identified geophysical receptors, the potential for further maritime and aviation archaeology receptors and potential submerged prehistory, are described in detail in Volume 3, Technical Appendix 16.1: Marine Archaeology Baseline Report. Further receptors identified for setting analysis are included within the assessment and are numbered using their relevant designation/catalogue number.

Study Area

16.4.1.2 For the purpose of this assessment the study area is referred to as the Development Archaeological Study Area (ASA). This includes the following areas:

- Moray West Site ASA (including a two-km buffer); and
- Offshore Transmission Infrastructure (OfTI) ASA (including a two-km buffer except where this would overlap with the Moray West Site ASA and also excluding all areas above Mean High Water Springs (MHWS)).

16.4.1.3 The two km buffer around the two ASAs is required to account for potential effects associated with scour and sedimentation, address uncertainty regarding the spatial accuracy of offshore cultural heritage records and to account for the potential for cultural heritage features to extend beyond the boundaries of both the Moray West Site and the export cable corridor. The ASA is illustrated in Volume 3a - Figure 16.4.1.

Data Sources

16.4.1.4 The approach to defining baseline characteristics of the Development ASA involved the following key activities:

- Analysis and interpretation of geophysical data acquired in 2010 for the Moray West Site ASA only (there is no geophysical data for the Export Cable Corridor ASA); and
- Review of findings from geophysical data interpretation in context of additional data obtained from desk-based assessments, historical data, known archaeological sites and other previous investigations in the Development ASA.

Geophysical Data Analysis

16.4.1.5 In 2010, Osiris carried out a geophysical survey of the Moray Firth Zone (now referred to as the Moray East and Moray West Sites). The survey was based on a grid comprising 23 main line transects orientated at 045°/225° with 600 m spacing and 30 cross line transects orientated at 135°/315° with 1,000 m spacing. This resulted in a total data coverage of 20% across the entire Moray West Site.

16.4.1.6 The type and quality of data acquired during the survey is summarised in Table 16.4.1.

Table 16.4.1: Moray West Site Geophysical Data

Data Type	Data Collection Method	Quality of Data (Based on Criteria Listed in Technical Appendix 16.1)
Side scan sonar	Klein 3000 digital dual frequency (100 kHz and 455 kHz) system operated in dual frequency mode at a maximum range of 200 m throughout the survey area.	Average Some noise on data. Data acquired with wide range setting of 200 m but only achieved 125 m on each channel at high frequency making identification of small objects difficult.

Table 16.4.1: Moray West Site Geophysical Data		
Data Type	**Data Collection Method**	**Quality of Data (Based on Criteria Listed in Technical Appendix 16.1)**
Multibeam bathymetry data	Reson Seabat 7101 high resolution multibeam echosounder. A Knudsen 320 M dual frequency hydrographic echo sounder was also used to validate the values from the multi-beam system	Good Data quality and resolution of 1 m is a good standard and suitable for identifying objects and debris over 1 m in size.
Sub bottom profiler	Geo-Spark 200 sparker system with a towed 8 element hydrophone receiver.	Good Good penetration achieved with reflector clearly visible and little background noise.
Magnetrometry	Geometrics G882 caesium vapour towfish capable of resolving anomalies to 5 nT.	Average Some background noise in data potentially masking smaller anomalies. Wide line spacing also increases potential for unidentified ferrous material to be present between survey lines.

16.4.1.7 Further detail on the methods used to process and analyse the various types of geophysical data is provided in Technical Appendix 16.1.

Desk-based Assessment

16.4.1.8 The desk-based assessment involved a review of the following data sources:

- The United Kingdom Hydrographic Office (UKHO) records of charted wrecks and obstructions (2017);
- Records held by Historic Environment Scotland (HES) (2017);
- Records held by the National Record of Historic Environment (CANMORE) (2017);
- Relevant mapping including Admiralty Charts, historic maps and Ordnance Survey; and
- Relevant documentary secondary sources relating to previous archaeological and geophysical work in the region and including both academic papers and unpublished reports that are in the public domain.

16.4.2 Current Baseline

Marine Archaeology Baseline

16.4.2.1 The key marine archaeology assets requiring consideration in this assessment include:

- Seabed prehistory (for example, palaeochannels and other features that contain palaeoenvironmental sediment sequences, and early prehistoric sites and derived artefacts e.g. lithic, bone and wooden tools, ecofacts and other archaeological materials);
- Seabed features, including maritime sites (such as shipwrecks and associated elements including cargo, obstructions and fishermens' fasteners); and; aviation sites (aircraft crash sites and associated debris); and
- Intertidal heritage assets such as hulks and buried land surfaces.

16.4.2.2 These marine archaeology assets are described below. Further detail on each of these assets is provided in Technical Appendix 16.1.

16.4.2.3 There are currently no known prehistoric sites within the ASA and no individual paleogeographic features (e.g. individual buried palaeochannels) of archaeological interest were identified within the geophysical data assessed by Wessex Archaeology (for the Moray West Site and 2 km buffer only; excludes export cable corridor). However, the potential for archaeological material of a prehistoric date to exist within the Development ASA cannot be overlooked.

16.4.2.4 The British Geological Society (BGS) has identified seven Quaternary stratigraphy units within the Inner Moray Firth. Of these, Unit 7: Holocene Estuarine (Technical Appendix Section 4.3) is located across a large area of the Moray West Site ASA. This comprises Holocene muds, sands, silts and clays which have the potential to contain material of palaeoenvironmental interest. This includes the presence of organic materials which suggested, that at least part of this Unit was dry land at one time (of high archaeological potential), potentially representing an estuarine or alluvial deposit, which would have been a favourable location for human occupation.

16.4.2.5 A total of 39 marine geophysical anomalies ranging from previously recorded wrecks to unidentifiable features with possible anthropogenic origin have been identified in the geophysical data obtained from the Moray West Site ASA (i.e. Moray West Site and 2 km buffer). These are illustrated in Volume 3a - Figure 16.4.2 (Seabed Features of Archaeological Potential within Moray West Site).

16.4.2.6 Of the 39 identified marine geophysical anomalies, 29 anomalies are located within the Moray West Site, with one confirmed wreck site (WA7228). This recorded wreck has been identified in the UKHO database as the *Sunbeam* (Possibly). This is a wooden sailing vessel with original dimensions of 30.4 m x 7.0 m x 3.4 m built in 1878 by Massey, Portreath, Cornwall. The vessel was captured by submarine and sunk by gunfire in 1915. When it sunk it was owned by William B. Firth of Finstown, Orkney. The wreck was last identified by geophysical survey for the UKHO in 2008 and recorded as being highly degraded. It was identified in the 2010 sidescan sonar data with dimensions of 25.0 m 20.0 m x 2.7 m and a slight magnetic anomaly.

16.4.2.7 The remaining 28 anomalies have been classified as being of A2 archaeological discrimination – uncertain origin of possible archaeological interest, ranging from seafloor disturbance to magnetic anomalies.

16.4.2.8 From records in the UKHO datasets, a further ten sites were identified within the Export Cable Corridor ASA, consisting of six recorded wrecks and five recorded obstructions (WA7229-WA7238). Volume 3a - Figure 16.4.3 (Seabed Features of Archaeological Potential within the Offshore Export Cable Corridor). The *U77* (WA7229) was a WWI German submarine that was sunk in 1916 by a British ship. WA7230 is probably the *Moray Firth* a British steamship that sank in 1943 following a collision. The *Mayflower* (WA7231) consisted of a wooden fishing vessel that sunk in 1973 following a collision with MFV Devotion II. Similarly, the *Artemis* (WA7233) was a MFV that grounded due to dense fog in 1974 whilst on passage for the Isle of Man. WA7234 possibly consists of a ditched A/C Day Jet aircraft.

16.4.2.9 A total of 167 assets within the Development ASA have only National Monument Records of Scotland (NMRS) records as Recorded Losses, with no obvious corresponding UKHO records. Four records are located within the Moray West Site ASA, whilst the remaining are located within the intertidal zone in the Offshore Export Cable Corridor ASA. These can be grouped into wreck sites (No. 121), aircraft sites (No. 34), possible wreck sites (No. 10) and obstructions (No. 1). All of these records are listed as having an arbitrary location as they are taken from the Recorded Loss register.

16.4.2.10 The four records located within the Moray West Site ASA consist of three 20th century vessels and one obstruction.

Setting of Designated Onshore Cultural Heritage Receptors

16.4.2.11 There is potential for the Moray West Offshore Wind Farm to be visible from a number of designated cultural heritage receptors found along the coastlines of Moray and Caithness. The following receptors listed in Table 16.4.2 and presented in Volume 3a - Figure 16.4.4 have been assessed for potential effects upon their setting. These assets are described below.

Table 16.4.2: Onshore Cultural Heritage Receptors Requiring Assessment

Asset Type	Onshore Cultural Heritage Asset
Scheduled monuments	• Dunbeath Inver Forth (SM5073) • Latheronwheel promontory fort (SM5182) • The Tulloch (Usshilly), Broch and field system (SM599)
Category A listed buildings	• Dunbeath Castle (LB7936) • Dunrobin Castle (LB7044) • Covesea Skerries Lighthouse, Keeper's Cottage and Steading (LB3705)
Gardens and designated landscapes	• Dunbeath Castle (GDL00150) • Dunrobin Castle (GDL00160)

Dunbeath Inver Forth

16.4.2.12 Dunbeath Inver Forth (SM5073) consists of a fort, a post medieval building and a Second World War (WWII) look-out post, located on a precipitous coastal promontory. The fort comprises a circular dry-stone structure measuring about 20 m in diameter and survives as a turf covered bank 4 to 5 m wide and up to 0.7 m high. It is possible that the circular fort is the surviving remains of a broch. This structure is defended by an outwork cutting across the neck of the promontory. The outwork consists of a turf-covered stony bank and outer ditch, the former being 1.7 m above the base of the ditch. Fronting the ditch is a less significant bank which has been partially removed. During the Second World War (1939-45), a look-out post with a chimney was inserted into the fabric of the circular fort on its east side.

16.4.2.13 The role of the WWII post was to protect the Caithness coast from a sea-borne invasion during the war. A clear vista out to sea is a therefore an important element of the setting of the site. The monument also has potential to contribute to the understanding of fortifications, warfare and defence in prehistory and more recent times.

Latheronwheel Promontory Fort

16.4.2.14 Latheronwheel promontory fort (SM5182) is a prehistoric promontory fort that sits on a sea stack joined to the mainland cliff by a narrow causeway. The fort is formed by a rampart on the sea stack, measuring up to 2 m high, with a central entrance and 3 to 4 scooped sub-circular huts. Possible traces of an outer rampart are noted on the mainland. As a 'fort' site, the monument commands views out across the Moray Firth. However, its setting in the landscape is not necessarily directly related to a maritime setting, but more towards a prehistoric defensive system, utilising the natural configuration of the coastal cliff and stack to define the site.

The Tulloch (Usshilly) Broch

16.4.2.15 The Tulloch (Usshilly) Broch and field system (SM599) comprises an Iron Age broch along with an extensive area of post-medieval cultivation. The broch survives as a low mound of stone, measuring approximately 20 m across and stands over 2 m high. It is set on the outside edge of a natural terrace on the hillside. Around the broch is an extensive area of particularly well-preserved rig-and-furrow cultivation. The rigs display lynchets (accumulations of soil at their lower side) in places, and are bounded on the west by a tumbled drystone wall, and on the east by a boggy area, within which stands a probable Bronze Age burnt mound. The current setting of the broch upon higher elevation, allows for views out into the Moray Firth and across the North Sea.

Dunbeath Castle

16.4.2.16 Dunbeath Castle (LB7936) is a Category A–listed castle, comprising a late 16th / early 17th century structure which was extensively altered and remodelled in the late 19th century. The castle is located on a cliff-top promontory, with an approach drive set within the garden channelling views to focus to and from the castle. The garden forms part of an associated designed landscape (GDL00150). Further associated listed buildings, including a gatehouse and stables are located to the north–west. The setting of the castle also commands views along the Caithness coast and out across the North Sea.

16.4.2.17 The designed landscape (GDL00150) associated with the castle dates to the late 17th / early 18th century, with additional features added in the 19th century. It comprises a rectangular strip of land some 200 m wide, aligned northwest to southeast and extending 1 km in length. The central, longitudinal axis of the design is formed by an avenue, bounded on each side by perimeter tree belts, and terminated by the castle to the south and the Doocot to the north.

Dunrobin Castle

16.4.2.18 Dunrobin Castle (LB7044) is a Category A-listed castle, comprising an altered 15th century tower, possibly dating to the 1300s, and a 17th century courtyard mansion, with round corner turrets. This was extensively enlarged in the 18th and 19th centuries. The castle is set on a rocky terrace above the shore overlooking the gardens, which form part of an associated designated designed landscape (GDL00160). The castle commands wide views out across the Moray Firth to the north Morayshire coast.

16.4.2.19 The designed landscape (GDL00160) associated with the castle dates to the 1600s, but the existing layout dates mainly from the mid-1800s, consisting of impressive formal gardens, kitchen gardens, parkland and woodland. The designed landscape is enclosed by Dunrobin Wood which covers the slopes and hills to the west and north of the Castle grounds. The inner core of the designed landscape today is bounded by the A9 and the railway to the north and by the Moray Firth to the south. The walled gardens can be viewed from the castle, and overlook the coast out towards the Moray Firth.

Covesea Skerries Lighthouse

16.4.2.20 The Covesea Skerries Lighthouse (LB3705), a Category A-listed building, was built between 1844 and 1846 by Alan Stevenson (engineer) and James Smith (contractor). The lighthouse was de-manned in 1984 and decommissioned in 2012. The lighthouse stands 36 m high, with a complex including two keepers' cottages and a well, along with workshops and offices on the lower ground. It is currently maintained by the Northern Lighthouse Board (NLB) and owned by the Covesea Lighthouse Community Company. The current setting of the lighthouse at Covesea is a relatively solitarily feature on the coast, separated from the main road by an open area of grass.

16.4.3 Future Baseline

16.4.3.1 The future marine archaeology and cultural heritage baseline, without the Development, will continue to be affected by natural processes influenced by changes in local environmental conditions and wider climate change. These factors may preserve or deteriorate the condition of cultural heritage assets, above and below the ground. Natural processes may be of larger magnitude over longer timescales.

16.5 Assessment Methodology

16.5.1 Assessment Approach

Approach to Assessing Impacts on Marine Archaeology Assets

16.5.1.1 This assessment considers the potential physical impacts associated with the construction, operation and maintenance and decommissioning of the Development and their effect on marine archaeology assets; and the potential effect of the Development on the setting of designated onshore cultural heritage assets.

16.5.1.2 The impact assessment process and methodology follows the principles and general approach outlined in the Moray West Offshore Wind Farm Scoping Report (2016) and the Moray West OfTI Scoping Report (2017). The methodology and parameters assessed have also taken into account issues identified through consultation with stakeholders as detailed in Section 16.3 and the understanding of baseline conditions informed by the data sources referenced in Section 16.4.

16.5.1.3 The nature of the marine archaeological resource is such that there is a high level of uncertainty concerning remains on the seabed. It is often the case that data concerning the nature and extent of sites is out of date, limited, or lacking and the Precautionary Principle is often necessarily applied to aspects of archaeological impact assessment.

16.5.1.4 Guidance on use of the Precautionary Principle (Wessex Archaeology, 2007) states that it should be applied on the basis of the evidence available at the time of decision-making, when:

- There is good reason to believe that the historic environment may be subject to harmful effects; and,
- The level of scientific uncertainty about the consequences or likelihood of these effects is such that risk cannot be assessed with sufficient confidence to inform decision-making.

16.5.1.5 Therefore, where these factors are relevant the Precautionary Principle has been applied.

Approach to Assessing Impact on Setting of Cultural Heritage Assets

16.5.1.6 The methodology for the assessment of setting impacts upon the cultural heritage assets has been undertaken with reference to current guidance *Managing Change in the Historic Environment: Setting* (HES, 2016b). The approach taken is to:

- Identify the cultural heritage assets that might be affected;
- Define the setting of each asset (without reference to the Development); and
- Assess how the Development would impact upon this defined setting.

16.5.1.7 Once an impact has been identified the final stage in this chapter is to consider the significance of any impact in EIA terms. The potential magnitude was assessed in conjunction with the Seascape, Landscape and Visual Impact Assessment (SLVIA) wireline models.

16.5.1.8 Some or all of the selected archaeology and cultural heritage receptors may also be analysed in the SLVIA (Chapter 14 of the EIA Report). This assessment concentrates on the cultural heritage setting impacts, which are distinct from the aesthetic heritage setting impacts discussed within Chapter 14: SLVIA, and are identified using cultural heritage specific guidance (e.g., HES, 2016b). The assessment of setting has been conducted to identify potential changes in setting which may affect the cultural heritage significance of individual receptors, distinct from the aesthetic landscapes and seascapes discussed in Chapter 14: SLVIA. There is therefore no correlation between the magnitude and significance of setting impacts identified within each chapter, even if a receptor is analysed in both.

16.5.1.9 Setting as defined in the HES guidance includes both visual factors and the contributions of the surroundings to the experience, understanding and appreciation of a cultural heritage asset. It is noted that due to the distances (approximately 22.5 km) between the Moray West Offshore Wind Farm and the onshore receptors, any significant indirect effects on the setting of receptors that do not reference the sea due to their function will only be visual impacts.

16.5.1.10 The assessment of the impacts to the setting of cultural heritage receptors remains rooted in the professional judgement of the assessor; however, a number of key factors can be noted which are considered in defining the setting of a receptor. These include the prominence of the receptor within views of the surrounding area, key vistas from the receptor and the relationship between built and natural features. The assessment of setting effects on a cultural heritage receptor is therefore complex and not simply a function of the proximity or inter-visibility of the development in question.

16.5.1.11 It is also noted that impacts on setting relating to the construction and decommissioning of the Moray West Offshore Wind Farm will be short term and temporary. The assessment of setting impacts therefore focuses solely on the operational impacts arising from the Moray West Offshore Wind Farm.

16.5.2 Impacts Identified as Requiring Assessment

16.5.2.1 Table 16.5.1 below lists all potential impacts on marine archaeology and cultural heritage identified as requiring consideration as part of the assessment. This list of impacts is based on expert judgement, reflects responses provided by statutory consultees and other stakeholders in the wind farm and OfTI Scoping Opinions and takes into account further comments received as part of ongoing community consultation activities.

Table 16.5.1: Impacts on Marine Archaeology and Cultural Heritage Requiring Assessment

Potential Impact	Nature of Impact (direct or indirect)	Inter-Relationships with Other EIA Topics / Receptors
Construction (and Decommissioning) Impacts		
Contamination, damage to, or loss of, marine archaeology assets (including seabed prehistory, seabed features including maritime and aviation sites and intertidal heritage assets) resulting from direct physical impacts.	Direct	None
Operation and Maintenance (O&M) Impacts		
Destabilisation of marine archaeology assets through changed hydrography and sedimentary regimes.	Indirect	Chapter 6: Physical Processes and Water Quality.
Indirect effects due to changes to the setting of designated cultural heritage assets.	Indirect	Chapter 14: Seascape, Landscape and Visual Assessment.

16.5.3 Scoped Out Impacts

16.5.3.1 Following the Scoping Opinions received for the Moray West Offshore Wind Farm and the OfTI, no potential impacts were scoped out at this stage.

16.5.4 Assessment Criteria

16.5.4.1 Specific criteria for defining receptor sensitivity and value, magnitude and significance is provided in Table 16.5.2, Table 16.5.3 and Table 16.5.4 respectively.

Sensitivity Criteria

16.5.4.2 The capability of a receptor to accommodate change and its ability to recover if affected is a function of its sensitivity. Receptor sensitivity is typically assessed via the following factors:

- **Adaptability** – the degree to which a receptor can avoid or adapt to an effect;
- **Tolerance** – the ability of a receptor to accommodate temporary or permanent change without significance adverse impact;
- **Recoverability** – the temporal scale over and extent to which a receptor will recover following an effect; and,
- **Value** – a measure of the receptor's importance, rarity and worth.

16.5.4.3 Archaeological and cultural heritage receptors cannot typically adapt, tolerate or recover from physical impacts resulting in material damage or loss caused by development. Consequently, the sensitivity of each asset is predominantly quantified only by its value.

16.5.4.4 The value of an archaeological receptor is assessed by examining the receptor's age, type, rarity, survival and/or condition, fragility and/or vulnerability, group value, documentation, associations, scientific potential and outreach potential. These factors help to characterise a site or feature, to assess how representative it is in comparison to other, similar sites, and to assess its potential to contribute to knowledge, understanding and outreach. In most cases, statutory protection is only provided to a site or feature judged to be the best known or an above average example in regard to these factors.

16.5.4.5 In accordance with the UK Marine Policy Statement (2011), while designation indicates that a receptor has been identified as being of high value, non-designated heritage assets are not necessarily of lesser importance. Very few offshore archaeological sites are designated due to a lack of knowledge of an asset through limitations in accessibility and available data in identifying potential sites. Therefore, non-designated receptors that can be demonstrated to be of equivalent significance to designated sites should be considered subject to the same policies as for designated heritage assets.

16.5.4.6 Based on Historic Environment Scotland's Policy Statement (HES, 2016a), the significance of a historic asset '*is inherent in the monument itself, its fabric, setting, use, associations, meanings, records.*

16.5.4.7 Within this assessment chapter, significance is weighed by consideration of the potential for the asset to demonstrate the following value criteria:

- **Evidential value** - deriving from the potential of a place to yield evidence about past human activities;
- **Historical value** - deriving from the ways in which past people, events and aspects of life can be connected through a place to the present. It tends to be illustrative or associative;
- **Aesthetic value** - deriving from the ways in which people draw sensory and intellectual stimulation from a place; and,

16.5.4.8 **Communal value** - deriving from the meaning of a place for the people who relate to it, or for whom it figures in their collective experience or memory. Communal values are closely bound up with historical (particularly associative) and aesthetic values, but tend to have additional and specific aspects. The value of known marine archaeology and cultural heritage assets were assessed on a five-point scale using professional judgement informed by criteria provided in Table 16.5.2 below.

Table 16.5.2: Sensitivity / Value Criteria	
Value	**Definition**
Very high	Best known or only example and/or significant potential to contribute to knowledge and understanding and/or outreach. Assets with a demonstrable international dimension to their importance are likely to fall within this category.
	Wrecked ships and aircraft with statutory protection, with an international dimension to their importance, plus as-yet undesignated sites that are demonstrably of equivalent archaeological value.
	Enlisted as a World Heritage Site – cultural and/or natural sites considered to be of 'Outstanding Universal Value', inscribed on the World Heritage List by the World Heritage Committee.
	Known seabed prehistoric sites and landscapes with the confirmed presence of largely *in situ* artefactual material.
High	Above average example and/or high potential to contribute to knowledge and understanding and/or outreach. Assets with a demonstrable national dimension to their importance are likely to fall within this category.
	Wrecked ships and aircraft with statutory protection, plus as-yet undesignated sites that are demonstrably of equivalent archaeological value.
	Category A-listed Structures – buildings of national or international importance, either architectural or historic; or fine, little-altered examples of some particular period, style or building type.
	Palaeogeographic features with demonstrable potential to include artefactual and/or palaeoenvironmental material, possibly as part of a prehistoric site or landscape.
Moderate	Average example and/or moderate potential to contribute to knowledge and understanding and/or outreach.
	Includes wrecks of ships and aircraft that do not have statutory protection or equivalent significance, but have moderate potential based on a formal assessment of their importance in terms of build, use, loss, survival and investigation.
	Category B-listed structures – buildings of regional or more than local importance; or major examples of some particular period, style or building type, which may have been altered.
	Prehistoric deposits with moderate potential to contribute to an understanding of the palaeoenvironment.
Low	Below average example and/or low potential to contribute to knowledge and understanding and/or outreach.
	Includes wrecks of ships and aircraft that do not have statutory protection or equivalent significance, but have low potential based on a formal assessment of their importance in terms of build, use, loss, survival and investigation.
	Category C-listed structures – buildings of local importance; lesser examples of any period, style or building type, as originally constructed or moderately altered.
	Prehistoric deposits with low potential to contribute to an understanding of the palaeoenvironment.
Negligible	Poor example and/or little or no potential to contribute to knowledge and understanding and/or outreach. Assets with little or no surviving archaeological interest.

Impact Magnitude

Magnitude of Impact on Marine Archaeology Assets

16.5.4.9 The magnitude of an impact is defined by a series of factors including the spatial extent of any interaction, the likelihood, duration, frequency and reversibility of a potential impact. The definitions of the levels of magnitude used in this assessment for scoped-in archaeology and cultural heritage assets are described in Table 16.5.3.

Table 16.5.3: Magnitude Criteria

Magnitude	Definition
Very high	Comprehensive, long term or permanent physical damage or changes to the character of the asset.
High	Extensive, long term or permanent physical damage or changes to the character of the asset.
Moderate	Considerable medium/long term semi-permanent or long-term temporary changes that affect the character of the asset, resulting in considerable physical damage.
Low	Minor medium-term temporary or semi-permanent change that partially affect the character of the asset, resulting in some physical damage.
Negligible	Very minor or negligible temporary or semi-permanent change to the character of the asset, with physical damage leading to an imperceptible change to the baseline.

Magnitude of Impact on Setting of Cultural Heritage Assets

16.5.4.10 The magnitude of an impact considers the level of change to a receptor's setting; the magnitude of a 4-storey building in close proximity to the asset would be judged to potentially induce a larger magnitude adverse impact than a 20-storey building several kilometres away. Several factors can affect the overall magnitude of an impact including:

- **Obstruction of or distraction from key views** - some assets are placed deliberately in the landscape to be afforded a certain view which visitors can still enjoy e.g. prehistoric tombs overlooking a particular bay or the designed vista of a country house;
- **Changes in prominence** - Assets can be placed on a prominent place in the landscape which is key to their importance and experience e.g. ridgetop cairns and castles on hilltops;
- **Changes in landscape character** - Assets may be linked to a particular land use, the changing or removal of which may compromise their setting and the importance of the asset as a whole e.g. the extra-mural fortifications of a town are of significance to the defensive town wall;
- **Duration of impact** - the longer the impact will continue, the larger the magnitude of the impact will be; and,
- **Reversibility of impacts** - if the setting will be restored at the end of the development or can be easily reversed then it will be of lesser magnitude than an irreversible change.

Significance Criteria

16.5.4.11 The magnitude of the impact is correlated against the sensitivity of the asset to provide a level of significance. For the purposes of this assessment any effect that is considered moderate or major, in the matrix (Table 16.5.4), is considered to be significant in EIA terms. Any effect that is minor or below is not considered significant in EIA terms.

Table 16.5.4: Significance Criteria					
Sensitivity of Receptor	**Impact Magnitude**				
	No change	**Negligible**	**Low**	**Moderate**	**High**
Negligible	Negligible	Negligible	Negligible	Negligible	Minor
Low	Negligible	Negligible	Negligible	Minor	Moderate
Moderate	Negligible	Negligible	Minor	Moderate	Major
High	Negligible	Minor	Moderate	Major	Major
Very high	Negligible	Minor	Moderate	Major	Major

16.5.5 Data Limitations

16.5.5.1 The baseline for recorded archaeological assets from the UKHO and NMRS should be considered complete to the extent of known marine archaeology and cultural heritage assets within the Development ASA.

16.5.5.2 As noted in the Moray West Offshore Wind Farm Scoping Report (2016) and Moray West OfTI Scoping Report (2017) the geophysical survey only covers 20% of the seabed in the Moray West Site. There is no data for the export cable corridor.

16.5.5.3 The geophysical data covering 20% of the Moray West Site has been archaeologically assessed to inform the baseline.

16.5.5.4 Additional, more detailed geophysical data will be collected for both the Moray West Site and the export cable corridor post consent. This data will then be archaeologically assessed to inform detailed design of the Development and planning of site-specific mitigation and construction management measures.

16.5.5.5 It is judged that the data utilised for the setting assessment, supported by SLVIA wirelines are sufficient for the assessment.

16.5.5.6 This assessment has been conducted in consideration of the worst case design scenario and, therefore, considers the maximum impact on marine archaeology and cultural heritage.

16.6 Design Envelope Parameters

16.6.1 Realistic Worst Case

16.6.1.1 As identified in Volume 2 - Chapter 4 Development Description, Moray West is considering a range of potential construction methods and design options for the Development. The Design Envelope presented in Chapter 4 (Volume 2) presents the range (minimum and maximum) of design parameters for each of the options under consideration e.g. substructure type or turbine model.

16.6.1.2 In order to determine potential impacts of the various options it is necessary to define the 'realistic worst case scenario'. The realistic worst case scenario represents, for any given receptor and potential impact on that receptor, various options in the Design Envelope that would result in the greatest potential for change to the receptor in question.

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

16.6.1.4 Table 16.6.1 presents the realistic worst case scenario for potential impacts on archaeology and cultural heritage during construction, operational and maintenance and decommissioning phases of the Development and provides justification as to why the options and design parameters identified are considered to be the realistic worst case scenario.

Table 16.6.1: Design Envelope Parameters Relevant to the Marine Archaeology and Cultural Heritage Impact Assessment		
Potential Impact	**Realistic Worst Case Scenario**	**Justification**
Construction (and Decommissioning)		
Contamination, damage to or loss of marine archaeology assets resulting from direct physical impacts.	The maximum area of seabed preparation and disturbance across the Moray West Site has been quantified based on the following: • Area of seabed preparation (125 m diameter dredge-affected area) required for installation of gravity base structure foundations (based on 55 m diameter gravity base for Model 4 turbines) (see Chapter 4 Description of Development Table 4.4.6). The resulting area of disturbance per foundation is 12,272 m^2. Therefore, for 62 foundations the maximum area of disturbance would be 1,043,120 m^2 (1.043 km^2); • Seabed disturbance within the area of seabed preparation (125m diameter dredge-affected area) required for two small offshore substation platforms (OSPs) using gravity base foundation (55 m diameter). Total area of seabed disturbance amounts to 24,544 m^2; • Jack up vessel seabed footprint for 85 WTG and 2 OSP foundations, based on a max jack up barge footprint of 1,650 m^2 (275 m^2 per spud can and max 6 legs per jack-up), the maximum disturbance would be 143,550 m^2; • Installation of up to 275,000 m inter-array cables (with worst case trench affected width of 15 m) of 4,125,000 m^2 (4.125 km^2); • Installation of up to 15,000 m of OSP interconnector cabling (with worst case trench affected width of 15 m) of 225,000 m2 (0.225 km^2); and • Seabed disturbance would occur over a 36 month period. The maximum area of temporary habitat loss and disturbance across the Offshore Export Cable Corridor has been quantified based on the following: • Installation of export cable circuits within up to two trenches, each 65,000 m in length and 15 m width. Which would result in a maximum disturbed area of 1,950,000 m^2 (1.95 km^2) and would occur over a six-month period (within the overall 36 month construction period). The overall total footprint of disturbance of the Moray West Site and Offshore Export Cable Corridor combined under a worst-case approach is 7,511,214 m^2 (7.511 km^2).	Maximum area of seabed that will be affected during installation of the WTG and OSP foundations, inter-array cables, OSP interconnector cables and offshore export cables. This equates to the worst case scenario for potential effects on marine archaeology both within the Moray West Site and along the Offshore Export Cable Corridor.

Table 16.6.1: Design Envelope Parameters Relevant to the Marine Archaeology and Cultural Heritage Impact Assessment		
Potential Impact	**Realistic Worst Case Scenario**	**Justification**
Operation and Maintenance		
Destabilisation of marine archaeology assets through changed hydrography and sedimentary regimes	Moray West Site (total footprint of 545,516 m^2) based on: • 45 m diameter gravity base foundations and scour protection calculated as 5,675 m^2 per foundation. For 85 foundations the maximum area of disturbance would be 482,333 m^2; • Scour protection for two small OSPs will have a footprint of 14,176 m2 based on a maximum requirement for scour protection to extend out over a 95 m diameter area (including the 55 m diameter gravity base foundation) (7,088 m^2 per foundation); • A worst-case measure of 10% of the total inter-array cable length is predicted to require cable protection. This would result in 27,500 m of the inter-array cables requiring protection. Assuming 3 m wide concrete mattress protection is used this would result in a footprint of up to 82,500 m^2; • Protection associated with 15 cable crossings for inter-array cables requiring rock protection extending 200 m in length and 6 m in width will result in a footprint of up to 18,000 m^2; and • A worst-case measure of 10% of the total OSP interconnector cabling is predicted to require cable protection. This would result in 1,500 m of the inter-array cable requiring protection, resulting in a footprint of up to 22,500 m^2. Offshore Export Cable Corridor (total footprint of 85,200 m^2) based on: • A worst- case measure of 20% of the total offshore export cable length is predicted to require cable protection. This would result in 26,000 m of the offshore export cable affording protection, resulting in a footprint of up to 78,000 m^2; and • Protection associated with six cable crossings for offshore export cables resulting in a footprint of up to 7,200 m^2.	Largest potential extent of scour protection and cable protection which leading to potential changes in hydrography and sedimentary regimes.
Turbine height and layout in relation to the setting of onshore cultural heritage receptors.	Based on Model 4f (SLVIA worst case scenario): • Number of structures = 62 turbines plus 2 OPSs on 4-legged jacket structures; and • Maximum tip height of 285 m; Maximum hub height of 160 m.	Largest ZTV from largest size and number of turbines.

16.6.2 Embedded Measures

16.6.2.1 Mitigation for the Development will include a range of embedded mitigation measures to minimise environmental effects from the Development. Implementation of these measures will ensure that the magnitude of impact of the Development will be reduced to a negligible level. The measures are as follows:

- A Development-specific Written Scheme of Investigation (WSI) will be prepared, in consultation with HES, once the layout of the Development and infrastructure is established. This document will be incorporated into the Environmental Management Plan (EMP). The WSI will set out the design and implementation of a programme of detailed mitigation works. This will comply with guidance current at the time of its development (presently The Crown Estate 2010).
- Mitigation strategies for known shipwreck sites will include maintenance of appropriate archaeological exclusion zones (AEZs) between the Development infrastructure including OSP(s) and cables. AEZs preclude development-related activity within their extents (Wessex Archaeology, 2007: 43).
- Analysis of pre-construction survey data will be undertaken to refine the identified potential marine archaeology assets at infrastructure locations. Appropriate micro-siting allowance for identified assets will be agreed in consultation with HES.
- Both the micro-siting allowance and exclusion zones will be detailed in the WSI described above. This will reduce any potential impacts on marine archaeology.
- The WSI will include a Protocol for Archaeological Discoveries (PAD) which will be prepared in consultation with HES. This will mitigate the risk of damage to any previously unrecorded archaeological remains.
- Mitigation relating to effects of the Development on the setting of cultural heritage receptors will be as per SLVIA mitigation (including draft Design Principles) described in Chapter 14 and should include:
    - WTGs will be placed in a regular grid subject to micro siting requirements;
    - WTGs will all be of similar dimensions to hub height and blade tip subject to WTG and substructure design and installation specification;
    - The WTGs will all be pale grey in colour (Light Grey RAL 7035) with a semi-matt finish. This tends to reduce the distance over which the WTGs are visible, especially in dull or overcast conditions, which often occur. As offshore WTGs are often viewed against the sky, pale grey is the most appropriate colour as it is closest to that of the lower part of the sky under the most frequent UK weather conditions.

16.7 Assessment of Potential Effects

16.7.1 Overview

16.7.1.1 This section considers the impacts associated with construction, operation and maintenance and decommissioning of the Development, and the effect of those impacts on marine archaeology assets and onshore cultural heritage assets.

16.7.2 Potential Construction Effects

Contamination, Damage to, or Loss of Marine Archaeology Assets Resulting from Direct Physical Impacts

16.7.2.1 Direct physical impacts on marine archaeological assets can occur as a result of any activity that disturbs the sea floor or cuts through seabed or intertidal deposits. Archaeological receptors with degrees of elevation, such as wrecks, may also be impacted by development or activities that occur within the water column.

16.7.2.2 Where a direct impact occurs this will potentially lead to the contamination, loss of, or damage to the marine archaeology asset affected.

16.7.2.3 Based on the worst case scenario design parameters listed in Table 16.6.1, the main activities occurring during construction of the Development that could potentially have a direct impact on marine archaeology assets found within, or on, the seabed including seabed prehistory and seabed features including maritime sites and intertidal heritage assets include seabed preparation prior to installation of gravity base substructures for up to 62 WTGs and two OSPs and installation of subsea inter-array, OSP interconnector and export cables and any associated cable protection. The total disturbance footprint equates to 7.511 km^2.

Magnitude of Impact

16.7.2.4 Physical impacts on recorded and potential marine archaeology assets in the Development ASA due to the worst-case scenario construction activities listed in Table 16.6.1 and summarised above are considered to be of **high** magnitude due to the potential for permanent loss of, or damage to, these assets.

Sensitivity of Receptor – Seabed Prehistory

16.7.2.5 There are no known seabed prehistory sites within the Development ASA. However, the palaeogeographic assessment of the geophysical data has demonstrated the potential for the presence of as yet undiscovered *in situ* prehistoric sites and finds. The values assigned to these potential heritage assets are outlined in Table 16.7.1.

Table 16.7.1 Value of Seabed Prehistory Heritage Assets

Asset Type	Definition	Value
Potential *in situ* prehistoric sites	Primary context features and associated artefacts and their physical setting (if found).	High
	Known submerged prehistoric sites and landscape features with the demonstrable potential to include artefactual material.	High
Potential submerged landscape features	Other known submerged palaeolandscape features and deposits likely to date to periods of prehistoric archaeological interest with the potential to contain *in situ* material.	High
Potential derived prehistoric finds	Isolated discoveries of prehistoric archaeological material discovered within secondary contexts (i.e. material moved from its original depositional environment, by erosion or other process, that reduces the understanding of the material).	Medium
Potential palaeoenvironmental evidence	Isolated examples of palaeoenvironmental material	Low
	Palaeoenvironmental material associated with specific palaeolandscape features or archaeological material	High

16.7.2.6 On the basis of age and the rarity of Palaeolithic and Mesolithic finds underwater, if any sites or material was discovered, it would likely be of **high**, probably national archaeological importance. A guidance note published by English Heritage (now Historic England) *Identifying and Protecting Palaeolithic Remains: archaeological guidance for planning authorities and developers* (1998) indicated that sites containing Palaeolithic features are so rare in Britain that they should be regarded as of national importance and wherever possible should remain undisturbed.

16.7.2.7 In the event that prehistoric archaeological material discovered offshore is found *in situ* it should be considered of particularly high archaeological importance. As such, the features and deposits that have the potential to contain within them *in situ* material should be considered as **high** value assets.

16.7.2.8 Prehistoric archaeological material discovered within secondary contexts also has the potential to provide valuable information on patterns of human land use and demography in a field of study that is still little understood and rapidly evolving (Hosfield *et al*., 2007). They are, however, by their very nature derived and, as such, isolated prehistoric finds should be regarded as **medium** value assets.

16.7.2.9 Palaeoenvironmental evidence in the context of an *in situ* prehistoric site (if found) will be of **high** value. More widely, palaeolandsurfaces and palaeolandscape features will be considered of **high** value for the purpose of this assessment owing to the Quaternary scientific potential of such sedimentary sequences, to contextualise the wider early prehistoric palaeogeography and the potential of palaeolandscape features to preserve in situ artefacts and sites (Bicket and Tizzard 2014). Palaeoenvironmental evidence from isolated contexts will be regarded as **low** value.

Sensitivity of Receptor – Seabed Features including Maritime and Aviation Sites and Intertidal Heritage Assets

Maritime sites

16.7.2.10 The perceived value assigned to an individual wreck site is, to a large degree, site specific. A vessel may be considered of special interest on the basis of any number of interrelating integral and relative factors, as discussed in Technical Appendix 16.1. Those regarded as being of special interest may further be designated under the Marine (Scotland) Act 2010 or the Protection of Military Remains Act 1986. Only features located within the Development ASA are discussed in this section.

16.7.2.11 There are no wrecks with statutory designations located within the Development ASA.

16.7.2.12 There are 39 known and charted sites or obstructions, and the potential for further wrecks or maritime-related debris to exist within the Development ASA. The values assigned to these heritage assets are outlined in Table 16.7.2 below.

Table 16.7.2 Value of Maritime Heritage Assets			
Asset Type	**Definition**		**Value**
Known assets	Wrecks (A1); identified in geophysical survey		High
	Named wrecks (A3); not identified in geophysical survey	*U77* (**7229**); *Moray Firth* (Probably) (**7230**); *Mayflower* (**7231**); *Artemis* (**7232**); *Sunbeam* (possibly) (**7228**)	High
	Un-named wrecks (A3); not identified in geophysical survey	**7234; 7237**	High

Table 16.7.2 Value of Maritime Heritage Assets

Asset Type	Definition		Value
	Obstructions (A3); not identified in geophysical survey	**7233; 7235; 7236; 7238**	Medium
Additional anomalies	Anomalies identified by geophysical assessment that could be of anthropogenic origin totalling 28 (A2), within the Moray West Site.		High
Potential wrecks	Wrecks within the study area that are yet to be discovered.		High
Potential derived maritime finds	Isolated artefacts lost from a boat or ship or moved from a wreck site.		Medium

Aviation sites

16.7.2.13 There is a total of 34 known aircraft crash sites in the Development ASA. There is also the possibility for any of the 28 geophysical anomalies found in the Moray West Site ASA that are of uncertain origin but with possible archaeological interest (category A2 – see Technical Appendix 16.1 for further detail) could relate to aircraft material. Therefore, there is the potential for aircraft or aircraft-related debris to exist on the seafloor of the Development ASA and it is still possible to comment on the value of such discoveries.

16.7.2.14 The values assigned to these known and potential aviation heritage assets are outlined in Table 16.7.3.

Table 16.7.3 Value of Aviation Heritage Assets

Asset Type	Definition	Value
Known assets (A3)	Named aircrafts; not identified in geophysical survey (Total 33)	High
	Unknown aircrafts; not identified in geophysical survey (**NMRS_321470**)	High
Additional anomalies	Anomalies identified by geophysical assessment that could be of anthropogenic origin totalling 28 (A2).	High
Potential aircraft	Aircraft within the study area that are yet to be discovered.	High
Potential derived aviation finds	Isolated artefacts lost from an aircraft or moved from a crash site.	Medium

Intertidal heritage assets

16.7.2.15 The Landfall Area considered covers a stretch of the Aberdeenshire Coast that runs between Findlater Castle and Redhythe Point. Information from the desk based assessment indicates that the inter-tidal zone within the Landfall Area was likely to have been exploited for subsistence, as well as potentially containing the remains of vessels, boats and other watercraft (Technical Appendix 16.1).

16.7.2.16 A number of recorded losses have been identified either within, or on the edge of the intertidal zone within the Landfall Area. These are listed in Annex IV of Marine Archaeological Technical Report (Volume 4 - Technical Appendix 16.1). There is also potential for wreck material from other unknown losses to be present.

Effect Significance

16.7.2.17 Currently, there is uncertainty in the distribution of known and potential marine archaeology assets across the entire Development ASA, linked to the partial coverage of marine geophysical dataset. Potential wrecks and seabed prehistory in the Development ASA are considered to be **high** sensitivity receptors requiring a precautionary approach. It is therefore considered that direct physical impacts of **high** magnitude on these potential receptors may result in effects of **major adverse significance**, in the absence of mitigation.

16.7.2.18 With the implementation of the embedded mitigation measures set out in Section 16.6.2 the physical impacts to the potential receptors will be reduced to **negligible** magnitude. This would result in effects of **minor adverse significance** and therefore not significant in EIA terms.

16.7.3 Potential Operational Effects

De-stabilisation of Sites Through Changed Hydrographic and Sedimentary Regimes

16.7.3.1 Indirect physical impacts on marine archaeology assets may occur where changes to normal tide, current and sedimentation patterns lead to physical effects on receptors. These may lead to adverse effects on the asset where protective cover is removed or positive effects where protection is increased.

16.7.3.2 Based on the worst case scenario design parameters listed in Table 16.6.1, the main aspects of the Development that could potentially lead to indirect impacts on marine archaeology assets found within, or on, the seabed include:

- Changes in hydrodynamics and sediment regime across the Moray West Site due to the presence of GBS foundations, scour protection and inter-array and OSP interconnector cable protection (maximum footprint on seabed = 545,516 m^2); and
- Scouring around cable protection on the export cable circuits (maximum area of seabed covered by cable protection = 85,200 m^2).

Magnitude of Impact

16.7.3.3 Based on information presented in Chapter 6: Physical Processes and Water Quality, changes in hydrodynamic and sedimentary regimes within the Moray West Site and along the export cable corridor, which may cause increased erosion/protection of marine archaeology assets, are predicted to be limited to the mobilisation of fine sand-sized sediments, resulting in a **negligible** magnitude of impact.

Sensitivity of Receptor – All Marine Archaeology Assets

16.7.3.4 As discussed in section 16.7.2, all physical impacts on archaeological assets (direct or indirect) are permanent and recovery is limited to stabilization or re-burial, limiting further impact. As such, the recoverability of any known and potential marine archaeology assets from erosion due to changes in hydrodynamics and sediment regimes should be regarded as negligible.

16.7.3.5 Since the existence and identity of potential marine archaeology assets is unknown, a precautionary approach to assessing impacts to these potential receptors is required. As identified in Tables 16.7.1 to 16.7.3 seabed prehistory, maritime assets and aviation assets in the Development ASA are considered to be of **high** sensitivity.

Significance of Effect

16.7.3.6 Acknowledging the uncertainty in the potential presence of known and unknown marine archaeology assets across the Development ASA, the sensitive of these assets to indirect effects associated with changes in the hydrodynamics and sediment regime is still considered to be **high.** However, as discussed above, the magnitude of any potential impact is considered to be **negligible.**

16.7.3.7 The potential significance of the effect on marine archaeology assets is therefore **minor** and therefore not significant in EIA terms.

16.7.3.8 With the implementation of the embedded mitigation measures set out in Section 16.6.2 the significance of any indirect effects on marine archaeology assets will be reduced further.

Effects on Setting of Onshore Cultural Heritage Assets

16.7.3.9 As identified in section 16.5.2 there is potential for the presence of WTGs to lead to changes in the setting of onshore cultural heritage assets which may affect the cultural heritage significance of individual assets. The assessment of effects on the setting of cultural heritage assets has been carried out in line with HSE guidance and considers both visual factors and the contributions of the surroundings to the experience, understanding and appreciation of a cultural heritage asset.

Dunbeath Inver Fort

16.7.3.10 The setting of the Second World War look-out post at the site of Dunbeath Inver Fort is largely based on its view out to sea, as it is set on a coastal promontory and functioned as an observation point. The offshore wind farm will be visible on a clear day from the look-out post, which is approximately 24 km from the nearest turbine, as thin vertical features on, but not extending substantially above the horizon (Volume 3a - Figure 16.7.1a). The overall understanding and appreciation of the look-out post will not be affected as it will remain clear that it was placed there to protect the coastline from invasion and to look out for attacking forces. The sensitivity of the receptor is judged to be **high**, related to its designated status. It is considered that the magnitude of effect on the setting of the look-out post will be **low**, with it retaining much of the significance of a defensive position on the shore. It is judged that the significance of the effect, based on the implementation of embedded mitigation such as SLVIA Design Principles as outline in Volume 2 - Chapter 14: Seascape, Landscape and Visual Assessment, will be **minor** which is not significant in EIA terms.

Latheronwheel Promontory Fort

16.7.3.11 Latheronwheel promontory fort lies approximately 24 km to the northwest of the Moray West Site, located on a sea stack along the coastline of Caithness, with commanding views out into the Moray Firth. The setting of this monument is not directly related to a maritime one, but inclines towards prehistoric defensive systems and territorial control. The overall understanding and appreciation of the fort will not be affected as it will remain clear that it was placed there as a defensive structure. The sensitivity of the receptor is judged to be **high**, related to its designated status.

16.7.3.12 The turbines will be visible on a clear day as small thin vertical features on the horizon (Volume 3a - Figure 16.7.1b). It is considered that the magnitude of effect on the setting of the fort will be **low**, with it retaining much of the significance of a defensive position on the coast. Based on the implementation of embedded mitigation such as SLVIA Design Principles as outline in Volume 2 - Chapter 14: Seascape, Landscape and Visual Assessment, it is concluded that the significance of the effect will be **minor**, which is not significant in EIA terms.

The Tulloch

16.7.3.13 The Tulloch Iron Age broch lies approximately 27 km northwest of the Moray West Site sitting on elevated ground, allowing for open views across the sea. The stark openness of the environment and the wide, open views across the sea form the important part of the setting of this receptor. Although this is not a particularly fully-preserved example, the overall understanding and appreciation of the broch, that remains in its original position, will not be affected. The sensitivity of the receptor is judged to be **high**, related to its designated status.

16.7.3.14 The turbines will only be visible on a clear day as very small features on the horizon (Volume 3a - Figure 16.7.2a). The turbines will take up a very small proportion of the vertical field of view and so the magnitude of the effect on the setting is judged to be **low**. Based on the implementation of embedded mitigation such as SLVIA Design Principles as outline in Volume 2 - Chapter 14: Seascape, Landscape and Visual Assessment, it is concluded that the significance of the effect will be **minor**, which is not significant in EIA terms.

Dunbeath Castle

16.7.3.15 The Moray West Site lies approximately 24 km southeast of Dunbeath Castle. The receptor has a commanding position on the cliffs overlooking the sea, as well as inland overlooking the garden and designed landscape. The sensitivity of the receptor is judged to be **high**, related to its value as a designated cultural heritage asset.

16.7.3.16 The Moray Offshore Wind Farm will be visible on a clear day as small thin vertical features on the horizon (Volume 3a - Figure 16.7.2b). The important views from the castle, along the coast and out to sea, along with the appreciation of the castle from the garden itself (facing away from the turbines) will not be compromised by the turbines on the horizon. It is considered the effect upon setting will be of **low** magnitude. Based on the implementation of embedded mitigation such as SLVIA Design Principles as outline in Volume 2 - Chapter 14: Seascape, Landscape and Visual Assessment, it is concluded that the significance of the effect will be **minor**, which is not significant in EIA terms.

Dunrobin Castle

16.7.3.17 Dunrobin Castle lies approximately 43 km west-southwest of the Moray West Site, with views overlooking the designated garden and designed landscape, and across the Moray Firth. The sensitivity of the receptor is judged to be **high**, related to its value as a designated cultural heritage asset.

16.7.3.18 The turbines will be visible on a clear day as very small thin vertical features on the horizon (Volume 3a - Figure 16.7.3a), with roughly half of the Moray West Offshore Wind Farm visible extending out from behind the coastline as it turns north towards Brora. The turbines will take up a very small vertical proportion of the field of view. The important views from the castle (along the coast and out to sea) are not compromised by the distant turbines, nor is the appreciation of the castle from the garden itself. The magnitude of the effect on the receptor is therefore judged to be **negligible**. Based on the implementation of embedded mitigation such as SLVIA Design Principles as outline in Volume 2 - Chapter 14: Seascape, Landscape and Visual Assessment, it is concluded that the significance of the effect will be **negligible to minor**, which is not significant in EIA terms.

Coversea Skerries Lighthouse

16.7.3.19 Covesea Skerries Lighthouse lies approximately 32 km south-southwest of the Moray West Site, commanding views out to sea. The lighthouse was decommissioned in 2012, nevertheless the views can still be appreciated, from the ground. The sensitivity of the receptor is judged to be **high**, related to its value as a designated cultural heritage asset.

16.7.3.20 From the Moray coastline, the turbines will be visible on a clear day as very small thin vertical features on the horizon (Volume 3a - Figure 16.7.3b). The magnitude of the effect on the receptor is therefore judged to be **negligible**. Based on the implementation of embedded mitigation such as SLVIA Design Principles as outline in Volume 2 - Chapter 14: Seascape, Landscape and Visual Assessment, it is concluded that the significance of the effect will be **negligible to minor**, which is not significant in EIA terms.

16.7.4 Potential Decommissioning Effects

16.7.4.1 Assuming the footprint of decommissioning is the same as the construction phase, the potential physical effects of decommissioning will have already occurred and mitigated against in the construction phase, leading to a situation of limited and/or no further physical impacts, as these will have either been avoided during the siting of foundations, OSPs and export cable(s) or where avoidance was not possible will have been investigated and recorded prior to construction.

16.7.4.2 Effects resulting from decommissioning activities on the setting of archaeology and cultural heritage receptors would be expected to be none or positive as with the construction phase. The approach to decommissioning is described in the Decommissioning Programme (Volume 4 - Technical Appendix 4.2).

16.7.5 Summary of Development Specific Effects

16.7.5.1 Table 16.7.7 below summarises the results of the assessment of the Development.

Table 16.7.4: Summary Development Specific Effects						
Impact	**Receptor**	**Impact Magnitude**	**Receptor Sensitivity**	**Effect Significance**	**Mitigation (in addition to embedded measures)**	**Residual Significance**
Construction (and Decommissioning)						
Contamination, damage to, or loss of, marine archaeology assets resulting from direct physical impacts	Seabed prehistory and seabed features including maritime and aviation sites and intertidal heritage assets	**High** (without embedded mitigation) **Negligible** (with embedded mitigation)	High	Minor or Positive (where unknown remains are identified and recorded)	N/A	N/A
Operation and Maintenance						
Destabilisation of marine archaeology assets through changed hydrography and sedimentary regimes	Seabed prehistory and seabed features including maritime and aviation sites and intertidal heritage assets	Negligible	High	Minor	N/A	N/A
Indirect effect due to changes to the setting of designated cultural heritage assets	Dunbeath Inver Forth	Low	High	Minor	N/A	N/A
	Latheronwheel promontory fort	Low	High	Minor	N/A	N/A
	The Tulloch (Usshilly) Broch and field system	Low	High	Minor	N/A	N/A
	Dunbeath Castle & Designed Landscape	Low	High	Minor	N/A	N/A
	Dunrobin Castle & Designed Landscape	Negligible	High	Minor	N/A	N/A
	Covesea Skerries Lighthouse	Negligible	High	Minor	N/A	N/A

16.8 Assessment of Cumulative Effects

16.8.1.1 Cumulative effects refer to effects upon receptors arising from the Development when considered alongside other proposed developments and activities and any other reasonably foreseeable project(s) proposals. In this context, the term 'projects' is considered to refer to any project with comparable effects and is not limited to offshore wind projects. The assessment focuses on the scope of this EIA, i.e. potential direct and indirect impacts on marine archaeology assets during construction, operational and maintenance and decommissioning phases of the Development and potential effects on the setting of onshore cultural heritage assets during the operation and maintenance phase of the Development.

16.8.1.2 Given the highly localised nature of direct impacts on marine archaeology assets, the extent of the offshore area considered for the assessment of cumulative effects has been defined as the Moray Firth. With respect to effects on the setting of onshore cultural heritage assets, other onshore wind farm projects have been taken into account where necessary based on information on cumulative effects from Volume 2 - Chapter 14: Seascape, Landscape and Visual Assessment (SLVIA).

16.8.1.3 BOWL (Beatrice Offshore Wind Farm) and Beatrice Wind Farm Demonstrator Project are both considered As Built for this assessment. With respect to the Moray East Offshore Wind Farm in absence of an approved Design Layout and Specification Plan (DLSP) at the time of application, it has been necessary to consider both the worst-case design parameters for the consented project (based on the EIAs for the Telford, Stevenson and MacColl Offshore Wind Farms) and a most likely design envelope based revised design parameters for the project following the award of a Contract for Difference (CfD) in September 2017.

16.8.1.4 Projects and activities considered within the cumulative impact assessment are set out in Table 16.8.1.

Table 16.8.1: Projects for Cumulative Assessment

Development Type	Project	Status	Data Confidence Assessment / Phase
Offshore Wind Farm	Moray East (Telford, Stevenson and MacColl Offshore Wind Farms)	Consented	High - Consented project details available
Offshore Wind Farm	Beatrice Offshore Wind Farm	Under Construction	High - Consented project details available
Offshore Wind Farm	Beatrice Wind Farm Demonstrator Project	Operational	High - Consented project details available
Cable	Caithness to Moray Interconnector	Under Construction	High - Consented project details available
Cable	SHEFA-2 Telecom Cable	Operational	Low – No project details available

16.8.2 Cumulative Construction Effects

16.8.2.1 Given that potential direct effects on marine archaeology assets during construction are extremely localised (asset specific) and generally permanent in nature, when determining which projects require assessment as part of the cumulative assessment, the focus is on the spatial extent of those projects, rather than temporal extents. Therefore, even if a construction period does not overlap (e.g. construction activities are not concurrent) there still remains the potential for a cumulative effect to occur as a result of construction activities where there is an overlap in the spatial extent of those projects (e.g. there is potential for the same marine archaeology assets to be affected by both project).

16.8.2.2 With respect to the projects listed in Table 16.8.1 above the only projects where there are spatial overlaps are:

- BOWL offshore wind farm (export cable route passes through the middle of the Moray West Site); and
- Caithness Moray HVDC Cable which crosses the Moray West Export Cable Corridor.

16.8.2.3 Potential cumulative effects of these two projects on marine archaeology assets are assessed below.

Cumulative Effects of Construction Activities Associated with the Development and BOWL Offshore Wind Farm Export Cable on Marine Archaeology Assets

16.8.2.4 The spatial extent of all potential cumulative physical effects to known cultural heritage receptors are localised and fall within the Development ASA. The only foreseen spatial overlap with the direct physical impacts of the BOWL offshore wind farm within the Moray West Site on known cultural heritage receptors are the crossing points of the Moray West inter-array cables with the BOWL export cable. There will be no spatial overlap between the BOWL export cable and Moray West turbines as an easement will be in place along the BOWL export cable route.

16.8.2.5 On the basis that there will be a requirement for BOWL to implement appropriate mitigation during installation of the export cables (similar to that described in Section 16.6.2 for this Development), potential for any cumulative effects on marine archaeological assets along the section of export cable that runs through the Moray West Site will be **negligible** and not significant in EIA terms.

Cumulative Effects of Construction Activities Associated with the Development and Caithness Moray HVDC Cable on Marine Archaeology Assets

16.8.2.6 The cumulative effects of the Development and the cables are unknown as no baseline heritage data is available for the considered cable projects. The Moray West export cable is required to cross Caithness to Moray Interconnector Cable and so could in principle create physical impacts to some marine archaeology assets at the point at which the cables cross.

16.8.2.7 The Caithness to Moray Interconnector project has an established a Protocol for Archaeological Discoveries which, if followed, will provide a mechanism to mitigate effects to unexpected discoveries, i.e. unknown cultural heritage receptors. In addition, the embedded mitigation confirmed for the Development would be capable of identifying cultural heritage assets within this overlapping footprint, through measures such as archaeological review of geophysical and geotechnical datasets, and offer effective mitigation for potentially arising physical effects – leading to effects being **not significant**, where adverse physical effects could be avoided during installation of the Moray West export cable circuits.

16.8.3 Cumulative Operational Effects

Cumulative Effects on Marine Archaeology Assets Due to Changes in Hydrodynamic and Sediment Regimes

16.8.3.1 There is potential that cumulative changes in hydrodynamics and sediment regimes resulting from the presence of seabed structures and cable protection across all three offshore wind farm sites (BOWL, Moray East and Moray West) could have cumulative effects on marine archaeology assets within these sites through erosion or increased protection from sedimentation. However, as concluded in Volume 2 - Chapter 6: Physical Processes and Water Quality, cumulative effects on hydrodynamic regimes and sedimentation across the three sites are considered to be negligible. Any resulting cumulative effects on marine archaeology assets will therefore also be of **negligible** magnitude and of **minor** significance.

Cumulative Effects on the Setting of Onshore Cultural Heritage Assets

16.8.3.2 There is the potential for a cumulative impact on the setting of designated onshore receptors from the Moray West Offshore Wind Farm in conjunction with the Moray East Offshore Wind Farm and BOWL (considered As Built for this assessment – see CIA wirelines Figures 16.7.1 – 16.7.3 (Volume 3a)), focussed on the assets on the coast of Caithness. The wireframe models for the closest assets (Dunbeath Inver Fort (Volume 3a - Figure 16.7.1a), Latheronwheel promontory Fort (Volume 3a - Figure 16.7.1b), The Tulloch (Volume 3a - Figure 16.7.2a) and Dunbeath Castle (Volume 3a - Figure 16.7.2b)) all present Moray West Offshore Wind Farm in conjunction with Moray East Offshore Wind Farm and BOWL, allowing a cumulative assessment of the impacts on these four nearest assets. The wire models illustrate the Model 4 turbines of the Moray West Site to be slightly larger if not approximating to the same visual height as the more distant Moray East and Beatrice turbines.

16.8.3.3 The overall cumulative effect is to increase the density of turbines on the skyline from these assets, although the turbines remain minor in proportion of the vertical field of view, based on conclusions from the SLVIA (Volume 2 - Chapter 14) there is potential for a significant increase in the horizontal field of view, in particular when the three wind farms are viewed from the Caithness Coast. As noted above the effects upon setting of the individual monuments have been judged **minor**. Implementation of SLVIA Design Principles as outlined in Volume 2 - Chapter 14, will seek to reduce, where possible, potential cumulative effects of the three wind farms from an SLVIA perspective.

16.8.3.4 Based on conclusions from the SLVIA, there is potential for cumulative effects on the setting of onshore cultural heritage assets from these three wind farms.

16.8.3.5 The CIA suggests that this cumulative effect on the setting of the identified receptors will be **minor**.

16.8.4 Cumulative Decommissioning Effects

16.8.4.1 There are no cumulative impacts on the archaeology and cultural heritage receptors foreseen during decommissioning.

16.9 References

Bicket, A., Firth, A., Tizzard, L. and Benjamin, J. (2014). 'Heritage management and submerged prehistory in the United Kingdom', in Evans, A., Flatman, J. and Flemming, N. (eds.) *Prehistoric Archaeology on the Continental Shelf: A Global Review*, New York: Springer, pp. 213-232.

CIfA (2014) (updated 2017). *Standard and Guidance for Archaeological Desk-Based Assessment.* Available

at: http://www.archaeologists.net/sites/default/files/CIfAS%26GDBA_3.pdf

COWRIE (2011). Offshore Geotechnical Investigations and Historic Environment Analysis: Guidance for the Renewable Energy Sector. Available at: https://www.thecrownestate.co.uk/media/5901/km-ex-pc-historic-012011-offshore-geotechnical-investigations-and-historic-environment-analysis-guidance-for-the-renewable-energy-sector.pdf

Department for Environment, Food and Rural Affairs (2009). *Our Seas – A Shared Resource, High Level Marine Objectives*. DEFRA.

English Heritage (now Historic England) (1998). *Identifying and Protecting Palaeolithic Remains: archaeological guidance for planning authorities and developers.* Available at: https://historicengland.org.uk/images-books/publications/identifying-protecting-palaeolithic-remains-archaeological-guidance-planning-authorities-developers/

English Heritage (now Historic England) (2002). *Military Aircraft Cash Sites: Archaeological guidance on their significance and future management*. English Heritage.

English Heritage (now Historic England) (2012). *Ships and Boats: Prehistory to Present: Designation Selection Guide.* English Heritage.

English Heritage (now Historic England) (2013). *Marine Geophysics Data Acquisition, Processing and Interpretation Guidance Notes.* English Heritage.

Historic England (2013). Historic Environment Guidance for Wave and Tidal Energy. Available at: https://content.historicengland.org.uk/images-books/publications/historic-environment-guidance-wave-tidal-energy/WaveTidal.pdf/

Historic Environment Scotland (2016a). Historic Environment Scotland Policy Statement. Available at: https://www.historicenvironment.scot/advice-and-support/planning-and-guidance/legislation-and-guidance/historic-environment-scotland-policy-statement/

Historic Environment Scotland (2016b). Managing Change in the Historic Environment: Setting. Available at: https://www.historicenvironment.scot/archives-and-research/publications/publication/?publicationId=80b7c0a0-584b-4625-b1fd-a60b009c2549

Hosfield, R., Straker, V. and Gardiner, P. (2007). 'Palaeolithic and Mesolithic', in Webster, C.J. (ed.) *The Archaeology of South West England: South West Archaeological Research Framework: Resource Assessment and Research Agenda*, Taunton: Somerset County Council, pp. 23-62.

Joint Nautical Archaeology Policy Committee (2008). JNAPC Code of Practice for Seabed Development. York, Joint Nautical Archaeology Policy Committee. Available at: http://www.jnapc.org.uk/jnapc_brochure_may_2006.pdf

Moray Offshore Renewables Ltd (2016). Western Development Area Offshore Wind Farm Infrastructure Scoping Report: May 2016.

MS-LOT (2016). Moray Offshore Renewables Limited Western Development Area Scoping Opinion: August 2016.

Moray Offshore Wind Farm (West) Limited (2017). Moray West Offshore Transmission Infrastructure Scoping Report: May 2017.

MS-LOT (2017). Scoping Opinion for the Proposed Marine Licence Application for Moray West Offshore Transmission Infrastructure: August 2017.

Oxford Archaeology (2008). Guidance for Assessment of Cumulative Impact on the Historic Environment from Offshore Renewable Energy. Commissioned by COWRIE Ltd (Project reference CIARCH-11-2008).

The Crown Estate (2010). Model Clauses for Archaeological Written Schemes of Investigation: Offshore Renewables Projects. Published guidance by Wessex Archaeology Ref 73830.

The Crown Estate (2014). Protocol for Archaeological Discoveries: Offshore Renewables Projects. Available at: https://www.thecrownestate.co.uk/media/148964/ei-protocol-for-archaeological-discoveries-offshore-renewables-projects.pdf

The Scottish Government (2011). Planning Advice Note 2/2011: Planning and Archaeology. Scottish Government, 2010. Scottish Planning Policy, Crown copyright 2010.

The Scottish Government (2014). Scottish Planning Policy.

The Scottish Government (2015. National Marine Plan. Available at: http://www.gov.scot/Topics/marine/seamanagement/national

Wessex Archaeology (2007). *Historic Environment Guidance for the Offshore Renewable Energy Sector*. Commissioned by COWRIE (project reference: ARCH-11-05).

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Chapter 17 Other Human Activities

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Acronyms	
Acronym	**Expanded Term**
AfL	Agreement for Lease
AIS	Automatic Identification System
ALARP	As Low as Reasonably Possible
BOWL	Beatrice Offshore Wind Limited
CBRA	Cable Burial Risk Assessment
CCS	Carbon Capture and Storage
CfD	Contract for Difference
CIA	Cumulative Impact Assessment
DECC	Department of Energy and Climate Change
DSLP	Development Specification and Layout Plan
EDA	Eastern Development Area
EIA	Environmental Impact Assessment
EMEC	European Marine Energy Centre
FEED	Front End Engineering Design
HVDC	High Voltage Direct Current
IEMA	Institute of Environmental Management and Assessment
km	kilometre
LAT	Lowest Astronomical Tide
LW	Low water
MFOWDG	Moray Firth Offshore Wind Development Group
MHWS	Mean High Water Springs
MoD	Ministry of Defence
MORL	Moray Offshore Renewables Limited
MS-LOT	Marine Scotland Licensing Operations Team
MW	Megawatt
nm	Nautical miles
NMPi	National Marine Plan interactive
NRA	Navigational Risk Assessment
OESEA3	Offshore Energy Strategic Environmental Assessment 3
OfTI	Offshore Transmission Infrastructure
OFTO	Offshore Transmission Owner
OfTW	Offshore Transmission Works
OGA	Oil and Gas Authority
OSP	Offshore Substation Platform
PEXA	Practice and Exercise Area

Acronyms	
Acronym	**Expanded Term**
RAF	Royal Air Force
RYA	Royal Yachting Association
SCCS	Scottish Carbon Capture and Storage
SEA	Strategic Environmental Assessment
SGB	Scottish Governing Body
SHEFA	SHEtland-FAroes
SHE-T	Scottish Hydro Electric Transmission
SSE	Scottish and Southern Energy
SSEN	Scottish and Southern Energy Networks
TCE	The Crown Estate
UXO	Unexploded Ordnance
VHF	Very High Frequency
WDA	Western Development Area
WTG	Wind Turbine Generator

17 Other Human Activities

17.1 Introduction

17.1.1.1 This chapter presents an assessment of the likely significant effects of the construction, operation and maintenance and decommissioning of the Moray West Offshore Wind Farm and associated OfTI ("the Development") on other human activities (with marine components) in the Moray Firth.

17.1.1.2 The specific objectives of this chapter are to:

- Identify the legislation, policy and guidance framework relevant to other human activities;
- Detail the consultation relevant to other human activities that has informed this assessment;
- Describe the other human activities baseline;
- Describe the assessment methodology and significance criteria used in completing the impact assessment;
- Describe the potential effects, including direct, indirect and cumulative effects;
- Describe the mitigation measures proposed to address likely significant effects; and
- Assess the residual effects remaining following the implementation of mitigation.

17.1.1.3 The assessment has been carried out by GoBe Consultants Ltd. GoBe Consultants have extensive experience undertaking EIA with specific reference to offshore wind schemes and are a member of the Institute for Environmental Management and Assessment (IEMA).

17.1.1.4 This chapter is supported by:

- Volume 4 - Technical Appendix 17.1: Pager Power (2009). Moray Firth High Level Screening Assessment; and
- Volume 4 - Technical Appendix 17.2: 6 Alpha Associates (2011). Unexploded Ordnance (UXO) Risk Assessment.

17.1.1.5 This chapter does not consider potential impacts on aviation users (see Volume 2, Chapter 13 – Military and Civil Aviation), commercial fisheries and other commercial shipping activity (see Volume 2, Chapters 11 and 12 – Commercial Fisheries and Shipping and Navigation), or marine recreational users (see Volume 2, Chapter 15 – Socio-economics, Tourism and Recreation).

17.2 Legislation, Policy and Guidance Framework

17.2.1 Relevant Policy

17.2.1.1 The National Marine Plan (Scottish Government, 2015) emphasises that development proposals which enable multiple uses of marine space are encouraged (Planning Policy Principle GEN 4) and it also provides sector-specific marine planning policies which variously support the economic growth of sectors, and aim to manage conflicts between marine users and manage environmental impacts. Sectors included in the Plan and relevant to this assessment include:

- Oil and Gas (Chapter 9 of the Plan);
- Carbon Capture and Storage (Chapter 10 of the Plan);
- Offshore Wind and Marine Renewable Technology (Chapter 11 of the Plan);
- Submarine Cables (Chapter 14 of the Plan); and
- Defence (Chapter 15 of the Plan).

17.2.1.2 The Scottish Government has developed plans for the development of offshore wind farms in Scottish waters. The draft plans identify areas of search for future offshore wind farm development, and one area of search had been identified to the east of the Moray Firth (OWNE2). The draft plans identify that the significant issues in this region, as relevant to this topic assessment, are 'defence activities' (Scottish Government, 2013).

17.2.1.3 Other relevant issues identified within the draft plans are:

- Shipping and navigation, which is addressed in Chapter 12: Shipping and Navigation;
- Fishing, which is addressed in Chapter 11: Commercial Fisheries;
- Aviation & Radar activities, which is addressed in Chapter 13: Military and Civil Aviation.

17.2.2 Relevant Guidance

17.2.2.1 The assessment of impacts on other human activities has been informed by guidance presented in the Draft Marine Renewables Licensing Manual (Marine Scotland, 2012a). The Draft Manual states that EIA should take account of the following "other sea users", as relevant to this chapter:

- Oil and gas;
- Subsea pipelines;
- Dredging and marine aggregate extraction;
- Military activity; and
- Munitions.

17.3 Consultation

17.3.1.1 Moray West has framed its assessment of potential effects on other human activities through consultation with key stakeholders.

17.3.1.2 Table 17.3.1 summarises the key issues raised in relation to other human activities in the Moray West Offshore Wind Farm Scoping Opinion (August 2016) and the OfTI Scoping Opinion (August 2017) and other issues / concerns that have been raised during additional consultation activities undertaken during the preparation of the EIA Report. This table also indicates how issues raised have been addressed or taken into consideration on the preparation of this EIA Report.

Table 17.3.1: Summary of Consultation Relating to Other Human Activities

Consultee and Date	Issue Raised	Moray West Approach
Marine Scotland Licencing Operations Team (MSLOT) on behalf of Scottish Ministers (Moray West OfTI Scoping Opinion 30/08/17)	The Scottish Ministers note that the nearest marine disposal site at Buckie requires further consideration. If disposal activities there coincide with construction nearby, there is a potential cumulative impact that will require careful consideration.	Potential impacts on marine disposal sites and activities are considered in 17.8: Assessment of Potential Effects of this chapter.
	Moray West is directed to the consultation response from Beatrice Offshore Windfarm Limited (BOWL) in which it is noted that the Moray West offshore export cable corridor intersects BOWL's 'Designated Area'. The response notes a requirement to acknowledge this area as a potential constraint on the development plans along with early	Potential interactions with BOWL and their assets are considered in 17.8: Assessment of Potential Effects of this chapter. Moray West acknowledge the need for ongoing liaison with BOWL through all stages of development, and will seek to develop formal

Table 17.3.1: Summary of Consultation Relating to Other Human Activities		
Consultee and Date	**Issue Raised**	**Moray West Approach**
	engagement on proximity and crossing agreements.	proximity and crossing agreements as required.
Beatrice Offshore Renewables Ltd (Response within Moray West OfTI Scoping Opinion 30/08/17)	BOWL advise that their approved Consent Plans be used to inform CIA and that BOWL be treated as new baseline in CIA.	The approach to CIA is summarised in Volume 2, Chapter 5 (EIA Methodology) and applied in 17.9: Assessment of Cumulative Effects., of this chapter. Moray West can confirm that BOWL 'as-built' parameters have informed the CIA, and been derived from their Consent Plans.
	The BOWL seabed lease allows for the installation of two export cables within the export cable route corridor (referred to in their lease as the 'Designated Area'). The Moray West offshore export cable corridor intersects with the BOWL Designated Area. The lease requires The Crown Estate to obtain BOWL's consent (which shall not be unreasonably withheld or delayed) before a lease, licence, or consent can be granted for the construction of any works within the Designated Area. BOWL request that Moray West acknowledged the BOWL Designated Area as a potential constraint on any plans submitted as part of a consent application.	Moray West understand the BOWL position and confirm that they will liaise with Crown Estate Scotland, BOWL and any other relevant parties in this regard, and take account of the Designated Area in development planning.
Joint Radio Company (JRC) Limited (Wind Farm Scoping Opinion 15/08/16)	JRC analyses proposals for wind farms on behalf of the UK Fuel & Power Industry. This is to assess their potential to interfere with radio systems operated by utility companies in support of their regulatory operational requirements. In the case of this proposed wind energy development, JRC does not foresee any potential problems based on known interference scenarios and the data you have provided. However, if any details of the wind farm change, particularly the disposition or scale of any turbine(s), it will be necessary to re-evaluate the proposal.	As the height of WTG has increased from an indicative height above Lowest Astronomical Tide (LAT) of 270m at the scoping stage, to the present maximum blade tip height above HAT of 285 (m). Moray West will contact JRC to re-evaluate the proposed development. Moray West intend to commence the re-evaluation post-consent, when WTG parameters will be further defined.

17.4 Baseline Conditions

17.4.1 Baseline Characterisation Approach

Study Area

17.4.1.1 The Study Area considered in this assessment of other human activities is the area of the Moray Firth (as shown on Volume 3a - Figure 17.4.1).

Desk Study / Field Survey

17.4.1.2 Given the proximity of the Moray East and Moray West Sites there is the potential for similar potential impacts to result from development in both portions of the Moray Firth Round 3 Zone. Other human activities in the Study Area have therefore been described based on a desk-based study of the available data, including review and update of information previously presented in the Moray East Environmental Statement (ES) (Moray East, 2012) and the Moray East Modified Transmission Infrastructure ES (Moray East, 2014).

17.4.1.3 Key data sources that have been used to inform this chapter are summarised in Table 17.4.1 below. In addition to the data sources listed, reference has also been made to relevant Strategic Environmental Assessment (SEA) outputs (e.g. DTI, 2004).

Table 17.4.1: Data Sources

Other Human Activity	Data Source(s)
Offshore wind	Blue Seas – Green Energy, A Sectoral Marine Plan for Offshore Wind Energy in Scottish Territorial Waters (Part A, The Plan) (Marine Scotland, 2011) The Crown Estate Scotland Wind Lease Sites shapefile (last updated June 2017) available on Marine Scotland NMPi (NMPi, 2017) Offshore Wind Energy in Scottish Waters - Regional Locational Guidance (Marine Scotland, 2012) Offshore Wind Initial Plan Framework (Draft Plan Options) (Marine Scotland, 2013) Potential Scottish Test Sites for Deep Water Floating Wind Technologies -Draft Regional Locational Guidance (Marine Scotland, 2014) The Crown Estate Scotland (https://www.thecrownestate.co.uk/energy-minerals-and-infrastructure/offshore-wind-energy/) [accessed November 2017] Marine Scotland Current Licensing http://www.gov.scot/Topics/marine/Licensing/marine/scoping [last accessed December 2017]
Wave and tidal	Crown Estate Scotland Tidal Lease Sites shapefile (last updated June 2017) available on Marine Scotland NMPi (NMPi, 2017) Crown Estate Scotland Wave Lease Sites (last updated June 2017) available on Marine Scotland NMPi (NMPi, 2017) Project/ operator websites Wave and Tidal Regional Locational Guidance (Marine Scotland, 2012b). Marine Scotland Current Licensing http://www.gov.scot/Topics/marine/Licensing/marine/scoping. [Accessed November 2017]. Wave and Tidal Initial Plan Framework (Draft Plan Options) (Marine Scotland, 2013a). Proposed project Scoping reports and Environmental Statements.
Carbon capture and storage	Carbon Capture and Storage – A Roadmap for Scotland (Scottish Government 2010); Scottish Carbon Capture and Storage (SCCS) website (SCCS, 2017). http://www.sccs.org.uk [accessed November 2017]; and "Carbon Capture and Storage Sites-Saline Aquifer" shapefile (last updated January 2009) produced by the British Geological Survey Natural Environment Research Council. Accessed on the Marine Scotland National Marine Plan Interactive (NMPi, 2017). [Last accessed November 2017].
Oil and gas activity	Oil and Gas Authority website. http://www.sccs.org.uk/ [accessed November 2017]. Oil and Gas Authority Offshore Interactive Map. https://www.ogauthority.co.uk/data-

Table 17.4.1: Data Sources	
Other Human Activity	**Data Source(s)**
	centre/interactive-maps-and-tools/ [accessed November 2017]. UK Oil and Gas Data website. https://www.ukoilandgasdata.com/dp/jsp/PleaseLogin.jsp (CDA, 2017) [accessed November 2017]. Open data obtained from CDA- Oil and Gas Data UK Operator websites and reports.
Marine dredging and disposal	Marine Scotland "Waste Disposal Sites Open" dataset (last updated February 2015) accessed on the Marine Scotland National Marine Plan Interactive (NMPi, 2017). Scotland's Marine Atlas, Information for the national Marine Plan, Chapter 5: Waste Disposal (Dredge Material) (Baxter et al, 2011).
Subsea cables and pipelines	Open data obtained from CDA- Oil and Gas Data UK. Open data obtained from the Crown Estate Scotland. Data obtained from Moray Offshore Windfarm (East) Ltd. SHEFA website (Faroese Telecom, 2017). http://www.shefa.fo/cable/ [accessed November 2017]. National Marine Plan Map 12 (2015) – "Main grid and submarine cables around Scotland and potential upgrades" available on Marine Scotland NMPi (NMPi, 2017). Telegeography's subsea cable online maps http://submarinecablemap.com. [Accessed November 2017]. Marine Scotland Current Licensing: http://www.gov.scot/Topics/marine/Licensing/marine/current-construction-projects [accessed May 2017].
Telecommunications	Pager Power (2009) RPS Moray Firth –High Level Screening Assessment.
Military training and practice areas	6 Alpha Associates (2011). Unexploded Ordnance Threat and Risk Assessment with Risk Mitigation. "Military exercise areas and danger areas (PEXAs)" shapefile (Last updated December 2014) produced by MoD and Oceanwise accessed on the Marine Scotland National Marine Plan interactive (NMPi 2017). [Last accessed November 2017]. National Marine Plan Map 13 (2015) – "Military Practice Areas around Scotland", available on Marine Scotland NMPi (NMPi, 2017).
Unexploded ordnance	6 Alpha Associates (2011). Unexploded Ordnance Threat and Risk Assessment with Risk Mitigation. "Military exercise areas and danger areas (PEXAs)" shapefile (Last updated December 2014) produced by MoD and Oceanwise accessed on the Marine Scotland National Marine Plan interactive (NMPi 2017). [Last accessed November 2017].

17.4.2 Current Baseline

Offshore Wind

Beatrice Wind Farm Demonstrator Project

17.4.2.1 The Beatrice Wind Farm Demonstrator Project is one of two operational offshore wind farms in Scottish waters and is located adjacent to the Beatrice oil field, immediately to the west of the Moray West Site (See Volume 3a - Figure 17.4.2). This small offshore wind farm was developed in 2007 in a joint venture between Scottish and Southern Energy (SSE) and Talisman Energy (now acquired by Respol Sinopec Resources UK) and comprises two 5 MW wind turbines. Each turbine has three rotor blades 126 m in diameter, with a hub height of 88 m above Lowest Astronomical Tide (LAT). All electricity generated by these two turbines is fed to a nearby oil platform.

17.4.2.2 It is understood that these turbines will be decommissioned at the same time as the Beatrice Oil Field infrastructure, with decommissioning work expected to begin in 2024 (Respol Sinopec Resources UK, 2017).

Beatrice Offshore Wind Farm

17.4.2.3 In 2014, a partnership of SSE Renewables and Repsol Nuevas Energias was granted consents to develop the Beatrice Offshore Wind Farm (BOWL) in Scottish Territorial Waters. The BOWL lease area lies adjacent to the extreme north-east corner boundary of the Moray West Site (see Volume 3a - Figure 17.4.2) approximately 13.5 km from the Caithness Coast in the Outer Moray Firth.

17.4.2.4 The Beatrice Offshore Wind Farm received consent under Section 36 of the Electricity Act 1989 from the Scottish Ministers on 19 March 2014 and was granted two Marine Licences from Scottish Ministers, one for the Offshore Wind Farm and one for the associated Offshore Transmission Works (OfTW) on 2nd September 2014.

17.4.2.5 Based on information presented in the Design Specification and Layout Plan (DSLP) (Revision 3, BOWL, November 2016), the Beatrice Offshore Wind Farm 'as built' will comprise 84 wind turbines and two offshore substation platforms, with associated inter-array, interconnector and export cabling. Export cables will connect the offshore substation platforms to a landfall at Portgordon.

17.4.2.6 The BOWL project will have a total installed capacity of 588 MW (BOWL, 2016). At the time of writing, the project is in construction and offshore installation works are expected to be complete by 2019.

17.4.2.7 Moray West and BOWL have agreed to maintain a separation distance between their respective development sites, based on a distance of five times the installed wind turbine rotor diameter from their mutual boundaries.

Potential Wind "Areas of Search"

17.4.2.8 Marine Scotland has published an Initial Plan Framework for Offshore Wind Energy in Scottish Waters (Marine Scotland, 2013a). The Framework details the draft Plan Options for future commercial scale offshore wind developments on a regional basis around the Scottish coastline. In the North East region, within which the Moray Firth is located, there are two draft Plan Option "Areas of Search" for offshore wind development, referred to as 'OWNE1' and 'OWNE2'. OWNE2 is located closest to the Development, lying to the south east, off the coast of Fraserburgh. The Plan areas are earmarked as medium to long term development options and there is unlikely to be any activity in these locations whilst the Development is under construction. As such, and as these are draft Plan Options rather than defined projects, the potential impacts of the Development on the draft Plan Option "Areas of Search" have not been considered further within this impact assessment.

Wave and Tidal Energy

17.4.2.9 The Crown Estate and Crown Estate Scotland are responsible for leasing areas of the UK seabed that are suitable for installing wave and tidal arrays, and for managing the associated seabed rights. The Crown Estate have so far granted leases for 30 UK tidal stream sites, 17 of which are in Scotland (now managed by Crown Estate Scotland), and nine of these are in the waters of the Pentland Firth and Orkney alone. No wave and tidal energy projects are currently planned within the Study Area.

Carbon Capture and Storage

17.4.2.10 The Scottish Government has a clear policy to decarbonise electricity generation by 2030 and it is intended that carbon capture and storage (CCS) will support this.

17.4.2.11 CCS is a technology that can capture 90% or more of the carbon dioxide (CO_2) emissions produced from the use of fossil fuels in electricity generation (The Scottish Government and Scottish Enterprise 2010). The captured CO_2 is then transported for permanent storage in depleted oil and gas fields or deep saline formations (The Scottish Government and Scottish Enterprise, 2010).

17.4.2.12 Potential offshore storage hubs for CO_2 in Scottish waters have been identified (Marine Scotland, 2013b), including a site within the Moray Firth, referred to as 'Mains' which overlaps the Moray West Site. Detailed modelling has also been completed on the Captain sandstone aquifer which lies directly east of the Development in the Moray Firth.

17.4.2.13 It is understood that there are no current plans to develop CCS projects in the Moray Firth and it is unlikely that any offshore storage opportunities in the Moray Firth will be further investigated prior to or during the installation of the Development. On this basis, potential interactions between the Development and CCS activity have not been considered within this impact assessment.

Military Practice and Exercise Areas

17.4.2.14 The Ministry of Defence uses Scotland's coasts and seas for training, as bases, for testing and evaluation activities, as well as surveillance and monitoring of potential threats.

17.4.2.15 Practice and Exercise Areas (PEXA) are used for various military practice activities by the Royal Navy, the Army, the Royal Air Force (RAF) and the Ministry of Defence (MoD).

17.4.2.16 The MoD have identified several PEXA's within the Study Area as "Danger Areas", these are:

- "Moray Firth D809 (South)" lies offshore, to the east of the Moray West Site;
- "Moray Firth D809 (North)" lies offshore, directly north of Moray Firth D809 (South);
- "Tain D703" lies to the west of the Development in the Dornoch Firth; and
- "Binhill X5702" which lies at the coastline just west of the Spey Bay.

17.4.2.17 These Danger Areas are illustrated in the figure of "Current Military Activity", within Appendix 04 of Volume 4 - Technical Appendix 17.2: UXO Risk Assessment. Please note that in March 2012, the area D807 ceased to exist.

17.4.2.18 The Moray Firth D809 (South), Moray Firth D809 (North), and Tain D703 Danger Areas are the largest of the PEXA Danger Areas listed above and are used by the RAF for a variety of flying and firing exercises. The offshore export cable corridor, although in close proximity to the Moray Firth D809 (South) Danger Area, does not intersect its boundary or that of any Danger Zone.

Oil and Gas

Oil Fields and Platforms

17.4.2.19 The Development is located within an area which supports oil exploration and production activity (see Volume 3a - Figure 17.4.3). Table 17.4.2 below provides details of the oil production platforms present within the Study Area, which are associated with the 'Beatrice' and 'Jacky' oil fields.

17.4.2.20 Both the Jacky and Beatrice oil fields are no longer producing and are scheduled for decommissioning.

17.4.2.21 Moray West understands that the indicative decommissioning timeline of the Beatrice field is as follows:

- Well plugging and abandonment on Beatrice Bravo and Charlie is expected to occur prior to commencing removal of the Beatrice Field infrastructure in 2024.
- Well plug and abandonment on Beatrice Alpha from 2020-2024; and
- Platform and subsea facility removal operations for the Beatrice field facilities from 2024 to 2027 (Respol Sinopec Resources UK, May 2017).

Table 17.4.2: Oil Platforms within the Study Area

Block Number	Oil Field	Platform Name	Operator	Production Start Date	Production End Date	Distance from Development (m)
11/30a	Beatrice	Beatrice Alpha Drilling platform	Repsol Sinopec Resources UK.	1981	2015	0
11/30a	Beatrice	Beatrice Alpha Production platform	Repsol Sinopec Resources UK.	1981	2015	0
11/30a	Beatrice	Beatrice Bravo platform	Repsol Sinopec Resources UK.	1981	2015	1,194
11/30a	Beatrice	Beatrice Charlie platform	Repsol Sinopec Resources UK.	1981	2015	204
12/21c	Jacky	Jacky platform	Ithaca Energy.	2009	2014	2,500

Well Locations

17.4.2.22 Several subsea wells are located near the Development. As shown in Volume 3a - Figure 17.4.3, there are 45 well heads within the Moray West Site, 12 plugged and abandoned, 29 completed and four suspended wells. One completed well, operated by Respol Sinopec Resources Ltd (previously Talisman), intersects the Offshore Export Cable Corridor at its extreme north-western corner.

Licensed Blocks

17.4.2.23 Suncor Energy have been granted a "potential award" licence within the 2nd tranche of the 28th licensing round for Blocks 12/21d, 18/1 and 18/2. The Offshore Export Cable Corridor also extends through Block 18/1. Further offshore to the east is the indicative boundary for the 30th Round of Oil and Gas leasing.

17.4.2.24 Licensed blocks are shown in Volume 3a - Figure 17.4.3 and detailed in Table 17.4.3 below.

Relinquished Licensing Blocks

17.4.2.25 When a petroleum license is granted, the licensee is given a limited time for the exploration of the license. If after the limited time, the company has not discovered or performed its minimal obligations (usually agreed with the government as a minimum number of exploration wells and investment on seismic survey) the license will be relinquished. Relinquished licenses can be re-attributed in next licensing rounds, or even kept as relinquished if the government believes there is little interest in that area for the petroleum exploration.

17.4.2.26 Table 17.4.4 below details the relinquished blocks within the Study Area. This table only includes the latest licence holder details for each relinquished block.

Table 17.4.3: Licensed Blocks							
Block Number	**Licence Reference**	**Licensing Round**	**Licence Holder(s)**	**Licence Start Date**	**Initial Term End Date**	**Second Term End Date**	**Licence End Date**
12/26a	P982	18th	Respol Sinopec Resources UK Limited	23rd December 1998	Information not available	Information not available	Information not available
11/24a	P1270	23rd	IGas Energy Enterprise Limited	22nd December 2005	21st December 2009	21st December 2013	21st December 2031 (Anticipated)
12/21c	P1392	23rd	Ithaca Energy (UK)Limited (52.5%) and Dyas UK Limited (47.5%)	22nd December 2005	21st December 2009	21st December 2013	21st December 2031 (Anticipated)
11/25a	P1031	20th	Respol Sinopec North Sea Limited (25%) and Respol Sinopec Resources UK Limited (75%)	2nd August 2001	1st August 2007	1st August 2019	1st August 2037 (Anticipated)
12/21a	P1031	20th	Respol Sinopec North Sea Limited (25%) and Respol Sinopec Resources UK Limited (75%)	2nd August 2001	1st August 2007	1st August 2019	1st August 2037 (Anticipated)
13/26a	P1891	26th	Maersk Oil North Sea UK Limited	1st February 2012 (Executed 23/04/2012)	31st January 2016	31st January 2020	31st January 2038 (Anticipated)
11/24b	P2235	28th	Corallian Energy Limited	1st December 2014 (Executed 16th April 2015)	30th November 2018	30th November 2022	30th November 2040 (Anticipated)
12/29a	P2227	28th	Jetex Petroleum UK Limited	1st December2 014 (Executed 4th March 2015)	30th November 2018	30th November 2022	30th November 2040 (Anticipated)
12/28a	P2227		Jetex Petroleum UK Limited	01/12/2014 (Executed 04/03/2015)	30/11/2018	30/11/2022	30/11/2040 (Anticipated)
12/30	P2277	28th	Maersk Oil North Sea UK Limited	1st September 2015	31st August	31st August	31st August

Table 17.4.3: Licensed Blocks							
Block Number	**Licence Reference**	**Licensing Round**	**Licence Holder(s)**	**Licence Start Date**	**Initial Term End Date**	**Second Term End Date**	**Licence End Date**
				(Executed 10th November 2015)	2019	2023	2041 (Anticipated)
12/21d	P2276	28th Second Tranche	Suncor Energy UK	Provisionally allocated	N/A	N/A	N/A
18/1	P2281	28th Second Tranche	Suncor Energy UK	Provisionally allocated	N/A	N/A	N/A
18/2	P2281	28th Second Tranche	Suncor Energy UK	Provisionally allocated	N/A	N/A	N/A
18/4	P2281	28th Second Tranche	Suncor Energy UK	Provisionally allocated	N/A	N/A	N/A
18/5	P2281	28th Second Tranche	Suncor Energy UK	Provisionally allocated	N/A	N/A	N/A
18/9	P2281	28th Second Tranche	Suncor Energy UK	Provisionally allocated	N/A	N/A	N/A

Table 17.4.4: Relinquished Blocks					
Block Number	**Licence Number**	**Licensing Round**	**Licence Holder**	**Licence Start Date**	**Licence Relinquish/Surrender Date**
12/30	P1400	23rd	First Oil Expro Ltd (formally Reach Exploration North Sea Ltd)	22nd December 2005	22nd December 2007
18/3 and 18/4	P1353	23rd	Faroe Petroleum plc	22nd December 2005	April 2008
12/28	P1265	23rd	Petro-Canada UK Ltd (50%) Samson North Sea Ltd (35%)	22nd December 2005	April 2008

Table 17.4.4: Relinquished Blocks

Block Number	Licence Number	Licensing Round	Licence Holder	Licence Start Date	Licence Relinquish/Surrender Date
			Reach Exploration Ltd (5%) First Oil Expro Ltd (10%)		
12/17b	P1301	23rd	Lundin Heather Ltd (30%) Revus Energy UK Ltd (35%) Britcana Energy Limited (35%)	22nd December 2005	September 2009
12/29	P1456	24th	Faroe Petroleum plc	1st April 2007	September 2009
12/14, 12/19a and 12/20a	P1255	23rd	Nexen Petroleum U.K. Limited	22nd December 2005	February 2010
11/25b	P1287	23rd	Caithness Oil Limited (now "Reach Exploration (North Sea) Limited") (65%) and Trap Oil Limited (35%)	22nd December 2005	21st August 2012
11/23	P1286	23rd	IGas Energy (Caithness) Ltd	22nd December 2005	30th December 2013
17/4b	P1342	23rd	PA Resources UK Ltd	22nd December 2005	October 2013
11/24	P1270	23rd	IGas Energy (Caithness) Ltd	22nd December 2005	7th January 2014
12/18 and 12/19c	P1921	26th	Elixir Petroleum (20%) and Adriatic Oil Plc (80%)	1st26 February 2012	May 2014
12/18, 12/19c, 12/20b and 12/24	P1266	23rd	Dana Petroleum (E&P) Limited (85%) First Oil PLC (10%) Trap Oil Group PLC (5%)	22nd December 2005	September 2014
12/14, 12/19a and 12/20a	P1886	26th	Premier Oil	1st February 2012	September 2014
12/25	P1267	23rd	Trap Oil Ltd	22nd December 2005	November 2015

Table 17.4.4: Relinquished Blocks					
Block Number	**Licence Number**	**Licensing Round**	**Licence Holder**	**Licence Start Date**	**Licence Relinquish/Surrender Date**
13/26b	P2099	27th	Maersk Oil North Sea UK Limited (50%) (operator) Nexen Petroleum UK Limited (50%)	20th December 2013	20th December 2015
12/26b and 12/17b	P1889	27th	Suncor Energy UK (Operator) 49.5% Trap Oil Ltd. 28.0% Noreco 22.5%	17th May 2012	July 2016
12/23	P2223	28th	Reach Energy Limited	01/12/2014	May 2017
12/21b	P1888	26th	Sendero Petroleum Limited, now Zennor Petroleum Ltd	1st February 2012	June 2017
11/30a	P187	4th	Respol Sinopec Resources UK Limited	16th March 1972	15th March 2018

Marine Dredging and Disposal

17.4.2.27 Dredging and disposal activity within the Moray Firth is sporadic and associated with port and harbour maintenance and development and coastal marine disposal sites.

17.4.2.28 The closest 'open' marine disposal site to the Development is "Buckie" which lies 2 km from the Offshore Export Cable Corridor, and 24.5 km from the Moray West Site (see Volume 3a - Figure 17.4.4). At this site an average of 10,001-15,000 tonnes (wet weight) of dredged material was disposed of between 2005-2009 (Baxter *et al*,. 2011) and in 2012 no deposits were made at disposal sites in the Moray Firth (DECC, 2016).

17.4.2.29 No marine aggregate extraction is licensed within the Study Area.

Subsea Cables and Pipelines

SHEFA-2 Telecommunication Cable

17.4.2.30 There is one existing subsea telecommunications cable in proximity to the Development (Volume 3a - Figure 17.4.5). The SHEFA-2 fibre-optic telecommunications cable, operated by Shefa Ltd (a subsidiary of Faroese Telecom), links the Faroe Islands to mainland Scotland via the Northern Isles (Faroese Telecom, 2017). It runs south from the Orkney Islands to the Scottish mainland at Inverboyndie and is buried under the seabed surface as it transits the Moray Firth and makes landfall 5 nm (10 km) east of the Moray West landfall area.

17.4.2.31 SHEFA has specific seabed rights granted to them as part of their seabed lease with The Crown Estate. In particular, permission must be granted by the cable owner for any works planned to be undertaken within 250 m either side of the cable. Where works are within 1 km of the cable, the operator must be notified prior to any works being undertaken.

Caithness - Moray Link

17.4.2.32 Scottish Hydro Electric Transmission (SHE Transmission) owns the Caithness – Moray Link, a 113 km subsea High Voltage Direct Current (HVDC) cable that runs between Noss Head on the east Caithness coast and Portgordon on the south coast of the Moray Firth. Once constructed, the project will provide transmission reinforcement along the East Coast of Scotland, with two onshore convertor stations at Spittal (Caithness) and Blackhillock (Moray) allowing for future connection to Shetland and offshore generation, along with upgrade of the onshore network in Caithness (SHE-T, 2015).

17.4.2.33 The Caithness-Moray Link is now under construction, with the cable laying campaign from Noss Head to the centre point of the Moray Firth having been completed in June 2017. It is anticipated that the remaining 56 km of HVDC cable will be installed in 2018 (SSEN, 2017).

Beatrice Demonstrator Cables

17.4.2.34 The two Beatrice Demonstrator turbines are connected in series via a 0.9 km cable (PL2331), with power supplied to Beatrice A via a 1.9 km long submarine cable (PL2331) (Respol Sinopec Resources UK, 2017). These cables are buried to a depth of 1 m below the seabed, with the exception of where the cable crosses the main oil export pipeline (PL16) (Respol Sinopec Resources UK, 2017).

17.4.2.35 Respol Sinopec Resources UK intend to decommission the subsea power cables as part of the decommissioning of the Beatrice Demonstrator turbines in 2024-2027 (Respol Sinopec Resources UK, 2017).

BOWL Export Cables

17.4.2.36 The Beatrice Offshore Wind Farm will have two parallel export cables totalling 130 km in length (65 km each) which will extend from the Beatrice Offshore Wind Farm, through the Development to make landfall 1.5 km west of Portgordon harbour (BOWL, 2016).

17.4.2.37 BOWL cable export cable installation will complete in 2018.

Beatrice Pipeline

17.4.2.38 Oil and gas extracted from the Beatrice Oil Field was exported to shore via an installed pipeline (see Volume 3a - Figure 17.4.5). This pipeline crosses the north-west corner of the Moray West Site and runs to shore at Nigg in the Cromarty Firth.

17.4.2.39 There is also a mid-line structure between Beatrice Alpha and the Jacky Platform which was installed in 2008. Ithaca Energy is responsible for the decommissioning of the related pipelines tied into the Beatrice field; no information is currently available regarding the anticipated decommissioning schedule.

Telecommunications

17.4.2.40 An initial screening exercise of the potential impacts of the development of the Moray Firth Round 3 Offshore Zone on telecommunications was undertaken in 2009 by Pager Power (Pager Power, 2009), and forms the basis of this assessment.

17.4.2.41 Table 17.4.5 below provides a summary of the baseline of the Pager Power report with regards to telecommunications.

Table 17.4.5: Severity of the Issues Identified by Pager Power

Issue Identified	Grading	Definition
TV and radio interference	3	No issues or easy to solve
Microwave links	3	No issues or easy to solve

TV and Radio

17.4.2.42 The Pager Power study stated that development in the western portion of the Moray Firth Round 3 Zone would not cause TV or radio interference (MORL, 2012).

Microwave Links

17.4.2.43 Some microwave links may pass through the northern edge of the Moray West Site, possibly associated with the heliports at Beatrice Alpha, Beatrice Bravo and Beatrice Charlie (Pager Power, 2009). Due to the high turnover rate of microwave links, Pager Power recommend full Ofcom consultation, which Moray West intend to undertake once Development design is refined.

Unexploded Ordnance (UXO)

17.4.2.44 In 2011, Moray East commissioned 6 Alpha Associates Ltd to undertake a desk-based study to identify the potential risk of UXO within the Moray Firth Round 3 Zone (Moray West and Moray East Sites), and to identify potential measures by which any risks may be reduced to an acceptable level. The study identified potential UXO sources based on an analysis of a variety of data and presented the results of a UXO risk assessment in a report, which considered the hazards associated with the potential UXO sources. The study also recommended measures to be taken to minimise the risk posed by potential sources of UXO. A summary of the key findings from the 6 Alpha Associates Ltd assessment is provided in the following sections. A copy of the UXO Risk Assessment report is provided in Volume 4 - Technical Appendix 17.2.

UXO Wrecks Sites

17.4.2.45 Wrecks sites are detailed within Chapter 16: Archaeology and Cultural Heritage, however, due to the UXO threat they may pose, wrecks are also discussed in this chapter.

17.4.2.46 The "Sunbeam" is the only wreck present within the Moray West Offshore Windfarm Site. The Sunbeam was a sailing/transport ship that was sunk in 1915 following a U-boat attack. The ship was captured at first and sunk subsequently by a deck gun. The UXO threat posed by this wreck is unknown.

17.4.2.47 Six further wrecks, have been recorded east of the Development, within the Moray East site. The UXO threat of five of these wrecks is unknown, however, UXO encounter is 'almost certain' on the wreck of the HMS Lynx, a steamer destroyer sunk in 1915, parts of which lie 12 km and 20 km east of the Moray West Offshore Windfarm site. HMS Lynx sank after striking a sea mine; she was armed with guns and torpedo tubes, though the volume of munitions being carried by the vessel at the time of sinking is unknown (6 Alpha Associates Ltd, 2011).

17.4.2.48 A figure illustrating the shipwrecks present within the Moray Firth is available in Appendix 08 of the 6-Alpha Associates Assessment, which is included in Volume 4 - Technical Appendix 17.2: UXO Risk Assessment.

Munition/Explosive Disposal

17.4.2.49 Although both chemical and conventional munitions were extensively dumped at sea off the UK coast following World War I (WWI) and World War II (WWII), the research conducted by 6 Alpha Associates did not identify any specific evidence for munitions dumping either within or close to the Development.

Armament Ranges

17.4.2.50 There are several WWII armament ranges within the Study Area. These include N220, the Moray Firth North armament range, which intersects the Moray West Site. This was a Royal Navy facility used for firing torpedoes from aircraft. The location of this, and other armament ranges is illustrated in the 6 Alpha Associates Ltd UXO Technical Report (2011) provided in Volume 4 - Technical Appendix 17.2: UXO Risk Assessment.

17.4.2.51 The following WWII armament ranges intersect the Offshore Export Cable Corridor:

- 127A Spey Bay: this range was an RAF facility used for live bombing; and
- A318, Strathlene Links: this was a "heavy and light" Army facility.

17.4.2.52 The following WWII armament ranges exist outwith the Moray West Site, but within the Study Area:

- N229, Moray Firth South lies just west of the Development: this was a Royal Navy facility used for firing torpedoes from aircraft; and
- N233 Fearm (Shandwick Bay) lies west of the development off the coast near Balintore: this was a "light" Army facility.

17.4.2.53 Due to the proximity of the Development to a number of armament ranges the threat of UXO is considered to be high.

17.4.2.54 In light of the UXO risks detailed (wrecks, munitions/explosives disposal and armament ranges) above, 6 Alpha Associates predicted that the probability of UXO encounter within the Moray West Site was "highly likely" across the majority of the site, with the probability reducing to "likely" at the far western extent and "remote" along to northern boundary (6 Alpha Associates Ltd, 2011).

17.4.3 Future Baseline

17.4.3.1 The future baseline scenario is considered unlikely to change substantially from that presented in Section 17.4.2 (current baseline) above.

17.4.3.2 The future baseline scenario for offshore developments is subject to gradual change as new projects/sites are identified.

17.4.3.3 The future baseline scenario for oil activities and associated development (including platforms, wells and pipelines) is considered to be subject to the greatest degree of change, which will depend upon currently unknown outcomes of, for example, acquisitions, exploration and development, and decommissioning. The OGA have reported that total production on the United Kingdom Continental Shelf decreased by 0.3% from 2016- 2017 (OGA, 2018). Production is projected to decrease from 1.63 million barrels of oil equivalent (boe) a day to 1.38 million boe a day by 2023 (OGA, 2018). While this decline is predicted to continue they report a range of possible outcomes because the future rate of production is dependent on such a large number of different and unknown factors, including the level of investment and the success of further exploration. Operators continue to find it difficult to predict production accurately as older fields mature and their reliability reduces. A significant share of future oil and gas production is expected to come from new fields and major projects in existing fields. With the recent dramatic fall in oil prices the projections are even less certain than normal. In light of these trends and the planned decommissioning of the Beatrice Field oil infrastructure, it is probably a reasonable assumption therefore that oil activity will continue to decline in the Moray Firth. The potential for future activity within oil and gas licence blocks is however taken into account within this chapter.

17.5 Assessment Methodology

17.5.1 Impacts Identified as Requiring Assessment

17.5.1.1 Table 17.5.1 below lists the potential impacts on other human activities identified as requiring consideration as part of the assessment. This list of impacts is based on expert judgement, reflects responses provided by MS-LOT, statutory consultees and other stakeholders in the Wind Farm and OfTI Scoping Opinions and takes into account further comments received as part of consultation activities.

17.5.1.2 Decommissioning activities have the potential to impact on other human activities but for the purposes of this EIA they are regarded as being comparable to those that occur as a result of construction activities. As a result, the effects of construction and decommissioning activities on other human activities are considered together.

Table 17.5.1: Impacts on Other Human Activities Requiring Assessment

Potential Impact	Nature of Impact (direct or indirect)	Inter-Relationships with Other EIA Topics / Receptors
Construction and Decommissioning Impacts		
Disturbance of existing offshore wind farm activities	Direct	Chapter 12: Shipping and Navigation
Disturbance of existing subsea cables	Direct	None
Exclusion of oil exploration and decommissioning activities	Direct	Chapter 12: Shipping and Navigation Chapter 13: Civil and Military Aviation
Disturbance of marine disposal activities	Direct	None

Table 17.5.1: Impacts on Other Human Activities Requiring Assessment		
Potential Impact	**Nature of Impact (direct or indirect)**	**Inter-Relationships with Other EIA Topics / Receptors**
Risks associated with UXO	Direct	None
Operation and Maintenance Impacts		
Disturbance of existing offshore wind farm activities	Direct	Chapter 12: Shipping and Navigation
Disturbance of existing subsea cables	Direct	None
Exclusion of oil exploration and decommissioning activities	Direct	Chapter 12: Shipping and Navigation Chapter 13: Civil and Military Aviation
Disturbance of marine disposal activities	Direct	None
Risks associated with UXO	Direct	None
Interference with telecommunications	Direct	None

17.5.2 Scoped Out Impacts

17.5.2.1 The following issues have been scoped out of this assessment on the basis of Scoping Opinion responses, baseline data gathering, consultation with stakeholders and expert judgement:

- Disturbance of PEXA activities;
- Disturbance to wave and tidal energy projects; and
- Disturbance to CCS projects.

17.5.2.2 Effects on wave energy projects, tidal energy projects and CCS projects were scoped out of the assessment as none are present within the Study Area. Effects on PEXA activities have been scoped out of the assessment on the basis that none overlap with the Development and the Ministry of Defence (MoD) did not identify any concerns about potential effects on PEXA during the scoping process.

17.5.3 Assessment Criteria

17.5.3.1 The impacts requiring assessment (listed in Section 17.5.2) have been identified using expert judgement and through consultation with MS-LOT and relevant stakeholders.

17.5.3.2 The approach to the assessment of impact significance is as detailed in Volume 2, Chapter 5: EIA Methodology. This is a two stage process involving the application of criteria to define the sensitivity of the receptors and the magnitude of the potential impacts. Specific criteria developed to inform the assessment of impacts on other human activities associated with the construction, operation and maintenance and decommissioning of the Development is described below.

Sensitivity Criteria

17.5.3.3 The sensitivity of other human activities to impacts associated with the development involves consideration of the value (or importance) of the asset or activity and the ability of the asset or activity to accommodate the predicted change. The overall sensitivity of a receptor to an impact then identified from a four point scale as presented in Table 17.5.2.

Table 17.5.2: Sensitivity Criteria	
Sensitivity	**Definition**
High	Activity / receptor is of strategic national importance (e.g. infrastructure or assets / developments) and have no or very limited capacity to accommodate the predicted change or interaction.
Moderate	Activity / receptor is of regional importance (e.g. infrastructure or assets / developments) and have limited capacity to accommodate the predicted change or interaction.
Low	Activity / receptor is of local importance (e.g. infrastructure or assets / developments) and have capacity to accommodate the predicted change or interaction.
Negligible	Activity / receptor is not considered to be any importance and is capable of accommodating the predicted change or interaction.

Impact Magnitude

17.5.3.4 The criteria for defining magnitude in this chapter follows the approach outlined in Table 17.5.3, which follows Chapter 5 of this EIA Report (EIA Methodology).

Table 17.5.3: Magnitude Criteria	
Magnitude of Impact	**Description**
High	Changes / interaction affecting the majority of the activity / receptor (infrastructure / asset) leading to a permanent / irreversible change or alteration to the key characteristics or functions of the activity or receptor (infrastructure or asset).
Moderate	Changes / interaction affecting a moderate proportion of the activity / receptor (infrastructure / asset) leading to a long term but reversible change or alteration to the key characteristics or functions of the activity or receptor (infrastructure or asset).
Low	Changes / interaction affecting a small proportion of the activity / receptor (infrastructure / asset) leading to a short term / temporary change or alteration to the key characteristics or functions of the activity or receptor (infrastructure or asset).
Negligible	changes / interaction affecting a very limited part / area of the activity / receptor (infrastructure / asset) with imperceptible change or alteration to the key characteristics or functions of the activity or receptor (infrastructure or asset).
No change	No loss of extent or alteration to infrastructure or asset.

Significance Criteria

17.5.3.5 The significance of the effect on other human activities is determined by correlating impact magnitude and the sensitivity of the receptor. The particular method employed for this assessment is presented in Table 17.5.4. Where a range of significance of effect is presented in Table 17.5.4, the final assessment for each effect is based upon expert judgement.

17.5.3.6 For the purposes of this assessment, any effects with a significance level of minor or less has been concluded to be not significant in terms of the EIA Regulations.

Table 17.5.4: Effect Significance				
Sensitivity of Receptor	**Impact Magnitude**			
	Negligible	**Low**	**Moderate**	**High**
Negligible	Negligible	Negligible or Minor	Negligible or Minor	Minor
Low	Negligible or Minor	Negligible or Minor	Minor	Minor or moderate
Moderate	Negligible or Minor	Minor	Moderate	Moderate or Major
High	Minor	Minor or moderate	Moderate or Major	Major

17.5.4 Data Limitations

17.5.4.1 The main data limitation relates to ongoing uncertainty with future oil and gas activities in the Moray Firth. At the time of writing it had not possible to contact all existing licence block holders to understand their future plans in terms of exploration and development of the blocks. An assumption therefore has been made that there could be some future activity in blocks (e.g. exploration drilling) in accordance with conditions of the existing licence.

17.5.4.2 There also remains some uncertainty of the specific activities to occur as part of the Beatrice Decommissioning and timescales over which specific activities will occur. Based on information presented in the Scoping Report it understood that most decommissioning activities will occur between 2024 and 2027.

17.6 Design Envelope Parameters

17.6.1 Realistic Worst Case Design Scenario

17.6.1.1 As identified in Chapter 4 (Volume 2): Description of the Development, Moray West is considering a range of potential construction methods and design options for the Development. The Design Envelope presented in Chapter 4 (Volume 2) represents the maximum design parameters for each of the options under consideration e.g. substructure type or turbine model.

17.6.1.2 In order to determine potential impacts of the various options it is necessary to define the 'realistic worst case scenario'. The realistic worst case scenario represents, for any given receptor and potential impact on that receptor, the scenario for various options in the Design Envelope that would result in the greatest potential for change to the receptor in question.

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

17.6.1.4 Table 17.6.1 presents the realistic worst case scenario for potential impacts on other human activities during construction, operational and maintenance and decommissioning phases of the Development and provides justification as to why the options and design parameters identified are considered to be the realistic worst case scenario.

<table>
<tr><th colspan="3">Table 17.6.1: Design Envelope Parameters Relevant to the Other Human Activities Impact Assessment</th></tr>
<tr><th>Potential Impact</th><th>Realistic Worst Case Scenario</th><th>Justification</th></tr>
<tr><td>Disturbance of existing offshore wind farm activities
Construction, operations and maintenance and decommissioning activity within the Moray West Site and along the Offshore Export Cable Corridor may disturb access to other existing offshore wind farms.</td><td rowspan="6">Development comprising:
Up to 85 wind turbines with gravity base foundations spread across the entire Site;
Up to two OSPs;
Interconnector cable of up to 15 km length;
Inter-array cables of up to 275 km length.
Up to two export cable trenches of up to 65 km in length each.
500 m safety zones around installation activity.
Up to 21 cable crossings.
Construction period of approximately 36 months, supported by regular vessel movements to and from the Development.
Operational phase lasting up to 50 years, with regular maintenance activity supported by vessel movements to and from the Development.
Decommissioning phase lasting up to approximately 36 months.</td><td>Parameters that create the greatest disruption to existing wind farm operation and maintenance activity in terms of area affected and duration.</td></tr>
<tr><td>Disturbance of existing subsea cables
Construction, operations and maintenance and decommissioning activity within the Moray West Site and along the Offshore Export Cable Corridor may affect existing subsea cables or restrict access to existing subsea cables.</td><td>The greatest amount of infrastructure within the Moray West Site and Offshore Export Cable Corridor leading to the crossing of the greatest number of existing cables.</td></tr>
<tr><td>Exclusion of oil exploration activities
Construction, operations and maintenance and decommissioning activity within the Moray West Site and along the Offshore Export Cable Corridor may exclude any planned seismic survey, drilling or placement of infrastructure within the Moray West Site and Export Cable Corridor.</td><td>Parameters that represent the largest area over which survey, drilling activity or the siting of infrastructure would potentially be restricted, and over the longest duration.</td></tr>
<tr><td>Disturbance of oil decommissioning activities
Construction, operations and maintenance and decommissioning activity within the Moray West Site and along the Offshore Export Cable Corridor may disturb access to existing oil infrastructure for the purposes of decommissioning.</td><td>Parameters that create the greatest disruption to decommissioning activity in terms of area affected and duration.</td></tr>
<tr><td>Disturbance of marine disposal activities
Construction, operations and maintenance and decommissioning activity within the Moray West Site and along the Offshore Export Cable Corridor may disturb marine disposal activities.</td><td>Parameters that create the greatest disruption to existing disposal activity in terms of area affected and duration.</td></tr>
<tr><td>Interference with telecommunications
The physical presence of the Development may interfere with telecommunications links, and affect TV and radio reception.</td><td>Parameters that create the greatest potential to interference with telecommunications. Noted that this may be influenced by the number, height and location of WTGs.</td></tr>
</table>

17.6.2 Embedded Measures

17.6.2.1 Where relevant, mitigation measures are incorporated as part of the Development design process and are referred to as embedded measures.

17.6.2.2 The following embedded mitigation strategies are industry standards which are used to reduce the significance of identified impacts on other marine users and mitigate the impacts wherever possible:

- The following Safety Zones will be applied for by Moray West:
  - 500 m safety zones around any structure where construction work is underway, as indicated by the presence of a large construction vessel(s);
  - 50 m safety zones around any partially completed structure during the construction phase where work is not underway;
  - 50 m safety zones around any completed structure prior to commissioning; and
  - 500 m safety zones around any structure undergoing major maintenance during the operational phase, defined as work requiring a large or 'restricted in the ability to manoeuvre' (RAM) vessel.
- A suite of further standard measures will ensure the safety of other sea users, including but not limited to:
  - Promulgation of information regarding Development activity during all phases of the Development, via regular Notices to Mariners (NtMs), Kingfisher Bulletins, radio navigation warnings and other appropriate means.
  - Dedicated marine coordination staff and facilities will coordinate all offshore activity associated with the Development.
  - Works areas and installed infrastructure will be appropriately marked and lit in accordance with standard industry guidance.
  - The location of all installed infrastructure will be confirmed to the UKHO and Defence Infrastructure Organisation (DIO) to allow for their marking on Admiralty Charts and PEXA charts.
- UXO will be identified through pre-construction seabed survey; this will determine the requirement for any UXO disposal.
- All cables will be installed and maintained in line with standard industry guidance and good practice (e.g. Subsea Cables UK Guidelines, International Cable Protection Committee Recommendations) that provide guidance on proximity of cables to existing assets and coordination with other operators.

17.6.2.3 Embedded mitigation methods specific to the Development include:

- Inter-array, OSP interconnector and offshore export cables will be buried beneath the seabed to a minimum target depth of 1 m, wherever practicable, in line with The Carbon Trust cable burial risk assessment (CBRA) methodology (or latest equivalent guidance). Cable protection measures would be applied in areas where burial is not possible, e.g. where the cables are required to cross existing cables or in areas of hard seabed are encountered.
- Pre-construction seabed surveys will accurately identify the location of existing seabed assets, including in-service cables and pipelines; all existing seabed infrastructure will be avoided by Development infrastructure wherever possible.

- Agreed buffers exist between the Moray West and Moray East sites, and between these sites and the Beatrice offshore wind farm; these will be adhered to.

17.6.2.4 Moray West is committed to re-contacting the JRC, British Broadcast Company (BBC) and Ofcom with final WTG layout design parameters to enable screening exercises to confirm that the Development will have no adverse effects on community TV, radio or telecommunications links.

17.7 Assessment of Potential Effects

17.7.1.1 Potential impacts occurring during the construction, operation and maintenance and decommissioning of the Development and the significance of the effect of those impacts on other human activities within the Moray Firth are discussed below.

17.7.2 Potential Construction/Decommissioning Effects

Disturbance of Existing Offshore Wind Farm Activities

17.7.2.1 The construction of the Development has the potential to interfere with activities at the other offshore wind farm projects in the Moray Firth.

17.7.2.2 The Beatrice Offshore Wind Farm is located immediately north of the Moray West Site and the Moray East Site lies immediately to the east of the Moray West Site. The Beatrice Demonstrator turbines are located within the Moray West Site. Construction works and vessel activity associated with the Development have the potential to disrupt routine operations and construction/decommissioning activity associated with these wind farm sites, with commercial and health and safety implications.

17.7.2.3 Embedded mitigation measures (notably the use of NtMs and other notifications of planned activity, appropriate lighting, marking and charting of each wind farm, and marine coordination of all offshore wind farm activities) and ongoing direct liaison between the responsible Company's (Moray West, Moray East, BOWL and Repsol Sinopec) and any nominated contractors will act to reduce or avoid the potential risk. With specific regard to the Beatrice offshore wind farm, a commercial agreement ensures separation of the turbines in the Beatrice and Moray East and Moray West sites by a distance equivalent to five times the installed wind turbine rotor diameter from their mutual boundaries. Moray West will also maintain a minimum buffer from the Moray East Site equivalent to five times the installed wind turbine rotor diameter installed on the Moray West Site.

17.7.2.4 In conclusion, the sensitivity of existing offshore wind farms to disturbance from construction of the Development is judged to be **high** given implications for human safety, and with the application of embedded mitigation measures the magnitude of the impact is assessed as **negligible**, with construction activities being relatively short-term and temporary. The resulting significance of the effect is **minor adverse**, and not significant in EIA terms.

Disturbance of Existing Subsea Cables

17.7.2.5 The BOWL offshore export cables run through the Moray West Site. Whilst the major infrastructure within the Moray site will be located so as to avoid direct effects on the integrity of the BOWL cables, it will be necessary for the Moray West inter-array, interconnector and export cables to cross the BOWL cables. In addition, the Moray West export cables will need to cross the SHE-T Caithness-Moray cable. Currently it is anticipated that up to 21 cable crossings may be required within the Moray West Site and Export Cable Corridor. The cable crossings, or other construction activities, have the potential to impact on the integrity of the existing cables; it is noted that subsea cables can be costly to repair and any damage to such energy infrastructure has the potential to have an impact on the supply of electricity.

17.7.2.6 Any significant effect will be avoided by the application of industry standard mitigation, supported by crossing agreements between the respective Companies which would require agreement on the crossing design such that it would be sufficient to protect all of the subsea cable assets. Pipeline and cable crossings are common across the UK Continental Shelf (UKCS), and there are established mechanisms for controlling the level of impact to both parties. Beyond the cable crossing points, agreements will also be reached on the effective exclusion areas around each of the BOWL cables and the SHE-T cable such that no damage would occur from construction activities, vessel anchoring etc.

17.7.2.7 In conclusion, the sensitivity of existing subsea cables to disturbance from construction of the Development is judged to be **high** given the difficulty and costs associated with cable repair, and with the application of embedded mitigation measures supported by commercial agreements and ongoing liaison with other operators, the magnitude of the impact is assessed as **negligible**. The resulting significance of the effect is **minor adverse**, and not significant in EIA terms.

Disturbance of Oil Exploration and Decommissioning Activities

17.7.2.8 The Development is located in the vicinity of the 'Jacky' and 'Beatrice' oil fields and their associated oil production infrastructure. Construction activity associated with the Development has the potential to interfere with the carrying on of normal operations by licensed oil operators and the safety of those operations.

17.7.2.9 The infrastructure associated with the Jacky and Beatrice fields is in the process of being decommissioned, with anticipated completion dates for the decommissioning of 2021 and 2027 respectively. Decommissioning of the Beatrice oil platforms is due to commence in 2024 and therefore could overlap temporarily with the construction of the Development, which is scheduled to occur between 2022 and 2024. Construction activity associated with the Development has the potential to interfere with decommissioning operations and the safety of those operations. In the 2nd tranche of the 28th Licensing Round, Suncor Energy were awarded three licensing blocks within the vicinity of the Moray West Site. Two of these blocks, 12/21d and 18/1 intersect the Moray West Site and Offshore Export Cable Corridor respectively. It is understood that these Operators exploration plans are currently unknown. However, it is possible, in the first instance, that the licence holders may wish to undertake seismic surveys within their licence blocks. Construction activity associated with the Development has the potential to interfere with exploration activities in the licence blocks.

17.7.2.10 There are 45 well heads within the Moray West Site, of which 12 are plugged and abandoned, 29 are completed and 4 are suspended. As shown in Volume 3a - Figure 17.4.3, one completed well, operated by Respol Sinopec Resources UK (following the acquisition of Talisman), intersects the Offshore Export Cable Corridor at its extreme north-western corner. Construction activity associated with the Development is not expected to disturb these wells, which will be avoided by Development infrastructure.

17.7.2.11 Embedded mitigation measures (notably the use of NtMs and other notifications of planned, appropriate lighting, marking and charting of each wind farm, and marine coordination of all offshore wind farm activities) and ongoing direct liaison between the responsible Company's and any nominated contractors will act to reduce or avoid the potential risk. Prior to construction, Moray West will continue to / seek to have further discussions with the relevant oil operators; such discussions would focus on exchanging information on planned operations and activities and seeking agreement on measures to minimise adverse impacts on either party.

17.7.2.12 In conclusion, the sensitivity of oil exploration and decommissioning activities to disturbance from construction of the Development is judged to be **high** given implications for human safety, and with the application of embedded mitigation measures the magnitude of the impact is assessed as **negligible**, with construction activities being relatively short-term and temporary. The resulting significance of the effect is **minor adverse**, and not significant in EIA terms.

Disturbance of Marine Disposal Activities

17.7.2.13 The closest 'open' marine disposal site to the Development is "Buckie" at a distance of 2 km from the Moray West Offshore Export Cable Corridor. Depending upon routes of construction vessel access to the Development, and the timing of disposal at the Buckie site, there is potential for disruption of marine disposal activity.

17.7.2.14 Based on publicly available data, it is understood that disposal activity at the Buckie site has been limited (low volumes, infrequent use) in recent years. The sensitivity of marine disposal activities to disturbance from construction of the Development is therefore judged to be **low**, and with the application of embedded mitigation measures the magnitude of the impact is assessed as **negligible**, with construction activities being relatively short-term and temporary. The resulting significance of the effect is **negligible or minor adverse**, and not significant in EIA terms.

Risks Associated with UXO

17.7.2.15 The potential presence of UXO within the areas affected by the construction of the Development has the potential to present a health and safety risk to construction personnel and other sea users.

17.7.2.16 The risk from UXO would be mitigated through industry standard procedures as follows:

- A UXO survey would be conducted as part of the final design and engineering process and prior to any construction works commencing;
- Potential UXO targets identified during the surveys would be subject to further investigation by, for example, Remotely Operated Vehicles (ROVs); and
- Confirmed UXO targets that could not be safely avoided would be subject to UXO disposal (noting that any disposal activity would be subject to a separate Marine Licence application and approvals process).

17.7.2.17 Adherence to standard practice will reduce the UXO risk to As Low As Reasonably Practicable (ALARP) levels. Receptor sensitivity will remain **very high**, but there would be **no impact**. The resulting significance of the effect is **negligible**, and not significant in EIA terms.

17.7.3 Potential Operation and Maintenance Effects

Disturbance of Existing Offshore Wind Farm Activities

17.7.3.1 Activity associated with the operation of the Development will be reduced relative to the construction and decommissioning phases. O&M vessels will routinely access the Moray West Site transiting from the selected operations and maintenance port; exceptional maintenance activity may be required and may necessitate the use of large vessels and the imposition of a temporary 500 m safety zone.

17.7.3.2 The Beatrice offshore wind farm will largely be served by its O&M base in Wick during its operation. It is not yet known where the Moray West and Moray East O&M bases will be located. In light of the embedded mitigation measures, which will include marine coordination between the offshore wind farm sites and use of predetermined vessel transit routes, it is considered that the potential for disturbance by the operational Development of O&M activities at other offshore wind farm sites is limited.

17.7.3.3 The sensitivity of existing offshore wind farms to disturbance from the operation and maintenance of the Development is judged to be **moderate**, and with the application of embedded mitigation measures the magnitude of the impact is assessed as **negligible**. The resulting significance of the effect is **negligible to minor adverse**, and not significant in EIA terms.

Disturbance of Existing Subsea Cables

17.7.3.4 The operation of the Development is not anticipated to have any significant effects upon existing subsea cables or pipelines. Should operators wish to install subsea cables or pipelines that cross, or are in close proximity to the operational Development, it is expected that Moray West and any such operator would enter discussions and be steered by advice from relevant authorities.

17.7.3.5 If it becomes necessary to replace or repair some part of the existing subsea cables (either that owned by Moray West or by one of the other operators) it is assumed that maintenance activities would be carried out in line with standard industry methods and good practice, and in line with any relevant commercial agreement such that no impact would occur.

17.7.3.6 The sensitivity of existing subsea cables to disturbance from the operation and maintenance of the Development is judged to be **moderate**, and with the application of embedded mitigation measures the magnitude of the impact is assessed as **negligible**. The resulting significance of the effect is **negligible to minor adverse**, and not significant in EIA terms.

Disturbance of Oil Exploration and Decommissioning Activities

17.7.3.7 In terms of exploration activities, the intentions of current oil and gas block licence holders are currently not fully known. Should licence holders seek to commence block exploration once the Moray West Offshore Wind Farm is operational, it is expected that activities such as seismic/geophysical survey may be spatially restricted by the physical presence of turbines and OSPs and vessels associated with ongoing maintenance. Drilling and the placement of new oil and gas infrastructure could also be restricted by the presence of the Moray West Offshore Wind Farm and the OfTI where it is necessary to co-locate such infrastructure. Should operators wish to drill or install infrastructure in close proximity to the Development, it is expected that Moray West and any such operator would enter discussions in order to seek agreement on how to proceed safely. On the basis that the Moray West Site and Offshore Export Cable Corridor occupy only a proportion of the licensed blocks, and not the entire blocks, and on the assumption that there would be a continuation of the consultation between Moray West and oil block licence holders, it is considered that there is limited potential for the operational Development and associated maintenance activity to impact exploration activities.

17.7.3.8 In terms of decommissioning activities, dependent upon the timing and nature of the decommissioning of the Beatrice and Jacky infrastructure, there is potential for the presence of operational Moray West infrastructure and associated maintenance vessels to influence vessel access to the decommissioning works.

17.7.3.9 In the case of all of the above, embedded mitigation measures and ongoing liaison with oil operators and licence holders, the sensitivity of oil activities to disturbance from the operation and maintenance of the Development is judged to be **moderate**, and with the application of embedded mitigation measures the magnitude of the impact is assessed as **negligible**. The resulting significance of the effect is **negligible to minor adverse**, and not significant in EIA terms.

Disturbance of Marine Disposal Activities

17.7.3.10 Depending upon routes of operation and maintenance vessel access to the Development, and the timing of disposal at the Buckie site, there is potential for disruption of marine disposal activity.

17.7.3.11 The sensitivity of marine disposal activities to disturbance from operation and maintenance of the Development is therefore judged to be **low**, and with the application of embedded mitigation measures the magnitude of the impact is assessed as **negligible**. The resulting significance of the effect is **negligible or minor adverse**, and not significant in EIA terms.

Health and Safety Risk due to Unexploded Ordnance

17.7.3.12 The natural processes of the sea, including tidal action, seabed conditions, movement of sand waves, wave action and bad weather, all contribute to the movement of objects on the seabed. Human activities such as seabed trawling can also contribute to the movement of objects and, as such, there is a risk of UXO moving into the Development during the operational phase. This could have implications for maintenance and repair activities at the seabed.

17.7.3.13 The risk of such migration is very low, and seabed surveys undertaken throughout the lifetime of the Development and prior to any localised seabed maintenance works, will identify any new UXO potential. The measures described under Section 17.7.1 would be applied. Adherence to standard practice will reduce the UXO risk to "As Low As Reasonably Practicable" (ALARP) levels. Receptor sensitivity will remain **very high**, but there would be **no impact**. The resulting significance of the effect is **negligible**, and not significant in EIA terms.

Interference with Telecommunications

17.7.3.14 Like other tall structures, WTGs can cause interference to telecommunication systems such as microwave links, radio transmission and television signals. There are two potential mechanisms that can cause problems to wireless services: physical blocking of the signal by the structure and reflection from the sides of the structure. Reports have been received of reflection effects affecting broadcast television up to 20km from the structure, although this has only occurred in exceptional circumstances and more typically effects will only be seen a relatively small distance from the structures (Ofcom, 2009).

17.7.3.15 The Moray West Site lies adjacent to, and further offshore than, the Beatrice Offshore Wind Farm. The Beatrice Offshore Wind Farm TV and Radio Impact Report (BOWL, July 2017) identified those coastal built-up areas within a 20 km buffer of the wind farm site that had the potential to be affected, and undertook surveys to confirm whether interference could be expected. The Report concludes that the Beatrice Offshore Wind Farm will have no impacts on TV or radio reception. Given that the Moray West Site is located at a minimum of 22.5 km from the coast, it is considered unlikely that the Development will interfere with telecommunications, and this will be confirmed by post-consent screening exercises (see Section 17.6.2).

17.7.3.16 The sensitivity of telecommunications to interference from operation and maintenance of the Development is judged to be **low**, and with the application of embedded mitigation measures the magnitude of the impact is assessed as **negligible**. The resulting significance of the effect is **negligible or minor adverse**, and not significant in EIA terms.

17.7.4 Summary of Development Specific Effects

17.7.4.1 Table 17.7.1 below summarises the results of the Development specific assessment.

Table 17.7.1: Summary of Development Specific Effects

Potential Impact	Receptors	Sensitivity of Receptor	Impact Magnitude	Effect Significance	Mitigation (in addition to Embedded Measures)	Residual Effect Significance
Construction and Decommissioning						
Disturbance of existing offshore wind farm activities	Offshore wind farm operators	High	Negligible	Minor adverse	None proposed	Minor adverse
Disturbance of existing subsea cables	Subsea cable operators	High	Negligible	Minor adverse	Cable crossing / proximity agreements	Minor adverse
Disturbance of oil exploration and decommissioning activities	Oil block licence holders Oil infrastructure operators	High	Negligible	Minor adverse	None proposed	Minor adverse
Disturbance of marine disposal activities	Buckie marine disposal site	Low	Negligible	Negligible or Minor adverse	None proposed	Negligible or Minor adverse
Risks associated with UXO	Offshore workers	Very High	No impact	Negligible	None proposed	Negligible
Operation						
Disturbance of existing offshore wind farm activities	Offshore wind farm operators	Moderate	Negligible	Negligible or Minor adverse	None proposed	Negligible or Minor adverse
Disturbance of existing subsea cables	Subsea cable operators	Moderate	Negligible	Negligible or Minor adverse	Cable crossing / proximity agreements	Negligible or Minor adverse
Disturbance of oil exploration and decommissioning activities	Oil block licence holders Oil infrastructure operators	Moderate	Negligible	Negligible or Minor adverse	None proposed	Negligible or Minor adverse
Disturbance of marine disposal activities	Buckie marine disposal site	Low	Negligible	Negligible or Minor adverse	None proposed	Negligible or Minor adverse
Risks associated with UXO	Offshore workers	Very High	No impact	Negligible	None proposed	Negligible
Interference with telecommunications	Transmitters and other telecommunications links	Low	Negligible	Negligible or Minor adverse	None proposed	Negligible or Minor adverse

17.8 Assessment of Cumulative Effects

17.8.1.1 The approach to Cumulative Impact Assessment (CIA) is described in Volume 2, Chapter 5: EIA Methodology.

17.8.1.2 The spatial context within which the CIA is set is based upon the range over which the Development may overlap and / or interact with other projects and activities in the Moray Firth. The projects and activities considered in detail within this CIA are as follows:

- Beatrice Demonstrator offshore wind turbines (noting that these are expected to be decommissioned at some point between 2024 and 2027);
- Beatrice Offshore Wind Farm and associated offshore export cables (as-built parameters assumed);
- Caithness to Moray interconnector cable;
- Moray East Offshore Wind Farm (consented parameters assumed);
- Beatrice and Jacky oil field infrastructure (including pipeline and cable) and decommissioning activities; and
- Buckie marine disposal site.

17.8.1.3 There is currently insufficient information available on which to base a detailed assessment of potential cumulative effects on potential oil exploration activity in licensed blocks, as the intent of licence holders is unknown.

17.8.1.4 As it is assumed that all offshore construction projects will apply the same standard approach to identification and management of UXO; potential cumulative effects on UXO have not been identified or considered in this assessment.

17.8.2 Cumulative Construction/Decommissioning Effects

Disturbance of Existing Offshore Wind Farm Activities

17.8.2.1 The offshore wind farm projects within the Moray Firth are seen to be complimentary rather than conflicting, and all are intended to meet renewable energy targets in Scotland and the wider UK. Relationships and communication between all offshore developers are considered to be good. Continued sharing of plans with regard to O&M and construction schedules and methodologies will ensure all works are undertaken safely and as a result **no cumulative effect** is predicted.

Disturbance of Existing Subsea Cables

17.8.2.2 Only the export cables associated with the Development will need to cross the Beatrice oil field subsea cable, the Beatrice offshore wind farm export cables, and the Caithness to Moray interconnector cable. The export cables associated with the Development will therefore not act cumulatively with other projects or activities during construction to impact existing subsea cables. **No cumulative effect** is predicted.

Disturbance of Oil Exploration and Decommissioning Activities

17.8.2.3 The exploration plans of oil block licence holders are currently unknown. Construction activity associated with the Development has the potential to restrict access to licence blocks for the purposed of exploration (e.g. seismic surveys, well drilling). Cumulative impacts may arise when a particular block that is already affected by the Development is also affected by another project or activity.

17.8.2.4 Oil exploration activity in licensed areas of blocks 11, 12 and 18 may be cumulatively impacted by the construction of the Beatrice, Moray West and Moray East offshore wind farms, with portions or blocks inaccessible. However, indicative construction programmes suggest minimal overlap of construction across the two projects and as described in Section 17.7.2 embedded mitigation measures and ongoing liaison with oil licence block holders will limit the scope for interference.

17.8.2.5 With a low sensitivity (assuming there is a degree of flexibility in terms of when seismic survey is undertaken and a variety of survey techniques that may be employed) and negligible magnitude (exclusion would be temporary during construction and/or decommissioning), the potential cumulative effect is deemed to be of **negligible or minor adverse** significance.

17.8.2.6 The Development is not expected to act cumulatively with other projects or activities to impact the planned decommissioning of the Beatrice and Jacky oil field infrastructure; **no cumulative effect** is predicted in this regard.

Disturbance of Marine Disposal Activities

17.8.2.7 At the time of installation of the export cables associated with the Development, no other nearby construction activities are expected to be taking place, and **no cumulative effect** is predicted on Buckie marine disposal site.

17.8.3 Cumulative Operational and Maintenance Effects

Disturbance of Existing Offshore Wind Farm Activities

17.8.3.1 The offshore wind farm projects within the Moray Firth are seen to be complimentary rather than conflicting, and all are intended to meet renewable energy targets in Scotland and the wider UK. Relationships and communication between all offshore developers are considered to be good. Continued sharing of plans with regard to O&M schedules and methodologies will ensure all works are undertaken safely and as a result **no cumulative effect** is predicted.

17.8.3.2 The Beatrice Demonstrator wind turbines are expected to be decommissioned once the Development is operational; however, it is not expected that the Development will act cumulatively with other projects and activities to impact decommissioning activity. **No cumulative effect** is predicted in this regard.

Disturbance of Existing Subsea Cables

17.8.3.3 Only the export cables associated with the Development will need to cross the Beatrice oil field subsea cable, the Beatrice offshore wind farm export cables, and the Caithness to Moray interconnector cable. The export cables associated with the Development will therefore not act cumulatively with other projects or activities during maintenance to impact existing subsea cables. **No cumulative effect** is predicted.

Disturbance of Oil Exploration and Decommissioning Activities

17.8.3.4 The exploration plans of oil block licence holders are currently unknown. The presence of the operational Development has the potential to restrict access to licence blocks for the purposed of exploration (e.g. seismic surveys, well drilling). Cumulative impacts may arise when a particular block that is already affected by the Development is also affected by another project or activity.

17.8.3.5 Oil exploration activity in licensed portions of blocks 11, 12 and 18 may be cumulatively impacted by the presence of the operational Beatrice, Moray West and Moray East offshore wind farms, with portions or blocks inaccessible.

17.8.3.6 In light of the application of embedded mitigation measures and ongoing liaison with oil operators and licence holders by all offshore wind farm operators, the sensitivity of oil exploration activities to disturbance from the operation of the Development is judged to be

Moderate, and with the application of embedded mitigation measures the magnitude of the impact is assessed as Negligible. The resulting significance of the cumulative effect is **negligible to minor adverse**, and not significant in EIA terms.

17.8.3.7 The Development is not expected to act cumulatively with other projects or activities to impact the planned decommissioning of the Beatrice and Jacky oil field infrastructure; **no cumulative effect** is predicted in this regard.

Disturbance of Marine Disposal Activities

17.8.3.8 During its operational phase, the Development, is not expected to act cumulatively with any other project or activity to impact Buckie marine disposal site and **no cumulative effect** is predicted.

17.9 References

6 Alpha Associates (2011). Unexploded Ordnance Threat and Risk Assessment with Risk Mitigation.

Baxter, J.M., Boyd, I.L., Cox, M., Donald, A.E., Malcolm, S.J., Miles, H., Miller, B., Moffat, C.F., (Editors) (2011). Scotland's Marine Atlas: Information for the national marine plan. Marine Scotland, Edinburgh. pp. 191.

BOWL (2017). TV and Radio Impact Report. July 2017.

BOWL (2016). Development Specification and Layout Plan.

CDA (2017). UK Oil and Gas Data website. https://www.ukoilandgasdata.com/dp/jsp/PleaseLogin.jsp [Accessed November 2017].

DECC (2016). UK Offshore Energy Strategic Environmental Assessment 3 (OESEA3). Accessed February 2017 at: https://www.gov.uk/government/consultations/uk-offshore-energy-strategic-environmental-assessment-3-oesea3.

The European Network of Transmission System Operators for Electricity (Entsoe) data https://www.entsoe.eu/major-projects/ten-year-network-development-plan/maps-and-data/Pages/default.aspx [accessed September 2017].

Faroese Telecom (2017). SHEFA website. http://www.shefa.fo/cable/. Accessed [November 2017].

Marine Scotland Current Licensing http://www.gov.scot/Topics/marine/Licensing/marine/scoping.

Marine Scotland (2011). Blue Seas – Green Energy, A Sectoral Marine Plan for Offshore Wind Energy in Scottish Territorial Waters (Part A, The Plan).

Marine Scotland (2012a). Draft Marine Scotland Licensing and Consents Manual, covering Marine Renewables and Offshore Wind Energy Development.

Marine Scotland (2012b). Wave and Tidal Regional Locational Guidance.

Marine Scotland (2013a). Offshore Wind Initial Plan Framework (Draft Plan Options).

Marine Scotland (2013b). Planning Scotland's Seas – Scotland's National Marine Plan Consultation Draft.

Marine Scotland (2014). Potential Scottish Test Sites for Deep Water Floating Wind Technologies - Draft Regional Locational Guidance.

MORL (2012). Environmental Statement - Telford, Stevenson, MacColl Wind Farms and Associated Transmission Infrastructure.

MORL (2014). Offshore Transmission Infrastructure Environmental Report. Modified Offshore Transmission Infrastructure: Offshore Substations & Offshore Export Cables. Telford, Stephenson, MacColl Windfarms and Associated Modified Transmission Infrastructure.

National Marine Plan interactive (NMPi) (2017). www.gov.scot/nmpi. [Last Accessed November 2017).

Ofcom (2009) Tall structures and their impact on broadcast and other wireless services.

Oil and Gas Authority (OGA) website (2017). https://www.ogauthority.co.uk/licensing-consents/licensing-rounds/offshore-licensing-rounds/#tabs. [Last Accessed November 2017].

Oil and Gas Authority (OGA) (2018). Projections of UK Oil and Gas Production and Expenditure. Available at: https://www.ogauthority.co.uk/media/4647/projections-of-uk-oil-and-gas-production-and-expenditure-march-2018.pdf [accessed March 2018].

Pager Power (2009) RPS Moray Firth – High Level Screening Assessment.

Respol Sinopec Resources UK (May 2017). Beatrice Decommissioning, Environmental Impact Assessment, Scoping Report.

Scottish Carbon Capture and Storage (SCCS) website (2017). http://www.sccs.org.uk. [Last accessed November 2017].

Scottish and Southern Electricity Networks (SSEN) (2017). Website. [Last accessed November 2017].

The Scottish Government (March 2015). Scotland's National Marine Plan, A Single Framework for Managing Our Seas.

The Scottish Government (2013). Initial Plan Framework (Draft Plan Options) - Offshore Wind.

The Scottish Government (March 2011). Blue Seas - Green Energy A Sectoral Marine Plan for Offshore Wind Energy in Scottish Territorial Waters Part A The Plan.

The Scottish Government and Scottish Enterprise (March 2010). Carbon Capture and Storage - A Roadmap for Scotland.

SHE Transmission (2015). Major Transmission Projects Update April 2015.

UK Offshore Energy Strategic Environmental Assessment 3 (OESEA3) https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/504567/OESEA3_A1h_Other_users.pdf [accessed September 2017].

Offshore EIA Report

Moray Offshore Windfarm (West) Limited

Chapter 18 Whole Project Assessment

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Acronyms	
Acronym	**Expanded Term**
EIA	Environmental Impact Assessment
HVAC	High Voltage Alternating Current
MHWS	Mean High Water Springs
MLWS	Mean Low Water Springs
MPS	Marine Policy Statement
NETS	National Electricity Transmission System
OfTI	Offshore Transmission Infrastructure
OnTI	Onshore Transmission Infrastructure
OnTO	Onshore Transmission Owner
PAB	Planning Application Boundary
PPP	Planning Permission in Principle
SLVIA	Seascape, Landscape and Visual Impact
TJB	Transition Joint Bay
UK	United Kingdom

18 Whole Project Assessment

18.1 Introduction

18.1.1.1 This chapter considers the likely significant effects arising from the Project (i.e. the Development and the Onshore Transmission Infrastructure [OnTI]) in its entirety based on the extent to which the components and location of the OnTI are defined at the time of writing. The assessment is provided to ensure that this Offshore EIA Report contains sufficient information on the OnTI to assist Scottish Ministers with making decisions on the consent applications submitted for the Development (Moray West Offshore Wind Farm and OfTI) in the context of the overall Project.

18.1.1.2 A separate Onshore EIA Report for the Onshore Transmission Infrastructure (OnTI), which fully assesses the likely significant effects of the OnTI, has been prepared in support of an application for Planning Permission in Principle (PPP) under the Town and Country Planning (Scotland) Act 1997.

18.2 The Onshore Transmission Infrastructure

18.2.1.1 The purpose of the OnTI is to supply electricity generated by the Moray West Offshore Wind Farm to the onshore National Electricity Transmission System (NETS). The electricity will be transmitted via two high voltage alternating current (HVAC) cable circuits with a transmission voltage of up to 400 kV.

18.2.2 Key Components

18.2.2.1 The key components of the OnTI are summarised below and the location of the OnTI Planning Application Boundary (PAB) is shown in Volume 3a - Figure 18.2.1. Detailed descriptions of the OnTI are provided in in the Onshore EIA Report (Chapter 2: Proposed Development).

Change to Onshore Planning Application Boundary

As noted in Chapters 1, 3 and 4 of this Offshore EIA Report (Volume 2), Moray West has removed Sandend Beach and potential landfall locations to the west of Sandend Beach to Findlater Castle from the Onshore PAB. This decision to change the Onshore PAB has been informed by work undertaken as part of the Onshore EIA and feedback received through consultation with local communities and other key stakeholders. The revised Onshore PAB is presented in Image 18.2.1 below.

The assessment presented in Section 18.3.3 below is based on the full extent of the original Onshore PAB (e.g. Findlater Castle to Redhythe Point). This is in line with the approach taken to other chapters within this Offshore EIA Report. Potential interactions occurring within the intertidal zone still remain applicable to this assessment on the basis that intertidal areas remain within the revised PAB (section of coast east of Sandend Beach to Redhythe Point). However, it should be noted that direct impacts on Sandend Beach and areas to the west of Sandend Beach are no longer applicable to the application.

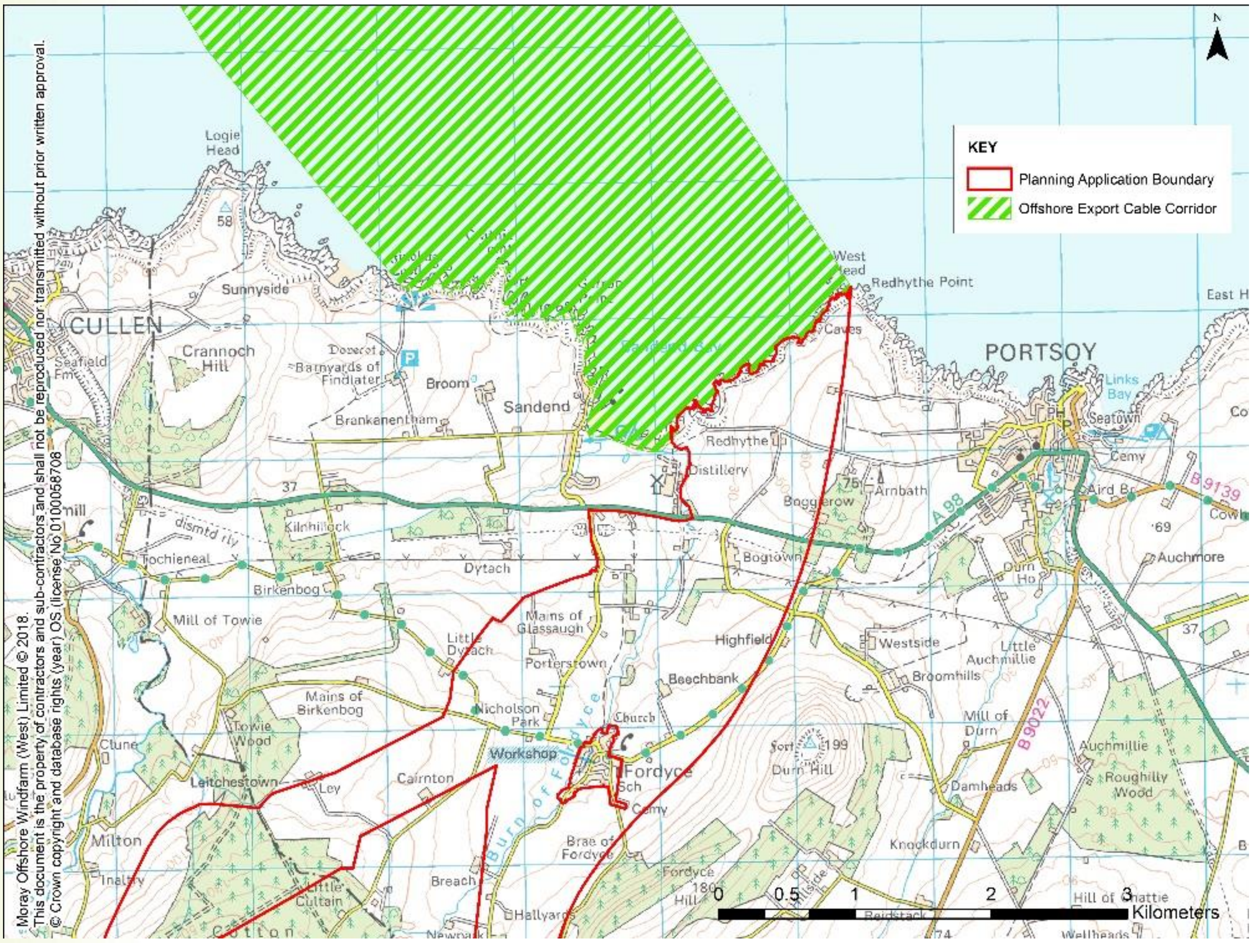

Image 18.2.1: Revised Onshore PAB excluding Sandend Beach and potential landfall locations to the west of Sandend Beach to Findlater Castle

Landfall Location and Transition Joint Bays

18.2.2.2 The offshore export cable circuits will make landfall at a location within the Landfall Area, which now extends from the rocks located at the east end of Sandend Beach to Redhythe Point on the Aberdeenshire coastline. The offshore and onshore export cable circuits will interface in two buried Transition Joint Bays (TJBs), which will be located above Mean High Water Springs (MHWS) and as close to the landfall location as practicable.

Onshore Cable Circuits

18.2.2.3 Onshore cable circuits will transmit power underground between the TJBs and the onshore substation.

18.2.2.4 On exiting the TJBs, the onshore cable circuits will be routed inland towards the onshore substation site. The HVAC system will comprise two cable circuits, with each circuit comprising three separate cables. The voltage for the cables will between 132 and 400 kV (most likely 220 kV). The cable circuits will be buried.

Onshore Substation

18.2.2.5 The proposed location of the onshore substation, in the vicinity of Whitehillock off the A96, is shown on Figure 18.2.1. The exact location and layout of the proposed infrastructure will be determined as part of the detailed design process. However, for the purposes of the Onshore EIA Report, the Design Envelope for the substation assumes a footprint of up to approximately 60,000 m^2 (including landscaping and parking) and a maximum height of up to 13 m, plus lightning rods of an additional 6 m height.

18.2.2.6 It should be noted that, as indicated in Figure 18.2.1, the permanent infrastructure, i.e. the onshore substation itself and landscape mitigation, will only be located within the western field. It is currently proposed that the eastern field be used for temporary works only, although it may be used for permanent landscaping if the detailed design process identifies a need.

18.2.2.7 The onshore substation will require a permanent access. This will be taken from the existing single-track road that provides access to the buildings of Whitehillock from the A96 trunk road, and borders the site to the east.

Transmission Interface

18.2.2.1 The transmission interface point, i.e. the location where the OnTI will connect to the NETS, is the existing Blackhillock substation. The works required at Blackhillock substation to facilitate the connection of the OnTI will be completed by Scottish Hydro Electric Transmission Limited (the Transmission Network Owner [TNO]). It is expected that the works will be completed under the TNOs permitted development rights and be located within the footprint of Blackhillock substation.

18.2.2.2 Interconnecting underground cable circuits will link the onshore substation at Whitehillock to the existing Blackhillock substation and these will be installed as part of the OnTI. Blackhillock is approximately 2.3 km to the north west of the onshore substation.

18.2.3 Indicative Construction Programme

18.2.3.1 It is currently proposed that any necessary pre-construction surveys and site investigations will occur during Q2 2020 until Q3 2021. Following the detailed design and planning processes, and on securing the necessary consents and licences, construction of the OnTI itself will commence during Q1 2022. Assuming no undue constraints, construction will continue until Q3 2024. First generation for the Moray West Offshore Wind Farm is planned for Q4 2024, with the completion of commissioning and handover of the Offshore Transmission Infrastructure (OfTI) and OnTI to the Offshore Transmission Owner (OfTO) occurring in Q4 2024.

18.2.3.2 Where possible, construction activities will be carried out concurrently, thus minimising the overall length of the construction programme. It is likely that installation of the OnTI's key components will be phased as follows:

- Q2 / Q3 2022 – Site preparation and construction activities at the landfall location;
- Q2 2022 to Q1 2024 – Installation of the onshore substation;
- Q2 2023 to Q1 2024 – Installation of the onshore cable circuits, including TJBs;
- Q1 2024 to Q3 2024 – Site reinstatement.

18.2.4 Operation and Maintenance of the OnTI

18.2.4.1 It is intended that the OnTI will operate 24 hours a day for 365 days a year, for the lifetime of the Project. Maintenance of the infrastructure will generally be separated into the following three categories:

- Periodic overhauls – Carried out in accordance with the manufacturer's warranty. These are usually scheduled to occur with planned maintenance outages;
- Scheduled maintenance – Largely required for the inspection and testing of equipment; and
- Unscheduled maintenance – Required in the event of unplanned defects or failures.

18.3 Consideration of the OnTI in this Offshore EIA Report

18.3.1.1 As noted in Section 18.1, the onshore aspects of the Project (the OnTI) are subject to a separate application for PPP, to be submitted to Moray and Aberdeenshire Councils. The OnTI application is supported by a separate Onshore EIA Report.

18.3.1.2 In accordance with the EIA Regulations and the UK Marine Policy Statement (MPS) (HM Government, 2011) there is a requirement to ensure that information about the whole project, and associated environmental effects, including inter-relationships between the marine and terrestrial consenting regimes, is provided as part of the application for the Development. This is necessary to ensure that, where projects extend across multiple jurisdictions and comprise multiple components, Scottish Ministers have sufficient information available to enable them to consider the project, and associated environmental effects, as a whole, rather than the different components being considered in isolation.

18.3.1.3 Given that submission of the PPP applications for the OnTI will follow submission of the Section 36 consent and Marine Licence applications for this Development, it is necessary to include information on potential effects of the OnTI, and potential inter-relationships between the marine and terrestrial component of the Project, in this Offshore EIA Report.

18.3.1.4 Information presented in this Chapter therefore comprises the following:

- Summary of all potential effects assessed as part of the OnTI EIA Report and conclusions from that assessment in terms of effect significance; and
- Identification, and description of, potential inter-related effects on onshore receptors as a result of effects arising from the Development and the OnTI on the same receptor.

18.3.1.5 Once the applications for PPP are submitted to Moray and Aberdeenshire Councils, copies of the Onshore EIA Report will be made available to view in the same advised public viewing locations in Moray and Aberdeenshire as this Offshore EIA Report. A copy of the Onshore EIA Report will also be provided to MS-LOT and The Highland Council.

18.3.1.6 Electronic copies will be made available to key stakeholders on request. Hard copies are also available at a cost of £300.

18.3.2 Spatial Overlaps and Receptor Interactions

18.3.2.1 There is a spatial overlap between the application boundaries for the Development and the OnTI. This occurs at the landfall where the OfTI application boundary extends up to MHWS and the OnTI application boundary extends down to Mean Low Water Spring (MLWS). Potential effects within the overlap area (intertidal zone) have been assessed within both this Offshore EIA Report (Chapter 6: Physical Processes and Water Quality and Chapter 7: Benthic and Intertidal Ecology) and the Onshore EIA Report (Chapter 5: Hydrology, Hydrogeology and Geology and Chapter 6: Terrestrial Ecology).

18.3.2.2 Where there is also potential for offshore components of the Project to affect onshore receptors (for example visual receptors or coastal watersport activities such as surfing) these have also been assessed in both this Offshore EIA Report (Chapter 14: Seascape, Landscape and Visual Impact Assessment (SLVIA) and Chapter 15: Socioeconomics, Tourism and Recreation) and the Onshore EIA Report (Chapter 7: Landscape and Visual Impact Assessment (LVIA) and Chapter 12: Socioeconomics, Tourism and Recreation).

18.3.3 Conclusions on Effect Significance from Onshore EIA Report and Potential Inter-Relationships

18.3.3.1 Conclusions on effect significance from the Onshore EIA Report and potential inter-relationships with the Offshore EIA Report, are summarised in Table 18.3.1 below.

Table 18.3.1: Summary of Effects from the Onshore EIA Report and Potential Inter-Related Effects

Impacts Assessed in the Onshore EIA Report	Phase			Potential Inter-Relationships Between the Development and the OnTI.
	Construction	Operation and Maintenance	Decommissioning	
Hydrology, Hydrogeology and Geology				
Reduction of water availability to support existing surface water and groundwater abstractions as a consequence of water quantity and / or quality effects.	Not significant	Not significant	Not significant	Potential for inter-related effects to occur at the landfall, in particular with respect to effects on coastal water quality and sensitive geological features (Cullen to Stake Ness Coast SSSI) which are located at the coast. The main source of inter-related effects on these receptors include Open Cut Trenching (OCT) or Horizontal Direction Drilling (HDD) operations required to bring the cables ashore. Both operations (OCT and HDD) extend from a point landward of MHWS to a point seaward of the MLWS and will be carried out as one continuous operation. Construction compounds and set up of OCT operations or drilling rigs required for the HDD solution will be located landward of the MHWS. Effects associated with these activities are assessed in the Onshore EIA Report. Where the cables are routed through, or beneath, the intertidal area, resulting potential effects on coastal water quality and the Cullen to Stake Ness Coast SSSI are assessed in this Offshore EIA Report (Chapter 6: Physical Processes and Water Quality) and in the Onshore EIA Report (Chapter 5: Hydrology, Hydrogeology and Geology and Chapter 6: Terrestrial Ecology). Both assessments have concluded no significant effects. There are no inter-related effects on these receptors (coastal water quality and the Cullen to Stake Ness Coast SSSI) associated with the onshore cable route (landward of MHWS) or substation on the basis that there is no potential for interactions between this Development and any freshwater systems that feed into the Landfall Area, or onshore soils / geological features.
Ground disturbance and mobilisation of sediments / contaminants leading to silt laden or contaminated runoff entering watercourses.	Not significant	Scoped out	Not significant	
Reduction of groundwater availability to support GWDTEs as a consequence of water quantity and / or quality effects.	Not significant	Not significant	Not significant	
Changes in runoff rates and new flow pathways and increases in flow due to dewatering of excavations.	Not significant	Not significant	Not significant	
Physical disruption to existing discharge infrastructure (e.g. septic tank, soakaways or discharge outfalls) from trenching and temporary access track / compound establishment.	Not significant	Scoped out	Not significant	
Changes in watercourse conveyance from temporary watercourse crossings.	Not significant	Scoped out	Not significant	
Changes to watercourse morphology as a result of works in, or near watercourses.	Not significant	Not significant	Not significant	
Potential for accidental contamination entering watercourses, associated with spillage or leakage of fuels, lubricants or other chemicals.	Not significant	Scoped out	Not significant	
Damage to the qualifying Dalradian geological features.	Not significant	Scoped out	Scoped out	
Volumetric displacement of flood water.	Scoped out	Scoped out	Not significant	

Table 18.3.1: Summary of Effects from the Onshore EIA Report and Potential Inter-Related Effects				
Impacts Assessed in the Onshore EIA Report	**Phase**			**Potential Inter-Relationships Between the Development and the OnTI.**
	Construction	**Operation and Maintenance**	**Decommissioning**	
Terrestrial Ecology				
Potential direct loss of ecological features (habitats and/or fauna) on statutory designated sites.	Not significant	Scoped out	Scoped out	As with effects on hydrology, hydrogeology and geology above, and discussed in Section 18.3.2, due to the overlap between the OnTI and OfTI application boundaries, it has been necessary to assess potential effects on intertidal ecology (in the overlap area) in both this Offshore EIA Report (Chapter 7) and the Onshore EIA Report (Chapter 6: Terrestrial Ecology). Both assessments have concluded no significant effects with respect to direct habitat and species loss and disturbance, increased suspended sediment concentrations / deposition, introduction of Marine Invasive Non-Native Species (MINNS) and accidental contamination. Where the preferred solution is HDD, the cables will be routed underground, limiting the potential for any effects on intertidal ecological receptors within the Landfall Area. Given that the construction compounds / HDD drill rig (if required) will be located landward of MHWS (and therefore assessed in the Onshore EIA Report), there is limited potential for any inter-related effects associated with the OfTI works. Potential effects on seals, seabirds (which breed in coastal locations), waterfowl and waders are assessed in this Offshore EIA Report (Chapter 10). Effects on otters (coastal) are assessed in the Onshore EIA Report (Chapter 7: Terrestrial Ecology). In terms of species present in, and associated with the Landfall Area, all effects are assessed to be not significant. There are no inter-related effects on these receptors associated with the onshore cable route or substation.
Potential direct loss of ecological features (habitats and/or fauna) on non-statutory designated sites.	Not significant	Scoped out	Scoped out	
Direct terrestrial habitat loss / disturbance.	Not significant	Scoped out	Scoped out	
Indirect terrestrial habitat loss / disturbance (e.g. from disruption or changes to hydrology).	Not significant	Not significant	Not significant	
Loss of, or disturbance to, intertidal habitat and species.	Not significant	Not significant	Not significant	
Increased suspended sediments / sediment deposition within the intertidal area.	Not significant	Not significant	Not significant	
Spread of invasive non-native terrestrial and/or freshwater species.	Not significant	Scoped out	Scoped out	
Potential injury or death of terrestrial and/or freshwater fauna (direct effect).	Not significant	Not significant	Not significant	
Noise disturbance leading to the displacement of terrestrial fauna (indirect effect).	Not significant	Not significant	Not significant	
Pollution leading to loss of or damage to ecological features (direct and/or indirect effect).	Not significant	Not significant	Not significant	

Table 18.3.1: Summary of Effects from the Onshore EIA Report and Potential Inter-Related Effects

Impacts Assessed in the Onshore EIA Report	**Phase**			**Potential Inter-Relationships Between the Development and the OnTI.**
	Construction	**Operation and Maintenance**	**Decommissioning**	
Biosecurity.	Not significant	Not significant	Not significant	
Landscape and Visual Amenity				
Physical changes to the landscape elements and features within the site boundary.	Not significant	Not significant	Not significant	There are no potential inter-related effects on visual amenity associated with the presence of the onshore substation and the Moray West Offshore Wind Farm on the basis that due to the distance of the substation from the coast (23 km from the Landfall Area and 19 km from nearest coastal location) there are no locations where it is possible to see both the wind farm and the substation at the same time. At the landfall, during construction, it is likely that activities offshore (presence of construction and cable lay vessels) will be visible at the same time as construction activities onshore. Potential effects of construction / cable installation activities at the landfall on landscape and visual amenity have been assessed in both this Offshore EIA Report (Chapter 14) and the Onshore EIA Report (Chapter 7: LVIA). Where inter-related effects occur these will be short term, localised and temporary in nature during construction only. Once installed, the cables and the TJBs will be buried and not visible. It has also been concluded that views of the Moray West Offshore Wind Farm from within the Landfall Area are very limited. Based on conclusions within this Offshore EIA Report (Chapter 14) and the Onshore EIA Report (Chapter 7: LVIA) it is concluded that potential inter-related effects on visual amenity receptors will be not significant.
Landscape character effects on the Coastal Character Area, landscape planning designations and landscape character types / units.	Significant but short-term and localised (on some of the LCT and SLA)	Not significant	Not significant	
Visual effects on views from visual receptors and viewpoints.	Significant but short-term and localised (five views from A98, minor roads and properties)	Not significant	Not significant	

Table 18.3.1: Summary of Effects from the Onshore EIA Report and Potential Inter-Related Effects				
Impacts Assessed in the Onshore EIA Report	**Phase**			**Potential Inter-Relationships Between the Development and the OnTI.**
	Construction	**Operation and Maintenance**	**Decommissioning**	
Night-time visual effects on views from visual receptors and viewpoints.	Not significant	Not significant	Not significant	In terms of effects on landscape character, it was concluded in Chapter 14 that there would be no significant effects on the Sandend Bay Regional Coastal Character Area (RCCA) due to the presence of the Moray West Offshore Wind Farm. Due to the distance of the substation from this RCCA, there is no potential for any inter-related effects due to presence of the substation in combination with the offshore wind farm. All landfall infrastructure and onshore cables will be buried and therefore not visible, further reducing the potential for any inter-related effects on landscape character with this Development and the OnTI.
Historic Environment				
Direct disturbance of designated, non-designated and as yet unknown archaeological remains where they are located within the footprint of the OnTI.	Not significant	Scoped out	Scoped out	There is potential for OCT activities at the landfall to affect known and undiscovered archaeological assets present in the nearshore (marine), intertidal and onshore parts of the Landfall Area. However, given the highly spatially discrete nature of archaeological assets, the potential for any interactions between archaeological receptors (assets) in different parts of the Landfall Area is highly limited. Potential effects on assets in the Landfall Area have been assessed in this Offshore EIA Report (Chapter 16) and the Onshore EIA Report (Chapter 8: Historic Environment). No significant effects were identified.

Table 18.3.1: Summary of Effects from the Onshore EIA Report and Potential Inter-Related Effects				
Impacts Assessed in the Onshore EIA Report	**Phase**			**Potential Inter-Relationships Between the Development and the OnTI.**
	Construction	**Operation and Maintenance**	**Decommissioning**	
Indirect effects on the settings of designated assets resulting from below ground infrastructure.	Scoped out	Not significant	Scoped out	In terms of potential inter-related effects on the setting of designated sites and archaeological features, as concluded for effects on landscape and visual amenity, given that there are no locations where both the offshore wind farm and substation are visible at the same time, and the onshore cable and all infrastructure at the landfall will be buried beneath the ground and therefore not visible, there is no potential for any inter-related effects during operation on the setting of designated sites and archaeological features. The onshore PAB has been located to the east of Findlater Castle to provide a stand-off area from the castle that allows potential temporary effects on the setting of Findlater Castle to be removed during installation of the cables at the landfall. This allows management of effects resulting due to construction activities both onshore and offshore (presence of cable lay vessels etc.) and these are now assessed as short term, temporary and not significant. A detailed assessment of potential effects on the setting of coastal and onshore designated sites and archaeological features is provided in Chapter 14 of this Offshore EIA Report.
Indirect effects on the settings of designated assets resulting from above ground infrastructure.	Scoped out	Not significant	Scoped out	
Traffic and Transport				
Disruption and delay to vehicle travellers.	Not significant	Scoped out	Not significant	All infrastructure for the Moray West Offshore Wind Farm (substructures, turbines and inter-array cables), OSP(s), OSP interconnector cables and export cables will be transported to site via offshore transport and construction vessels, reducing the requirement for any onshore transport requirements. However, it is likely that some equipment and plant required for operations at the landfall (e.g. transport to site of the HDD rig)
Disruption to pedestrian amenity and pedestrian severance.	Not significant	Scoped out	Not significant	

Table 18.3.1: Summary of Effects from the Onshore EIA Report and Potential Inter-Related Effects				
Impacts Assessed in the Onshore EIA Report	**Phase**			**Potential Inter-Relationships Between the Development and the OnTI.**
	Construction	**Operation and Maintenance**	**Decommissioning**	
Disruption to the use of core paths.	Not significant	Scoped out	Not significant	will require onshore traffic movements. Although activities at the landfall relate to both the OnTI and OfTI, potential effects of transporting equipment required for construction activities at the landfall on traffic and transport are assessed in Chapter 9: Traffic and Transport of the Onshore EIA Report only. This is on basis that most of the equipment for the landfall will be located in the construction compound which lies landward of the MHWS mark. The potential for any further inter-related effects to occur between the OnTI and OfTI at the landfall are limited as all transport requirement for the OfTI have already been considered as part of the Onshore EIA Report (Chapter 9: Traffic and Transport).
Potential to cause accidents and reduce road safety.	Not significant	Scoped out	Not significant	
Disruption and delay to public transport services.	Not significant	Scoped out	Not significant	
Noise and Vibration				
Noise effects on human and ecological receptors resulting from laying and operation of the onshore cable circuits.	Not significant	Scoped out	Scoped out	No inter-related effects on basis that due to the distance of the Moray West Offshore Wind Farm from shore, there is no potential for any effects from airborne noise on humans or terrestrial ecological receptors. Potential effects of underwater and airborne noise on marine ecological receptors are assessed in Chapters 8, 9 and 10 of this Offshore EIA Report. There are no designated seal haul out sites at or in close proximity to the landfall. The nearest non-designated seal haul out is a small grey seal haul out approximately 3 km from Sandend Bay, but it is not considered important for breeding or moulting. Construction works associated with cable installation at landfall are not expected to result in any disturbance to hauled-out seals, Potential effects on onshore and coastal birds from noise at the landfall have been assessed as not significant (Onshore EIA Report, Chapter 6: Terrestrial Ecology).
Noise effects on human and ecological receptors resulting from the onshore substation infrastructure and components.	Not significant	Not significant	Not significant	
Vibration effects on human, ecological receptors and infrastructure resulting from the HDD activities, onshore substation infrastructure and components.	Not significant	Scoped out	Not significant	
Socio-economics, Tourism and Recreation				

Table 18.3.1: Summary of Effects from the Onshore EIA Report and Potential Inter-Related Effects				
Impacts Assessed in the Onshore EIA Report	**Phase**			**Potential Inter-Relationships Between the Development and the OnTI.**
	Construction	**Operation and Maintenance**	**Decommissioning**	
Direct and indirect employment opportunities	Significant positive effects	Positive effects	Scoped out	It was concluded in Chapter 15 of this Offshore EIA Report that there is potential for the Development to have significant positive effects with the local study area (Aberdeenshire, Moray and Highland local authority areas) in terms of employment opportunities and GVA creation during construction and positive effects during operation and decommissioning. These employment opportunities and GVA creation assume a certain level of supply of goods and services from the local study area during construction, operation and decommissioning of the Development. The conclusions also assume construction ports and O&M bases will be located within the local study area. Opportunities for employment and GVA creation associated with the OnTI relate specifically to installation of the onshore cables and the construction and long term operation of the substation. While the opportunities are geographically more constrained (mainly in Aberdeenshire and Moray), and the total number of jobs created will be lower than for the Moray West Offshore Wind Farm and OfTI, the potential effects are still considered to be of positive significance. This is on the basis that the OnTI works will be creating employment opportunities in an area where current levels of employment are low. The Project therefore as a whole, has the potential to create a range of jobs and opportunities for GVA creation both offshore and onshore in a location where traditionally employment opportunities are limited with reliance on tourism or agriculture. It is also acknowledged that although construction jobs are generally temporary, when considering cumulative effects associated with the Caithness Moray Interconnector, Beatrice Offshore Wind Farm and Moray East offshore wind farm projects there will potentially be longer term opportunities where
Direct and indirect GVA creation	Significant positive effects	Positive effects	Scoped out	
Change in demand for housing and local services associated with influx of labour – socio economics.	Not significant	Scoped out	Scoped out	

Table 18.3.1: Summary of Effects from the Onshore EIA Report and Potential Inter-Related Effects				
Impacts Assessed in the Onshore EIA Report	**Phase**			**Potential Inter-Relationships Between the Development and the OnTI.**
	Construction	**Operation and Maintenance**	**Decommissioning**	
				contractors can move from project to project given the nature of the works associated with all these projects are the same.
Value of tourism.	Not significant	Scoped out	Scoped out	**Recreation and tourism** The Landfall Area encompasses the beach at Sandend. Sandend is one of only a few beaches located along this section of the Aberdeenshire Coast and therefore is recognised as being of local importance due to both its recreational and amenity value. Sandend Beach is also an important surfing location. Potential effects on the quality of the waves for surfing and the surfing community and local surfing businesses are assessed in Chapter 15 of this Offshore EIA Report. This concluded that, although the final location of the landfall is still to be determined, in the event that the cable is brought ashore via the beach, any potential effects on the quality of the beach for surfing or surfers using the beach would be not significant. This is on the basis that, although the assessment acknowledges the importance of the beach for surfing, potential effects during installation of the cable will be

Table 18.3.1: Summary of Effects from the Onshore EIA Report and Potential Inter-Related Effects				
Impacts Assessed in the Onshore EIA Report	**Phase**			**Potential Inter-Relationships Between the Development and the OnTI.**
	Construction	**Operation and Maintenance**	**Decommissioning**	
Short-term path / route closures and diversions; noise; dust or visual disturbance – recreation.	Significant (only at Sandend Bay and Beach in relation to surfing, remainder is not significant)	Scoped out	Scoped out	temporary and short term in nature. Potential long terms effect on the quality of the surf, due to the presence of the cable were assessed as negligible and not significant. Effects on surfers in terms of restricted access to the beach were also assessed in the Onshore EIA Report (Chapter 12: Socio-economics, Tourism and Recreation). These effects were also assessed as not significant due to their temporary and short term nature, with the exception of Sandend Bay where access for surfing may be temporarily affected. Once the cables are installed, access to the beach will be fully reinstated. Potential long term effects are therefore negligible. The Onshore EIA Report (Chapter 12: Socio-economics, Tourism and Recreation) also concluded that, potential effects on local residents of Sandend due to restricted access to the beach and a reduction in local amenity value of the area during cable installation would also not be significant due to the temporary and short term nature of the potential effects. Once installed, no infrastructure will be visible above ground and access to the beach will be fully reinstated. Potential long term effects during operation are therefore negligible and not significant. Given that activities at the landfall relate to both the OfTI and OnTI, any beach access restrictions will occur at the same time for both components of the Project.
Land Use				
Direct, temporary disturbance of, or change in land use.	Not significant	Scoped out	Scoped out	Due to the direct and spatially specific nature of effects on landfall, the only location where there is any potential for inter-related effects is at the landfall. Land uses in the Landfall Area comprise agricultural (above MHWS) along the coast, residential (Sandend) or recreational (beach, dunes and playing fields at

Table 18.3.1: Summary of Effects from the Onshore EIA Report and Potential Inter-Related Effects				
Impacts Assessed in the Onshore EIA Report	**Phase**			**Potential Inter-Relationships Between the Development and the OnTI.**
	Construction	**Operation and Maintenance**	**Decommissioning**	
Direct, permanent change in land use.	Scoped out	Significant (for substation only - change from agricultural land to developed land)	Significant (for substation only – change from built up to agricultural land only if substation is removed during decommissioning)	Sandend). There is also a small, private fishing harbour at the west end of Sandend Bay. Potential effects on the fishing harbour are assessed in Chapter 17 of this Offshore EIA Report (Other Human Activities). These are assessed as not significant. The only area where there is a potential inter-related effect is Sandend Beach. Potential effects on the use of Sandend Beach for recreational purposes are discussed with respect to effects on recreation and tourism (Onshore EIA Report, Chapter 12: Socio-economics, Tourism and Recreation).
Air Quality				
Dust arising from excavations and earth movements.	Not significant	Scoped out	Scoped out	Potential effects on air quality associated with the Moray West Offshore Wind Farm or OfTI have been scoped out of this EIA Report. Therefore there is no potential for any inter-related effects.
Emissions from construction plant and vehicles.	Not significant	Scoped out	Scoped out	
Population and Human Health				
Effects of EMFs on human health.	Scoped out	Scoped out	Scoped out	Potential effects of EMFs on population and human health for the OnTI, including at the landfall, were scoped out as part of the OnTI Scoping Report and Scoping Opinion received from Moray Council and Aberdeenshire Council. Effects of EMFs on marine wildlife have been assessed in Chapters 7, 8 and 9 of this Offshore EIA Report. There are no inter-related effects with respect to human health.
Other potential effects upon population and human health.	Addressed within appropriate environmental topic e.g. Noise and Vibration, Tourism and Recreation.			Inter-related effects discussed in relation to relevant topics above.

References

HM Government 2011. UK Marine Policy Statement.

Moray West. May 2016. Moray West Offshore Wind Farm Environmental Impact Assessment Scoping Report.

Moray West. May 2017. Moray West Offshore Transmission Infrastructure Scoping Report.

MORAY WEST

OFFSHORE WINDFARM

Offshore EIA Report

Moray Offshore Windfarm (West) Limited

Chapter 19 Summary of EIA

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Acronyms	
Acronyms	**Expanded Term**
AEZ	Archaeological Exclusion Zone
AIS	Automatic Identification System
AtoN	Aids to Navigation
CAA	Civil Aviation Authority
CFMS	Commercial Fisheries Mitigation Strategy
COLREGS	Convention on the International Regulations for Preventing Collisions at Sea
DP	Decommissioning Programme
EMF	Electromagnetic Fields
EMP	Environmental Monitoring Plan
ERCoP	Emergency Response Cooperation Plan
FIR	Fisheries Industry Representative
FLOWW	Fishing Liaison With Offshore Wind And Wet Renewables
GDL	Garden and Designed Landscapes
GVA	Gross Value Added
IALA	International Association of Marine Aids to Navigation and Lighthouse Authorities
LMP	Lighting and Marking Plan
MARPOL	International Convention for the Prevention of Pollution from Ships
MCA	Maritime and Coastguard Agency
MGN	Marine Guidance Note
MHWS	Mean High Water Spring
MINNS	Marine Invasive Non-Native Species
MPCP	Marine Pollution Contingency Plan
MRT	Multi-Radar Tracker
MS-LOT	Marine Scotland Licensing Operations Team
NATS	National Airtraffic Service
NCMPA	Natur Conservation Marine Protected Area
NERL	NATS En-Route PLC
NLB	Northern Lighthouse Board
NSP	Navigational Safety Plan
NtM	Notice to Mariners
O&M	Operation and Maintenance

Acronyms	
Acronyms	**Expanded Term**
OfTI	Offshore Transmission Infrastructure
PMF	Priority Marine Features
PSR	Primary Surveillance Radar
RAF	Royal Air Force
SAR	Search and Rescue
SLA	Special Landscape Area
SSC	Suspended Sediment Concentration
UKHO	UK Hydrographic Office
VMP	Vessel Management Plan

19 Summary of EIA

19.1 Introduction

19.1.1.1 This chapter of the Environmental Impact Assessment (EIA) Report presents a summary of the key environmental issues associated with the Development, as identified via the impact assessment work carried out to date. The content of this summary chapter is based upon Chapters 6 to 17 of this Offshore EIA Report (Volume 2).

19.1.1.2 The potential impacts of the proposed Development were identified and then assessed by considering both the magnitude (which may include spatial extent, duration and frequency) and the sensitivity (which may consider the vulnerability, recoverability and importance of the receptor) for each potential impact.

19.1.1.3 There are a range of embedded mitigation measures (built into the project design and to which Moray West is committed) which have also been taken into account in the impact assessment process. These are presented in Section 19.2 below.

19.1.1.4 The significance of effect was judged according to a matrix such as that illustrated in Volume 2, Chapter 5: EIA Methodology. Effects arising, both adverse and beneficial, were graded on a scale ranging from negligible to major. Effects rated as ‘moderate’ to ‘major’ are considered to be ‘significant’ and will usually require mitigation. Effects rated as ‘minor’ or ‘negligible’ are not considered to be significant in EIA terms. However, there are exceptions to this for certain topics, and where such variations to the standard approach have been adopted, this is clearly set out within the individual topic chapter.

19.1.1.5 Where significant effects are considered likely to occur, additional mitigation measures are proposed to reduce such effects to acceptable levels; these are also captured in the summary tables in Section 19.2 below.

19.2 EIA Outcomes

19.2.1.1 Sections 19.2 below summarise the outcomes of the EIA (and Cumulative Impact Assessment) on a topic-by-topic basis. Based on the results of the EIA, undertaken against the realistic worst-case design scenario and reported in this EIA Report, the Development is predicted to result in a limited number of significant adverse effects. With the application of mitigation, the majority of significant effects are reduced to a non-significant level. However, some significant residual effects do remain for seascape, landscape and visual receptors. Specific measures to reduce these effects will be agreed, post-consent, with key stakeholders for consideration as part of the final design and layout of the offshore wind farm.

19.2.2 Physical Processes and Water Quality

Embedded Mitigation Measures

Table 19.2.1: Embedded Measures – Physical Processes & Water Quality	
Development Phase	**Measures**
General	• The number, type and dimensions of the foundations used will determine the blockage presented to waves and currents, both locally and by the Moray West Offshore Wind Farm as a whole. However, the design and dimensions of individual foundations also determine the forces exerted on those structures by waves and currents, and the complexity and cost of construction, which will tend to minimise the dimensions of the individual foundations as far as is possible. • Scour formation around the base of foundations or exposed sections of cable also presents an engineering risk. More extensive scour formation is likely to be mitigated by the application of scour protection.
Construction	• Dredging and drilling of the seabed are common activities, both globally and in UK. The vessels, equipment and methods used have been optimised through design over time to maximise the efficiency of the dredging or drilling process and to minimise potential environmental effects (e.g. potential rates of sediment disturbance and release), thereby reducing the magnitude, extent and duration of potential adverse effects. • Cable burial into the seabed and transitioning the cable between the offshore and onshore environment at a landfall is a common activity, both globally and in UK. Cable burial tools and techniques will aim to efficiently and rapidly achieve burial of the cable into the seabed whilst maximising sediment cover. Therefore, by design, the majority of sediment in the trench affected area is likely to remain within or near to the trench (for subsequent backfilling) and would therefore not contribute to effects on Suspended Sediment Concentration (SSC) or sediment deposition elsewhere. Landfall techniques aim to establish long term and stable burial and will therefore minimise any activities that would potentially destabilise or change the affected coastline.
Construction, Operation and Maintenance, Decommissioning	• An appropriate Environmental Management Plan (EMP) will be produced and followed to cover the construction, operation and maintenance phase of the Development. This will include planning for accidental spills, address all potential contaminant releases and include key emergency contact details. A Decommissioning Programme (DP) will also be developed to cover the decommissioning phase. The measures outlined in these documents will be adopted to ensure that the potential for release of contaminants from construction, operation and maintenance, and decommissioning equipment and activities is minimised. In this manner, accidental release of potential contaminants from drilling rigs and other construction / operation and maintenance (O&M) vessels will be strictly controlled, thus providing protection for marine life across all phases of the offshore wind farm development. • Best-practice techniques including appropriate vessel maintenance would be used at all times to minimise the potential for contamination as outlined in the Marine Pollution Contingency Plan (MPCP) and International Convention for the Prevention of Pollution from Ships (MARPOL).

Summary of Effects

Table 19.2.2: Summary of Development Specific and Cumulative Effects on Physical Processes and Water Quality					
Potential Impact	**Receptors**	**Significance of Effect**	**Additional Mitigation Measures**	**Residual Effect**	**Cumulative Effect**
Construction					
Increases in SSC and deposition of disturbed sediments to the seabed due to dredging for seabed preparation prior to foundation installation	(Pathway not receptor)	N/A (marine processes receptors insensitive to change)	N/A	N/A (marine processes receptors insensitive to change)	N/A No overlap in construction activities with other Moray Firth projects
Increases in SSC and deposition of disturbed sediments to the seabed due to the release of drill arisings during foundation installation	(Pathway not receptor)	N/A (marine processes receptors insensitive to change)	N/A	N/A (marine processes receptors insensitive to change)	
Increases in SSC and deposition of disturbed sediment to the seabed due to cable installation within the Moray West Site and Offshore Export Cable Corridor	(Pathway not receptor)	N/A (marine processes receptors insensitive to change)	N/A	N/A (marine processes receptors insensitive to change)	
Indentations left on the seabed by jack-up vessels and large anchors	(Pathway not receptor)	N/A (marine processes receptors insensitive to change)	N/A	N/A (marine processes receptors insensitive to change)	
Impacts to designated marine features (due to construction activities)	Designated marine features	Minor	N/A	N/A	N/A as no overlap in construction activities with other projects.
Impacts to designated coastal geomorphological features (due to construction activities)	Designated coastal geomorphological features	Negligible	N/A	N/A	

Table 19.2.2: Summary of Development Specific and Cumulative Effects on Physical Processes and Water Quality					
Potential Impact	**Receptors**	**Significance of Effect**	**Additional Mitigation Measures**	**Residual Effect**	**Cumulative Effect**
Impacts to recreational surfing venues (due to construction activities)	Recreational surfing venues	Minor	N/A	N/A	N/A as no overlap in construction activities with other projects.
Impacts to Smith Bank (due to construction activities)	Smith Bank	Negligible	N/A	N/A	
Changes to water quality from chemical releases	Water quality	Minor	N/A	N/A	
Changes to water quality from contaminated sediments	Water quality	Minor	N/A	N/A	
Operation and Maintenance					
Changes to the tidal regime	(Pathway not receptor)	N/A (marine processes receptors insensitive to change)	N/A	N/A (marine processes receptors insensitive to change)	N/A (marine processes receptors insensitive to change).
Changes to the wave regime	(Pathway not receptor)	N/A (marine processes receptors insensitive to change)	N/A	N/A (marine processes receptors insensitive to change)	
Changes to sediment transport and sediment transport pathways	(Pathway not receptor)	N/A (marine processes receptors insensitive to change)	N/A	N/A (marine processes receptors insensitive to change)	
Scour of seabed sediments	(Pathway not receptor)	N/A (marine processes receptors insensitive to change)	N/A	N/A (marine processes receptors insensitive to change)	
Impacts to designated marine and coastal geomorphological features (due to operation)	Designated marine and coastal	Minor	N/A	N/A	Negligible

Table 19.2.2: Summary of Development Specific and Cumulative Effects on Physical Processes and Water Quality

Potential Impact	Receptors	Significance of Effect	Additional Mitigation Measures	Residual Effect	Cumulative Effect
	geomorphological features				
Impacts to recreational surfing venues (due to operation)	Recreational surfing venues	Negligible	N/A	N/A	Negligible
Impacts to stratification fronts (due to operation)	Stratification fronts	Negligible	N/A	N/A	Negligible
Impacts to Smith Bank (due to operation)	Smith Bank	Negligible	N/A	N/A	Negligible
Changes to water quality from chemical releases	Water quality	Minor	N/A	N/A	Minor
Changes to water quality from contaminated sediments	Water quality	Minor	N/A	N/A	Minor
Decommissioning					
Increases in SSC and deposition of disturbed sediment to the seabed within the Moray West Site and Offshore Export Cable Corridor	(Pathway not receptor)	N/A (marine processes receptors insensitive to change)	N/A	N/A (marine processes receptors insensitive to change)	N/A as no overlap in decommissioning activities with other Moray Firth projects.
Impacts to designated marine and coastal geomorphological features (due to decommissioning activities)	Designated marine and coastal geomorphological features	Minor	N/A	N/A	N/A as no overlap in decommissioning activities with other Moray Firth projects.
Impacts to Smith Bank (due to decommissioning activities)	Smith Bank	Negligible	N/A	N/A	N/A as no overlap in decommissioning

Table 19.2.2: Summary of Development Specific and Cumulative Effects on Physical Processes and Water Quality					
Potential Impact	**Receptors**	**Significance of Effect**	**Additional Mitigation Measures**	**Residual Effect**	**Cumulative Effect**
Changes to water quality from chemical releases	Water quality	Minor	N/A	N/A	activities with other Moray Firth projects.
Changes to water quality from contaminated sediments	Water quality	Minor	N/A	N/A	

19.2.3 Benthic and Intertidal Ecology

Embedded Mitigation Measures

Table 19.2.3: Embedded Measures – Benthic and Intertidal Ecology	
Development Phase	**Measures**
General	• Careful cable corridor selection has taken place for the Offshore Export Cable Corridor to avoid, as far as possible, European and nationally designated sites that are present along the coastline considered for landfall, the proposed Southern Trench Nature Conservation Marine Protected Area (NCMPA) as well as Priority Marine Features and other species / habitats of conservation interest; • A detailed cable routing study and Cable Burial Risk Assessment (CBRA) will be undertaken post consent (based on results from post-consent geophysical and geotechnical surveys). The presence of sensitive benthic habitats/species and species/habitats of conservation importance will be a key consideration in the detailed design of the final cable routes; • An appropriate EMP will be produced and followed to cover the construction, operation and maintenance phases of the Development. This will include planning for management of Marine Invasive Non-Natives (MINNS); and • An appropriate Marine Pollution and Contingency Plan (MPCP) will be produced and followed to cover the construction, operation and maintenance phases of the Development. This will include planning for accidental spills, address all potential contaminant releases and include pollution event response protocols.
Construction	• Cable design incorporates burial of the cable to a minimum target depth of 1 m, as far as possible, in order to reduce the potential impacts of Electromagnetic Fields (EMF), reducing the need for cable protection and the amount of introduced hard substrate (albeit that artificial substrate can be beneficial in term of benthic habitat creation). Where burial is not possible, cables will be protected; • To minimise the extent of any unnecessary habitat disturbance, material displaced as a result of cable burial activities will be back filled, where possible, in order to promote recovery;
Operation and Maintenance	• Cable specifications will be used that reduce EMF emissions as per industry standards and best practice such as the relevant International Electrotechnical Commission (IEC) specifications.

Additional Mitigation

19.2.3.1 The assessment of benthic and intertidal ecology has not identified any significant effects that specifically require additional mitigation to be identified in order to reduce the level of significance. However, some additional mitigation measures have been identified that will ensure that benthic ecology and intertidal aspects remain fully assessed and considered during the final design stages of the Development. These additional measures are described below:

- Should the final location of the landfall works lie outwith surveyed intertidal areas, it is acknowledged that further survey of the final location may be required pre-construction in order to confirm the nature of the intertidal habitats present in the works area;
- In relation to the small area of potential Annex I habitat recorded in the site specific benthic survey of the Moray West Site, Moray West will seek to confirm the extent of this feature following further geophysical survey, which will be undertaken pre-construction. At present, Moray West would propose micro-siting of infrastructure to avoid this feature; and

- Further discussion with MS-LOT, MSS and SNH will take place as part of the post-application consultations and setting of consent conditions to determine the requirement for and scope of any monitoring. Any project-specific monitoring requirements will be confirmed within any Project Environmental Monitoring Programme (PEMP) required to be approved prior to construction commencing.

Summary of Effects

Table 19.2.4: Summary of Development Specific and Cumulative Effects on Benthic and Intertidal Ecology					
Potential Impact	**Receptors**	**Significance of Effect**	**Additional Mitigation Measures**	**Residual Effect**	**Cumulative Effect**
Construction					
Temporary Habitat Loss / Habitat Disturbance (Subtidal)	Benthic and intertidal habitats and species	Minor adverse	Confirmation of the presence/extent of any Annex I habitat, and avoidance where present and as practicable	Minor adverse	N/A as no overlap in construction activities with other projects.
Temporary Habitat Loss / Habitat Disturbance (Intertidal)	Benthic and intertidal habitats and species	Negligible – Minor adverse	N/A	N/A	
Increased Suspended Sediment Concentrations/Sediment Deposition (Subtidal)	Benthic and intertidal habitats and species	Minor adverse	N/A	N/A	
Increased Suspended Sediment Concentrations/Sediment Deposition (Intertidal)	Benthic and intertidal habitats and species	Negligible – Minor adverse	N/A	N/A	
Noise and Vibration	Benthic and intertidal habitats and species	No impact - Negligible	N/A	N/A	
Accidental and Controlled Discharges	Benthic and intertidal habitats and species	Negligible – Minor adverse	N/A	N/A	
Risk of Introduction of Marine Invasive Non-Native Species (MINNS)	Benthic and intertidal habitats and species	Minor adverse	N/A	N/A	
Operation and Maintenance					
Long Term Habitat Loss	Benthic and intertidal habitats and species	Minor adverse	N/A	N/A	Negligible

Table 19.2.4: Summary of Development Specific and Cumulative Effects on Benthic and Intertidal Ecology					
Potential Impact	**Receptors**	**Significance of Effect**	**Additional Mitigation Measures**	**Residual Effect**	**Cumulative Effect**
Accidental and Controlled Discharges	Benthic and intertidal habitats and species	Negligible – Minor adverse	N/A	N/A	Minor
Scouring of Benthic Habitats at Foundations and Around Cables	Benthic and intertidal habitats and species	Negligible – Minor adverse	N/A	N/A	Negligible
Creation of New Substrate and Habitat	Benthic and intertidal habitats and species	Minor adverse	N/A	N/A	Minor
EMF	Benthic and intertidal habitats and species	Negligible – Minor adverse	N/A	N/A	Minor
Seabed Sediment Heating from Cables	Benthic and intertidal habitats and species	Negligible – Minor adverse	N/A	N/A	Minor
Risk of Introduction of MINNS	Benthic and intertidal habitats and species	Minor adverse	N/A	N/A	Minor
Decommissioning					
Temporary Habitat Loss / Habitat Disturbance	Benthic and intertidal habitats and species	Minor adverse	N/A	N/A	N/A as no overlap in decommissioning activities with other Moray Firth projects.
Loss of Habitat from Removal of Introduced Hard Substrate	Benthic and intertidal habitats and species	Minor adverse	N/A	N/A	
Increased Suspended Sediments/Sediment Deposition	Benthic and intertidal habitats and species	Negligible – Minor adverse	N/A	N/A	
Noise and Vibration	Benthic and intertidal habitats and species	Negligible – Minor adverse	N/A	N/A	
Accidental and Controlled Discharges	Benthic and intertidal habitats and species	Negligible – Minor adverse	N/A	N/A	
Risk of Introduction of MINNS	Benthic and intertidal habitats and species	Minor adverse	N/A	N/A	

19.2.4 Fish and Shellfish Ecology

Embedded Mitigation Measures

Table 19.2.5: Embedded Measures – Fish and Shellfish	
Development Phase	**Measures**
General	• Site-specific surveys and review of previous Moray East and Beatrice Offshore Wind Farm survey data used to inform careful site selection of the Moray West Site and Offshore Export Cable Corridor to avoid key commercial fisheries and protected fish species and habitats (e.g. PMFs, spawning areas and sites designated for fish and shellfish interests such as rivers designated as SACs for diadromous fish) as far as possible; • An appropriate Environmental Management Plan (EMP) will be produced and followed to cover the construction, operation and maintenance phase of the Development. This will include planning for accidental spills, address all potential contaminant releases and include key emergency contact details. A Decommissioning Programme (DP) will also be developed to cover the decommissioning phase; • The measures outlined in EMP and DP will be adopted to ensure that the potential for release of contaminants from construction, operation and maintenance, and decommissioning equipment and activities is minimised. In this manner, accidental release of potential contaminants from drilling rigs and other construction / O&M vessels will be strictly controlled, thus providing protection for marine life across all phases of the offshore wind farm development; and • Best-practice techniques including appropriate vessel maintenance will be used at all times to minimise the potential for contamination as outlined in a Development-specific Marine Pollution and Contingency Plan (MPCP) and MARPOL.
Construction	• To minimise the extent of any unnecessary habitat disturbance, material displaced as a result of cable burial activities will be back filled, where possible, in order to promote recovery; • A Piling Strategy will be submitted to Marine Scotland Licensing Operations Team (MS-LOT) for approval prior to the commencement of piling outlining any mitigation and management measures that will be implemented during pile installation taking account of the environmental sensitivities outlined within this chapter; • During piling, soft starts will be used, with lower hammer energies used at the beginning of the piling sequence before increasing energies to the higher levels. This measure will reduce the risk of injury to fish species in the immediate vicinity of piling operations; • The cable design incorporates burial of the cables to a minimum target depth of 1 m as far as possible in order to reduce the potential effects of Electromagnetic Fields (EMF), reducing the need for cable protection and the amount of introduced hard substrate (albeit that artificial substrate can be beneficial in term of benthic habitat creation). A Cable Burial Risk Assessment (CBRA) will inform cable burial depth which will depend on ground conditions, with this CBRA to be undertaken post consent. Burial of cables will increase the distance between cables and fish and shellfish receptors, thereby potentially reducing the effect on those receptors. Where burial is not possible, cables will be protected by rock dumping or an alternative suitable approach (e.g. mattress protection).

Table 19.2.5: Embedded Measures – Fish and Shellfish	
Development Phase	**Measures**
	• To minimise the extent of any unnecessary habitat disturbance, material displaced as a result of cable burial activities will be back filled, where possible, in order to promote recovery;
Operation and Maintenance	• Cable specifications will be used that reduce EMF emissions as per industry standards and best practice such as the relevant IEC specifications;

Summary of Effects

Table 19.2.6: Summary of Development Specific and Cumulative Effects on Fish and Shellfish Ecology					
Potential Impact	**Receptors**	**Significance of Effect**	**Additional Mitigation Measures**	**Residual Effect**	**Cumulative Effect**
Construction					
Temporary habitat loss / disturbance	Brown crab, European lobster, scallops, Nephrops	Minor adverse	N/A	N/A	N/A as no overlap in construction activities with other projects in the Moray Firth.
	Sandeel	Minor adverse	N/A	N/A	
	Herring, cod and other spawning adults	Minor adverse	N/A	N/A	
	All other fish and shellfish	Negligible to minor	N/A	N/A	
Increased SSC / sediment deposition	Scallops	Minor	N/A	N/A	
	Spawning grounds	Minor	N/A	N/A	
	Fish	Negligible to minor	N/A	N/A	
	Shellfish	Negligible to minor	N/A	N/A	
Noise and vibration	Sea lamprey	Minor	N/A	N/A	
	Herring, sprat, cod, whiting, salmonids	Minor	N/A	N/A	
	Other fish and shellfish	Minor	N/A	N/A	
Accidental release of hydrocarbons and chemicals	All fish and shellfish species	Minor	N/A	N/A	
Operation and Maintenance					
Long term habitat loss	Herring	Minor	N/A	N/A	Negligible to minor
	Sandeel	Minor	N/A	N/A	Negligible to minor

Table 19.2.6: Summary of Development Specific and Cumulative Effects on Fish and Shellfish Ecology					
Potential Impact	**Receptors**	**Significance of Effect**	**Additional Mitigation Measures**	**Residual Effect**	**Cumulative Effect**
	Nephrops	Minor	N/A	N/A	Negligible to minor
	Brown crab	Minor	N/A	N/A	Negligible to minor
	European lobster	Minor	N/A	N/A	Negligible to minor
	All other fish and shellfish	Negligible	N/A	N/A	Negligible to minor
Noise and vibration	Herring, sprat, cod, whiting, migratory fish (turbine noise only)	Negligible to minor	N/A	N/A	Scoped out of cumulative assessment
	All other fish and shellfish (turbine noise only)	Negligible to minor	N/A	N/A	Scoped out of cumulative assessment
	All fish and shellfish (vessel noise)	Negligible to minor	N/A	N/A	Scoped out of cumulative assessment
Accidental release of hydrocarbons and chemicals	All fish and shellfish	Minor	N/A	N/A	Minor
Creation of new substrate and habitat	Scallop and other shellfish	Negligible to minor	N/A	N/A	Negligible to minor
	Soft substrate species e.g. *Nephrops*, sandeel, flatfish)	Minor	N/A	N/A	Negligible to minor
	Fish	Negligible to minor	N/A	N/A	Negligible to minor
EMF	Shellfish	Negligible to minor	N/A	N/A	Negligible to minor
	Elasmobranchs	Negligible to minor	N/A	N/A	Negligible to minor
	Migratory Fish	Minor	N/A	N/A	Negligible to minor
	All other fish	Negligible to minor	N/A	N/A	Negligible to minor
Seabed sediment heating	Fish	Negligible to minor	N/A	N/A	Minor
	Shellfish	Negligible to minor	N/A	N/A	Minor

Table 19.2.6: Summary of Development Specific and Cumulative Effects on Fish and Shellfish Ecology					
Potential Impact	**Receptors**	**Significance of Effect**	**Additional Mitigation Measures**	**Residual Effect**	**Cumulative Effect**
	Spawning activity	Minor	N/A	N/A	Minor
Decommissioning					
Temporary habitat loss/ habitat disturbance	Demersal / spawning adults (sandeel, herring, cod)	Minor	N/A	N/A	N/A as no overlap in decommissioning activities with other Moray Firth projects.
	Brown crab, European lobster, scallop, *Nephrops*	Minor	N/A	N/A	
	All other fish and shellfish	Negligible to minor	N/A	N/A	
Increased SSC / sediment deposition	Scallops	Minor	N/A	N/A	
	Spawning grounds	Minor	N/A	N/A	
	Fish	Negligible to minor	N/A	N/A	
	Shellfish	Negligible to minor	N/A	N/A	
Noise and vibration	Sea lamprey	Negligible	N/A	N/A	
	Herring, sprat, cod, whiting, salmonids	Negligible to minor	N/A	N/A	
	All other fish and shellfish	Negligible	N/A	N/A	
Removal of structures and hard substrates	Shellfish	Minor	N/A	N/A	
	Fish	Negligible or minor	N/A	N/A	
Accidental release of hydrocarbons and chemicals	All fish and shellfish species	Minor	N/A	N/A	

19.2.5 Marine Mammals

Embedded Mitigation Measures

Table 19.22.7: Embedded Mitigation Relating to Marine Mammals	
Parameter	**Mitigation measures embedded into the design of the Development**
General	
Vessels	A Vessel Management Plan (VMP) will be developed which will determine vessel routing to and from construction areas and ports to avoid areas of high risk. This will also include codes of conduct for vessel behaviour and for vessel operators including advice to operators to not deliberately approach marine mammals and to avoid abrupt changes in course or speed should marine mammals approach the vessel to bow-ride. This plan will be informed by emerging information from the monitoring at the Beatrice Offshore Wind Farm (BOWL).
Construction	
Pile-driving WTG	**Monopiles (5,000 kJ maximum hammer energy)** A soft start is included, whereby the piling hammer energy is gradually increased over a period of time to ensure that any remaining animals will move out of the area before full hammer energy is reached. A ramp-up has been assumed for monopiles that reach a maximum of up to 5,000 kJ hammer energy. This ramp up involves a constant strike rate of 30 strikes per minute and the following schedule: • 1,000 kJ for 150 mins • 2,000 kJ for 90 mins • 3,000 kJ for 50 mins • 4,000 kJ for 40 mins • 5,000 kJ for 30 mins **Monopiles (3,500 kJ maximum hammer energy)** A ramp-up has been assumed for monopiles that reach a maximum of up to 3,500 kJ hammer energy. This ramp up involves a constant strike rate of 30 strikes per minute and the following schedule: • 1,000 kJ for 150 mins • 2,000 kJ for 90 mins • 2,500 kJ for 50 mins • 3,000 kJ for 40 mins • 3,500 kJ for 30 mins **Quadropod/jacket (3,000 maximum hammer energy)** A ramp-up has been assumed for monopiles that reach a maximum of up to 3,000 kJ hammer energy. This ramp up involves a constant strike rate of 30 strikes per minute and the following schedule: • 500 kJ for 170 mins • 1,000 kJ for 83 mins • 1,500 kJ for 67 mins • 2,000 kJ for 83 mins • 3,000 kJ for 67 mins
All Pile-driving	A Piling Strategy, incorporating a Marine Mammal Mitigation Plan (MMMP) will be produced for approval by the Scottish Ministers in advance of construction and will

Table 19.22.7: Embedded Mitigation Relating to Marine Mammals	
Parameter	**Mitigation measures embedded into the design of the Development**
	subsequently be followed during the construction phase. This will outline the final piling approach, the soft-start procedure, monitoring, and any other agreed mitigation options deemed necessary, to reduce to acceptable levels the potential risk of injury or death to marine mammals in close proximity to piling operations.
Pollution prevention	An appropriate Environmental Management Plan (EMP) will be produced and followed to cover the construction, operation and maintenance phases of the Development. In addition, an appropriate Marine Pollution and Contingency Plan (MPCP) will be produced and followed to cover the construction, operation and maintenance phases of the Development. This will include planning for accidental spills, address all potential contaminant releases and include pollution event response protocols. A Decommissioning Programme will be developed to cover the decommissioning phase. The purpose of the measures to be implemented ensure that potential for contaminant release is strictly controlled and therefore provides protection to marine life across all phases of the life of the Development.
Decommissioning	
Embedded mitigation measures implemented in the decommissioning phase are likely to be similar to those implemented during the construction phase.	

Summary of Effects

Table 19.2.8: Summary of Development Specific and Cumulative Effects on Marine Mammals					
Potential Impact	**Receptors**	**Significance of Effect**	**Mitigation Measures**	**Residual Effect**	**Cumulative Effect**
Construction					
'Instantaneous' PTS	Harbour porpoise	Minor Adverse	N/A	N/A	N/A as no temporal overlap in piling activities with other Moray Firth projects
	Bottlenose dolphin	Minor Adverse	N/A	N/A	
	Minke whale	Minor Adverse	N/A	N/A	
	Harbour seal	Negligible	N/A	N/A	
	Grey Seal	Negligible	N/A	N/A	
PTS from prolonged cumulative exposure	Harbour porpoise	Minor Adverse	N/A	N/A	N/A as no temporal overlap in piling activities with other Moray Firth projects
	Bottlenose dolphin	Minor Adverse	N/A	N/A	
	Minke whale	Minor Adverse	N/A	N/A	
	Harbour seal	Negligible	N/A	N/A	
	Grey Seal	Negligible	N/A	N/A	
Disturbance (displacement)	Harbour porpoise	Minor Adverse	N/A	N/A	Minor adverse for ALL (based on sequential piling and construction activities from other offshore wind farms and Aberdeen Harbour Extension).
	Bottlenose dolphin	Minor Adverse	N/A	N/A	
	Minke whale	Minor Adverse	N/A	N/A	
	Harbour seal	Minor Adverse	N/A	N/A	
	Grey Seal	Minor Adverse	N/A	N/A	
Vessel collision risk	All species	Minor Adverse	N/A	N/A	Scoped out on basis underwater noise from piling and other construction
Reduction in prey availability	All species	Minor Adverse	N/A	N/A	

Table 19.2.8: Summary of Development Specific and Cumulative Effects on Marine Mammals					
Potential Impact	**Receptors**	**Significance of Effect**	**Mitigation Measures**	**Residual Effect**	**Cumulative Effect**
Reduction in foraging ability	All species	Minor Adverse	N/A	N/A	activities considered to be key potential cumulative effects on marine mammals.
Operation and Maintenance					
Vessel collision risk	All species	Minor Adverse	N/A	N/A	Scoped out on basis potential cumulative effects during operation considered to be negligible based on results from Development specific assessment.
Reduction in prey availability	All species	Minor Beneficial	N/A	N/A	
Decommissioning					
Underwater noise	All species	Minor Adverse	N/A	N/A	N/A as no temporal overlap in decommissioning activities with other Moray Firth projects
Vessel collision risk	All species	Minor Adverse	N/A	N/A	
Reduction in prey availability	All species	Minor Adverse	N/A	N/A	
Reduction in foraging ability	All species	Minor Adverse	N/A	N/A	

19.2.6 Ornithology

Embedded Mitigation Measures

Table 19.2.9: Embedded Measures – Ornithology	
Measures adopted as part of Moray West	**Justification**
General	
An appropriate Environmental Management Plan (EMP) will be produced and followed to cover the construction, operation and maintenance phases of the Development. An appropriate Marine Pollution and Contingency Plan (MPCP) will be produced and followed to cover the construction, operation and maintenance phases of the Development. This will include planning for accidental spills, address all potential contaminant releases and include pollution event response protocols.	Measures will be adopted to ensure that the potential for release of pollutants from construction, operation and maintenance, and decommissioning plant is minimised. In this manner, accidental release of contaminants from rigs and supply/service vessels will be strictly controlled, thus providing protection for birds and their prey species across all phases of the wind farm development.
A vessel management plan (VMP) will be developed which will determine vessel routing to and from construction areas and ports to avoid areas of high risk. This will also include codes of conduct for vessel behaviour and for vessel operators including advice to operators to not deliberately approach aggregations of seabirds. This plan will be informed by emerging information from the monitoring at Beatrice.	The VMP will minimize disturbance of seabird species and allow the identification of standard routes.
Operation and Maintenance	
Installation of appropriate lighting on wind farm structures.	Lighting of wind turbines will meet minimum requirements, namely as set out in the International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) Recommendation O-117 on 'The Marking of Offshore Wind Farms' for navigation lighting and by the Civil Aviation Authority in the Air Navigation Orders (CAP 393 and guidance in CAP 764). In keeping with the minimum legal requirements, this will minimise the risks of migrating birds becoming attracted to, or disorientated by turbines at night or in poor weather.
A minimum wind turbine hub-height of 35 m (above HAT) will be used for Moray West. This provides for a lower blade tip height clearance of 35m LAT.	This hub-height is considered appropriately conservative so as to minimise the risk of bird collisions.

Summary of Effects

Table 19.2.10: Summary of Development Specific and Cumulative Effects on Ornithology					
Potential Impact	**Receptors**	**Significance of Effect**	**Mitigation Measures**	**Residual Effect**	**Cumulative Effect**
Construction					
Disturbance	Scaup	Negligible	None	N/A	Minor
	Eider	Negligible	None	N/A	Minor
	Long-tailed duck	Negligible	None	N/A	Minor
	Common scoter	Negligible	None	N/A	Minor
	Velvet scoter	Negligible	None	N/A	Minor
	Goldeneye	Negligible	None	N/A	Minor
	Red-breasted merganser	Negligible	None	N/A	Minor
	Red-throated diver	Minor adverse	None	N/A	Minor
	Great northern diver	Minor adverse	None	N/A	Minor
	Shag	Minor adverse	None	N/A	Minor
	Slavonian grebe	Negligible	None	N/A	Minor
	Guillemot	Minor adverse	None	N/A	Minor
	Razorbill	Minor adverse	None	N/A	Minor
	Puffin	Minor adverse	None	N/A	Minor
	Scaup	Negligible	None	N/A	Minor

Table 19.2.10: Summary of Development Specific and Cumulative Effects on Ornithology					
Potential Impact	**Receptors**	**Significance of Effect**	**Mitigation Measures**	**Residual Effect**	**Cumulative Effect**
Indirect effects (prey and habitat loss)	Eider	Negligible	None	N/A	Scoped out of cumulative assessment
	Long-tailed duck	Negligible	None	N/A	Scoped out of cumulative assessment
	Common scoter	Negligible	None	N/A	Scoped out of cumulative assessment
	Velvet scoter	Negligible	None	N/A	Scoped out of cumulative assessment
	Goldeneye	Negligible	None	N/A	Scoped out of cumulative assessment
	Red-breasted merganser	Negligible	None	N/A	Scoped out of cumulative assessment
	Red-throated diver	Minor adverse	None	N/A	Scoped out of cumulative assessment
	Great northern diver	Minor adverse	None	N/A	Scoped out of cumulative assessment
	Fulmar	Negligible	None	N/A	Scoped out of cumulative assessment
	Gannet	Negligible	None	N/A	Scoped out of cumulative assessment
	Shag	Negligible	None	N/A	Scoped out of cumulative assessment
	Slavonian grebe	Negligible	None	N/A	Scoped out of cumulative assessment

Table 19.2.10: Summary of Development Specific and Cumulative Effects on Ornithology					
Potential Impact	**Receptors**	**Significance of Effect**	**Mitigation Measures**	**Residual Effect**	**Cumulative Effect**
	Guillemot	Minor adverse	None	N/A	Scoped out of cumulative assessment
	Razorbill	Minor adverse	None	N/A	Scoped out of cumulative assessment
	Puffin	Minor adverse	None	N/A	Scoped out of cumulative assessment
	Kittiwake	Negligible	None	N/A	Scoped out of cumulative assessment
	Herring gull	Negligible	None	N/A	Scoped out of cumulative assessment
	Great black-backed gull	Negligible	None	N/A	Scoped out of cumulative assessment
	Scaup	Negligible	None	N/A	Scoped out of cumulative assessment
Pollution effects	Eider	Negligible	None	N/A	Scoped out of cumulative assessment
	Long-tailed duck	Negligible	None	N/A	Scoped out of cumulative assessment
	Common scoter	Negligible	None	N/A	Scoped out of cumulative assessment
	Velvet scoter	Negligible	None	N/A	Scoped out of cumulative assessment
	Goldeneye	Negligible	None	N/A	Scoped out of cumulative assessment

Table 19.2.10: Summary of Development Specific and Cumulative Effects on Ornithology					
Potential Impact	**Receptors**	**Significance of Effect**	**Mitigation Measures**	**Residual Effect**	**Cumulative Effect**
	Red-breasted merganser	Negligible	None	N/A	Scoped out of cumulative assessment
	Red-throated diver	Negligible	None	N/A	Scoped out of cumulative assessment
	Great northern diver	Negligible	None	N/A	Scoped out of cumulative assessment
	Fulmar	Negligible	None	N/A	Scoped out of cumulative assessment
	Gannet	Negligible	None	N/A	Scoped out of cumulative assessment
	Shag	Negligible	None	N/A	Scoped out of cumulative assessment
	Slavonian grebe	Negligible	None	N/A	Scoped out of cumulative assessment
	Guillemot	Negligible	None	N/A	Scoped out of cumulative assessment
	Razorbill	Negligible	None	N/A	Scoped out of cumulative assessment
	Puffin	Negligible	None	N/A	Scoped out of cumulative assessment
	Kittiwake	Negligible	None	N/A	Scoped out of cumulative assessment
	Herring gull	Negligible	None	N/A	Scoped out of cumulative assessment

Table 19.2.10: Summary of Development Specific and Cumulative Effects on Ornithology					
Potential Impact	**Receptors**	**Significance of Effect**	**Mitigation Measures**	**Residual Effect**	**Cumulative Effect**
	Great black-backed gull	Negligible	None	N/A	Scoped out of cumulative assessment
	Fulmar	Negligible	None	N/A	Scoped out of cumulative assessment
Operation and Maintenance					
Displacement / Barrier Effects	Puffin	Minor adverse	None	N/A	Minor
	Razorbill	Minor adverse	None	N/A	Minor
	Guillemot	Minor adverse	None	N/A	Minor
	Kittiwake	Minor adverse	None	N/A	Minor
	Fulmar	Negligible or minor adverse	None	N/A	Negligible
Indirect effects (prey and habitat loss)	Gannet	Negligible or minor adverse	None	N/A	Scoped out of cumulative assessment
	Puffin	Negligible or minor adverse	None	N/A	Scoped out of cumulative assessment
	Razorbill	Negligible or minor adverse	None	N/A	Scoped out of cumulative assessment
	Guillemot	Negligible or minor adverse	None	N/A	Scoped out of cumulative assessment
	Kittiwake	Negligible or minor adverse	None	N/A	Scoped out of cumulative assessment
	Herring gull	Negligible or minor adverse	None	N/A	Scoped out of cumulative assessment

Table 19.2.10: Summary of Development Specific and Cumulative Effects on Ornithology					
Potential Impact	**Receptors**	**Significance of Effect**	**Mitigation Measures**	**Residual Effect**	**Cumulative Effect**
	Great black-backed gull	Negligible or minor adverse	None	N/A	Scoped out of cumulative assessment
Collision risk	Gannet	Minor adverse	None	N/A	Minor adverse
	Kittiwake	Minor adverse	None	N/A	Minor adverse
	Herring gull	Minor adverse	None	N/A	Minor adverse
	Great black-backed gull	Minor adverse	None	N/A	Minor adverse
Attraction to lit structures and disorientation	Fulmar	Negligible or minor adverse	None	N/A	Scoped out of cumulative assessment
	Gannet	Negligible or minor adverse	None	N/A	Scoped out of cumulative assessment
	Puffin	Negligible or minor adverse	None	N/A	Scoped out of cumulative assessment
	Razorbill	Negligible or minor adverse	None	N/A	Scoped out of cumulative assessment
	Guillemot	Negligible or minor adverse	None	N/A	Scoped out of cumulative assessment
	Kittiwake	Negligible or minor adverse	None	N/A	Scoped out of cumulative assessment
	Herring gull	Negligible or minor adverse	None	N/A	Scoped out of cumulative assessment
	Great black-backed gull	Negligible or minor adverse	None	N/A	Scoped out of cumulative assessment

Table 19.2.10: Summary of Development Specific and Cumulative Effects on Ornithology					
Potential Impact	**Receptors**	**Significance of Effect**	**Mitigation Measures**	**Residual Effect**	**Cumulative Effect**
	Arctic skua	Negligible or minor adverse	None	N/A	Scoped out of cumulative assessment
	Scaup	Negligible	None	N/A	Scoped out of cumulative assessment
Pollution effects	Eider	Negligible	None	N/A	Scoped out of cumulative assessment
	Long-tailed duck	Negligible	None	N/A	Scoped out of cumulative assessment
	Common scoter	Negligible	None	N/A	Scoped out of cumulative assessment
	Velvet scoter	Negligible	None	N/A	Scoped out of cumulative assessment
	Goldeneye	Negligible	None	N/A	Scoped out of cumulative assessment
	Red-breasted merganser	Negligible	None	N/A	Scoped out of cumulative assessment
	Red-throated diver	Negligible	None	N/A	Scoped out of cumulative assessment
	Great northern diver	Negligible	None	N/A	Scoped out of cumulative assessment
	Fulmar	Negligible	None	N/A	Scoped out of cumulative assessment
	Gannet	Negligible	None	N/A	Scoped out of cumulative assessment
	Shag	Negligible	None	N/A	Scoped out of cumulative assessment
	Slavonian grebe	Negligible	None	N/A	Scoped out of cumulative assessment
	Guillemot	Negligible	None	N/A	Scoped out of cumulative assessment

Table 19.2.10: Summary of Development Specific and Cumulative Effects on Ornithology					
Potential Impact	**Receptors**	**Significance of Effect**	**Mitigation Measures**	**Residual Effect**	**Cumulative Effect**
	Razorbill	Negligible	None	N/A	Scoped out of cumulative assessment
	Puffin	Negligible	None	N/A	Scoped out of cumulative assessment
	Kittiwake	Negligible	None	N/A	Scoped out of cumulative assessment
	Herring gull	Negligible	None	N/A	Scoped out of cumulative assessment
	Great black-backed gull	Negligible	None	N/A	Scoped out of cumulative assessment
	Scaup	Negligible	None	N/A	Scoped out of cumulative assessment
Decommissioning					
Disturbance / displacement	Eider	Negligible	None	N/A	Scoped out of cumulative assessment
	Long-tailed duck	Negligible	None	N/A	Scoped out of cumulative assessment
	Common scoter	Negligible	None	N/A	Scoped out of cumulative assessment
	Velvet scoter	Negligible	None	N/A	Scoped out of cumulative assessment
	Goldeneye	Negligible	None	N/A	Scoped out of cumulative assessment
	Red-breasted merganser	Negligible	None	N/A	Scoped out of cumulative assessment
	Red-throated diver	Minor adverse	None	N/A	Scoped out of cumulative assessment
	Great northern diver	Minor adverse	None	N/A	Scoped out of cumulative assessment
	Shag	Minor adverse	None	N/A	Scoped out of cumulative assessment

Table 19.2.10: Summary of Development Specific and Cumulative Effects on Ornithology					
Potential Impact	**Receptors**	**Significance of Effect**	**Mitigation Measures**	**Residual Effect**	**Cumulative Effect**
	Slavonian grebe	Negligible	None	N/A	Scoped out of cumulative assessment
	Guillemot	Moderate adverse	None	N/A	Scoped out of cumulative assessment
	Razorbill	Moderate adverse	None	N/A	Scoped out of cumulative assessment
	Puffin	Minor adverse	None	N/A	Scoped out of cumulative assessment
	Scaup	Negligible	None	N/A	Scoped out of cumulative assessment
Indirect effects (prey and habitat loss)	Eider	Negligible	None	N/A	Scoped out of cumulative assessment
	Long-tailed duck	Negligible	None	N/A	Scoped out of cumulative assessment
	Common scoter	Negligible	None	N/A	Scoped out of cumulative assessment
	Velvet scoter	Negligible	None	N/A	Scoped out of cumulative assessment
	Goldeneye	Negligible	None	N/A	Scoped out of cumulative assessment
	Red-breasted merganser	Negligible	None	N/A	Scoped out of cumulative assessment
	Red-throated diver	Minor adverse	None	N/A	Scoped out of cumulative assessment
	Great northern diver	Minor adverse	None	N/A	Scoped out of cumulative assessment
	Fulmar	Negligible	None	N/A	Scoped out of cumulative assessment
	Gannet	Negligible	None	N/A	Scoped out of cumulative assessment
	Shag	Negligible	None	N/A	Scoped out of cumulative assessment

Table 19.2.10: Summary of Development Specific and Cumulative Effects on Ornithology					
Potential Impact	**Receptors**	**Significance of Effect**	**Mitigation Measures**	**Residual Effect**	**Cumulative Effect**
	Slavonian grebe	Negligible	None	N/A	Scoped out of cumulative assessment
	Guillemot	Minor adverse	None	N/A	Scoped out of cumulative assessment
	Razorbill	Minor adverse	None	N/A	Scoped out of cumulative assessment
	Puffin	Minor adverse	None	N/A	Scoped out of cumulative assessment
	Kittiwake	Negligible	None	N/A	Scoped out of cumulative assessment
	Herring gull	Negligible	None	N/A	Scoped out of cumulative assessment
	Great black-backed gull	Negligible	None	N/A	Scoped out of cumulative assessment
	Scaup	Negligible	None	N/A	Scoped out of cumulative assessment
Pollution effects	Eider	Negligible	None	N/A	Scoped out of cumulative assessment
	Long-tailed duck	Negligible	None	N/A	Scoped out of cumulative assessment
	Common scoter	Negligible	None	N/A	Scoped out of cumulative assessment
	Velvet scoter	Negligible	None	N/A	Scoped out of cumulative assessment
	Goldeneye	Negligible	None	N/A	Scoped out of cumulative assessment
	Red-breasted merganser	Negligible	None	N/A	Scoped out of cumulative assessment
	Red-throated diver	Negligible	None	N/A	Scoped out of cumulative assessment
	Great northern diver	Negligible	None	N/A	Scoped out of cumulative assessment

Table 19.2.10: Summary of Development Specific and Cumulative Effects on Ornithology					
Potential Impact	**Receptors**	**Significance of Effect**	**Mitigation Measures**	**Residual Effect**	**Cumulative Effect**
	Fulmar	Negligible	None	N/A	Scoped out of cumulative assessment
	Gannet	Negligible	None	N/A	Scoped out of cumulative assessment
	Shag	Negligible	None	N/A	Scoped out of cumulative assessment
	Slavonian grebe	Negligible	None	N/A	Scoped out of cumulative assessment
	Guillemot	Negligible	None	N/A	Scoped out of cumulative assessment
	Razorbill	Negligible	None	N/A	Scoped out of cumulative assessment
	Puffin	Negligible	None	N/A	Scoped out of cumulative assessment
	Kittiwake	Negligible	None	N/A	Scoped out of cumulative assessment
	Herring gull	Negligible	None	N/A	Scoped out of cumulative assessment
	Great black-backed gull	Negligible	None	N/A	Scoped out of cumulative assessment

19.2.7 Commercial Fisheries

Embedded Mitigation Measures

Table 19.2.11: Embedded Measures – Commercial Fisheries	
Development Phase	**Measures**
General	• Appointment of a Fisheries Liaison Officer (FLO) who will be responsible for liaising with local fishermen prior to, during and post construction and to maintain communications during O&M phase of the Development; • Appointment of Fisheries Industry Representatives (FIR) for key fisheries who will be responsible for liaising with the wider fishing industry. Specific roles and responsibilities of the FIR and how they operate will be defined within the CFMS; • Navigational Safety Plan (NSP) – this will be submitted to the licensing authority six months prior to commencement of works and will include: • Information on navigational safety measures including protocols and procedures for the navigation of vessels (construction and maintenance) to and from the Moray West Site and along the Offshore Export Cable Corridor (i.e. agreement of vessel transit routes in order to minimise, as far as possible, interference with fishing activities and fishing gear); • Details on the location and timings for advisory safety zones as listed above; • Timely and efficient issue of Notice to Mariners (NtMs), Kingfisher notifications and Radio Navigation warnings advising the fishing community of the position and nature of construction activities and partially installed infrastructure including inter-array, OSP interconnector and export cables and cable crossings; • Identification of refuge/shelter areas for construction vessels to avoid fishing activities and gear. • Preparation of a Lighting and Marking Plan (LMP) to set out the lighting and marking requirements during the construction and operation of the wind farm and OfTI (for further details please see Chapter 12 Shipping and Navigation). The information will be distributed to fisherman through agreed channels as defined in the CFMS; • Moray West will advise the United Kingdom Hydrographic Office (UKHO) on the final location of WTGs, OSPs, inter-array cables and export cables for these to be added to appropriate Admiralty Charts; and • Appropriate liaison would be undertaken with relevant fishing interests for the duration of the Development to ensure that they are informed of development planning, construction, operation, maintenance and decommissioning activities.
Construction	• Inter-array cabling, inter OSP cables and offshore export cables will be buried, where possible, to a minimum depth of 1 m to prevent damage to and from fishing gear. Cable protection measures will be applied in areas where burial is not possible. Specific protection measures will be determined as part of final detailed design for the cable routes which will be informed by a Cable Burial Risk Assessment (CBRA) which will be completed post consent. Specific cable protection measures will be agreed in consultation with fisheries stakeholders; • The following advisory safety zones will be applied for by Moray West: o Standard rolling 500 m safety zones around any structure where construction work is underway, as indicated by the presence of a large construction vessel(s); and

Table 19.2.11: Embedded Measures – Commercial Fisheries	
Development Phase	**Measures**
	○ 50 m safety zones around partially (and fully) installed infrastructure during the construction phase where work is not underway. These safety zones will only be in place prior to commissioning of the WTGs.
Operation and Maintenance	• The following advisory safety zones will be applied for by Moray West: ○ 500 m safety zones around any structure undergoing major maintenance during the operational phase, defined as work requiring a large construction vessel.
Commercial Fisheries Mitigation Strategy (CFMS)	• An draft CFMS has been developed as part of this assessment in consultation with the SFF and other fisheries stakeholders (Appendix 11.2). This draft CFMS will form the basis upon which more detailed discussions with the fishing community will be undertaken post consent to agree specific measures to be implemented to minimise potential effects on key fisheries in the area. • Once the final design of the Development has been agreed (post consent), the draft CFMS will be updated, amended where required, and finalised through consultation with local fishing community and other fisheries groups and stakeholders, to ensure that that it fully reflects the final detailed design of the Development. • The draft CFMS provides information on the following: ○ Measures for facilitating on-going dialogue with the fishing community throughout all phases of the Development; ○ Outline measures for managing and mitigating potential effects on key fisheries associated with a loss of, or restriction in access to, traditional fishing grounds during pre-construction, construction, operations and maintenance and decommissioning; ○ Outline measures and procedures for minimising interactions (navigation conflict) between wind farm construction and fishing activities; ○ Procedures to be implemented in the event of interactions (navigation conflict) between wind farm construction and fishing activities (i.e. claims for lost / and or damaged gear); ○ Protocols and procedures for ensuring compliance with standard offshore policies such as the Dropped Objects Policy. These policies prohibit the discarding of objects or materials overboard and require rapid recovery of any accidentally dropped objects; and ○ Supplementary industry wide initiatives.

Summary of Effects

Table 19.2.12: Summary of Development Specific and Cumulative Effects on Commercial Fisheries

Potential Impact	Receptors	Significance of Effect	Additional Mitigation Measures	Residual Effect	Cumulative Effect
Construction					
Adverse effects on commercially exploited Fish and Shellfish Populations	All fleets	Minor	N/A	N/A	Minor
Temporary loss or restricted access to traditional fishing grounds	Creel fleet	Minor	N/A	N/A	Minor
	Mackerel jigging fleet	Minor	N/A	N/A	Minor
	Demersal trawl fleet in general	Minor	N/A	N/A	Minor
	Local Nephrops fleet	Minor	N/A	N/A	Minor
	Local squid fleet	Minor	N/A	N/A	Minor
	Local whitefish fleet	Minor	N/A	N/A	Minor
	Local scallop fleet	Minor	N/A	N/A	Minor
	Nomadic scallop fleet	Minor	N/A	N/A	Minor
	Scottish seine fleet	Negligible	N/A	N/A	Scoped out of cumulative assessment
Safety issues for fishing vessels	All fleets	Within acceptable limits	N/A	N/A	Scoped out of cumulative assessment
Increased steaming times to fishing grounds	Creel fleet	Negligible	N/A	N/A	Negligible
	Mackerel jigging fleet	Negligible	N/A	N/A	Negligible
	Demersal trawl fleet (including local fleets)	Negligible	N/A	N/A	Minor

Table 19.2.12: Summary of Development Specific and Cumulative Effects on Commercial Fisheries					
Potential Impact	**Receptors**	**Significance of Effect**	**Additional Mitigation Measures**	**Residual Effect**	**Cumulative Effect**
	Scallop dredging fleet (local and nomadic)	Negligible	N/A	N/A	Minor
	Scottish seine fleet	Negligible	N/A	N/A	Scoped out of cumulative assessment
Interference with fishing activities	Creel fleet	Minor	N/A	N/A	Minor
	Mackerel jigging fleet	Negligible	N/A	N/A	Negligible
	Demersal trawl fleet (including local fleets)	Negligible	N/A	N/A	Negligible
	Scallop dredging fleet (local and nomadic)	Negligible	N/A	N/A	Negligible
	Scottish seine fleet	Negligible	N/A	N/A	Negligible
Displacement of fishing activity into other areas	Creel fleet	Minor	N/A	N/A	Minor
	Mackerel jigging fleet	Minor	N/A	N/A	Minor
	Demersal trawl fleet in general	Minor	N/A	N/A	Minor
	Local Nephrops fleet	Minor	N/A	N/A	Minor
	Local squid fleet	Minor	N/A	N/A	Minor
	Local whitefish fleet	Minor	N/A	N/A	Minor
	Local scallop fleet	Minor	N/A	N/A	Minor
	Nomadic scallop fleet	Minor	N/A	N/A	Minor
	Scottish seine fleet	Negligible	N/A	N/A	Scoped out of cumulative assessment

Table 19.2.12: Summary of Development Specific and Cumulative Effects on Commercial Fisheries					
Potential Impact	**Receptors**	**Significance of Effect**	**Additional Mitigation Measures**	**Residual Effect**	**Cumulative Effect**
Obstacles on the seabed post construction	All fleets	Within acceptable limits	N/A	N/A	Scoped out of cumulative assessment
Operation and Maintenance					
Adverse effects on commercially exploited Fish and Shellfish Populations	All fleets	Minor	N/A	N/A	Minor
Permanent loss or restricted access to fishing grounds	Creel fleet	Negligible	N/A	N/A	Negligible
	Mackerel jigging fleet	Negligible	N/A	N/A	Negligible
	Demersal trawl fleet (including local fleets)	Minor	N/A	N/A	Minor
	Scallop dredging local fleet	Minor	N/A	N/A	Minor
	Scallop dredging nomadic fleet	Minor	N/A	N/A	Minor
	Scottish seine fleet	Negligible	N/A	N/A	Scoped out of cumulative assessment
Safety issues for fishing vessels	All fleets	Within acceptable limits	N/A	N/A	Scoped out of cumulative assessment
Increased steaming times	All fleets	Negligible	N/A	N/A	Negligible
Interference with fishing activities	Creel fleet	Minor	N/A	N/A	Minor
	Mackerel jigging fleet	Negligible	N/A	N/A	Negligible
	Demersal trawl fleet (including local fisheries)	Negligible	N/A	N/A	Negligible

Table 19.2.12: Summary of Development Specific and Cumulative Effects on Commercial Fisheries

Potential Impact	Receptors	Significance of Effect	Additional Mitigation Measures	Residual Effect	Cumulative Effect
	Scallop dredging fleet (including local and nomadic vessels)	Negligible	N/A	N/A	Negligible
	Scottish seine fleet	Negligible	N/A	N/A	Scoped out of cumulative assessment
Displacement of fishing activity into other areas	Creel fleet	Negligible	N/A	N/A	Minor
	Mackerel jigging fleet	Negligible	N/A	N/A	Minor
	Demersal trawl fleet (including local fleets)	Minor	N/A	N/A	Minor
	Scallop dredging local fleet	Minor	N/A	N/A	Minor
	Scallop dredging nomadic fleet	Minor	N/A	N/A	Minor
	Scottish seine fleet	Negligible	N/A	N/A	Scoped out of cumulative assessment
Obstacles on the seabed	All fleets	Within acceptable limits	N/A	N/A	Scoped out of cumulative assessment
Decommissioning					
Considered to be equal to or less than impacts stated in construction.					

19.2.8 Shipping and Navigation

Embedded Mitigation Measures

Table 19.2.13: Embedded Measures – Shipping and Navigation	
Development Phase	**Measures**
General	• Application, and use of safety zones, of up to 500 m (rolling) during construction / maintenance and decommissioning as well as 50 m per commissioning; • Blade clearance (at least 22 m above Mean High Water Spring (MHWS)); • Compliance from all vessels with international maritime regulations as adopted by the flag estate, including the International Convention for the Prevention of Collisions at Sea (COLREGs) (IMO, 1972); • Design Statement and Layout Plan (DSLP), which will be developed post consent and facilitate discussions with regulators as to the final layout design for various constraints; • Emergency Response and Cooperation Plan (ERCoP); • Fisheries Liaison Officer (FLO) who will facilitate promulgation of information post consent to ensure fishing stakeholders are fully informed; • Vessel health and safety requirements including competency assessments and audits; • Lighting and Marking Plan (LMP) which will detail lighting and marking (for installations and cables) mitigations as agreed with key stakeholders; • Marine coordination to monitor and control Moray West vessels and personnel; • Marine Pollution and Contingency Plan (MPCP) to ensure any pollutions events are effectively managed in line with Maritime and Coastguard Agency (MCA) requirements; • Compliance with Marine Guidance Note (MGN) 543 – including SAR annex; • Monitoring by Automatic Identification System (AIS) to ensure mitigations are working; • Promulgation of information (including Notice to Mariners, Kingfisher Bulletins); • Provision of the positions of all OSPs and cables to Clyde Cruising Club, for inclusion in the "Clyde Cruising Club Sailing Directions and Anchorages"; and, • WTGs, cables and OSP(s) marking on Admiralty Navigational Charts.
Construction	• Buoyed construction area - temporary (as per Northern Lighthouse Board (NLB) Requirements); • CBRA (post consent); • Navigational Safety Plan (NSP) to ensure that Moray West vessels do not interact with other third parties during the construction phase; • Use of guard vessels during construction and decommissioning (as required by risk assessment); and
Operation and Maintenance	• Permanent Aids to Navigation (AtoN) (International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) Requirements, NLB Requirements, Civil Aviation Authority (CAA) Requirements and MCA Search and Rescue (SAR) Requirements).

Summary of Effects

Table 19.2.14: Summary of Development Specific and Cumulative Effects on Shipping and Navigation					
Potential Impact	**Receptors**	**Significance of Effect**	**Additional Mitigation Measures**	**Residual Effect**	**Cumulative Effect**
Construction					
Vessel Displacement	Commercial vessels	Broadly Acceptable	N/A	N/A	Broadly Acceptable
	Oil and gas vessels	Tolerable with mitigation	N/A	N/A	Information sharing in place between Moray West and relevant oil and gas developers. No significant effects on oil and gas vessels or third-party vessels expected.
	Recreational vessels	Broadly Acceptable	N/A	N/A	Broadly Acceptable
	Fishing vessels	Broadly Acceptable	N/A	N/A	Broadly Acceptable
Increased collision (vessel to vessel) risk	All vessels	Broadly Acceptable	N/A	N/A	Broadly Acceptable
Allision (vessel to structure) risk	All vessels	Broadly Acceptable	N/A	N/A	Broadly Acceptable
Anchor interaction and snagging	All vessels	Broadly Acceptable	N/A	N/A	Broadly Acceptable
Operation and Maintenance					
Vessel Displacement	Commercial vessels	Broadly Acceptable	N/A	N/A	Broadly Acceptable
	Oil and gas vessels	Broadly Acceptable	N/A	N/A	Broadly Acceptable
	Recreational vessels	Broadly Acceptable	N/A	N/A	Broadly Acceptable
	Fishing vessels	Broadly Acceptable	N/A	N/A	Broadly Acceptable

Table 19.2.14: Summary of Development Specific and Cumulative Effects on Shipping and Navigation					
Potential Impact	**Receptors**	**Significance of Effect**	**Additional Mitigation Measures**	**Residual Effect**	**Cumulative Effect**
Increased collision (vessel to vessel) risk	All vessels	Broadly Acceptable	N/A	N/A	Scoped out. Assessment focus on allision (vessel to structure – see below)
Allision (vessel to structure) risk	All vessels excluding commercial fishing	Broadly Acceptable	N/A	N/A	Broadly Acceptable
	Fishing vessels	Broadly Acceptable	N/A	N/A	Broadly Acceptable
Anchor interaction and snagging	All vessels	Broadly Acceptable	N/A	N/A	Scoped out of cumulative assessment.
Diminishing emergency response capability	Emergency response resources	Broadly Acceptable	N/A	N/A	Broadly Acceptable
Reduction in under keel clearance	All vessels	Broadly Acceptable	N/A	N/A	Scoped out of cumulative assessment.
Decommissioning					
Vessel displacement	Commercial fishing vessels	Broadly Acceptable	N/A	N/A	Scoped out of cumulative assessment.
Allision (vessel to structure) risk	All vessels	Broadly Acceptable	N/A	N/A	Scoped out of cumulative assessment.
Anchor interaction and snagging	All vessels	Broadly Acceptable	N/A	N/A	Scoped out of cumulative assessment.

19.2.9 Military and Civil Aviation

Embedded Mitigation Measures

19.2.9.1 No measures were identified as embedded mitigation for consideration as part of the assessment of potential impacts in relation to military or civil aviation receptors.

Additional Mitigation Measures

19.2.9.2 As identified in the assessment above, in order to prevent significant effects on key civil and military aviation receptors associated with the Moray Firth there is a requirement to implement a number of receptor specific measures. These measures, as identified above, include:

- Revise and re-publish the Approach Procedures for Wick Airport. As part of this Moray West will be required to fund a review of the Instrument Flight Procedures;
- To prevent significant effect on helicopter approach procedures to offshore installations Moray West will be required to notify NATS AIS of the final locations and heights of the turbines and other infrastructure so that aviation charts and other relevant documents can be updated;
- Raise Minimum Safe Altitude in the Moray Firth Region from 1,500 ft (current) to 2,000 ft to ensure 1,000 ft clearance from blade tip;
- Implementation of Multi-Radar Tracker (MRT) Blanking to mitigate effects at the Allanshill PSR; and
- Agreement and implementation of suitable ATC PSR mitigation to prevent significant effects on RAF Lossiemouth.

Summary of Effects

Table 19.2.15: Summary of Development Specific and Cumulative Effects on Military and Civil Aviation					
Potential Impact	**Receptors**	**Significance of Effect**	**Additional Mitigation Measures**	**Residual Effect**	**Cumulative Effect**
Construction					
Interference with aircraft approach procedures	Wick Airport	Significant	Revise and re-publish Wick Airport Approach Procedures to increase the lowest altitude to which inbound aircraft	Not significant	Aviation receptors considered on a case by case basis and measures applied to mitigate against any potential effects. If an effect is not significant at the Project level then it is considered sufficiently managed so as not to result in an additive cumulative effect.
Interference with helicopter approach procedures	Helicopter operators to offshore platforms	Significant	To reduce the risk of safety incidents, it will be necessary to notify the presence of physical obstructions to National Air Traffic Services (NATS) AIS for inclusion in appropriate aviation related documentation and addition to aviation mapping.	Not significant	
Minimum safe altitude	Aircraft operators	Significant	Minimum Safe Altitude in the Moray Firth region will need to be raised from 1,500 ft to 2,000 ft from the point of the first turbine being installed.	Not significant	
Operation and Maintenance					
Radar interference from operating turbines	NERL Allanshill PSR	Significant	Multi-Radar Tracker (MRT) blanking; which is a technical mitigation technique offered by NATS En-Route PLC (NERL)	Not significant	Aviation receptors considered on a case by case basis and measures applied to mitigate against any potential effects. If an effect is not significant at the Project level then it is considered sufficiently managed so as not to result in an additive cumulative effect.
	RAF Lossiemouth Primary Surveillance Radar (PSR)	Significant	Implementation of a Transponder Mandatory Zone in advance of agreement for an enduring technical solution with the Ministry of Defence (MoD).	Not significant	

Table 19.2.15: Summary of Development Specific and Cumulative Effects on Military and Civil Aviation					
Potential Impact	**Receptors**	**Significance of Effect**	**Additional Mitigation Measures**	**Residual Effect**	**Cumulative Effect**
Interference with aircraft approach procedures	Wick Airport	Significant	Revise and re-publish Wick Airport Approach Procedures to increase the lowest altitude to which inbound aircraft	Not significant	
Helicopter Main Route X-RAY	Helicopter operators	Not significant	N/A	Not significant	
Interference with helicopter approach procedures	Helicopter operators	Significant	Potential changes to helicopter operational procedures and notification of the presence of physical obstructions to NATS AIS for inclusion in appropriate aviation related documentation and addition to aviation mapping.	Not significant	
Minimum safe altitude	Aircraft operators	Significant	Minimum Safe Altitude in the Moray Firth region will need to be raised from 1,500 ft to 2,000 ft from the point of the first turbine being installed.	Not significant	
Decommissioning					
Radar interference from operating turbines	NERL Allanshill PSR	Not significant	N/A	Not significant	Aviation receptors considered on a case by case basis and measures applied to mitigate against any potential effects. If an effect is not significant at the Project level then it is considered sufficiently managed so as not to result in an additive cumulative effect.
	RAF Lossiemouth PSR	Not significant	N/A	Not significant	
Interference with aircraft approach procedures	Wick Airport	Not significant, subject to continuation of mitigation applied during operation.	N/A	Not significant	

Table 19.2.15: Summary of Development Specific and Cumulative Effects on Military and Civil Aviation					
Potential Impact	**Receptors**	**Significance of Effect**	**Additional Mitigation Measures**	**Residual Effect**	**Cumulative Effect**
Helicopter Main Route X-RAY	Helicopter operators	Not significant	N/A	Not significant	
Interference with helicopter approach procedures	Helicopter operators	Not significant	N/A	Not significant	
Minimum safe altitude	Aircraft operators	Not significant, subject to continuation of mitigation applied during operation.	N/A	Not significant	

19.2.10 Seascape, Landscape and Visual Impact Assessment

Embedded Mitigation Measures

19.2.10.1 Impacts on SLVIA receptors was assessed with no specific embedded mitigation measures which was considered to represent the realistic worst case.

19.2.10.2 As part of the final wind farm design and layout Moray West will work with stakeholders to seek to reduce, where possible, the perception of turbines as 'outliers' which could appear to extend the horizontal extent of the wind farm disproportionately when compared to the energy gained, or potentially appear to 'close off' views of the open sea that lie between Moray West and the coast. The final wind farm design and layout will also be required to take into account other stakeholder requirements such as navigation, commercial fisheries and search and rescue (SAR); other technical and environmental factors within the Moray West Site (ground conditions, wind resources etc.); and proximity to the neighbouring BOWL and Moray East offshore wind farms.

Summary of Effects

Table 19.2.16: Summary of Development Specific and Cumulative Effects on Seascape, Landscape and Visual Receptors					
Potential Impact	**Receptors**	**Significance of Effect**	**Additional Mitigation Measures**	**Residual Effect**	**Cumulative Effect**
Construction, Operation and Decommissioning[1]					
Daytime visual effects on representative viewpoints	Viewpoint 1: Duncansby Head	Not significant	N/A	N/A	Scoped out of cumulative assessment
	Viewpoint 2: Keiss (A99)	Not significant	N/A	N/A	Scoped out of cumulative assessment
	Viewpoint 3: Wick (path south of South View)	Significant	N/A	N/A	Scoped out of cumulative assessment
	Viewpoint 4: Sarclet (Sarclet Haven Info Board)	Significant	N/A	N/A	Significant
	Viewpoint 5: Whaligoe Steps	Significant	N/A	N/A	Significant
	Viewpoint 6: Minor Road (south east of Oscloy)	Significant	N/A	N/A	Significant (subject to positive determination of project applications currently under consideration by the relevant licensing authority)
	Viewpoint 7: Lybster (end of Main Street)	Significant	N/A	N/A	Significant
	Viewpoint 8: Latheron (A9)	Significant	N/A	N/A	Significant

[1] Note, the summary of conclusions presents the significance for all phases of the Development for the Project alone. Where the EIA conclusions vary between construction / decommissioning and operation this is specified. For the cumulative assessment the summary table specifies the assessment based on consented wind farms. Where an additional determination of significance is different when considering additional projects that are currently within the application phase this is specified in the Cumulative Effect column.

Table 19.2.16: Summary of Development Specific and Cumulative Effects on Seascape, Landscape and Visual Receptors					
Potential Impact	**Receptors**	**Significance of Effect**	**Additional Mitigation Measures**	**Residual Effect**	**Cumulative Effect**
	Viewpoint 9a: Dunbeath (nr Heritage Centre)	Significant	N/A	N/A	Significant
	Viewpoint 9b: Dunbeath (by harbour)	Significant	N/A	N/A	Significant
	Viewpoint 10: Morven	Not significant	N/A	N/A	Significant (subject to positive determination of project applications currently under consideration by the relevant licensing authority)
	Viewpoint 11: Berriedale (A9)	Significant	N/A	N/A	Significant
	Viewpoint 12: Navidale	Significant	N/A	N/A	Significant
	Viewpoint 13a: Brora (picnic area off Salt Street)	Not significant	N/A	N/A	Not significant
	Viewpoint 13b: Dornoch (beach parking)	Not significant	N/A	N/A	Not significant
	Viewpoint 14: Tarbat Ness Lighthouse	Not significant	N/A	N/A	Not significant
	Viewpoint 15: Burghead Visitor Centre	Not significant	N/A	N/A	Not significant
	Viewpoint 16: Lossiemouth Harbour – day and night time	Not significant	N/A	N/A	Not significant
	Viewpoint 17: Buckie (Cliff Terrace)	Not significant	N/A	N/A	Not significant

Table 19.2.16: Summary of Development Specific and Cumulative Effects on Seascape, Landscape and Visual Receptors					
Potential Impact	**Receptors**	**Significance of Effect**	**Additional Mitigation Measures**	**Residual Effect**	**Cumulative Effect**
	Viewpoint 18: Bin Hill	Not significant	N/A	N/A	Not significant
	Viewpoint 19 Portnockie (Bow Fiddle Rock Info Point):	Not significant	N/A	N/A	Significant
	Viewpoint 20: Cullen (viaduct)	Not significant	N/A	N/A	Significant
	Viewpoint 21: Findlater Castle	Not significant	N/A	N/A	Significant
	Viewpoint 22: Sandend	Significant (during Construction / Decommissioning only)	N/A	N/A	Not significant
	Viewpoint 23: Portsoy	Not significant	N/A	N/A	Not significant
Visual effects on people in settlements	Wick	Significant	N/A	N/A	Not significant
	Thrumster	Not significant	N/A	N/A	Not significant
	Lybster	Significant	N/A	N/A	Significant
	Latheronwheel	Significant	N/A	N/A	Significant
	Dunbeath	Significant	N/A	N/A	Significant
	Helmsdale	Significant	N/A	N/A	Significant
	Brora	Not significant	N/A	N/A	Not significant
	Sandend	Significant (during Construction / Decommissioning only)	N/A	N/A	Not significant
	A9 (Brora to Spittal)	Significant	N/A	N/A	Significant

Table 19.2.16: Summary of Development Specific and Cumulative Effects on Seascape, Landscape and Visual Receptors

Potential Impact	Receptors	Significance of Effect	Additional Mitigation Measures	Residual Effect	Cumulative Effect
Visual effects on people using routes	A99 (Latheron to Wick)	Significant	N/A	N/A	Significant
	Far North Line (Brora to Helmsdale)	Significant	N/A	N/A	Significant
Night time visual effects on representative viewpoints	Viewpoint 3: Wick (path south of South View)	Not significant	N/A	N/A	Not assessed cumulatively
	Viewpoint 9a: Dunbeath (nr Heritage Centre)	Significant	N/A	N/A	Not assessed cumulatively
	Viewpoint 12: Navidale	Significant	N/A	N/A	Not assessed cumulatively
	Viewpoint 16: Lossiemouth Harbour	Not significant	N/A	N/A	Not assessed cumulatively
Impact on Landscape character types	Sweeping Moorland - 25	Not significant	N/A	N/A	Not significant
	Small Farms and Crofts -23	Significant	N/A	N/A	Significant
	Moorland Slopes and Hills - 18	Significant	N/A	N/A	Significant
	Coastal Shelf -6	Not significant	N/A	N/A	Significant (subject to positive determination of project applications currently under consideration by the relevant licensing authority)
	Coastal High Cliffs and Sheltered Bays - 11	Significant	N/A	N/A	Significant
	Long Beaches Dunes and Links - 16	Not significant	N/A	N/A	Not significant
	Sarclet Head - G	Significant	N/A	N/A	Significant

Table 19.2.16: Summary of Development Specific and Cumulative Effects on Seascape, Landscape and Visual Receptors					
Potential Impact	**Receptors**	**Significance of Effect**	**Additional Mitigation Measures**	**Residual Effect**	**Cumulative Effect**
Regional coastal characters areas	Lybster Bay - H	Significant	N/A	N/A	Significant
	Dunbeath Bay - I	Significant	N/A	N/A	Significant
	Helmsdale to Berriedale Coastal Shelf - J	Significant	N/A	N/A	Significant
	Brora to Helmsdale Deposition Coast - K	Not significant	N/A	N/A	Not significant
Landscape planning designations	Dunbeath Castle GDL (Gardens and Designed Landscapes)	Significant	N/A	N/A	Significant
	Dunrobin Castle GDL	Not significant	N/A	N/A	Not significant
	Flow Country and Berriedale Coast SLA (Special Landscape Area)	Significant	N/A	N/A	Significant
	Loch Fleet, Loch Brora and Glen Loth SLA	Not significant	N/A	N/A	Significant (subject to positive determination of project applications currently under consideration by the relevant licensing authority)

19.2.11 Socio-economics, Recreation and Tourism

Embedded Mitigation Measures

19.2.11.1 Most potential effects on socio-economic receptors are beneficial and therefore do not require embedded measures. In relation to tourism and recreation no specific measures were identified as embedded mitigation for consideration as part of the assessment.

Summary of Effects

Table 19.2.17: Summary of Development Specific and Cumulative Effects on Socio-economics, Tourism and Recreation					
Potential Impact	**Receptors**	**Significance of Effect**	**Additional Mitigation Measures**	**Residual Effect**	**Cumulative Effect**
Construction					
Direct and indirect construction employment	Construction employment	**Local study area:** minor beneficial significance for the low assessment scenario; Major beneficial significance for the high assessment scenario. **Scotland:** minor beneficial significance for low assessment scenario Moderate beneficial significance for high assessment scenario.	N/A	N/A	Major beneficial significance
Direct and indirect construction Gross Value Added (GVA)	GVA	**Local study area:** minor beneficial significance for the low assessment scenario; Major beneficial significance for the high assessment scenario. **Scotland:** minor beneficial significance for low assessment scenario Moderate beneficial significance for high assessment scenario.	N/A	N/A	Major beneficial significance
Change in demand for housing and local services associated with influx of labour in the local study area	Housing and local services in local study area	Negligible	N/A	N/A	Minor adverse significance
Access to, and enjoyment of, watersports activity in the local study area	Watersports activity in local study area	Negligible	N/A	N/A	Scoped out of cumulative assessment on basis construction related effects only

Table 19.2.17: Summary of Development Specific and Cumulative Effects on Socio-economics, Tourism and Recreation

Potential Impact	Receptors	Significance of Effect	Additional Mitigation Measures	Residual Effect	Cumulative Effect
	Moray Firth Surfers (Sandend)	Minor adverse significance	N/A	N/A	Scoped out of cumulative assessment on basis construction related effects only
Change in economic activity onshore supported by local watersports activity: local study area	Economic activity supported by local watersports activity in Local Study Area	Minor adverse significance	N/A	N/A	Scoped out of cumulative assessment on basis construction related effects only
Operation and Maintenance					
Direct and indirect O&M employment: Scotland and Local Study Area	O&M employment	Minor beneficial significance under low and high assessment scenario and in both study areas.	N/A	N/A	Major beneficial significance
Direct and indirect O&M GVA: Scotland and Local Study Area	GVA	Minor beneficial significance under low and high assessment scenario and in both study areas.	N/A	N/A	Major beneficial significance
Decommissioning					
The decommissioning phase impacts (including impact on employment, GVA, enjoyment of watersports and associated value) will have a similar range of effects as for the construction phase					

19.2.12 Archaeology & Cultural Heritage

Embedded Mitigation Measures

Table 19.2.18: Embedded Measures – Archaeology and Cultural Heritage	
Development Phase	**Measures**

General	• A Development-specific Written Scheme of Investigation (WSI) will be prepared, in consultation with HES, once the layout of the Development and infrastructure is established. This document will be incorporated into the Environmental Management Plan (EMP). The WSI will set out the design and implementation of a programme of detailed mitigation works. This will comply with guidance current at the time of its development (presently The Crown Estate 2010);
	• Mitigation strategies for known shipwreck sites will include maintenance of appropriate archaeological exclusion zones (AEZs) between the Development infrastructure including OSP(s) and cables. AEZs preclude development-related activity within their extents (Wessex Archaeology, 2007: 43);
	• Analysis of pre-construction survey data will be undertaken to refine the identified potential marine archaeology assets at infrastructure locations. Appropriate micro-siting allowance for identified assets will be agreed in consultation with HES;
	• Both the micro-siting allowance and exclusion zones will be detailed in the WSI described above. This will reduce any potential impacts on marine archaeology; and.
	• Mitigation relating to effects of the Development on the setting of cultural heritage will include:
	    o WTGs will be placed in a regular grid subject to micro siting requirements;
	    o WTGs will all be of similar dimensions to hub height and blade tip subject to WTG and substructure design and installation specification; and
	    o The WTGs will all be pale grey in colour (Light Grey RAL 7035) with a semi-matt finish. This tends to reduce the distance over which the WTGs are visible, especially in dull or overcast conditions, which often occur. As offshore WTGs are often viewed against the sky, pale grey is the most appropriate colour as it is closest to that of the lower part of the sky under the most frequent UK weather conditions.

Summary of Effects

Table 19.2.19: Summary of Development Specific and Cumulative Effects on Archaeology and Cultural Heritage					
Potential Impact	**Receptors**	**Significance of Effect**	**Additional Mitigation Measures**	**Residual Effect**	**Cumulative Effect**
Construction					
Contamination, damage to, or loss of, marine archaeology assets resulting from direct physical impacts	Seabed prehistory and seabed features including maritime and aviation sites and intertidal heritage assets	Minor Adverse or Positive (based on opportunities to identify and record new assets)	N/A	N/A	Negligible to Minor Adverse
Operation and Maintenance					
Destabilisation of marine archaeology assets through changed hydrography and sedimentary regimes	Seabed prehistory and seabed features including maritime and aviation sites and intertidal heritage assets	Minor Adverse	N/A	N/A	Minor Adverse
Indirect effect due to changes to the setting of designated cultural heritage assets	Dunbeath Inver Forth	Minor Adverse	N/A	N/A	Minor Adverse
	Latheronwheel promontory fort	Minor Adverse	N/A	N/A	Minor Adverse
	The Tulloch (Usshilly) Broch and field system	Minor Adverse	N/A	N/A	Minor Adverse
	Dunbeath Castle & Designed Landscape	Minor Adverse	N/A	N/A	Minor Adverse
	Dunrobin Castle & Designed Landscape	Minor Adverse	N/A	N/A	Minor Adverse
	Covesea Skerries Lighthouse	Minor Adverse	N/A	N/A	Minor Adverse
Decommissioning					
The decommissioning phase impacts will have a similar range of effects as for the construction phase					

19.2.13 Other Human Activities

Embedded Mitigation Measures

Table 19.2.20: Embedded Measures – Other Human Activities	
Development Phase	**Measures**
General	• UXO will be identified through pre-construction seabed survey; this will determine the requirement for any UXO disposal. • Inter-array cabling, interconnector cables and offshore export cables will be buried beneath the seabed wherever practicable, in line with The Carbon Trust cable burial risk assessment (CBRA) methodology (or latest equivalent guidance). Cable protection measures would be applied in areas where burial is not possible, e.g. where the cables are required to cross existing cables or in areas of hard seabed are encountered; • Pre-construction seabed surveys will accurately identify the location of existing seabed assets, including in-service cables and pipelines; all existing seabed infrastructure will be avoided by Development infrastructure wherever possible; and • Agreed buffers exist between the Moray West and Moray East sites, and between these sites and the Beatrice offshore wind farm; these will be adhered to.

Construction	• The following Safety Zones will be applied for by Moray West:
	  ○ 500 m safety zones around any structure where construction work is underway, as indicated by the presence of a large construction vessel(s);
	  ○ 50 m safety zones around any partially or fully completed (prior to commissioning) structure during the construction phase where work is not underway; and
	  ○ 500 m safety zones around any structure undergoing major maintenance during the operational phase, defined as work requiring a large or 'restricted in the ability to manoeuvre' (RAM) vessel.
	• A suite of further standard measures will ensure the safety of other sea users, including but not limited to:
	  ○ Promulgation of information regarding Development activity during all phases of the Development, via regular Notices to Mariners (NtMs), Kingfisher Bulletins, radio navigation warnings and other appropriate means;
	  ○ Dedicated marine coordination staff and facilities will coordinate all offshore activity associated with the Development; and
	  ○ Works areas and installed infrastructure will be appropriately marked and lit in accordance with standard industry guidance.
	• All cables will be installed and maintained in line with standard industry guidance and good practice (e.g. Subsea Cables UK Guidelines, International Cable Protection Committee Recommendations) that provide guidance on proximity of cables to existing assets and coordination with other operators.

Operation and Maintenance	• 500 m safety zones around any structure undergoing major maintenance during the operational phase, defined as work requiring a large or 'restricted in the ability to manoeuvre' (RAM) vessel. • The location of all installed infrastructure will be confirmed to the UKHO and Defence Infrastructure Organisation (DIO) to allow for their marking on Admiralty Charts and PEXA charts.

Summary of Effects

Table 19.2.21: Summary of Development Specific and Cumulative Effects on Other Human Activities					
Potential Impact	**Receptors**	**Significance of Effect**	**Additional Mitigation Measures**	**Residual Effect**	**Cumulative Effect**
Construction and Decommissioning					
Disturbance of existing offshore wind farm activities	Offshore wind farm operators	Minor adverse	N/A	N/A	No cumulative effect
Disturbance of existing subsea cables	Subsea cable operators	Minor adverse	Cable crossing and proximity agreements	Minor adverse	No cumulative effect
Disturbance of oil exploration and decommissioning activities	Oil block licence holders Oil infrastructure operators	Minor adverse	N/A	N/A	Oil and gas exploration: negligible or minor Decommissioning activities: No cumulative effect
Disturbance of marine disposal activities	Buckie marine disposal site	Negligible or minor adverse	N/A	N/A	No cumulative effect
Risks associated with UXO	Offshore workers	Negligible	N/A	N/A	Scoped out of cumulative assessment
Operation and Maintenance					
Disturbance of existing offshore wind farm activities	Offshore wind farm operators	Negligible or minor adverse	N/A	N/A	No cumulative effect
Disturbance of existing subsea cables	Subsea cable operators	Negligible or minor adverse	Cable crossing and proximity agreements	Negligible or minor adverse	No cumulative effect
Disturbance of oil exploration and decommissioning activities	Oil block licence holders Oil infrastructure operators	Negligible or minor adverse	N/A	N/A	Oil and gas exploration: negligible or minor Decommissioning activities: No cumulative effect

Table 19.2.21: Summary of Development Specific and Cumulative Effects on Other Human Activities					
Potential Impact	**Receptors**	**Significance of Effect**	**Additional Mitigation Measures**	**Residual Effect**	**Cumulative Effect**
Disturbance of marine disposal activities	Buckie marine disposal site	Negligible or minor adverse	N/A	N/A	No cumulative effect
Risks associated with Unexploded Ordnance (UXO)	Offshore workers	Negligible	N/A	N/A	No cumulative effect