EIA Quality Mark

This Environmental Statement, and the Environmental Impact Assessment (EIA) carried out to identify the significant environmental effects of the proposed development, was undertaken in line with the EIA Quality Mark Commitments.

The EIA Quality Mark is a voluntary scheme, operated by the Institute of Environmental Management and Assessment (IEMA), through which EIA activity is independently reviewed, on an annual basis, to ensure it delivers excellence in the following areas:

EIA Management
EIA Team Capabilities
EIA Regulatory Compliance
EIA Context & Influence
EIA Content
EIA Presentation
Improving EIA practice

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FOREWORD

The MeyGen Project is the largest tidal stream development in Europe to seek consent to build from a government. The Environmental Impact Assessment is the culmination of over two years of primary, multi-disciplinary environmental research and forms the core basis for the consent application.

The project is located in the Inner Sound in the Pentland Firth, off the northern coast of Caithness and contains one of Europe's best tidal stream resources. It was identified more than four years ago by a consortium consisting of Morgan Stanley (45%), International Power (45%) and Atlantis Resources Corporation (10%), who in turn, competed for seabed rights under The Crown Estate, Agreement for Lease tender round. The consortium was awarded the Agreement for Lease in October 2010. MeyGen Ltd., a Scottish Registered Company with the single purpose of developing the Inner Sound site was formed and a dedicated team employed to take the development of the project forward. MeyGen Ltd. is quite unique from other developers as it is solely focused on the commercialisation of tidal stream energy from the Inner Sound site. This, combined with in house technical strength, strong financial backing, power project experience and synergistic turbine technology relationships, provides the company with the flexibility, expertise and drive to develop the first commercial scale project of its type in the world.

The submission of this document to the regulatory authorities and its publication to all stakeholders is a key milestone in the project's progression and provides an opportunity for everyone to contribute to the decision making process. Should consent of this project be granted by the Scottish Government and The Highland Council, it will symbolise a momentous step towards the commercialisation of this powerful and predictable renewable energy resource and with it, the opportunity to create a sustainable industry in Scotland and the UK.

Although the marine energy sector is still in its infancy, employing approximately 800 people, the predicted future contribution to the Scottish and UK economy is significant with 19,500 jobs being created by 2035 and associated revenue generation estimated at £6.1Billion. Moreover, tidal energy is also an attractive form of low-carbon generation as its predictability offers system balancing benefits that result in an overall reduction in the cost of electricity to the consumer. From a local perspective, MeyGen is committed to continue to work with regional development organisations and the Caithness and North Highlands supply chain in order to attract inward investment and diversify the existing skills base. We recognise that there is high potential for the project and the industry to significantly contribute to the socio economic landscape of the region. This project will hopefully be one of the catalysts to help transition the tidal energy industry from the developmental phase into the commercial phase and therefore create wealth for Scotland and Caithness.

We are conscious that being the first application and possibly the first commercial scale project we have a heightened burden of responsibility to shareholders, government, industry and the local community. MeyGen seeks to be transparent, communicative and thorough, such that the success of the project will benefit all. To date, we have consulted extensively with over one hundred stakeholder organisations and have incorporated their concerns and observations when making project decisions. We see consultation as an ongoing process which will continue after the submission of the application throughout detailed design and the life of the project, should we obtain consent.

We trust that the content herein demonstrates to the reader the methodical process by which we have approached the research, consultation and design of the project. Thank you to all who have contributed to its composition.

MeyGen's commitment to deliver the world's first commercial tidal stream project safely and in accordance with our agreed environmental obligations is paramount, and we look forward to continuing our dialogue with all interested parties.

Dan Pearson

Chief Executive Officer

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ACRONYMS

AADT	Annual Average Daily Traffic
AIS	Automatic Identification System
ADCP	Acoustic Doppler Current Profiler
AfL	Agreement for Lease
AGLV	Areas of Great Landscape Value
AHC	Active Heave Compensation
ALARRP	As Low as Reasonably Practicable
AMAA	Ancient Monuments and Archaeological Areas Act
AOD	Above Ordnance Datum
AON	Apparently Occupied Nests
AOS	Apparently Occupied Sites
AQS	Air Quality Strategy
ARC	Atlantis Resources Corporation
ASCOBANS	Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas
ASFB	Association of Salmon Fisheries Board
ASML	Aquatic Survey and Monitoring Limited
ATC	Automatic Traffic Counter
AWAC	Acoustic Wave and Current
BAP	Biodiversity Action Plan
BAT	Best Available Technique
BERR	Department of Business, Enterprise and Regulatory Reform
BFI	Baseline Flow Index
BGS	British Geological Survey
BODC	British Oceanographic Data Centre
BP	Before Present
BS	British Standard
BSI	British Standards Institution
CAA	Civil Aviation Authority
CASE	Caithness and Sutherland Enterprise
CBD	Convention on Biological Diversity
CEFAS	Centre for Environment, Fisheries and Aquaculture Science
CEMP	Construction Environmental Management Plan
CFD	Computational Fluid Dynamics
CLBAP	Caithness Local Biodiversity Action Plan
CD	Chart Datum
CIRIA	Construction Industry Research and Information Association
CMACS	Centre for Marine and Coastal Studies
CO_2	Carbon dioxide
CPA	Coast Protection Act
CRM	Collision Risk Modelling
CTF	Caithness Transport Forum

dB	Decibel
DBA	Desk Based Assessment
DECC	Department of Energy and Climate Change
DEFRA	Department for Environment, Food and Rural Affairs
DMRB	Design Manual for Roads and Bridges
DP	Dynamic Positioning
DP	Decommissioning Programme
EC	European Commission
EEC	European Economic Community
EIA	Environmental Impact Assessment
EHO	Environmental Health Officer
EMEC	European Marine Energy Centre
EMF	Electro Magnetic Field
EMP	Environmental Management Plan
EMR	Electricity Market Reform
ENVID	Environmental Issue Identification
EPS	European Protected Species
ERI	Environmental Research Institute
ES	Environmental Statement
ESAS	European Seabirds at Sea
ETA	Estimated Time of Arrival
EU	European Union
FAO	Food and Agriculture Organisation
ERCoP	Emergency Response Cooperation Plan
EU	European Union
FEED	Front End Engineering Design
FLO	Fisheries Liaison Officer
FSA	Formal Safety Assessment
FREDS	Forum for Renewable Energy Development in Scotland
FRS	Fisheries Research Services
FRV	Fisheries Research Vessel
GBS	Gravity Based Structure
GCR	Geological Conservation Review
GIS	Geographical Information Systems
GWDTE	Groundwater Dependant Terrestrial Ecosystems
HGV	Heavy Goods Vehicle
HIE	Highlands and Islands Enterprise
HMPA	Historic Marine Protected Area
HOST	Hydrology of Soil Types
HRA	Habitat Regulations Appraisal
HS	Historic Scotland
HSE	Health and Safety Executive
HwLDP	Highland wide Local Development Plan

HVDC	High Voltage Direct Current
IBA	Important Bird Area
ICES	International Council for the Exploration of the Sea
IFA	Institute for Archaeologists
GBS	Gravity Base Structure
GIS	Geographic Information System
IBA	Important Bird Area
IEA	Institute of Environmental Assessment
IEEM	Institute of Ecology and Environmental Management
IEMA	Institute of Environmental Management
IFG	Inshore Fisheries Group
IMO	International Maritime Organisation
IROPI	Imperative Reason of Overriding Public Interest
IUCN	International Union for Conservation of Nature
JNCC	Joint Nature Conservation Committee
JSA	Job Seekers Allowance
kg	Kilogram
km	Kilometre
km^2	Square kilometre
Km/h	Kilometre per hour
LAT	Lowest Astronomical Tide
LBAP	Local Biodiversity Action Plan
LAQM	Local Air Quality Management
LCA	Landscape Character Assessment
LDP	Local Development Plan
LGV	Light Goods Vehicle
LOA	Lease Option Agreement
LSCA	Landscape Seascape Character Assessment
m	Metre
MAGIC	Multi Agency Geographic Information for the Countryside
MarLIN	Marine Life Information Network
MAIB	Marine Accident Investigation Branch
MARPOL	International Convention for the Prevention of Pollution from Ships
MS	Marine Scotland
MBES	Multibeam Echo Sounder
MCA	Maritime and Coastguard Agency
MCS	Marine Conservation Society
MCT	Marine Current Turbines Limited
MESH	Marine European Seabed Habitats
MFA	Marine and Fisheries Agency
MGN	Marine Guidance Note
MHWS	Mean High Water Springs

MLWS	Mean Low Water Springs
MLURI	Macaulay Land Use Research Institute
mm	Millimetre
MNNS	Marine Non Native Species
MoD	Ministry of Defence
MP	Member of Parliament
MPA	Marine Protected Area
MPS	Marine Policy Statement
MRESF	Marine Renewable Energy Strategic Framework for Wales
MS	Marine Scotland
MS-LOT	Marine Scotland Licensing Operations Team
ms^{-1}	Metres per second
MW	Megawatts
NATS	National Air Traffic Service
NMRS	National Monuments Records of Scotland
NBN	National Biodiversity Network
NDA	Nuclear Decommissioning Authority
NGR	National Grid Reference
NPF	National Planning Framework
NRA	Navigational Risk Assessment
NLB	Northern Lighthouse Board
NRTF	National Rural Touring Forum
NSA	National Scenic Area
nm	Nautical miles
NO_x	Oxides of nitrogen
NRTF	National Road Traffic Forecast
NSA	National Scenic Area
OFA	Orkney Fisheries Association
OIC	Orkney Islands Council
ORCA	Orkney Research Centre for Archaeology
OSPAR	Oslo and Paris Conventions for the protection of the marine environment
OREI	Offshore Renewable Energy Installation
OS	Ordnance Survey
PA	Position Approximate
PAM	Passive Acoustic Monitoring
PAN	Planning Advice Note
PBR	Potential Biological Removal
PCC	Power Conversion Centre
PCUB	Power Conversion Unit Building
PEXA	Practice and Exercise Area
PFOW	Pentland Firth and Orkney Waters
PPG	Pollution Prevention Guidelines
PHA	Preliminary Hazard Analysis

PMF	Priority Marine Feature
PPE	Personal Protective Equipment
PTS	Permanent Threshold Shift
RBMP	River Basin Management Plan
RCAHMS	Royal Commission for Ancient and Historical Monuments for Scotland
ReDAPT	Reliable Data Acquisition Platform Tidal
RES	Renewable Energy Strategy
REZ	Renewable Energy Zone
RIFE	Radioactivity in Food and the Environment
RNLI	Royal National Lifeboat Institution
RO-RO	Roll on – Roll off
ROCs	Renewables Obligation Certificates
ROS	Renewable Obligation Order for Scotland
ROV	Remotely Operated Vehicle
RPM	Revolutions per Minute
RPS	RPS Group Plc
RSPB	Royal Society for the Protection of Birds
RTP	Roger Tym and Partners
RYA	Royal Yachting Association
SAAR	Standard Annual Average Rainfall
SAC	Special Area of Conservation
SAM	Scheduled Ancient Monument
SAMS	Scottish Association for Marine Science
SAR	Search and Rescue
SBL	Scottish Biodiversity List
SCANS	Small Cetacean Abundance in the North Sea
SCADA	Supervisory Control and Data Acquisition
SCOS	Special Committee on Seals
SEPA	Scottish Environment Protection Agency
SEA	Strategic Environmental Assessment
SFF	Scottish Fishermen's Federation
SHEP	(Historic Scotland's) Scottish Historic Environment Policy
SHEPD	Scottish Hydro Electric Power Distribution
SHETL	Scottish Hydro Electric Transmission Limited
SIFAG	Scottish Inshore Fisheries and Advisory Group
SING	Semi Improved Neutral Grassland
SLM	Sound Level Meter
SLA	Scenic Landscape Area
SMRU	Seal and Mammal Research Unit
SNH	Scottish Natural Heritage
SNMP	Scotland's National Marine Plan
SOPEP	Ship Oil Pollution Emergency Plan
SO_x	Oxides of sulphur

SPA	Special Protection Area
SPG	Supplementary Planning Guidance
SPP	Scottish Planning Policy
SPR	Scottish Power Renewables Limited
SPR	Standard Percentage Runoff
SRSL	SAMS Research Services Limited
SSE	Scottish and Southern Energy
SSSI	Special Site of Scientific Interest
STCEF	Scientific Technical and Economic Committee for Fisheries
TCE	The Crown Estate
TAC	Total Allowable Catch
TGL	Tidal Generation Limited
THC	The Highland Council
THCHET	Highland Council Historic Environment Team
TSS	Turbine Support Structure
TTS	Temporary Threshold Shift
UK	United Kingdom
UKAEA	UK Atomic Energy Authority
UKBAP	UK Biodiversity Action Plan
UKC	Under Keel Clearance
UKCP	UK Climate Projections Report
UKHO	UK Hydrographic Office
UKRES	UK Renewable Energy Strategy
UNCLOS	United Nations Convention of the Law of the Sea
VHF	Very High Frequency
VP	Vantage Point
VMS	Vessel Monitoring System
VTS	Vessel Traffic Services
WGNAS	Working Group on North Atlantic Salmon
WHO	World Health Organisation
WFD	Water Framework Directive
ZAV	Zone of Actual Visibility
ZTV	Zone of Theoretical Visibility

GLOSSARY

Agreement for Lease	Agreement entered into between MeyGen Ltd and The Crown Estate for the rights to development on the seabed, named as the Inner Sound, shown in Figure 1.3.
Dynamic positioning vessel	A Dynamic Positioning Vessel (DP) can safely maintain its position and heading in a tidal flow using a system of thrusters. DP vessels are able to work safely and efficiently in waters deeper than vessels using anchors.
Export cables	Cables used to export power generated by the tidal turbines to the onshore infrastructure.
Gravity based structure (GBS)	A structure which uses ballast to sit securely on the seabed without needing to be stabilized by piles or anchors. The GBS is used to support a tidal turbine.
Horizontal Directional Drilling	Horizontal Directional Drilling (HDD) is a process whereby drilling of a bore departs from the vertical axis and exceeds 80° allowing bores to be drilled through a target geological formation. Directional drilling allows the drill bit to be steered in a pre-planned and hence the bore can be designed to exit the seabed in a pre-determined location.
Jumper cables	Short lengths of cables connecting the turbine support structures and export cable.
MeyGen Tidal Energy Project	Tidal energy project in the Inner Sound, Pentland Firth developed by MeyGen Ltd.
Monopile	A single large diameter steel tube that is grouted into a hole bored into the seabed. The monopile is used to support a tidal turbine.
Nacelle	The enclosure of the tidal turbine's mechanical and electrical equipment.
Pin pile	The use of multiple small diameter steel tubes that are grouted into a hole bored into the seabed. The pin piles are used to support a tidal turbine.
Power Conversion Centre (PCC)	The PCC is an onshore facility that receives power generated by the tidal turbines and converts it into a grid compliant form for onwards transmission. The PCC will comprise offshore cable terminations, power conversion equipment, transformers and switchgear for grid connection.
Project	For the purpose of this ES, the Project refers to Phase 1 of the MeyGen Tidal Energy Project.
Remotely operated vehicle (ROV)	A Remotely Operated Vehicle (ROV) is an underwater vehicle able to undertake multiple subsea operations. ROVs are highly manoeuvrable and are controlled by operators on-board the DP vessel.
Tidal turbine	A device that converts hydrodynamic energy in the tidal flow into electrical energy.
Tidal turbine array	Term used to describe a group of tidal turbines.
Turbine support structure (TSS)	A turbine support structure is the structure placed on the seabed onto which a tidal turbine is installed.
Wet mate connector	A device used to connect electrical and data cables underwater.

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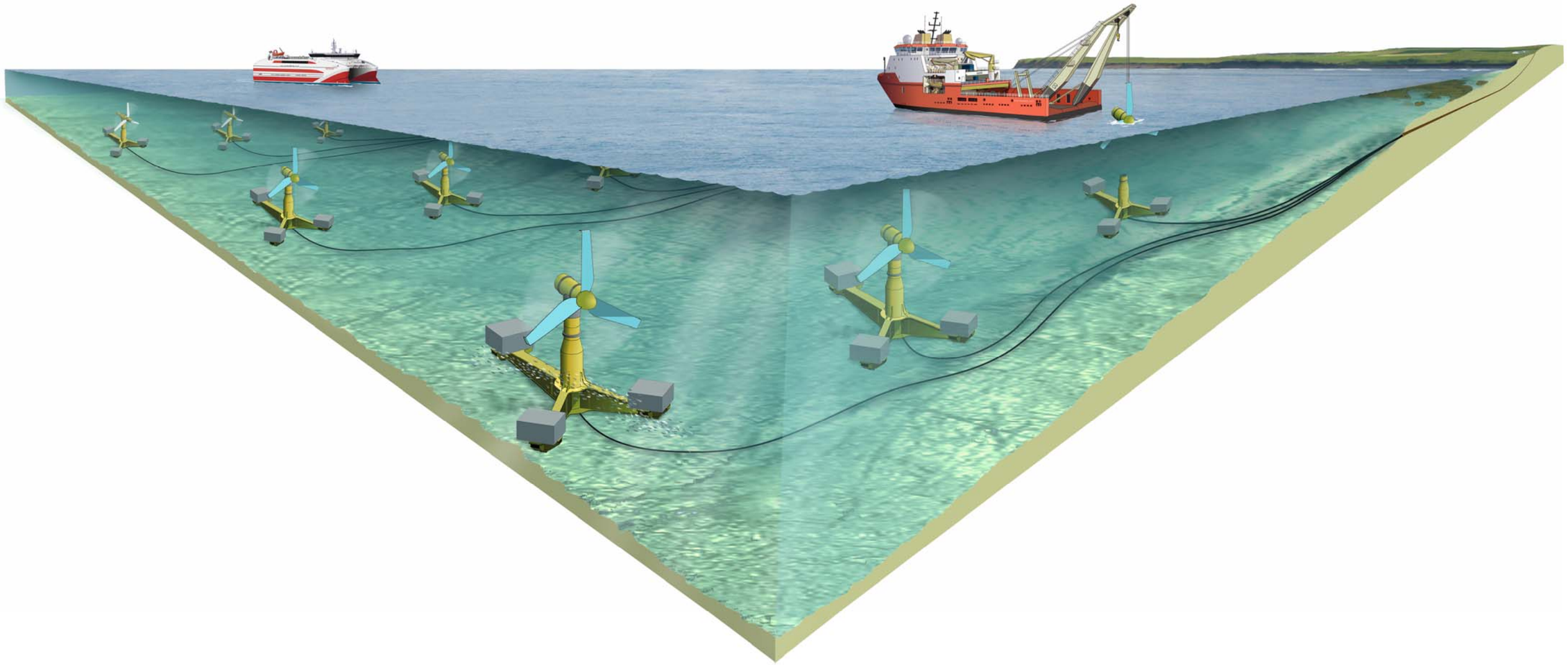

Figure 1.1 The MeyGen Project

1 INTRODUCTION

1.1 Project Background

1.1 MeyGen Ltd ("MeyGen") was awarded an Agreement for Lease (AfL) for the Inner Sound tidal development site on 21st October 2010 by The Crown Estate (TCE). The Inner Sound AfL is for the installation of 398MW tidal stream energy capacity by 2020. The Inner Sound is the body of water in the Pentland Firth between the north coast of the Scottish mainland and the island of Stroma.

1.2 The Inner Sound AfL was awarded to MeyGen as part of TCE Pentland Firth and Orkney Waters (PFOW) leasing round for wave and tidal energy projects (Figure 1.2). This was the first competitive seabed leasing round for wave and tidal projects in the UK and was designed to develop the industry on a commercial scale. Through the PFOW leasing round the TCE has agreements for 11 sites with a potential capacity of 1600MW.

1.3 The AfL does not give consent for MeyGen to develop the site, it provides MeyGen with the security required to develop the project whilst seeking the required consents for the installation and operation of the project from the regulatory authorities.

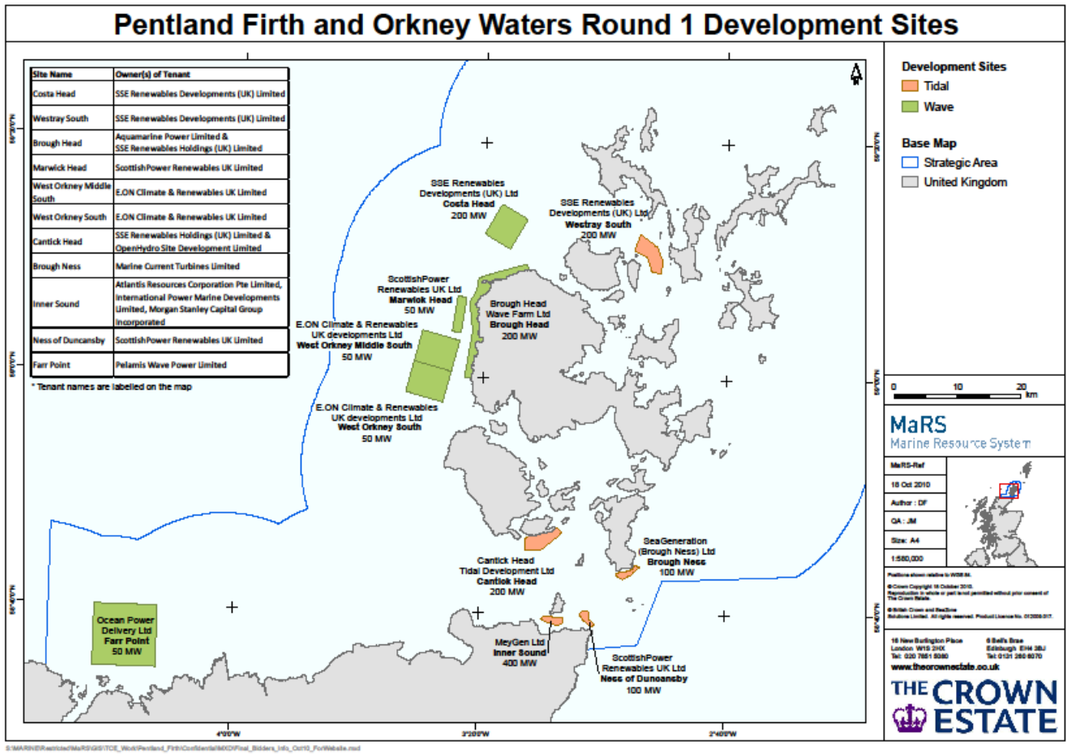

Figure 1.2: Pentland Firth and Orkney Waters Wave and Tidal Development Sites

1.2 MeyGen Ltd

1.4 MeyGen is a Scottish registered company created in 2010 for the purpose of developing the MeyGen project. MeyGen shareholders provide an excellent combination of development expertise, tidal technology manufacturer, secure financial backing and project operations experience.

1.5 MeyGen has an in-house development team with a broad range of expertise and experience in offshore energy project development and managing the successful installation of tidal energy devices.

1.3 Project Overview

1.6 MeyGen intends to consent the 398MW project in two separate phases. The MeyGen Tidal Energy Project Phase 1 ("the Project") will have a maximum aggregated capacity of 86MW, with up to 86 tidal turbines and associated infrastructure. The artist's impression provides an overview of the Project (Figure 1.1). Phase 1 is the subject of this Environmental Impact Assessment (EIA), Environmental Statement (ES) and accompanying consent application.

1.7 The Project requires an area of approximately 1.1km^2, the remainder of the AfL area will be developed as Phase 2 (312MW). Phase 2 will be subject to a separate consent application and supporting ES.

1.8 Figure 1.3 illustrates the AfL area, the Phase 1 turbine deployment area, potential offshore cable corridors and potential areas for onshore infrastructure.

1.9 The Project will comprise a maximum of 86 fully submerged tidal turbines in the deep water channel in the Inner Sound. All turbines will be located in water depths of over 31m at Lowest Astronomical Tide (LAT). The turbines will comprise of a rotor and nacelle and will be supported by a Turbine Support Structure (TSS).

1.10 Each turbine will have its own dedicated electricity export cable to shore. Cable landfalls will take the form of Horizontally Directionally Drilled (HDD) bores which will be drilled from onshore. Cables will be laid across the seabed from the turbines to the HDD bores.

1.11 An onshore Power Conversion Centre (PCC) will comprise terminations of the export cables from the turbines, power conversion equipment, transformers and switchgear for grid connection housed in Power Conversion Unit Buildings (PCUBs), and a control centre.

1.12 Electricity will be exported to the local electricity grid via buried onshore cables to grid connection point.

1.13 The Project is split into three distinct generating stations, each with turbines, PCUB and export cable to the grid connection.

1.14 It is anticipated that onshore construction and offshore installation will commence in 2014 and continue over a 3 year period. Following this the operational life of the Project will be 25 years. After this there will be a decommissioning programme in place to remove the turbines and the associated infrastructure. However at that time there may be an option to gain further consent to extend the Project.

1.4 Document Purpose

1.15 This document reports the findings of the Environmental Impact Assessment (EIA) conducted for Phase 1 in line with EIA Regulations (Section 3). The document will form part of the Project consent application to The Highland Council (onshore) and Marine Scotland (offshore).

1.16 MeyGen has considered two sites for the combined HDD and PCC site, Ness of Quoys and Ness of Huna (Figure 1.3). At this stage in the development programme of the Project it is not possible to confirm, which of these two sites will be taken forward. As such, planning applications will be submitted for both of these sites, however only one will be developed for Phase 1 of the project.

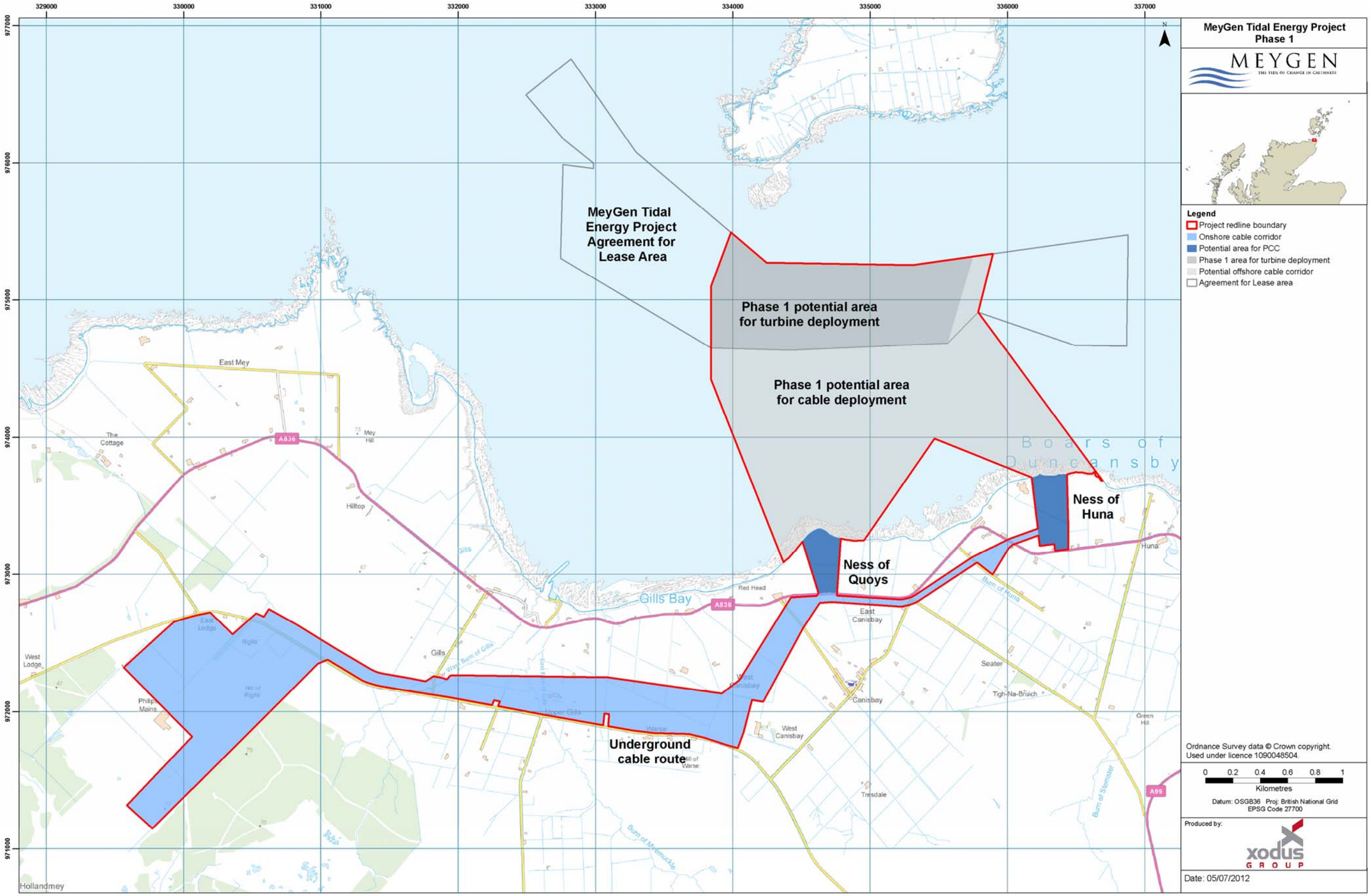

Figure 1.3: MeyGen Tidal Energy Project, Phase 1

2 PURPOSE AND SCOPE OF THE ENVIRONMENTAL IMPACT ASSESSMENT

2.1 Introduction

2.1 The Environmental Impact Assessment (EIA) process identifies the areas of a project or development where significant environmental effects may occur and outlines mitigation measures or management techniques aimed at reducing or offsetting these effects. Several different EIA Regulations (Section 3) enforce the EIA requirements in relation to the Project.

2.2 The purpose of the EIA process is to:

- Identify likely significant effects to be taken into account by the relevant decision maker;
- Integrate environmental considerations into the project planning and design activities in order to achieve a high standard of environmental performance for the Project; and
- Consult with stakeholders and address their concerns.

2.3 The Environmental Statement (ES) details the findings of the EIA process and provides explanations on how conclusions were reached. Recommendations for an appropriate environmental management plan and a proposed environmental monitoring strategy are also included.

2.4 The Scope of the EIA is to assess the impact of the following:

- The installation and operation of up to 86 tidal stream turbines in the Inner Sound;
- The installation of cable connections between the tidal turbines and onshore infrastructure;
- Horizontal Directional Drilling (HDD) of the cable landfalls;
- Construction and operation of the onshore Power Conversation Centre (PCC);
- Connection of the Project to the grid; and
- Decommissioning.

2.2 Consideration of Design Options

2.2.1 Rochdale Envelope

2.5 Throughout the EIA process the approach has been to assess the maximum potential impacts (also sometimes referred to as a “worst case”) of the Project. This approach has been established through relevant case law (R. v Rochdale MBC ex parte Milne (No. 1) and R. v Rochdale MBC ex parte Tew [1999] and R. v Rochdale MBC ex parte Milne (No. 2) [2000]) and is referred to as the "Rochdale Envelope".

2.6 These case precedents have established a custom and practice that has evolved in relation to projects where the final design is not available at the consent application stage. This approach has been confirmed by the courts and endorsed by the Scottish Government as enabling the legal requirements of the relevant EIA Regulations to be complied with, so long as appropriate conditions are placed in the resulting consents to ensure that the maximum potential likely impacts will not be exceeded by the final built development, and will not give rise to a likely significant effect on the environment which has not been assessed.

2.7 The commercial wave and tidal energy industry is rapidly evolving, with on-going improvements in turbine technology, infrastructure and installation techniques. The Rochdale Envelope approach provides essential flexibility to enable projects to take full advantage of these improvements. To commit to a detailed project design at this stage would also prevent the Project benefiting from the lessons learned from other work being done in the tidal energy industry, including the continued testing of the proposed tidal technology to be taken into consideration. The Rochdale Envelope approach allows the detailed design of a project or scheme to vary within specific defined parameters. Full details of the approach are provided in Section 8.

2.2.2 Onshore project area

2.8 At the commencement of the EIA process, the onshore Project area was not defined, with a number of different cable routes from the PCC site to grid connection having been identified and the precise boundaries of the PCC sites not determined. The onshore EIA assessment and subsequent ES section write up has considered a more extensive potential project area (Figure 2.1) than included in the planning applications. The results of the EIA surveys and studies have informed project design and allowed the refinement of the onshore Project area for the planning application (Figure 1.3).

2.9 Following the completion of the EIA, landowner consultation has identified potential issues with small areas of the proposed cable route. It has therefore been necessary to include areas outside that surveyed for the onshore impact assessments. The area is 0.50km^2 and is shown in Figure 2.1. Unfortunately this issue was not identified at the time of ES compilation and therefore is not addresses in this document. Work to survey and assessment of any changes required to the original impact assessment as a result of the altered cable route is ongoing and will be provided in an ES addendum.

2.2.3 Offshore project area

2.10 The offshore Project area is defined by the potential areas for turbine and cable deployment (Figure 1.3). Further refinement of these areas will be carried out through future design work and turbine layout analysis.

2.3 Consent Applications

2.3.1 Overview of required consents

2.11 Table 2.1 provides a list of the consent applications and the Project assets covered by each application.

Works	Consent	Description	Authority
Tidal turbines	Section 36 consent under the Electricity Act 1989	Section 36 consent is required for development of offshore generating stations over 1MW within Scottish territorial waters.	Scottish Ministers (through Marine Scotland)
Turbines, Turbine Support Structures (TSS), inter-array cables and export cable to shore	Marine licence under Section 25 of the Marine (Scotland) Act 2010	Consent under a Marine License covers construction and deposit of structures below Mean High Water Springs (MHWS). The covers the following offshore areas of the Project: ▪ Deposit of objects on the seabed, e.g. turbines, cables and TSS; ▪ The deposit of objects under the seabed, e.g. cables to shore with HDD boreholes; and, ▪ Construction on and under the seabed, e.g. drilling for piling or HDD bores.	Scottish Ministers (through Marine Scotland)
Onshore underground cables, PCC, HDD compound and associated infrastructure.	Planning permission under Section 28 of the Town and Country Planning (Scotland) Act 1997	Planning permission under Section 28 will be required for all onshore aspects of the Project to the Mean Low Water Springs (MLWS).	The Highland Council
Turbines, Turbine Support Structures (TSS), inter-array cables and export cables to shore.	Energy Act 2004	Once the Project is granted Section 36 consent, the Department of Energy and Climate Change (DECC) will request production of a Decommissioning Programme (DP) which must be approved prior to the commencement of installation.	Secretary of State (DECC)

Table 2.1: Consent application supported by this ES

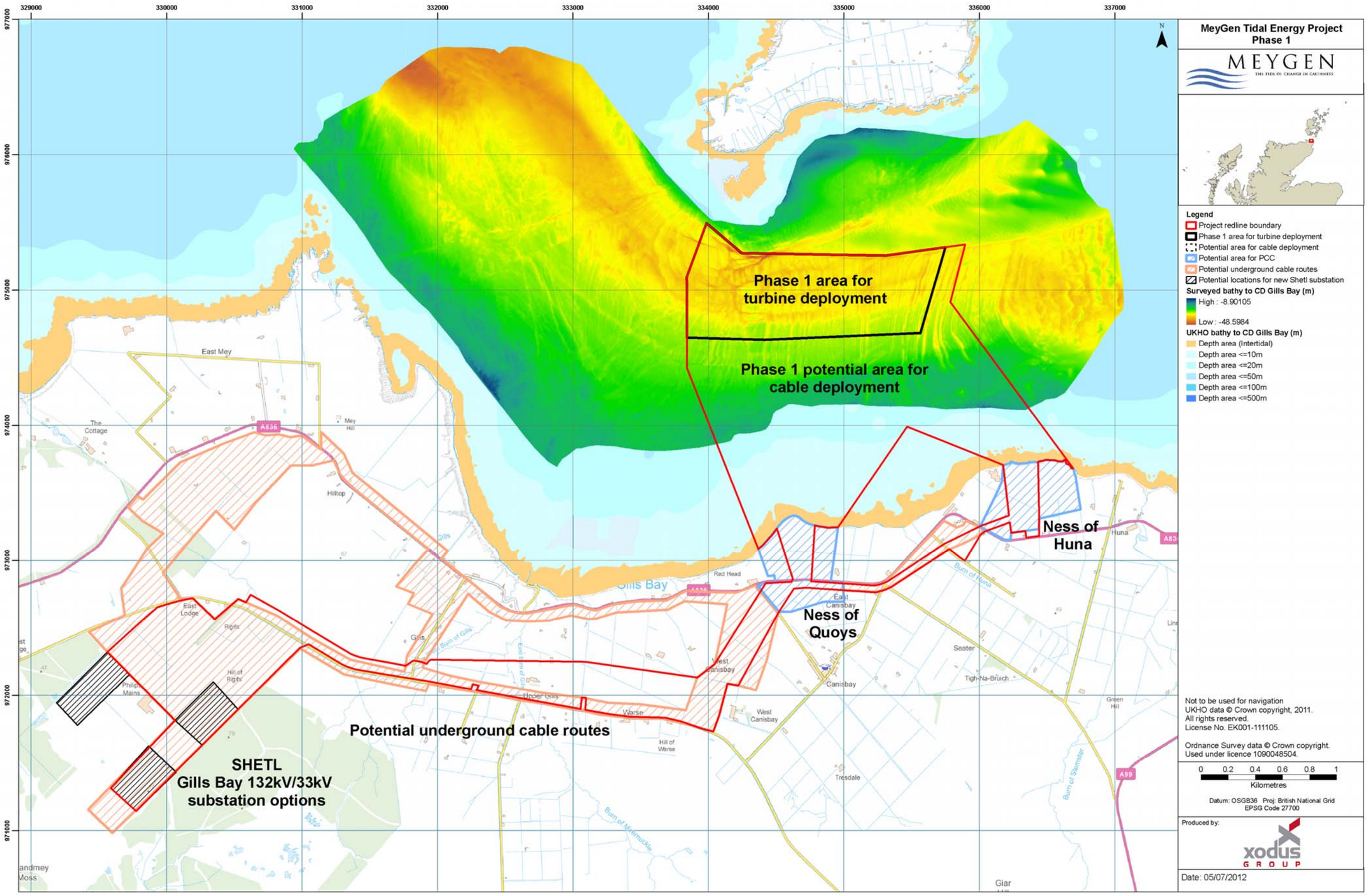

Figure 2.1: Potential project areas at EIA commencement

2.12 At the time of ES compilation two sites are being considered for the onshore location of the cable landfalls and PCC; Ness of Quoys and Ness of Huna (Figure 1.3). A planning application will be submitted for both of these sites. The final chosen site will be determined by land availability, technical and environmental constraints.

2.3.2 Scoping of the Environmental Impact Assessment

2.13 The EIA Scoping Document (and accompanying navigational preliminary hazard analysis (PHA)) formed MeyGen's written request to the Marine Scotland Licencing Operations Team and The Highland Council, for their opinion as to the information to be provided in the ES for the Project. A formal EIA Scoping Opinion was received on the 30th September 2011. Following receipt of the EIA Scoping Opinion each issue raised (of which there were over 250) was reviewed and implications for the overall Project and EIA considered. All issues relevant to individual EIA studies are highlighted in individual ES sections.

2.14 The EIA Scoping Document, PHA and EIA Scoping Opinion can be found on the supporting studies CD that can be found inside the front cover of the ES.

2.4 Data Gaps and Uncertainties

2.4.1 Environmental Impact Assessment surveys and studies

2.15 Where uncertainties in scientific understanding were identified, specific studies to address the issues were commissioned. These included undertaking a range of surveys to help characterise the environmental receptors and other technical studies to inform the impact assessment.

2.16 The relevant regulators (Marine Scotland and The Highland Council) were consulted regarding the scope of surveys before the studies were undertaken. Initial draft guidance from Scottish Natural Heritage (SNH) on survey and monitoring in relation to marine renewables deployments was published in September 2011. At the time of publication of this draft guidance, the majority of the surveys and studies were already underway. Having reviewed the document, MeyGen are satisfied that the surveys are consistent with the guidance. The methodologies of the surveys and studies within this EIA represent best practice at the time the studies were undertaken and were based on available published guidance and advice received through consultation with Marine Scotland, The Highland Council and statutory consultees.

2.17 The final EIA scope has involved the study of 16 different topics. The results of these studies are summarised in Sections 9 to 24 of the ES. In addition all supporting studies are provided on a CD located inside the front cover of the ES. All supporting studies relevant to each ES section are summarised at the beginning of each section. The ES structure is detailed in Figure 2.2 and a full list of ES contributors and ES supporting studies is provided in Table 2.2.

2.18 **Following the completion of the EIA, landowner consultation has identified potential issues with small areas of the proposed cable route. It has therefore been necessary to include areas outside that surveyed for the onshore impact assessments. The area is 0.50km^2 and is shown in Figure 2.1. Unfortunately this issue was not identified at the time of ES compilation and therefore is not addresses in this document. Work to survey and assessment of any changes required to the original impact assessment as a result of the altered cable route is ongoing and will be provided in an ES addendum.**

2.4.2 Survey, Deploy and Monitor policy

2.19 Due to the emerging nature of the tidal energy industry there are some potential impacts that have yet to be verified by operational monitoring in the industry. Where single turbines have been installed and potential environmental impacts monitored, MeyGen has made use of the available data. However, MeyGen recognises that there is little data currently available and its application to the assessment of a commercial array of turbines is limited. MeyGen therefore propose to implement a Survey, Deploy and Monitor strategy.

2.20 The Survey, Deploy and Monitor strategy is recognised by the Scottish Government as an important mechanism for the development of marine renewable energy in Scotland. Marine Scotland has produced guidance for Survey, Deploy and Monitor strategies and MeyGen has and will continue to, consult with the regulatory body to ensure the Project strategy is properly aligned with Scottish Government policy.

2.21 The MeyGen Tidal Energy Project is to be developed in two distinct phases, consistent with Scottish Government Policy. Phase 1 (i.e. the Project) will be monitored to increase knowledge and reduce uncertainty for the development of Phase 2. The programme itself will also enable monitoring to be undertaken as the works progress.

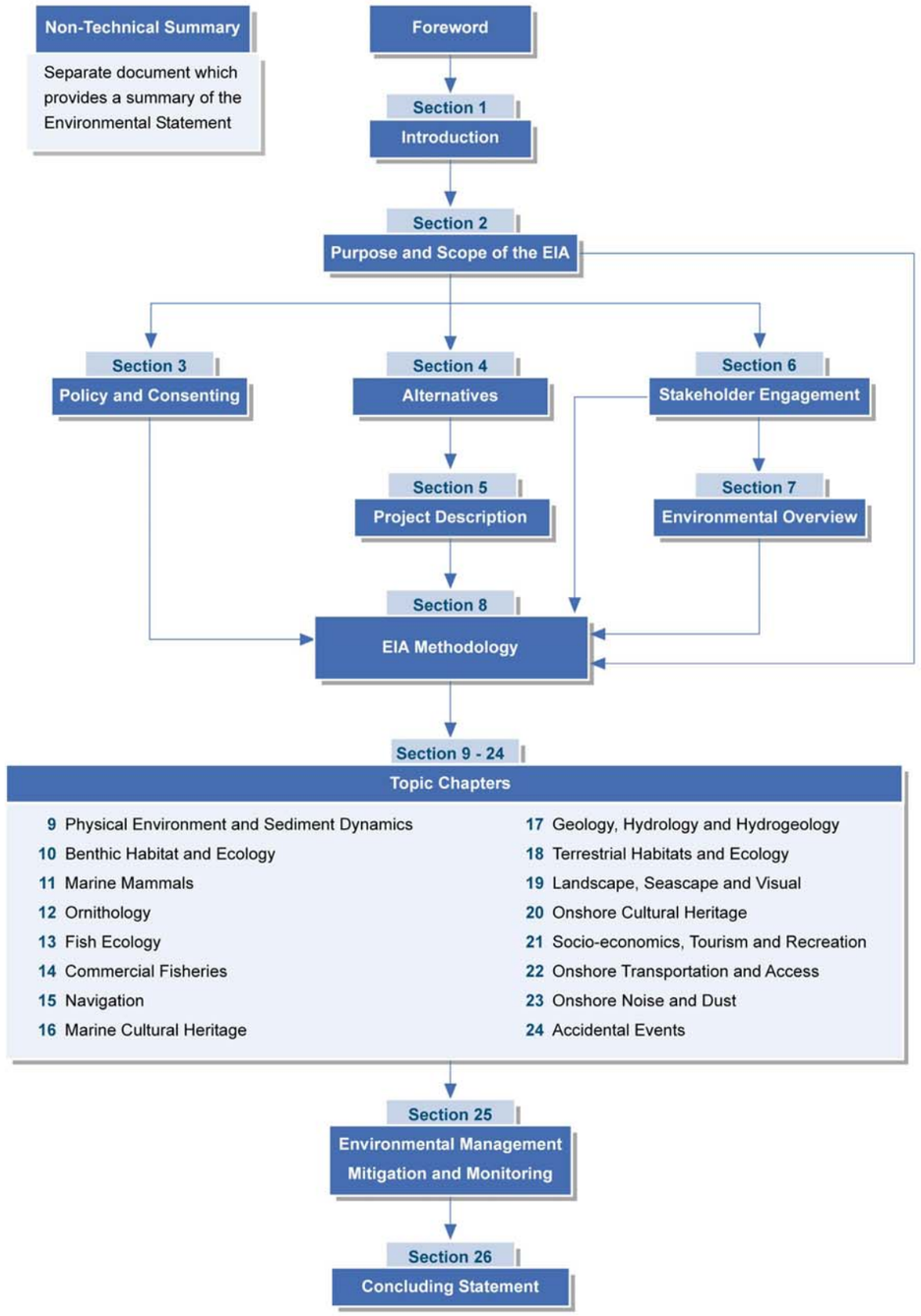

Figure 2.2: Environmental Statement Structure

2.22 Through the EIA process, MeyGen has recognised that being the first application for a commercial scale tidal stream project in Scotland and the first from The Crown Estate's Pentland Firth and Orkney Waters leasing round, means there is a degree of uncertainty in respect of the impact assessment due to the nascent status of the industry and in some cases a lack of data on a particular receptor at a regional, national or international scale. In response MeyGen has identified two approaches to the monitoring programme.

- Where MeyGen identifies a monitoring requirement for Project specific issues, a Project specific monitoring programme will be developed in consultation with the regulators and stakeholders.
- Where uncertainties in the assessment are identified that are considered of strategic importance to the development of the tidal steam industry, MeyGen would participate in a collaborative effort with the wider industry, regulators and stakeholders to reduce the uncertainty in this area. In the monitoring programme MeyGen would wish to engage the wider marine renewables industry in discussions in how best to take this forward in the most efficient way for the benefit of the Project and future marine projects elsewhere in Scotland and the UK.

2.23 MeyGen is committed to producing a robust monitoring programme, giving the regulators the security to consent the Project and enabling the development of commercial scale tidal energy projects, benefiting the industry as a whole.

2.5 Contributors to the Environmental Impact Assessment

2.24 The ES has been compiled by Xodus and presents the results of a number of assessments carried out by specialist consultants. The area of expertise of these consultants and their contribution to the ES is detailed in Table 2.2.

ES section	Contributors	Supporting studies
EIA Coordinator	Xodus	None
Legal advice	Burges Salmon	None
Non-Technical Summary	Xodus	None
Foreword	MeyGen	None
Sections 1 – 8	Xodus MeyGen Burges-Salmon	None
Section 9 Physical Environment and Sediment Dynamics	Xodus - Section author DHI – Coastal processes modelling	MeyGen EIA Coastal Processes Modelling – Modelling setup, calibration and results (DHI, 2012) Benthic survey for Phase 1 of the MeyGen Tidal Stream Energy Project, Inner Sound, Pentland Firth – Report (ASML, 2011) Report of Survey for Atlantis Resources Corporation for Site Survey Stroma. JN3475 (IXSurvey, 2009)
Section 10 Benthic Habitats and Ecology	Xodus – Section author Aquatic Surveys and Monitoring Limited (ASML) - Benthic surveys	Benthic survey for Phase 1 of the MeyGen Tidal Stream Energy Project, Inner Sound, Pentland Firth – Report (ASML, 2011) MeyGen EIA Coastal Processes Modelling – Modelling setup, calibration and results (DHI, 2012) Report of Survey for Atlantis Resources Corporation for Site Survey Stroma. JN3475 (IXSurvey, 2009)
Section 11 Marine Mammals	Xodus – Section author RPS – Marine mammal surveys and baseline report	Distribution and abundance of marine mammals and basking sharks in the Inner

ES section	Contributors	Supporting studies
	SRSL – Modelling of marine mammal encounter rates Ecologic UK –Towed hydrophone survey Kongsberg – baseline underwater noise measurements, noise propagation modelling	Sound and wider Pentland Firth and Orkney waters (RPS, 2011a) MeyGen tidal-stream turbine array environmental impact assessment: modelling encounter rate between turbines and marine mammals (SRSL, 2012) Analysis of towed hydrophone data collected for MeyGen (Ecologic UK, 2011) Underwater noise impact study for tidal turbine development in Inner Sound, Pentland Firth (Kongsberg, 2012)
Section 12 Ornithology	RPS – Section author, ornithological surveys, modelling and technical report	MeyGen Tidal Energy Project Inner Sound, Pentland Firth Ornithological Technical Report (RPS, 2011b) Underwater noise impact study for tidal turbine development in Inner Sound, Pentland Firth (Kongsberg, 2012) Benthic survey for Phase 1 of the MeyGen Tidal Stream Energy Project, Inner Sound, Pentland Firth – Report (ASML, 2011)
Section 13 Fish Ecology	Xodus - Section author and technical report Kongsberg – baseline underwater noise measurements, noise propagation modelling	Estimating encounter rate for Atlantic salmon for the MeyGen Tidal Energy Project, Phase 1 and potential population effects. (Xodus, 2012) Underwater noise impact study for tidal turbine development in Inner Sound, Pentland Firth (Kongsberg, 2012) MeyGen EIA Coastal Processes Modelling – Modelling setup, calibration and results (DHI, 2012)
Section 14 Commercial fisheries	Xodus – Section author	Benthic survey for Phase 1 of the MeyGen tidal stream energy project, Inner Sound, Pentland Firth (ASML, 2011) Navigation Risk Assessment (NRA) MeyGen Inner Sound (Anatec, 2012)
Section 15 Navigation	Anatec – Section author, collision risk modelling and author of the Navigation Risk Assessment (NRA)	Navigation Risk Assessment MeyGen Inner Sound Phase 1 (Anatec, 2012) MeyGen EIA Coastal Processes Modelling – Modelling setup, calibration and results (DHI, 2012)
Section 16 Marine Cultural Heritage	Orkney Research Centre for Archaeology (ORCA) – Section author and Marine Cultural Heritage technical study and geophysical survey report	Inner Sound, Caithness Marine Cultural Heritage Environmental Impact Assessment (ORCA, 2011a) MeyGen EIA Coastal Processes Modelling – Modelling setup, calibration and results (DHI, 2012) Benthic survey for Phase 1 of the MeyGen Tidal Stream Energy Project, Inner Sound, Pentland Firth – Report (ASML, 2011)
Section 17 Geology, Hydrology and Hydrogeology	Mouchel – Section author and geology, hydrology and hydrogeology walkover survey of the onshore Project area	None
Section 18 Terrestrial Habitats and Ecology	Xodus – Section author and Extended Phase 1 habitat survey report	Extended Phase 1 Habitat Survey Report – MeyGen (Xodus, 2011a)
Section 19 Landscape, Seascape and Visual	HRI/Mike Wood Consulting – Section authors	MeyGen Socio Landscape, Seascape & Visual Impact Assessment. Technical Appendix (HRI, 2011)
Section 20 Onshore Cultural Heritage	ORCA – Section author, onshore archaeological walkover survey and report	Inner Sound, Canisbay Onshore Cultural Heritage Environmental Impact Assessment (ORCA, 2012) Inner Sound Canisbay, Caithness Geophysical Survey 2011 Final Report. Report for MeyGen Ltd (ORCA, 2011b) MeyGen Socio Landscape, Seascape & Visual Impact Assessment. Technical Appendix (HRI, 2011)
Section 21 Socio Economics, Tourism and Recreation	Roger Tym and Partners (RTP) – Section author and impact assessment report	Socio Economic Impact Assessment Report (RTP, 2011)
Section 22 Onshore Transportation and Access	Xodus – Section author and also undertook a site visit to the Project area to gather information on the road network and photographic evidence of condition of current road network	None
Section 23 Onshore Noise and Dust	Xodus – Section author, baseline onshore noise surveys and noise modelling report.	Baseline onshore noise survey results (Xodus, 2011b)
Section 24 Accidental Events	Xodus – Section author	None
Section 25 Environmental Management and Monitoring	Xodus – Section author	None
Section 26 Summary and Concluding Statement	Xodus	None

Table 2.2: ES contributors and supporting studies to the ES

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3 POLICY AND CONSENTING

3.1 Introduction

3.1 This section provides a summary and overview of the international, UK, Scottish, regional and local planning policies and guidance (and associated legislation) which are directly relevant to the Project and the assessment of potential likely environmental impacts.

3.1.1 The need for renewable energy

3.2 The UK has committed to sourcing 15% of its total energy needs from renewable sources by 2020 under the 2009 Directive on Renewable Energy (2009/28/EC) including electricity, heat and transport. The UK and Scottish Governments have also made legally binding commitments through the Climate Change Act 2008 and the Climate Change (Scotland) Act 2009.

3.3 There are four key drivers for the shift in energy production to low carbon sources, including renewable energy, in the UK and Scotland and these are discussed in the following sections:

- The need to tackle climate change;
- The need to secure energy supply;
- The need for new energy infrastructure; and,
- The need to maximise economic opportunities.

The need to tackle climate change

3.4 The potential effects of climate change are well documented. A continuation of global emissions, including greenhouse gases like carbon dioxide, at current levels could lead average global temperatures to rise by up to 6°C by the end of this century (IPCC, 2007). The implications of such predicted effects would be profound, with a rise in frequency in extreme weather events like floods and drought resulting in increased global instability, conflict, public health-related deaths and migration of people to levels beyond any recent experience (DECC, 2011). Within the UK it is considered that heat waves, droughts, and floods would become more prevalent (DECC, 2011).

3.5 Climate change also poses a significant economic threat. The Stern Report (Stern, 2006) investigated the economic implications of not addressing this issue and concluded that with no action, the overall costs and risk of climate change will be equivalent to losing at least 5% of global gross domestic product (GDP) each year. Taking a wide range of risks and impacts into account, global GDP could be 20% lower than it might otherwise be (Stern, 2006).

The need to secure energy supply

3.6 Indigenous energy production with the UK has fallen year on year since 1999 and, in 2004, the United Kingdom became a net importer, at a level of 4.5% of inland consumption. This increased to 26.7% in 2009, the highest level since 1976 (DECC, 2010). This reliance has long been identified as an unsustainable energy model. It puts the UK at both financial and demand risk through increased global competition for resources combined with increased national growth and exacerbated by the loss of 25% of our existing electricity generating capacity by 2018 through scheduled power station closures (DECC, 2009).

3.7 Without action the UK will become even more reliant on imported energy sources and would have greater exposure to global energy price fluctuations (DECC, 2009). In 2009, the UK Government released the Low Carbon Transition Plan White Paper which plots how the UK will meet the 34% cut in emissions on 1990 levels by 2020. Within this White Paper it was identified that by decarbonising our electricity supplies we can greatly reduce our reliance on fossil fuels. Developing a low carbon energy sector for the longer term can deliver both increased energy security for the UK and ensure that it meets international targets for the reduction of greenhouse gas emissions (HM Government, 2009).

The need for new energy infrastructure

3.8 There are four key themes driving the requirement for new energy infrastructure within the UK:

- Currently three quarters of UK electricity comes from coal and gas. To meet climate change targets by 2050, virtually all electricity will need to come from zero carbon energy generation such as renewable sources, nuclear or fossil fuel (where they employ carbon capture and storage techniques) (DECC, 2009);
- There will be an increased emphasis on electricity as the source for supporting the heat and transport sectors. This could see the UK's demand for electricity in 2050 increasing to 50% higher than it is today, making it possible that electricity could account for half of the UK's overall energy use (DECC, 2009);
- As the UK moves to low carbon energy sources it is acknowledged that there will be a need for net additional electricity generating infrastructure to ensure adequate supplies because of changes in the nature and location of generating capacity. It is estimated that this will require about 43GW net of new capacity by 2020 and about 60GW by 2025 (DECC, 2011); and,
- This rise in electricity demand will coincide with the scheduled closure of around sixteen power stations by 2018 representing approximately 25% (18GW) of our electricity generating capacity and also the decline of North Sea oil and gas reserves (DECC, 2010 and DECC, 2009).

3.9 In the UK, at least 22GW of existing electricity generating capacity will need to be replaced in the coming years, particularly by 2020. This is as a result of tightening environmental regulation and ageing power stations.

The need to maximise economic opportunities

3.10 The energy industries in the UK play a central role in the economy and supporting a key commitment within the UK's Low Carbon Transition Plan to help make the UK a centre of green industry by supporting the development and use of clean technologies (DECC, 2009).

3.11 The growth of a decarbonised energy sector can play a key role in supporting the economy. In 2009, the energy industries contributed 3.7% GDP and directly employed over 150,000 people (5% of industrial employment) (DECC, 2010). In addition, the low carbon and environment sector currently employs around 880,000 people and is worth £106 billion per year. It is estimated that employment levels could rise to more than a million people by 2020, if the UK is able to maximise the opportunity presented by being a world leader in low carbon technologies (DECC, 2009).

3.12 The Scottish Government estimates that if the 2020 electricity target alone is met it will create up to 40,000 jobs and £30bn investment in Scotland (2020 Renewables Routemap).

3.1.2 Benefits of tidal energy generation

3.13 Tidal energy is a form of low carbon electricity generation benefitting from a predictability of generation as it is powered by the tides which, unlike other forms of renewable energy production, are not affected by weather conditions. Tidal energy schemes such as the Project will make a significant contribution to the mix of energy sources.

3.14 This Project will generate 86MW of renewable energy by 2016. This will represent a significant contribution towards meeting UK and Scottish targets.

3.2 Energy Policy

3.2.1 International energy context

3.15 The Kyoto Protocol (to the United Nations Framework Convention on Climate Change (1997)) forms the highest level of international agreement on Climate Change across 189 States. In 2005 it set binding targets for 37 industrialised countries and the European community for reducing greenhouse gas emissions by an average of 5% against 1990 levels over the five-year period 2008-2012.

3.16 At a European level, Directive 2001/77/EC, on the "Promotion of Electricity Produced from Renewable Energy Sources in the Internal Electricity Market", was adopted in September 2001. Among other measures, it requires under Article 3 that Member States take appropriate steps to encourage greater consumption of renewable electricity in conformity with national indicative targets.

3.17 In January 2008 the European Commission published the "20 20 by 2020" package (COM(2008)30 final). This package proposed committing the EU to a 20% reduction in its greenhouse gas emissions and to achieving a target of deriving 20% of the EU's final energy consumption from renewable sources by 2020. In order to achieve the overall European Union (EU) renewable energy target of 20% the proposal included individual targets for each Member State (with the UK's proposed target being 15%). In January 2008, the European Commission proposed binding legislation to implement the 20-20-20 targets. The "climate an energy package" was agreed by the European Parliament and Council in December 2008 and became law in June 2009. The Renewable Energy Directive (2009/28/EC) also provides for European Climate Change Opportunity, where the Commission set the emissions reduction target at 20% "rising to 30% if there is an international agreement".

3.2.2 National Policy and Guidance

UK energy policy

3.18 The UK's agreed (legally binding) target under the Kyoto Protocol is to reduce greenhouse gas emissions (comprising six gases, including carbon dioxide) by 12.5% compared to 1990 levels, averaged over the period 2008 to 2012.

3.19 The Climate Change Act 2008 introduces into UK law a legal requirement on the UK Government to cut emissions by 80% compared to 1990 levels by 2050.

3.20 A Government objective of working towards the target of obtaining 10% of the UK's of the UK's electricity supply from renewable sources by 2010 with an extension of this target to 15% by 2015, with an aspiration that by 2020 the renewables share of the electricity supply will be increased to 20%.

Scottish energy policy

3.21 The Scottish Government has signalled its commitment to tackling climate change and strong support for renewable energy development through both legislation and policy.

3.22 The Climate Change (Scotland) Act 2009 imposes a legal commitment on the Scottish Government to reduce emissions by 42% from 1990 levels by 2020 and 80% by 2050.

3.23 In July 2011 the Scottish Government published the 2020 Routemap for Renewable Energy in Scotland. This document builds upon the 2009 Scottish Renewables Action Plan.

3.24 The Scottish Government's stated objective[1] is for the equivalent of 100% of Scotland's electricity demand to be generated from renewable sources by 2020, with an aim of Scotland generating twice as much electricity as it needs (50% from renewables and 50% from conventional sources) and exporting as much as it consumes.

3.25 The Marine Energy Roadmap (published by FREDS in 2010) highlights the key role marine renewables will play in meeting these targets and objectives.

[1] 2020 Routemap for Renewable Energy in Scotland

3.2.3 Renewables Obligation

3.26 The Renewable Obligation Order for Scotland (ROS) came into effect in 2002. The Order places an obligation on licensed electricity suppliers to source an increasing proportion of electricity from renewable sources. The current proportion of electricity that must be sourced from renewable sources is 10.4%, and will rise to 15.4% by 2015. The ROS has recently been amended to provide a legal guarantee that the ROS will apply to accredited schemes until 2037.

3.27 Electricity Market Reform (EMR) aims to develop and deliver a new market framework that will enable the cost effective delivery of secure supplies of low carbon energy. The EMR Project will overhaul the electricity market to help to promote investment in energy infrastructure, especially low-carbon generation and is a replacement mechanism for the renewables obligation.

3.3 Marine Planning Framework

3.3.1 Marine (Scotland) Act 2010 and the Marine and Coastal Access Act 2009

3.28 The Marine (Scotland) Act 2010 created a new legislative and management framework for the marine environment within Scottish Territorial Waters (0 to 12 nautical miles). This follows the UK Marine and Coastal Access Act 2009 under which Scottish Ministers have devolved authority for marine planning and conservation powers in the offshore region (12 to 200 nautical miles).

3.3.2 Marine Policy Statement - UK

3.29 The UK Marine Policy Statement (MPS) applies to all UK waters and has been adopted by the UK Government, the Scottish Government, the Welsh Assembly Government and the Northern Ireland Executive.

3.30 The function of the MPS is to provide the framework for preparing Marine Plans and taking decisions affecting the marine environment. All national and regional marine plans must be in conformity with the MPS.

3.31 The objectives of the MPS are given as:

- "Promote sustainable economic development;
- Enable the UK's move towards a low-carbon economy, in order to mitigate the causes of climate change and ocean acidification and adapt to their effects;
- Ensure a sustainable marine environment which promotes healthy, functioning marine ecosystems and protects marine habitats, species and our heritage assets; and
- Contribute to the societal benefits of the marine area, including the sustainable use of marine resources to address local social and economic issues.

3.32 The MPS emphasises the importance of renewable energy and recognises the importance of considering marine renewable projects in marine planning, stating that "Contributing to securing the UK's energy objectives, while protecting the environment, will be a priority for marine planning" (paragraph 3.3.1).

3.3.3 National and regional marine plans

3.33 Under the Marine (Scotland) Act 2010 and Marine and Coastal Access Act 2009 the Scottish Government must prepare a National Marine Plan for Scottish Territorial Waters and the offshore zone. The Scottish Government may also choose to prepare Regional Marine Plans.

3.34 Section 15(1) of the Marine (Scotland) Act 2010 states that "a public authority must take any authorisation or enforcement decision in accordance with the appropriate marine plans, unless relevant considerations indicate otherwise". This includes consents and licences. However, there are currently no adopted marine plans in place for the purposes of s.15(1).

3.35 The National Marine Plan is being developed to clarify the overall objectives which provide the basis for managing Scotland's marine environment. A pre-consultation draft of the National Marine Plan was published in March 2011 and the responses to the consultation were published in a document in July 2011. The responses are now being evaluated although it is hoped to publish a final version in the spring/summer of 2012.

3.36 Regional marine boundaries for the Regional Marine Plans are in the process of being formulated. These are expected to be finalised in line with the publication of the National Marine Plan. Thereafter, the regional marine plan preparation process will be undertaken.

3.37 A framework for the Pentland Firth and Orkney Waters Marine Spatial Plan was published in 2011. The document sets out the framework for future development of the Pentland Firth and Orkney Waters Marine Spatial Plan. It summarises existing and proposed uses of the seas and shows how these uses may impact on each other. The document also sets out draft Regional Locational Guidance for the development of wave and tidal resources and identifies the Project site (referred to as Stroma Sound) as a suitable site for tidal development[2]

3.3.4 Marine Protected Areas

3.38 Marine Protected Areas (MPAs) are a requirement of the Marine (Scotland) Act 2010. The purpose of MPAs is to afford protection to particular features of the marine environment. There are three categories of MPA, namely Nature Conservation MPAs, Demonstration and Research MPAs and Historic MPAs.

3.39 The Scottish Government is currently consulting on suitable areas for Nature Conservation MPAs. This has resulted in 30 locations identified for possible designation as MPAs. None of these include, or are adjacent to, the Project.

3.40 Nature Conservation MPAs are scheduled to be approved by the Scottish Government in late 2012.

3.4 Terrestrial Planning Framework

3.41 The principal planning legislation is contained within and derived from The Town and Country Planning (Scotland) Act 1997. Statutory planning control under the Town and Country Planning (Scotland) Act 1997 extends to the mean low water springs. The Marine (Scotland) Act extends to the mean high water mark of ordinary spring tides and there is a degree of overlap between the marine and terrestrial planning frameworks.

3.4.1 National Planning Framework 2

3.42 The Framework sets out the Scottish Government's strategy for long term strategic development up to 2030. National Planning Framework 2 (NPF2) was published in June 2009 and contains policies on the marine and coastal environment and the development of renewable energy and grid infrastructure.

3.4.2 Scottish Planning Policy

3.43 The Scottish Planning Policy (SPP) sets out Scottish Government policy on nationally important land use planning matters. Paragraph 184 of the SPP states *"Planning authorities should support the development of a diverse range of renewable energy technologies, guide development to appropriate locations and provide clarity on the issues that will be taken into account when specific proposals are assessed".*

3.44 There are a range of other land use planning documents which are relevant to the Project, these include:

- PAN 42: Archaeology–Planning Process and Scheduled Monument Procedures
- PAN 45: 2002 Renewable Energy Technologies (including online supplementary guidance)
- PAN 50: Controlling the Environmental Effects of Surface Mineral Workings
- PAN 51: Planning, Environmental Protection and Regulation
- PAN 58: Environmental Impact Assessment
- PAN 60: Planning for Natural Heritage
- PAN 62: Radio Telecommunications
- PAN 68: Design Statements
- PAN 69: Planning and Building Standards Advice on Flooding
- PAN 75: Planning for Transport
- PAN 79: Water and Drainage
- PAN 81 and PAN 3/2010 (Community Engagement)
- PAN 1/2011 – Planning and Noise

3.4.3 Statutory development plan

3.45 ***At the time of ES compilation the Highland-wide Local Development Plan (HWLDP) had not been adopted. However, during the final stages of ES review this situation changed and the plan was adopted in April 2012. The text of the ES still refers to the previous plan but also takes account of policies in the recently adopted HWLDP.***

3.46 The statutory development plan applicable to the onshore elements of the Project comprises the Highland Structure Plan 2001 and Caithness Local Plan 2002.

3.47 These plans are to be superseded by the HWLDP. Following an examination in public, reporters appointed by the Scottish Government have submitted their report on the draft HWLDP to The Highland Council for consideration. It is expected that the HWLDP will be adopted in the autumn of 2012. Prior to adoption the emerging HWLDP is a material consideration to which weight will be attached. (See italics above regarding the earlier adoption of the HWLDP).

3.4.4 Statutory development plan policies

3.48 The Highland Structure Plan provides the spatial framework for development across the Highlands. The Plan contains general policies which are applied to most types of development and policies which are more specific to a location or type of development, e.g. renewables.

3.49 The Plan also includes a proposals map, which shows both onshore sites (Ness of Quoys and Ness of Huna) as located within a "rural development area". This defined as an area that offers opportunities for the further development of natural resources.

3.50 Relevant policies within the Structure Plan are:

- Policy G2 – Design for sustainability
- Policy G4 - Community benefit and commitment
- Policy T6 - Scenic views
- Policy E1 - Distributed renewable energy developments
- Policy E6 – Offshore energy developments

[2] Pentland Firth and Orkney Waters Marine Spatial Plan p166

- Policy L4 – Landscape character

3.51 The Caithness Local Plan provides more site specific and detailed policies to augment the Structure Plan. However, it has limited policies that are directly relevant to the Project. The Local Plan is broadly supportive of renewable energy projects (paragraph 1.34) and contains similar guidance to policy T6 of the Structure Plan regarding coastal development.

3.4.5 Emerging Highland - wide Local Development Plan

3.52 The Vision section of the Plan makes a commitment to safeguarding the environment by promoting the development of renewable energy schemes, but ensuring such schemes and sited so as to protect and enhancing the special quality of the natural built and cultural environment. They also wish to provide opportunities that encourage economic development and create new employment though renewables development.

3.53 Ness of Quoys and Ness of Huna are identified in the spatial strategy as an offshore renewable base, in an area for potential offshore renewable energy and also an area for electricity grid reinforcement.

- General policies
- Policy 29 - Sustainable Design
- Policy 37 – Wider Countryside
- Policy 50 – Coastal Development
- Safeguarding our environment policies
- Policy 58 – Natural, Built and Cultural Heritage
- Policy 59 – Protected species/ Policy 60 – Other important Species/Policy 61 - Other important Habitats
- Policy 62 – Landscape
- Sustainable Development and Climate Change
- Policy 68 Renewable Energy Developments
- Policy 70 – Electricity Transmission Infrastructure

3.4.6 Existing supplementary guidance

3.54 In addition to the extant and emerging HWLDP there is a range of supplementary guidance produced by The Highland Council relevant to the Project (Table 3.1).

Document	Policies
Highland Coastal Development Strategy - May 2010	The Council will support marine renewable energy and this strategy envisages assisting in finding the most appropriate sites for such development. The Pentland Firth is identified as an appropriate site.
Highland Renewable Energy Strategy and Planning Guidelines – May 2006	Policy E.14:- supports the full investigation and exploration of the potential for tidal energy production, but recognises that there are significant gaps in knowledge including nature conservation impacts that need to be filled before large scale exploitation of tidal energy is supported. Nevertheless, the large amount of energy that could be available means that finding answers should be a key priority. Policy F.1:- is a recommendation for the management of renewables projects to be locally based to assist with "local empathy and awareness" and also to encourage procurement and opportunities for local businesses. Policy J.1:- states that all renewable projects should undertake a pre-scoping phase of evaluation before locations, timing and development type are specified; and, Policy J2:- states that at a national or major level the proposal will have considered alternatives.
Highland Council Renewables Action Plan	The purpose of the plan is to ensure that there is a co-ordinated planning approach to the delivery of on-shore development for the marine renewables industry. It provides focus on key actions and gives information on timescales, lead agency and partners involved.
North Highland Vision June 2011	The Highland Council published an action plan which sets out a framework designed to coordinate the delivery of onshore development required for marine renewables in North Highland.

Table 3.1: Highland Council Supplementary Guidance

3.5 Environmental Impact Assessment Legislation

3.55 The purpose of the EIA Directive (Council Directive 2011/92/EU) is to ensure that the competent authority, in relation to development that is likely to have significant effects on the environment, has appropriate information to enable it to come to a decision on whether or not to grant consent. The EIA Directive sets out procedures that must be followed for such projects before they can be given 'development consent'.

3.56 If a development is deemed to need an EIA, environmental information must be provided by the developer in the form of an ES. The competent authority cannot grant consent for an EIA development without taking into account an ES.

3.57 The Directive is legally transposed into Scots Law via statutory instruments known as regulations. The following regulations are applicable to the Project:

3.5.1 Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2000 (as amended)

3.58 These regulations are relevant to those elements of the Project which requires Section 36 consent under the Electricity Act 1989.

3.5.2 The Marine Works (Environmental Impact Assessment) Regulations 2007 (as amended)

3.59 These regulations are relevant to those elements of the Project which require a marine license under the Marine (Scotland) Act 2010.

3.5.3 The Town and Country Planning (Environmental Impact Assessment) (Scotland) Regulations 2011

3.60 These regulations are relevant to those elements of the Project which require planning permission under the Town and Country Planning (Scotland) Act 1997.

3.61 This ES has been produced in accordance with the regulations listed above.

3.6 Habitats Regulations

3.62 The European Habitats Directive (92/43/EEC) and Birds Directive (79/409/EEC) are transposed into Scots law by the Conservation (Natural Habitats, &c.) Regulations 1994 as amended in 2004, 2007 and 2008.

3.63 European sites protected under this legislation include Special Protection Areas (SPAs), Special Areas of Conservation (SACs) and RAMSAR sites. The European Habitats Directive (92/43/EEC) aims to promote the maintenance of biodiversity by requiring EU Member States to maintain or restore representative natural habitats and wild species at a favourable conservation status, through the introduction of robust protection for those habitats and species of European importance.

3.6.1 Habitats Regulations Appraisal and Appropriate Assessment

3.64 Habitats Regulations Appraisal (HRA) is an iterative process which aims to determine likely significant effects and if necessary assess adverse impacts on the integrity of European sites.

3.65 Appropriate Assessment is one stage of this process. A competent authority shall make an Appropriate Assessment of the implications for a site in view of that site's conservation objectives, 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 the UK (either alone or in combination with other plans or projects); and
- Is not directly connected with or necessary to the management of the site.

3.66 The need for Appropriate Assessment extends to plans or projects outwith the boundary of the site in order to determine their implications for the interests protected within the site. Competent authorities need to identify the qualifying interests and the conservation objectives for each European site involved in an appropriate assessment. There are a number of Natura 2000 sites in proximity to the Project which have been considered during the EIA.

3.67 It should be noted that HRA is a separate process from EIA. However, the HRA process has been followed for the Project and the findings of this have been used to inform specific topic sections of this ES. A stand-alone HRA report has been produced and is provided on the supporting documents CD accompanying this ES.

3.68 The Crown Estate, under its stewardship of the Pentland Firth and Orkney Waters wave and tidal projects, conducted a plan-level HRA to ensure that the leasing round would not have an adverse effect on European site integrity. The recommendation of the plan-level HRA was that 'the need for, and sufficiency of, project-specific mitigation measures will be taken in the context of project-level HRA and will be a matter for the consenting body as competent authority' (The Crown Estate, 2010). This should be 'completed in the context of the latest scientific information and understanding' (The Crown Estate, 2010). MeyGen has taken due regard of the recommendations of the plan-level HRA in undertaking the HRA for the Project.

3.6.2 European Protected Species

3.69 For any European Protected Species (EPS), Regulation 39 of the Conservation (Natural Habitats, &c.) Regulations 1994, makes it an offence to deliberately or recklessly capture, kill, injure, harass or disturb any such animal. It is also an offence to deliberately or recklessly obstruct access to a breeding site or resting place of any such animal, or otherwise to deny the animal use of the breeding site or resting place. In addition, it is an offence to disturb such an animal in a manner that is, or in circumstances which are, likely to significantly affect the local distribution or abundance of the species to which it belongs. For cetaceans (dolphins, porpoises and whales) only, there is a more general offence deliberately or recklessly to disturb these creatures. The damage or destruction of a breeding site or resting place of any EPS of animal is an offence of strict liability. An EPS Licence is required for any activity that might result in disturbance to an EPS.

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4 SITE SELECTION AND CONSIDERATION OF ALTERNATIVES

4.1 Introduction

4.1 It is a requirement of the Environmental Impact Assessment (EIA) Regulations (Section 3) that alternatives for achieving the objectives of the proposed Project are described and an explanation for the basis for the selection of the preferred proposal should be outlined in the Environmental Statement (ES).

4.2 One of the key drivers in the selection of the preferred proposal for a tidal energy project is the location of tidal resource suitable for exploitation by tidal stream technology. Tidal resource is by its nature very spatially constrained e.g. compared to other offshore renewable energy resources such as offshore wind and wave, and therefore there are only a limited number of areas with the potential resource to develop tidal stream energy projects. Not only are there a limited number of tidal sites with suitable resource, these are further constrained by what is assessed as technically and economically viable resource. The UK Marine Energy Atlas published in 2008 (ABPmer, POL and Met Office, 2008) and subsequent work commissioned by The Carbon Trust (The Carbon Trust, 2011) has identified the key areas of tidal resource around the UK considered suitable for commercial scale tidal projects. These areas are illustrated in Figure 4.1 and it can be seen that the Pentland Firth contains a significant proportion of the UKs tidal stream energy resource.

4.3 The Sustainable Development Commission (2007) and more recently others (Scottish Renewables, 2010; RenewableUK, 2011) have predicted that the Pentland Firth is likely to become the centre of the UK tidal stream energy industry. This is consistent with the findings of the Marine Renewables Strategic Environmental Assessment (SEA) which was undertaken by the Scottish Government in 2007. The SEA concluded that the Pentland Firth has a medium to high potentially achievable tidal energy generating capacity taking into account major, moderate and unknown environmental effects[3]. This work also specifically identified the Inner Sound as a potential tidal development area.

4.4 Following completion of the SEA; in September 2008 The Crown Estate (TCE) announced the world's first licensing round for marine (wave and tidal) projects for the Pentland Firth and Orkney Waters (PFOW). This announcement led to the focus of marine energy development in the UK to the Pentland Firth area.

4.5 Combining the above with the Scotland Government's financial support mechanism at the time of site evaluation (i.e. Marine Supply Obligation Renewable Subsidy (and subsequent Renewables Obligation Certificates (ROCs)), the nine month target for determination of marine energy project consents and the £10 million Saltire Prize for marine renewable energy projects in Scotland, further enhanced the attraction of the Pentland Firth.

4.2 Background to the Project

4.6 The MeyGen Tidal Energy Project, through various iterations, has been developed in parallel with the Scottish Government's marine renewable energy development initiatives.

4.7 In 2008, Atlantis Resources Corporation (ARC) as the founder of the Project undertook a global search to identify potential economically viable sites for commercial scale tidal energy development. It commissioned a study to identify all sites globally with a flow rate in excess of 1.5m/s. This work identified the Pentland Firth as a priority site, in terms of a high tidal flow and the number of tidal turbines that could be deployed.

4.8 At that time ARC together with Morgan Stanley, made a decision to progress a commercial scale tidal energy project in the Pentland Firth. The Caithness coast was identified as being the most attractive medium term tidal opportunity due to infrastructure, logistics and quality of the tidal resources (3 of the top 6 UK tidal sites according to Sustainable Development Commission (2007) including the Inner Sound) with focus around potential sites in the Inner Sound and at Duncansby Head.

[3] The SEA was designed to 'provide for a high level of protection of the environment and to contribute to the integration of environmental considerations into the preparation and adoption of plans and programmes with a view to promoting sustainable development'.

4.9 The development of a tidal model (Figure 4.2) was commissioned and tidal current data collected using Acoustic Doppler Current Profilers (ADCPs) during 2008 and early 2009 helped calibrate the model. This work confirmed that the Inner Sound was the preferred location for the Project and an application would be submitted to TCE under the world's first licensing round for marine (wave and tidal) projects.

4.10 Following successful pre-qualification, MeyGen submitted tender documents based on further extensive site investigation conducted over an 18 month period. MeyGen was successfully awarded an Agreement for Lease (AfL) for the Inner Sound site on 21st October 2010.

4.3 Site Evaluation

4.3.1 Overview of Site Evaluation Process

4.11 As described above, the evaluation of sites in the Pentland Firth began back in 2008. This work included the mapping of constraints to development including those listed below.

- Technical (accessibility, bathymetry and grid connection);
- Environmental (species and habitats and designated sites); and,
- Other sea users (navigation, fisheries and recreation).

4.12 Initial site assessment focused on the evaluation of offshore constraints. Once a suitable offshore location for the Project was identified onshore constraints were considered. The constraints were interrogated in Geographical Information Systems (GIS), which has formed the basis of project development from conception to the current time.

4.13 Consultation with various stakeholders was also undertaken to assist in locating the Project in the most appropriate area. These included;

- Scottish Natural Heritage (SNH);
- Joint Nature Conservation Committee (JNCC);
- Chamber of Shipping;
- Marine Scotland (MS);
- The Crown Estate (TCE);
- Ministry of Defence (MoD);
- The Highland Council (THC);
- Scottish Government (SG);
- Maritime and Coastguard Agency (MCA); and
- Royal Society for Protection of Birds (RSPB).

4.14 The Inner Sound between the island of Stroma and the Scottish mainland was assessed as the best site for commercial development. The below sections detail the key reasoning behind proceeding with the Inner Sound as the chosen site and the proposed methods for addressing constraints relating to the Project.

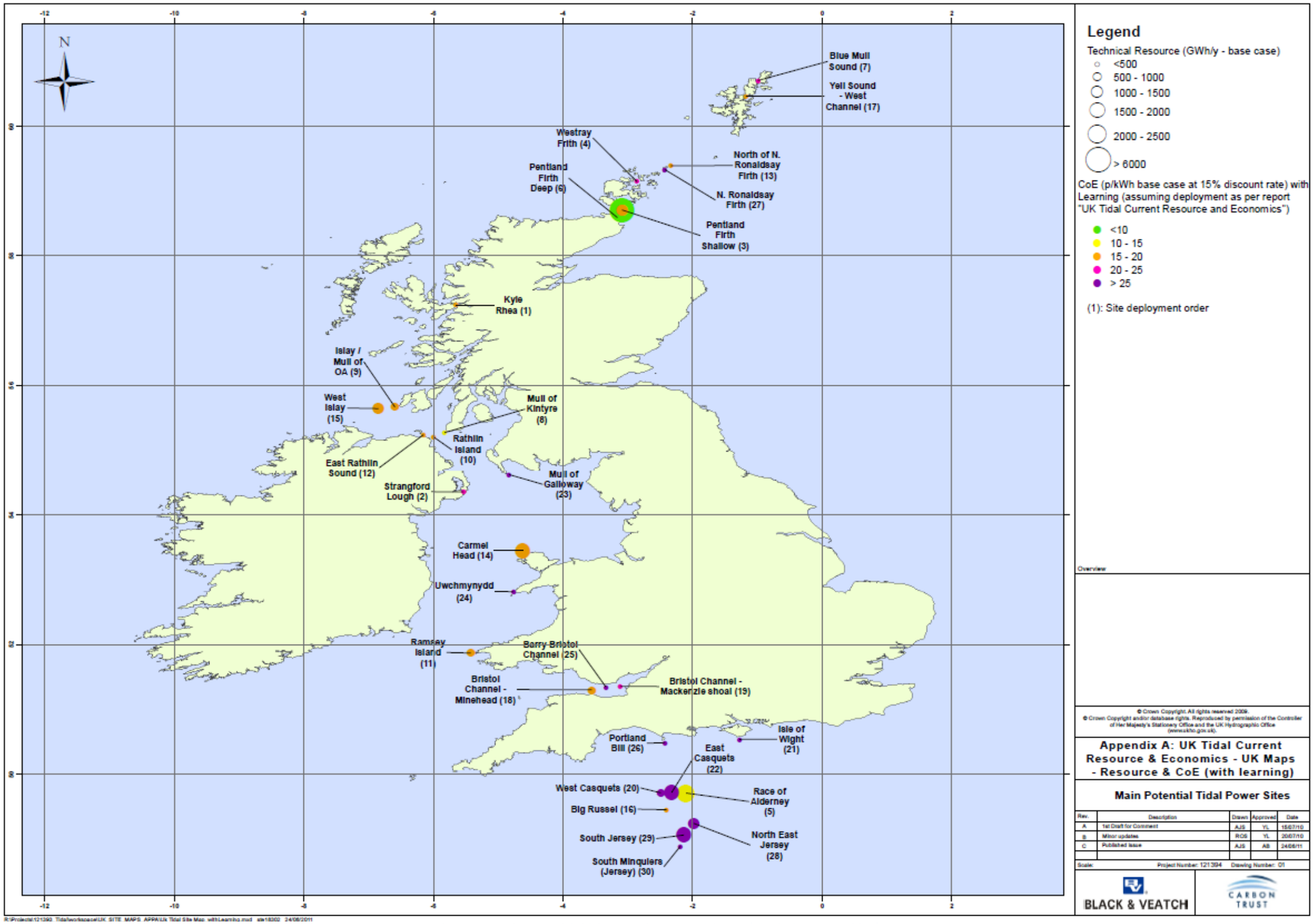

Figure 4.1: Main potential tidal power sites around the UK (The Carbon Trust, 2011)

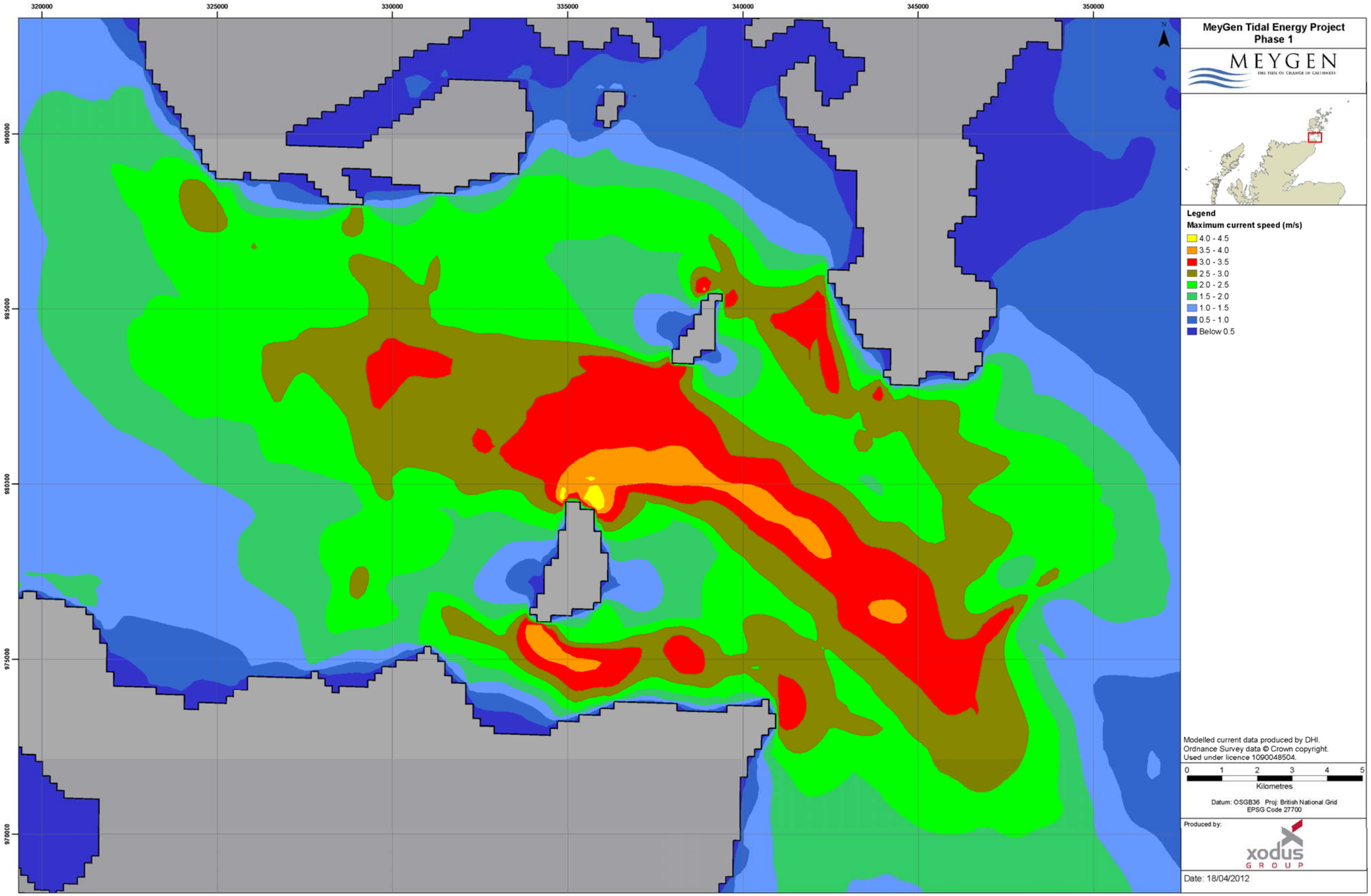

Figure 4.2: Maximum flow speed through the Pentland Firth (initial flow modelling)

4.3.2 Technical

4.15 The site selection process, from international as well as the UK sites has indicated that the Pentland Firth and the Inner Sound especially provides one of the very few high resource sites with suitable bathymetry which is also close to a relatively strong grid connection for the export of electricity. Figure 4.2 (from the initial Pentland Firth model) shows that the Inner Sound has an excellent tidal resource; the maximum current speed reaches 3.5 – 5 m/s.

4.16 MeyGen has continued to investigate the Inner Sound; collating ADCP data in 2011 to recalibrate the flow model and conducting a geophysical survey of the seabed to get more accurate bathymetry data and information on seabed conditions to further inform design of the Project.

4.3.3 Other offshore constraints

4.17 At the same time as establishing the technical constraints for the Project, other key offshore constraints were investigated, including consideration of birds, marine mammals, navigation and fisheries.

4.18 Areas of tidal resource are also known to be ecologically productive areas, and as such will inevitably result in tidal stream energy projects having to be deployed alongside ecological sensitivities. The Pentland Firth supports nationally and internationally important seabirds and is also an important area for mammals including the grey seal, harbour seal and harbour porpoise. As such there are international and national designated sites protecting species and habitats in the area.

4.19 The North Caithness Cliffs Special Protection Area (SPA) which is designated for breeding populations of peregrine falcon, razorbill, northern fulmar, kittiwake, puffin and guillemot overlaps with the Inner Sound AfL area. The SPA was designated on 16th August 1996. The SPA received a marine extension to 2km, classified on 25th September 2009, following the initial tender to TCE for the Inner Sound site in spring 2009. In addition, the western side of the island of Stroma is designated as a Site of Special Scientific Interest (SSSI) for its nationally important colonies of breeding seabirds. Although there are no protected areas designated for marine mammals in the vicinity of the Inner Sound, marine mammal species from protected sites further afield (e.g. Special Areas of Conservation (SACs) in Orkney and elsewhere in Scotland) could be present in the Inner Sound and some species are also protected wherever they are present in European waters.

4.20 MeyGen recognised these ecological sensitivities from the outset of the Project and was proactive in organising surveys of the Agreement for Lease (AfL) area to better understand the presence of birds and mammals in the proposed Project area. With no specific survey methodology guidance available at the time, the methodologies were developed closely with SNH and agreed with Marine Scotland. MeyGen has committed to conducting an extensive and robust survey programme to support the EIA and Habitats Regulations Appraisal (HRA) processes.

4.21 The Pentland Firth is recognised as an important shipping route around the north of Scotland, however initial research on marine traffic through the Firth concluded that the Inner Sound is not a significant navigational route and is generally used by small, shallow draught vessels. The Outer Sound (north of the Island of Stroma) is the designated navigation route through the Pentland Firth.

4.22 Initial consultation indicated that the Inner Sound was not important for aquaculture or for mobile (i.e. trawl) fishing gears and was targeted to only a limited extent by static fishing gears (creelers).

4.4 Project Design

4.4.1 Project design process

4.23 Having secured the AfL in the Inner Sound, MeyGen undertook an initial design phase (Concept Design) to evaluate engineering options and alternatives for the Project. This work was completed in November 2009, following which there has been a two year period of Front End Engineering Design (FEED) which concluded in December 2011. During these initial engineering design phases there has been further refinement of the offshore aspects of the Project and definition provided for the onshore aspects of the Project, in particular in terms of the location at which the Project will connect to the grid and the details for the other onshore infrastructure requirements. The final project design stage (Detailed Design) began in January 2012.

4.24 Through these design stages options for the locations of the offshore and onshore components of the Project were considered and engineering solutions have been developed. Each component is discussed below, including details of the options that are still being considered at the time ES compilation.

4.4.2 Turbine deployment area

4.25 Following the detailed bathymetric survey conducted in the Inner Sound in September 2009, the available seabed suitable for the deployment of tidal current turbines within the lease area was proven to be less than original assessments had predicted due to minimum water depth constraints. Further investigation proved that altering the lease area to extend the site west and east in the sound whilst keeping the same overall area would enable the same generating capacity to be achieved as previously predicted. A revised AfL area was agreed with TCE following this. The originally awarded and subsequently modified areas are shown in Figure 4.3.

4.26 Having refined the AfL area, MeyGen then had to select which part of the area would be developed for the first 86MW (i.e. Phase 1) of the Project. A review of Phase 1 requirements and site characteristics was conducted and the initial development area selected on the basis of the following requirements:

- Provision of an area of 1.1km^2, a conservative estimate (i.e. larger) for the area required for 86 tidal turbines;
- Requirement for high flow velocities;
- Requirement for as close as possible to 180° return between flood and ebb tide;
- Provision of relatively flat and stable seabed;
- Protection (as far as possible) from potential extreme wave climate;
- Access to suitable cable landing sites; and
- Provision of a cable corridor to shore.

4.27 MeyGen considered two areas for Phase 1; one in the centre and one in the west of the AfL area. Based on the above criteria the decision was made in May 2011 to use the central area of the site as the Phase 1 area.

4.4.3 Tidal array

4.28 The exact location of the turbines within the Project area is yet to be determined and is dependent on a number of factors including:

- Full modelling of the turbine array to optimise the cross-flow and down-flow turbine spacing to maximise energy capture;
- Turbulence;
- Seabed topography;
- Requirements for installation and maintenance vessel operations;
- Location, stability of export cables; and
- Environmental issues.

4.29 Individual studies used to inform the EIA as well as engineering expertise, will inform the micro siting of individual turbines at the Detailed Design stage.

4.4.4 Export cables

4.30 An initial cable option study identified three potential options:

- Array cables collected at an offshore platform for export to grid;
- Turbines linked together offshore in an array and brought together via a single cable directly to shore; and
- Turbines with individual export cables brought directly to shore.

4.31 In Concept Design the offshore platform option was rejected based on engineering and economic constraints. Turbine technology is still developing and therefore linking and critically, controlling turbines as an array instead of individual units has not yet been proven technically and commercially.

4.32 The conclusion of the Front End Engineering Design (FEED) study was that bringing multiple cables to shore was the best technical option based on technology currently available. The system has a number of advantages including, providing fault tolerance in the system so a failure in one turbine would not stop others from generating and retaining flexibility to control turbines individually. This solution will require a relatively wide cable corridor for up to 86 export cables between the turbine deployment area and cable landfall.

4.4.5 Cable landfall

4.33 During the Concept Design a review of desk and site based information and appraisal of environmental and planning issues was conducted on potential beach landfalls. The review concluded that there were few beach landing options in close proximity to Inner Sound suitable for cable landings.

4.34 The turbines will supply electricity for export to onshore at relatively low voltages (up to 6.6kV). These export voltages are limited by the current availability of transformer technology within the turbine nacelle and wet-mate connector technology used to link export cables.

4.35 To reduce electrical losses associated with low voltage individual export cables there needs to be a short distance to grid and with no viable beach landing in the area, the option to bring cables to shore via HDD bores was investigated during FEED.

4.36 During FEED initial site investigations concluded three options for HDD landing point. The options critically required enough area to complete the temporary Horizontal Directional Drill (HDD) works and to house the Power Conversion Centre (PCC), discussed below.

4.4.6 Power Conversion Centre

4.37 The PCC design was developed through FEED. The PCC houses conversion equipment for the turbine array and transformers to increase the voltage ready for export to the grid. The PCC is required to be relatively close to the coast to minimise electrical losses from the cables.

4.38 The site investigation concluded three costal locations provided enough area for the PCC and temporary HDD works:

- St John's Point;
- Ness of Quoys; and,
- Ness of Huna.

4.39 Based on the location of Phase 1 in the centre of the AfL area, St John's Point was not taken forward during FEED and the two more central sites, Ness of Quoys and Huna have been considered as potential alternative development sites in the EIA and results of investigations at both sites included in this ES.

4.40 The designs for both the Ness of Quoys and Ness of Huna sites has been completed for the planning application based on the requirements for the construction and operation of the PCC and HDD activity. The final site designs have been informed by the EIA surveys and studies in due regard to limit the impact of the works.

4.41 At the commencement of the EIA the PCC area was less well defined; as a result the onshore EIA assessment and subsequent ES section write up has considered a larger potential project area then that that will be applied for in the planning application.

4.4.7 Onshore export cables

4.42 The onshore export cables link the PCC to the national grid. MeyGen has, from project conception, always proposed to bury onshore cables, instead of using overhead cables on poles or pylons. This position has been welcomed during stakeholder and public consultation.

4.43 The cable route to the grid connection is dependent on the available grid capacity, proposed grid upgrades both on the distribution and transmission network and the grid applications submitted by MeyGen.

4.44 In 2010, MeyGen secured a 15MW grid connection available on the distribution network (SHEPD). MeyGen has agreed a connection to the transmission network that covers a large proportional of the remainder of the project capacity with the transmission network (SHETL). The SHEPD connection was planned to be made at a new West Gills 33kV substation, whilst the SHETL grid connection would be made at the proposed Gills Bay 132KV substation site (Figure 1.3).

4.45 MeyGen identified possible cable routes from both PCC sites to both grid connection points. The cable routes were based on minimising the impact of the installation on local area, following the road network as much as possible.

4.46 In September 2011 it was agreed that the SHEPD connection would be brought directly to the PCC location. This connection, underground cable and route is now the responsibility of SHEPD. This has therefore reduced the number of export cables that require consent under the planning application for the Project.

4.47 The cable corridor route has been finalised for the planning application based on the technical requirements and the EIA surveys and studies (Figure 5.2). From the results of the EIA the key constraint on the potential underground cable routes was watercourse crossings (Section 17). The selected cable corridor will have to cross waterways but in areas where these are much less deeply incised and therefore this reduces potential disturbance during construction. The cable route has also been designed to avoid cultural heritage assets, and any sensitive habitats.

4.48 MeyGen still requires some flexibility in the underground cable route towards the grid connection as the exact location of the substation is not yet known (Figure 5.2). Once further information is available, MeyGen will begin the design of this final section with due regard to the EIA results.

4.49 At the commencement of the EIA the potential underground cable route was less well defined; as a result the onshore EIA assessment and subsequent ES section write up has considered a more extensive potential project area then that that will be applied for in the planning application.

4.50 **Following the completion of the EIA, landowner consultation has identified potential issues with small areas of the proposed cable route. It has therefore been necessary to include areas outside that surveyed for the onshore impact assessments. The area is 0.50km^2 and is shown in Figure 2.1. Unfortunately this issue was not identified at the time of ES compilation and therefore is not addresses in this document. Work to survey and assessment of any changes required to the original impact assessment as a result of the altered cable route is ongoing and will be provided in an ES addendum.**

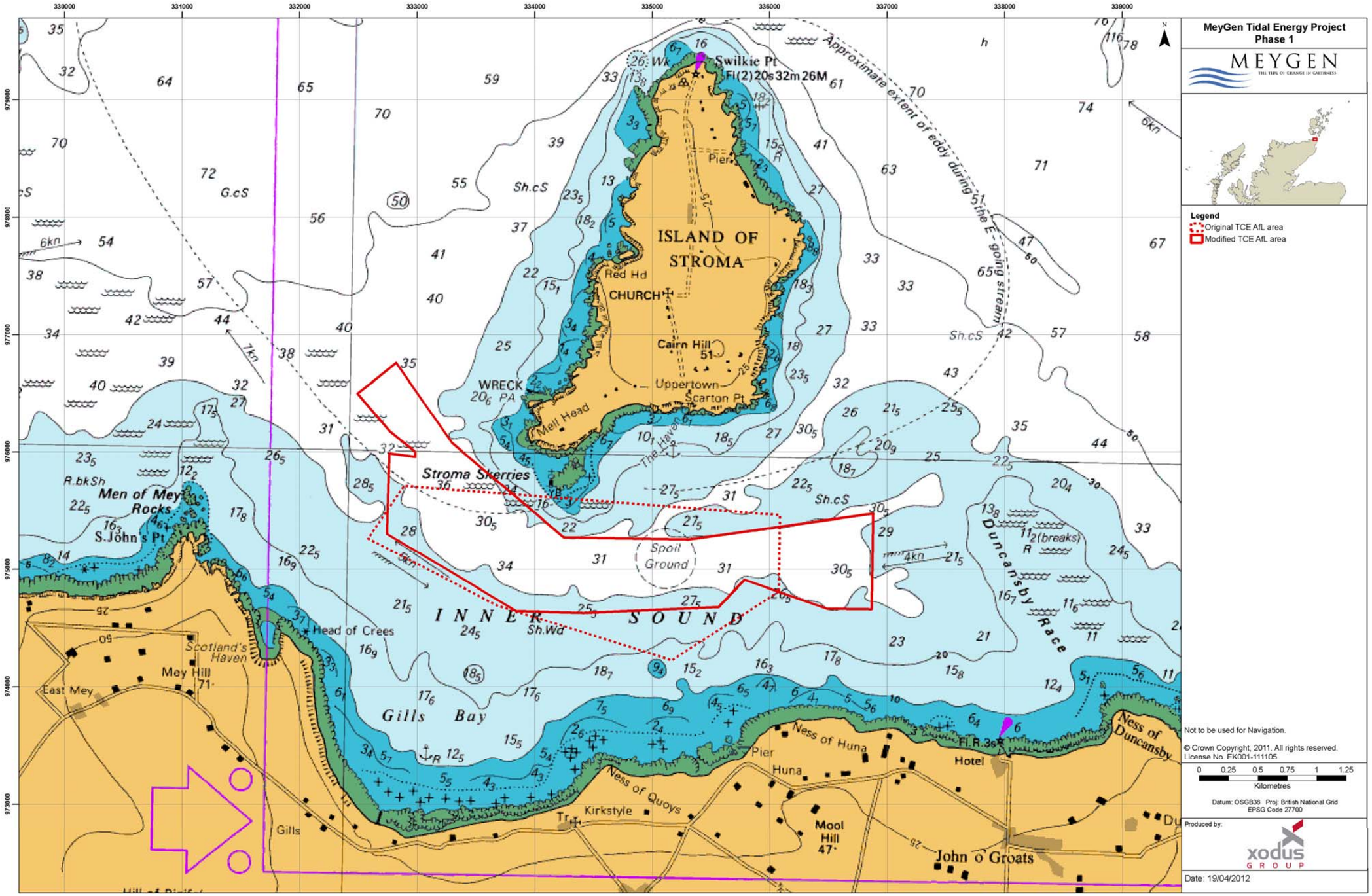

Figure 4.3: Location of MeyGen Tidal Energy Project (original and modified Agreement for Lease area)

4.5 Assessment of Alternative Tidal Technologies

4.51 There are a number of tidal turbine manufacturers that are currently testing prototype turbines. MeyGen has worked closely with a number of these turbine manufacturers throughout the project development process.

4.52 Further site characterisation surveys carried out in 2011 has meant that the turbine specification required for the Inner Sound has changed since the submission of the EIA Scoping Document. MeyGen has subsequently reviewed the turbine parameters to give project design flexibility whilst giving sufficient detail to allow the EIA to be conducted.

4.53 By using a Rochdale Envelope approach for turbine parameters, the procurement process and detailed design of turbines remains flexible and can make use of technology evolution, whilst retaining a competitive market and optimising project economics for MeyGen.

4.54 The turbines will comprise of a 2 or 3 bladed single rotor turning on a horizontal axis. The turbines will be able to capture energy from the flood and ebb tide by either using a rotate system to turn the turbine nacelle, or by having pitching or bidirectional blades. Electricity generated by the turbine will either be converted and transformed in the nacelle and then transmitted to shore through a subsea cable or the converter and transformers will be located in an onshore facility before transmission to the national grid.

4.55 The full details of the turbine Rochdale Envelope can be found in Section 5.3.2. Changes from what was presented in the EIA Scoping Document include the increase of the potential rated capacity of the turbines up to 2.4MW and the maximum rotor diameter to 20m. An increased in turbine rated capacity would mean a reduction in the overall number of turbines required to meet the Project capacity.

4.56 A final decision on the technology used for the Project should be made in 2013 based on the performance of the candidate technology developers.

4.6 Mitigation through Site Selection and Consideration of Alternatives

4.57 Given the detailed deliberation that has been offered to the site selection process, the present Project design is considered to be the most appropriate solution available. It should be noted that mitigation has been applied where possible to this process through the avoidance of specific sensitive receptors and the application of techniques for dealing with remaining constraints and/or residual impacts. Detailed mitigation relating to specific receptors will be outlined in individual ES sections (Sections 9 to 24).

4.7 References

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5 PROJECT DESCRIPTION

5.1 Introduction

5.1 This section of the Environmental Statement (ES) details the Project and describes the following:

- Project timescale;
- Offshore and onshore infrastructure;
- Installation techniques;
- Operations and maintenance; and
- Decommissioning;

5.2 MeyGen proposes taking a Rochdale Envelope approach during the Environmental Impact Assessment (EIA) (see Sections 2 and 8) to address elements of uncertainty associated with the ongoing design and refinement of tidal technology and the overall design of the Project. The project description provided in this section discusses the options and a series of maximum extents or magnitudes for key aspects of the proposed Project, for which the significance of environmental effects have been assessed during the EIA.

5.3 At the start of each ES section the maximum project extents relevant to the specific assessment are defined. Potential variances in the impacts predicated based on the different design options have been summarised qualitatively following the main impact assessment.

5.4 There are clear difficulties in undertaking an accurate EIA if the parameters of the envelope are too flexible / too broad, however following in-depth consideration of the potential variances in environmental impact based on current design uncertainties, MeyGen are confident the project design presented here has enabled a robust and accurate EIA.

5.5 The Project will consist of a maximum of 86 fully submerged tidal turbines, with a maximum aggregate installed capacity of 86MW. Associated with the turbine array will be offshore and onshore infrastructure including subsea cables, landfall cables, a Power Conversion Centre (PCC) and cable connection to the national grid. The overall footprint of the Project is presented in Figure 5.2.

5.6 The Project is split into three distinct generating stations, each with turbines, Power Conversion Unit Building (PCUB) and export cable to the grid connection.

5.2 Project Timescale

5.7 The Project will be installed over a number of years, as shown in Table 5.1. There will be different schedules for offshore and onshore aspects of the Project; these are discussed in more detail in Section 5.5.6 and 5.6.4 respectively.

Year	Phase installed capacity (MW)	Total installed capacity (MW)	Maximum turbine number
Year 1	2 to 10MW	2 to 10MW	10
Year 2	10 to 20MW (dependant on year 1 installation)	12 to 30MW	20
Year 3	56 to 74MW	86MW	86

Table 5.1: Phased development of the Project

5.8 The build out of the Project in terms of overall capacity and number of turbines is dependent on the rated capacity of the turbine. During the first two years of the Project, there will be a maximum of 20 turbines installed with a maximum of 30MW capacity. In Year 3 the remaining project capacity will be installed.

5.3 Offshore Infrastructure

5.3.1 Site description

5.9 The Project is located in the Inner Sound, a body of water in the Pentland Firth between the north coast of Scotland and the island of Stroma. The Inner Sound is approximately 3km wide at the widest point between Mell Head on Stroma and Gills Bay on the Scottish mainland. The deepest part of the Sound is 48.6m and the Project is situated in the centre of the main channel where the useable water depths range from 31.5 to 38m at Lowest Astronomical Tide (LAT). The turbine deployment area is 1.1km^2 in the centre of the Agreement for Lease (AfL) area (Figure 1.3Figure 1.). A cable corridor to shore has been identified (Figure 5.2); of this area an estimated maximum area of 1.3km^2 is required.

5.3.2 Turbine specification

5.10 The Project proposes a maximum of 86 tidal turbines in the Inner Sound. However, the actual number of turbines installed will depend on the rated capacity of the selected tidal technology. Each turbine is fully submerged, seabed mounted and will consist of a rotor and a nacelle (which houses mechanical and electrical equipment). Each turbine will be supported by a Turbine Support Structure (TSS).

5.11 The devices will be single rotor, horizontal axis turbines with a rotor diameter of between 16 and 20m.

5.12 The turbines will always have a minimum clearance from the blade tip to sea surface at LAT of 8m. Figure 5.1 provides an indicative overview of turbine dimensions and position in the water column, while Table 5.2 gives greater detail on the turbine specification.

5.13 The turbines will convert kinetic energy from the flow of water through the Inner Sound into electrical energy via the turbine blades turning the generator. The turbines are able to extract energy from the easterly flood and westerly ebb tide in the Inner Sound by either rotating the turbine into the on-coming flow, or by using 180° pitching or bi-directional blades which can generate from flows in opposite directions. The turbines will operate for an estimated 73% of the time.

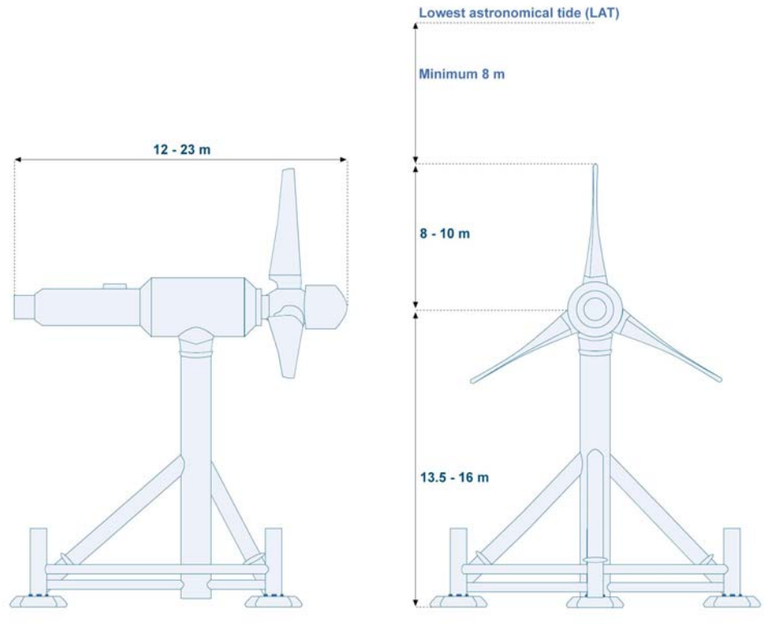

Figure 5.1: Schematic of turbine dimensions

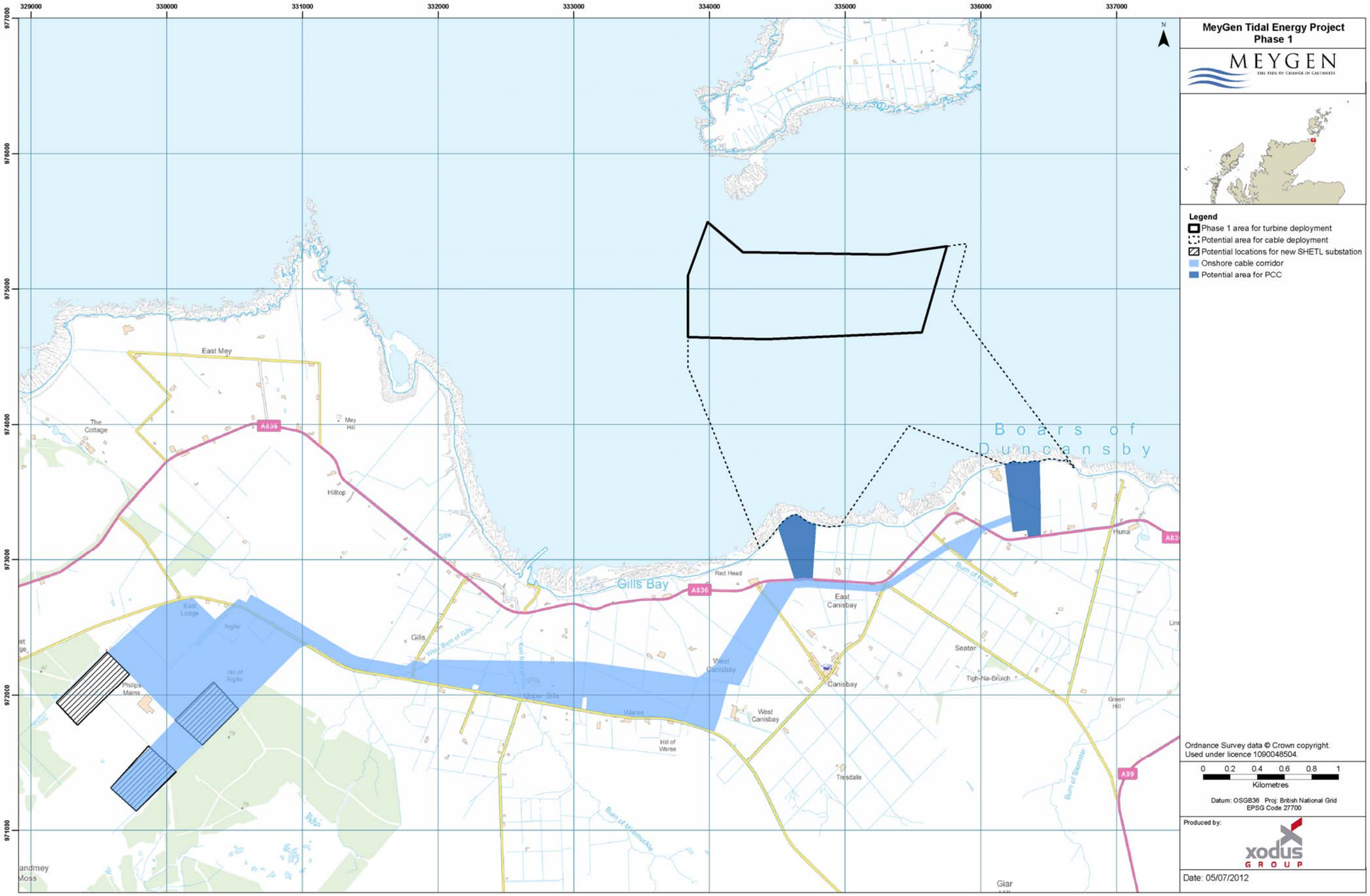

Figure 5.2: The Project area

Turbine Component	Specification
Rated Power	1.0 – 2.4MW[4]
Number of rotors	1
Number of blades per rotor	2 or 3
Rotor diameter	16 to 20m
Maximum blade swept area	201 to 314m^2
Height of structure above seabed (to centre of nacelle)	13.5 – 16m
Minimum clearance from blade tip to seabed	4.5m
Minimum clearance from blade tip to sea surface at LAT	8m
Length of turbine nacelle	12 – 23m
Design options for generation in ebb and flood tides	Mechanical/electrical system to rotate the nacelle into the principal flow direction Thruster in the nacelle tail to rotate the turbine into principal flow direction Bidirectional blades that can generate from flows in opposite directions Mechanical/electrical system to pitch blades 180° to principle flow direction
Cut in flow speed	approximately 1.0m/s
Cut out flow speed	3.4 – 5.0m/s
Operating rotational speed	8-20rpm (3 bladed) 12-20rpm (2 bladed)
Options for power conditioning equipment	All power conditioning is onshore at the PCC Power conditioning within turbine nacelle and onshore transformer at the PCC
Options for transport of turbine to site location	On deck of dynamic positioning (DP) vessel, or Under tow by an installation vessel
Options for turbine installation	Installation vessel lowers nacelle to foundation, or Nacelle is pulled down onto foundation by a cable

Table 5.2: Specifications of tidal turbines

5.3.3 Turbine systems

Heating and cooling systems

5.14 Some equipment in the turbines, including generators, gearboxes, brakes and bearings, will produce heat in operation which will be directly cooled by the surrounding seawater.

5.15 The power conditioning systems in the turbine nacelle may also require a cooling system, which will involve a liquid cooled closed loop system expelling heat to the external seawater environment via a heat exchanger.

Hydraulic systems

5.16 The turbines may include hydraulically controlled mechanical brake, rotate system and a system for pitching of the rotor blades. Subsea electrical enclosures and cables may be oil filled and a grease pump will be required to lubricate the shaft seal. Only recognised marine standard fluids and substances will be used with due regard to the environment.

Electrical systems

5.17 The turbines will produce variable AC power from the generator for transmission to the onshore site at up to 6.6kV.

5.3.4 Turbine protection systems

Antifouling

5.18 The prevention of marine growth is an important consideration, even in a fast flow environment. Different approaches, including antifouling paints and copper coatings, are being explored on full scale prototype devices. These tests will inform the need for and type of antifouling system to be deployed for the Project.

Corrosion

5.19 Appropriate corrosion protection for the turbines is paramount in the harsh seawater environment. A combination of specialist paints and cathodic protection will be used as in other marine applications.

5.3.5 Lighting and marking

5.20 The turbines will be completely submerged during operation and therefore it is not possible to physically mark them individually. Consultation with the Northern Lighthouse Board (NLB) has indicated that they do not expect there to be any lighting requirements (buoys or onshore leading lights). Lighting and demarcation have therefore not been considered as part of EIA. However, the regulatory authorities will make their final recommendation for all charting, lighting or demarcation requirements following the submission of the consent application and the Navigational Risk Assessment (NRA).

5.3.6 Turbine Support Structure

5.21 Each turbine will be supported on the seabed via a TSS. There is as yet no single established TSS solution for tidal turbines in this kind of environment, but deployments at the European Marine Energy Centre (EMEC) have demonstrated the viability of monopile, pin pile and Gravity Based Structure (GBS) solutions. All three of these TSS options are presently under consideration for the Project.

5.22 The overall proposed installation methodology is designed for the efficient placement of multiple units within an acceptable time period. As far as practicable, the design must allow for the placement, maintenance and eventual removal of the turbine and support structure while giving due regard to the operational difficulties inherent in the offshore installation environment of the Inner Sound.

TSS Option 1: Gravity Based Structure (tripod)

5.23 A GBS (Figure 5.3) has been successfully installed at EMEC, consisting of a steel tripod with large steel weights on each of the three legs. The GBS will have a maximum footprint of 30m by 20m, and consist of approximately 1,350 tonnes of steel. Each component will weigh no more than 450 tonnes. The installation of the GBS requires the use of a Dynamic Positioning (DP) vessel.

[4] Phase 1 has an aggregate installed capacity of 86MW. Individual turbines can be between 1 and 2.4MW rated power.

Figure 5.3: Gravity Base Substructure

5.3.7 TSS Option 2: Drilled pin pile tripod

5.24 A drilled pin pile tripod (Figure 5.4) has been successfully installed at EMEC. The main structure is a braced steel tripod, secured to the seabed with three small diameter pin piles. Installation is possible from a DP vessel using a subsea drilling technique. A socket is drilled into the rock, into which the pile is inserted and fixed using high strength grout.

Figure 5.4: Pin-piled TSS

5.3.8 TSS Option 3: Monopile

5.25 The drilled monopile (Figure 5.5) has been successfully installed at EMEC. The main structure is a single pile. A larger diameter socket (compared to pin pile) is drilled into the rock using a temporary subsea frame, into which the pile is inserted and fixed using high strength grout. Installation is possible from a DP vessel using a subsea drilling technique.

Figure 5.5: Monopile TSS

5.3.9 Turbine layout

5.26 The hydrodynamic and computational fluid dynamics (CFD) flow modelling completed for the Inner Sound has enabled MeyGen to assess array configurations through the Project area in order to optimise the energy yield. The final array layout has not been finalised and will be determined through analysis of:

- Maximum and average current speeds;
- Current direction;
- Turbulence;
- Wave action;
- Bathymetry;
- Seabed topography;
- Turbine wake interaction;
- Installation and maintenance vessel operating requirements;
- Export cable layout;
- Environmental issues; and
- Navigational safety issues.

5.27 Although the final array configuration has not yet been confirmed, it is most likely the turbines will be placed in rows aligned perpendicular to the dominant flow direction. Array optimisation will continue as new data is collected on the site.

5.28 An indicative turbine layout has been produced for the purposes of this assessment based on an 86 turbine array with the minimum separation distance of 45m cross-flow and 160m down-flow spacing (Figure 5.6).

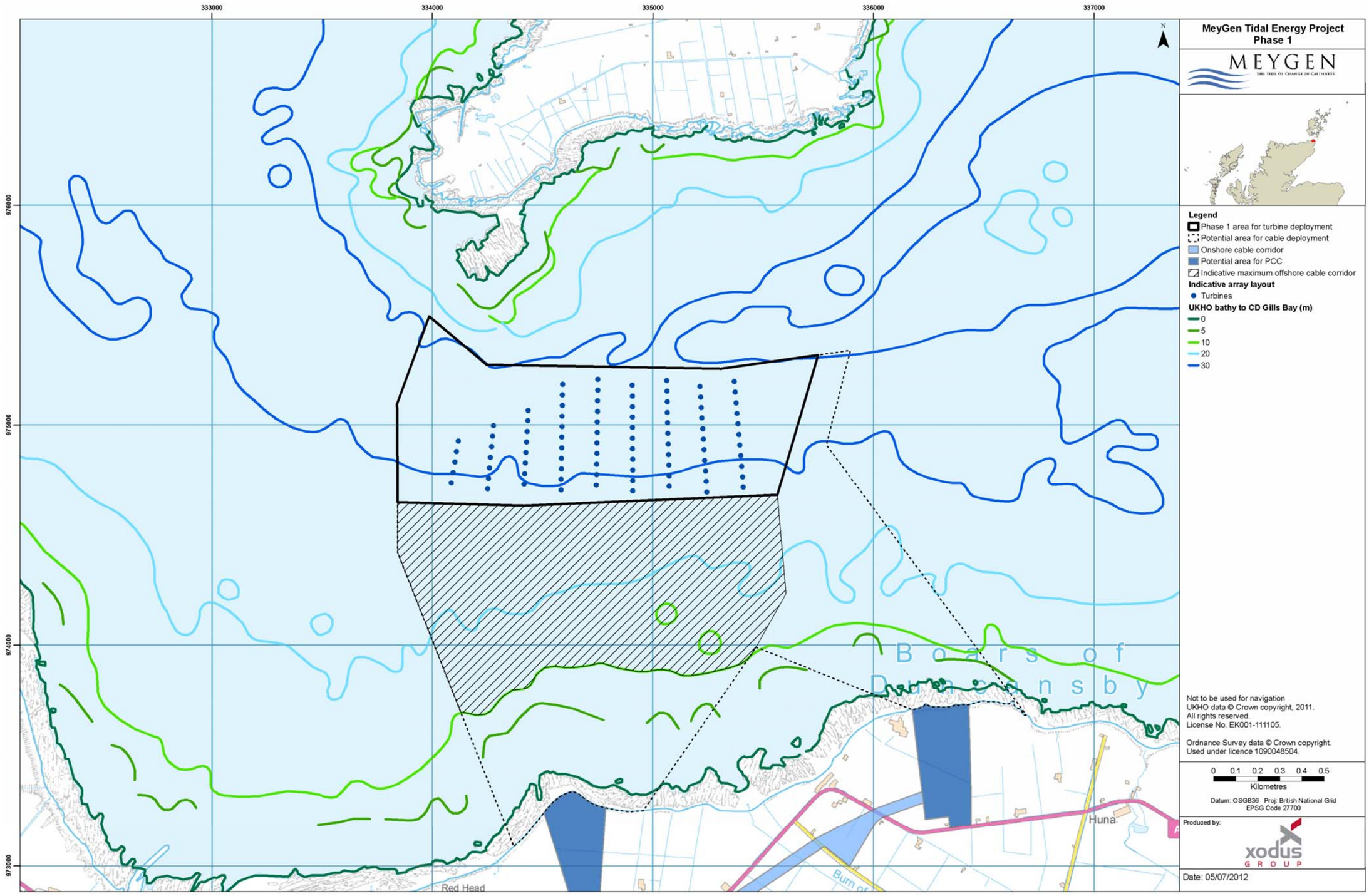

Figure 5.6: Indicative tidal turbine layout and offshore cable deployment area (for EIA assessment purposes)

5.3.10 Export cables

5.29 Each turbine will require a dedicated export cable to shore, with an external diameter of up to 120mm, including double armour. It is intended that these cables will be laid in groups of three to reduce marine operations and provide some mutual protection.

5.30 An alternative would be to use specially manufactured cables with multiple circuits that allow power from more than one turbine to be exported in a single cable. A three circuit cable and a five circuit cable will have a diameter of approximately 130mm and 250mm respectively.

5.31 Each export cable will have a wet mate connector on the offshore end. Either the wet mate will be connected to the TSS directly or much shorter jumper cables, of approximately 50m, will then run between the turbine base and the offshore cable wet mate connector (Figure 5.7). The shore cables will be landed using Horizontal Directionally Drilled (HDD) bores (further details in Section 5.6). Extreme wave and tidal conditions in the Inner Sound mean that the export cable is likely to experience significant hydrodynamic forces, but these forces can be reduced by running the cable in natural crevices and so it is planned to make use of the existing bathymetry as far as possible. Optimisation of the length of the HDD bores between the shore and turbine deployment area can also ensure that the cables receive protection where the natural bathymetry cannot provide shelter.

5.32 The closest distance to shore at which the HDD bores will emerge at the seabed is 700m. The maximum distance from shore is 2,000m. The length of cable laid on the seabed is between 100m and 1,300m depending on the length of the HDD bore. An indicative representation of the offshore cable area and layout is shown in Figure 5.6 and Figure 5.7.

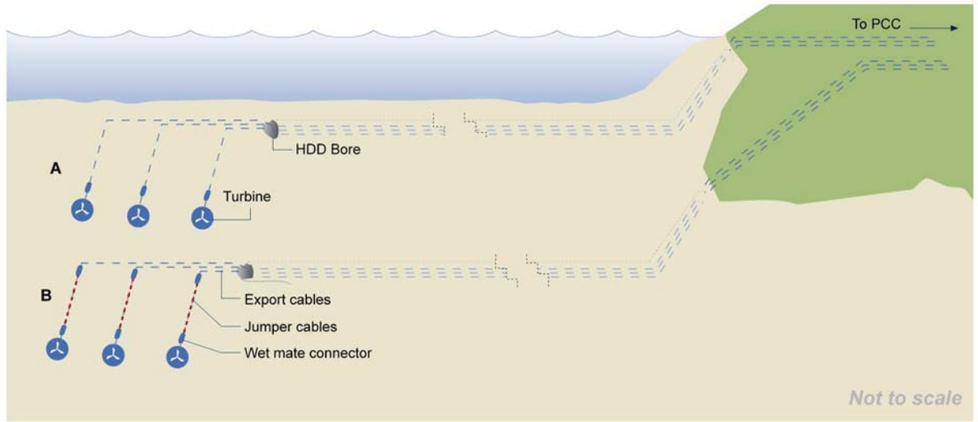

Figure 5.7: Indicative offshore cable layout

5.4 Onshore Infrastructure

5.4.1 Site description

5.33 MeyGen require an onshore site for:

- A PCC which comprises 3 PCUBs and a control building;
- Temporary HDD activities and cable landfall; and
- Cable routes from the PCC to the grid connection location.

5.34 At the time of writing, MeyGen has identified two options for the combined PCC and HDD site. This document covers both options. MeyGen has identified an underground cable route to export electricity generated from the PCC to the grid connection point from either of the two sites. The locations for the onshore infrastructure are illustrated in Figure 5.2.

5.35 Figure 5.2 also shows the potential locations for the SHETL substation. As SHETL are responsible for the consenting of the substation it does not form part of the applications submitted by MeyGen for this Project.

Ness of Quoys

5.36 The site is located roughly 1km from Canisbay village on the mainland coast 2km east of Gills Bay. The land is currently used for mixed agriculture.

Ness of Huna

5.37 The site is located on the mainland coast next to the hamlet of Huna, roughly 1.5km west of John o' Groats. The land is currently used for mixed agriculture.

5.4.2 Horizontal Directional Drilling site

5.38 The cables from the tidal turbines will be brought onshore via HDD bores. From the landing point the cables must be linked to the power conditioning equipment in the PCUB.

5.39 In the worst case scenario in which every turbine requires a single cable and a dedicated bore there will be 86 HDD bores required for the Project. The most likely scenario is that one bore will be sufficient for 3 cables resulting in 29 bores. The HDD bores will need to be spaced 5m apart to ensure integrity of the bores.

5.40 It is planned that the cables will be laid directly from the HDD bore to the PCUB. If the cables cannot be laid directly to the PCUB it will be necessary to construct a cable pit at the HDD site where the offshore cables will be spliced with onshore cables which will then go to the PCUB. The cable pit will be a buried concrete box with a locked manhole cover on the surface for access. The rest of the HDD site will be reinstated following construction.

5.41 To minimise de-rating (i.e. limit electrical and thermal stress) it may be necessary to space cable trenches to the PCUB in a corridor of up to 135m wide.

5.42 The HDD works will require temporary construction facilities and access roads off the permanent PCC access road. The topsoil on site will be stripped back and stored to prepare the temporary works area. The site will be reinstated once construction is complete. An indicative HDD site layout for the Ness of Quoys and Ness of Huna are shown in Figure 5.13 and Figure 5.14 respectively. The exact location of HDD pits will be determined following detailed design of the horizontal and vertical profile of the bores.

5.4.3 Power Conversion Centre

5.43 The PCC will contain;

- 3 PCUBs, each housing;
- power conversion equipment;
- switchgear for grid connection and offshore cable terminations;
- indoor transformers for connecting to the grid at 33kV; and
- A control building incorporating facilities for manual control and monitoring of the turbine array and metering equipment for the distribution network operator (DNO).

5.44 The PCC needs to be located as close to the HDD site as possible based on the following technical requirements:

- Offshore export cables will be rated at a maximum of 6.6kV. At these relatively low voltages, transmission loss between turbines and the PCC will be significant. For technical reasons the power cannot be transmitted at higher voltage subsea;
- Each turbine requires a single dedicated export cable. The multiple subsea cable approach will require a very wide cable corridor onshore, therefore it is necessary to increase the voltage and reduce the number of cables before exporting electricity to the grid connection;
- Each cable is directly installed from subsea to the PCUB with no transition pit/cable vault. This is proposed as it removes a spliced connection in the system and so increases reliability; and
- Export to grid is at 33kV and losses are negligible at this voltage. It is therefore not critical to locate the PCC near to the potential grid connection.

5.45 Each PCUB will be up to 30m wide, 45m long and a maximum of 13m high (Figure 5.8 and Figure 5.9).

5.46 The PCUBs are required to provide a number of functions including;

- Securely terminate each subsea turbine power cable;
- Provide all weather protection of the equipment inside;
- Permit protected access for maintenance and repair of all equipment;
- Provide cooling to the internal environment and limit the noise from operational equipment; and
- Provide security to the high voltage equipment.

5.47 The PCUBs have been designed following consultation with The Highland Council (THC) Planning and Development and Historic Environments Team and Scottish Natural Heritage (SNH).

5.48 The design evolution of the PCC started with the concept of a traditional barn structure commonly found in the region and a combination of standard modular building structures to provide the control room. The design workshop (6th September 2011), held on site involving MeyGen, THC and SNH was used to discuss the design of all onshore works.

5.49 The desire expressed by THC was that the buildings should be designed in the spirit of the North Highland Onshore Visioning work[5]. THC recommended that traditional barn structure would not be appropriate and the buildings needed to both celebrate the fact they are part of the new marine power industry as well as be sympathetic to their surroundings. MeyGen was prepared to support the design approach as long as it could be realised at a small additional cost. It should be noted that it is not the intention of MeyGen to attract uninvited visitors to the PCC as there are to be no facilities for visitors. All visitor information is planned to be located at John o' Groats.

5.50 The design brief was revised to specify a set of functional modern industrial buildings that compiled with all the Project requirements but also satisfied the statutory historic environment interests (i.e. scheduled monuments and their setting, category A listed buildings and their setting and Inventory designed landscapes). In addition, work was carried out to assess the indications of past anthropogenic activity on the two sites identified, to ensure building design and site layout was planned to avoid all potential archaeological sites.

5.51 The landowner's and local resident's views were also taken into account in the design and layout of the sites with particular respect to layout, visual impact, noise and access requirements. The result of all the consultations and considerations was an iterative design process resulted in a revised design for the PCUB which is essentially an economic steel enclosure, required to satisfy the functional requirements, but shaped to blend with the exposed landscape and softened by being partially clad in natural materials. The control building is a more traditional structure also clad in natural materials.

5.52 Features of the PCUB design includes:

- Limiting PCUB height and lowering the buildings by up to 1.5m in taking away superficial soil layers;
- A curved roof to reflect the surrounding landscape;
- Use of natural finishes as part of the cladding; and
- A site layout and PCUB orientation that minimises the PCC scale from key visual receptors.

5.53 For the initial years of Phase 1 i.e. years 1 and 2 (Table 5.1) only one PCUB and the control building will be required. The remaining 2 PCUB units will be required and constructed in year 3 of the Project.

5.54 The control building (Figure 5.10) is required to provide a temporary operations room during the initial commissioning of all onshore equipment and turbines. After commissioning it will provide an ongoing operations room facility for up to 4 people with associated facilities (e.g. meeting room and messing facilities). It is intended that ultimately the turbine array will be controlled remotely, so the PCC will only be visited when required.

5.55 In addition to the buildings themselves the site will require a permanent access road with a wide roadside entrance and cattle grid; a car parking for up to 12 cars; hard standing and turning area sufficient for two articulated lorries carrying a 40ft container; CCTV and limited external lighting. The area will have the appropriate drainage system and stock proof fencing around the perimeter.

5.56 The PCC will not be a permanently lit operational site, as it is intended to be an unmanned facility.

5.57 Site designs for both the Ness of Quoys and Ness of Huna are shown in Figure 5.11 and Figure 5.12 respectively.

5.4.4 Grid connection

5.58 The low voltage distribution network in the local area is managed by the DNO, Scottish Hydro Electric Power Distribution plc. (SHEPD). The current distribution network is made up of an 11kV line coming into Gills Bay.

5.59 MeyGen has secured a 15MW grid connection with SHEPD. Provision of this grid connection at the PCC site will be made by SHEPD via a single underground cable (shown as the pink cable route in Figure 5.11 and Figure 5.12) and as such is outwith the scope of this assessment.

5.60 The high voltage transmission network in the area is managed by Scottish Hydro Electric Transmission Ltd. (SHETL). As part of the drive to deliver renewable energy projects throughout Scotland, SHETL has produced a roadmap of transmission extensions and upgrades required to meet demand for project connections.

5.61 As part of the upgrades, SHETL has proposed an extension of the 132kV transmission network to Gills Bay. The extension will include a 132kV/33kV substation at one of the three option areas shown in Figure 5.2.

5.62 MeyGen has agreed for a connection to the transmission network that covers a large proportion of the remainder of the Project (beyond the 15MW already secured) capacity. The connection will require a maximum of four 33kV underground cables between the PCC site and the proposed SHETL 132kV/33KV substation (shown as the green cable route in Figure 5.11 and Figure 5.12).

5.63 Cables between the PCC and grid connection will be trenched and buried, with a required spacing of 3m to ensure thermal independence. If all four cables are laid in a flat formation, the worst case onshore cable

[5] http://www.highland.gov.uk/NR/rdonlyres/637F7B9A-0444-45F7-85A5-5860630255F5/0/OnshoreVisioningReportFinal160511c.pdf

corridor would be 20m wide. MeyGen does not propose to install any overhead lines from the PCC as part of the Project.

5.64 The proposed underground cable corridor route and SHETL substation is shown in Figure 5.2. As the exact location of the SHETL substation has yet to be confirmed it is not yet possible to finalise the cable route in this area.

5.65 **Following the completion of the EIA, landowner consultation has identified potential issues with small areas of the proposed cable route. It has therefore been necessary to include areas outside that surveyed for the onshore impact assessments. The area is 0.50km^2 and is shown in Figure 2.1. Unfortunately this issue was not identified at the time of ES compilation and therefore is not addresses in this document. Work to survey and assessment of any changes required to the original impact assessment as a result of the altered cable route is ongoing and will be provided in an ES addendum.**

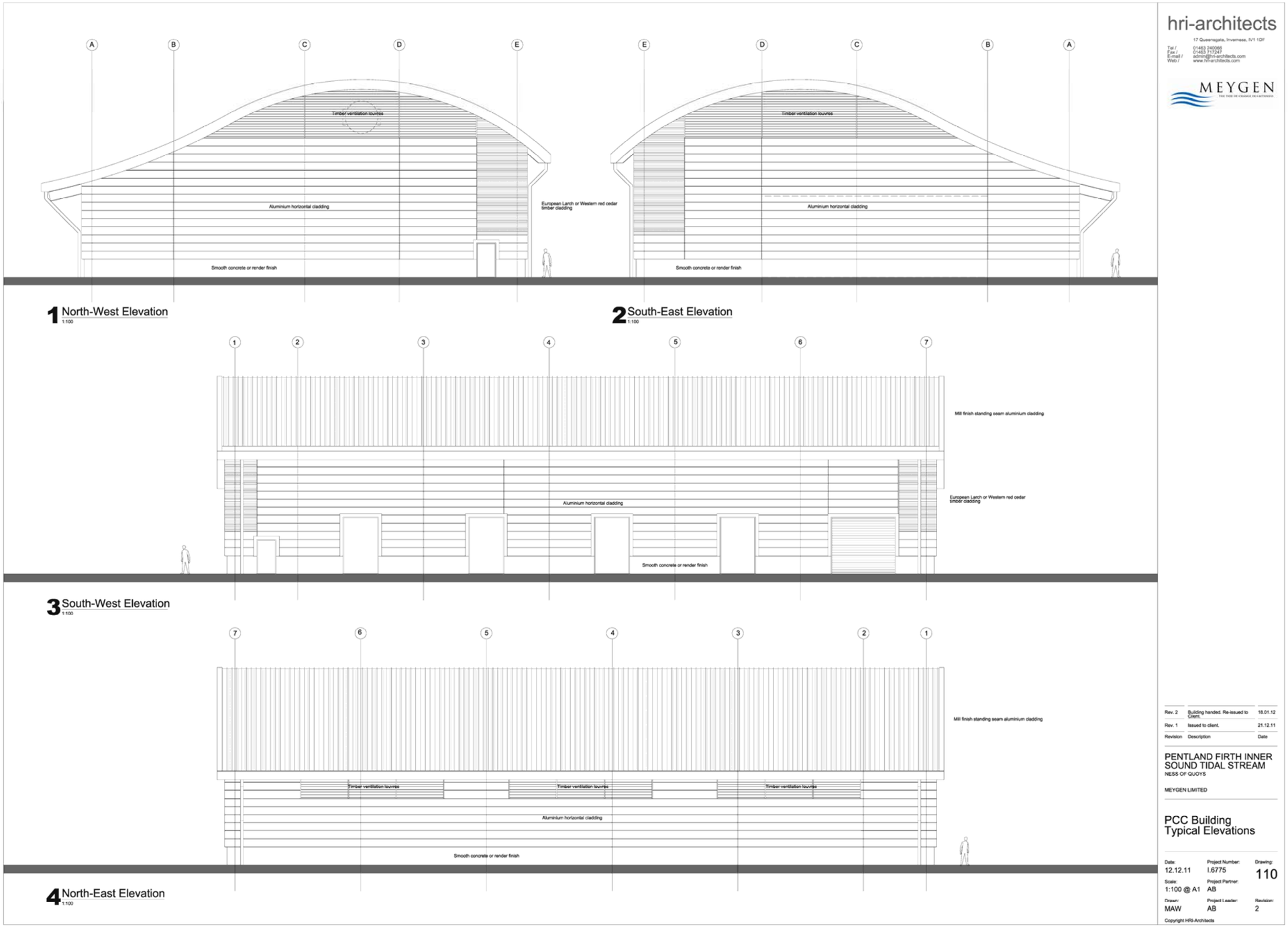

Figure 5.8: PCUB design

Figure 5.9: PCUB Design

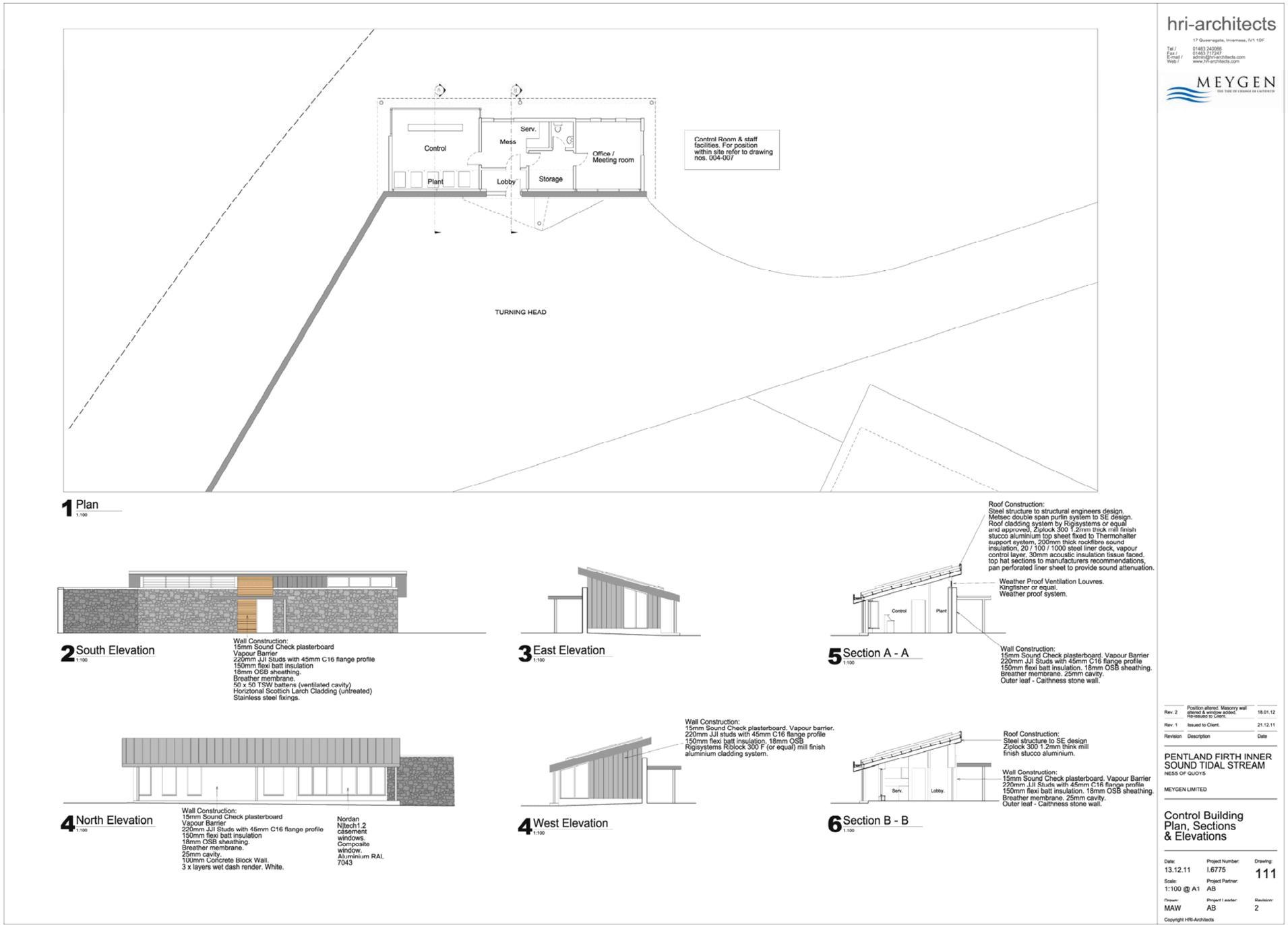

Figure 5.10: Control building design

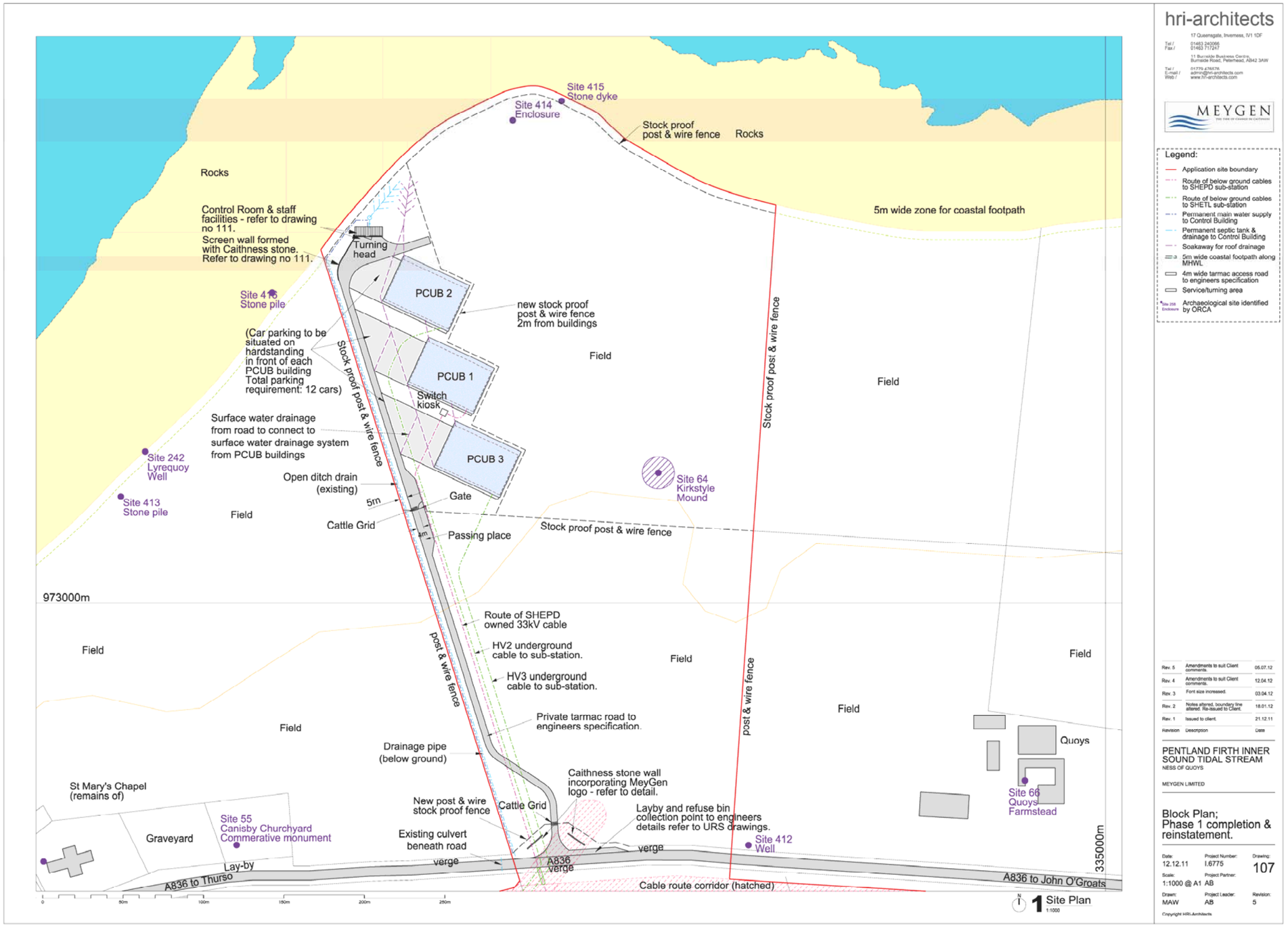

Figure 5.11: Ness of Quoys site layout

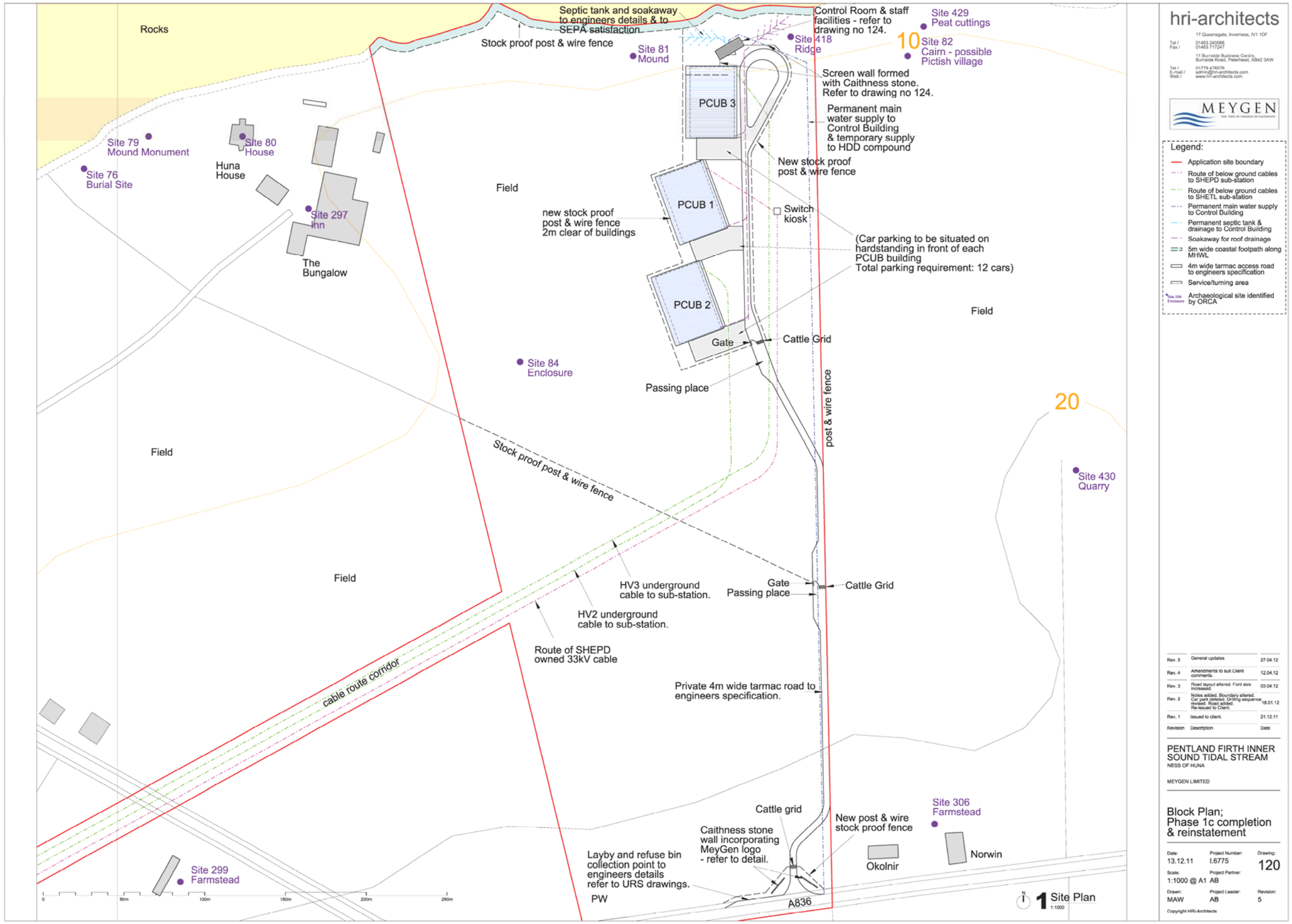

Figure 5.12: Ness of Huna site layout

5.5 Offshore Installation

5.66 The Inner Sound is an area of high tidal flow and impermeable seabed conditions presenting a challenge for offshore operations. MeyGen plans to use techniques and equipment trialled at EMEC to mitigate installation risks associated with in this environment.

5.5.1 Turbine Support Structure installation

5.67 The three types of TSS will have different installation approaches:

- The GBS which requires heavy lifting capacity and no seabed preparation;
- Pin pile tripod which requires specialist drilling equipment and multi-stage operations to grout the piles into the sockets; and,
- Monopile, which again requires specialist drilling equipment.

Gravity base

5.68 The gravity based option will need a DP vessel. No seabed preparation is required, and nor will there be a need for scour protection as the seabed consists of exposed bedrock. The positioning of the TSS will carried out with the assistance of Remotely Operated Vehicle (ROV) from the DP vessel.

5.69 This type of TSS is currently installed during slack water on a neap tide, but work is progressing to extend the operation window of installation to be less dependent on environmental conditions.

5.70 Gravity based installation operations will take approximately one to two days per TSS (assuming 24 hour working on site).

Pin pile

5.71 The pin pile drilling equipment will be deployed from a DP vessel.

5.72 Drilling operations will result in a direct release of drill spoil to the marine environment. Dimensions of the pin pile are approximately 900mm diameter, and between 5 and 8m length, and so up to 5m^3 of drill spoil could be released into the water column per socket, or 15m^3 per TSS.

5.73 There is no requirement for scour protection as seabed consists of exposed bedrock.

5.74 Pin pile operations will take approximately three to four days per TSS (assuming 24 hour working on site).

Monopile

5.75 The monopile drilling equipment will be deployed from a DP vessel.

5.76 Drilling operations will result in a direct release of drill spoil to the environment. Dimensions of the monopile are likely to be up to 3.5m diameter, and an estimated 15m length, up to 200m^3 of drill spoil could be released into the water column per socket.

5.77 There is no requirement for scour protection as seabed consists of exposed bedrock.

5.78 Monopile operations will take approximately two to three days per TSS (assuming 24 hour working on site).

5.5.2 Turbine installation

5.79 Depending on the turbine type the installation method will either use:

- A DP installation vessel that can safely hold station and work in up to 4 knots (2m/s) current speed. The DP vessel will have an Active Heave Compensated (AHC) system to lower the turbine through the water column and onto the TSS; or
- A towed system. The buoyant nacelle will be towed to site by a smaller DP vessel or tug and then attached to the TSS by a cable and will be winched down into position.

5.80 Installation of the turbines will take place over periods of slack tide.

5.5.3 Offshore cable installation

5.81 The installation of the export cables on the seabed will be conducted by either a modified DP construction vessel or a dedicated cable installation vessel.

5.82 In some areas it may be necessary to add additional weight to the cable during the installation process to provide on bottom stability. This additional weight is likely to be in the form of cast iron spilt pipes.

5.83 Depending on the length of the HDD bores, cables may need to be installed across an area of kelp forest. In this instance kelp would need to be cleared by diver from the seabed prior to cable installation.

5.84 An ROV may be required on the cable lay vessel to achieve sufficiently accurate laying of the cable, given the need to rely on seabed features to maintain cable stability. A vessel will also be required during cable landfall installation (cables pulled through the HDD bores, see below).

5.5.4 Marine installation operations

5.85 Marine installation works will be planned to take place during the spring, summer and autumn months when weather conditions are most favourable. To ensure that turbine installation time is maximised, operations are likely to be confined to periods when the tidal flows are lowest. To take advantage of the restricted tidal windows works will be undertaken at any time during the day or night.

5.5.5 Installation vessel requirements

5.86 The intended installation sequence is as follows:

1. A DP installation vessel will install the rows of TSS's.
2. A DP vessel or a cable laying vessel will install the export cables along the line between the rows of TSS's. The same vessel will either connect the export cables to the TSS or a smaller vessel with a Remotely Operated Vehicle (ROV) will then install the short lengths of jumper cable between the TSS and the export cables.
3. A DP vessel or tug will install the turbines onto the TSS's.

5.87 During year 1 and 2 of installation there will not be more than one large DP vessel on site at any one time. During year 3 there may be the requirement for two DP vessels to conduct TSS installation.

5.88 These vessels may require smaller vessels to be present for support services.

5.89 Table 5.3 provides details for the different vessel activities in the Project and the estimated number of operating days required (i.e. over 3 years). This takes into consideration the options for turbine and TSS deployments.

Activity	Vessel type	Maximum operating days
Laying cable bundles	DP cable laying vessel	260
Joining jumper cables to export cable	Lightweight vessel with ROV	100
Deploying gravity base, pin pile or monopile TSS and positioning turbines into support	DP construction vessel	345
Transporting turbines to site	DP vessel	170
Towing floating turbine to array site	Tug	20

Table 5.3: Vessel activities

5.5.6 Installation programme

5.90 The Project will be build out over a number of years as described in Table 5.1. The offshore installation will follow the same programme with activity on site taking place through spring, summer and autumn months when weather windows permit (Table 5.4).

Phase installed capacity (MW)	Total installed capacity (MW)	Offshore activity	Maximum no. of turbines installed	Year
2-10MW	2-10MW	Installation of 2-10 turbines and related TSS and cables	10	1
10-20MW	12-30MW	Installation of 4-18 turbines and related TSS and cables[6]	20	2
56-74MW	86MW	Installation of 23-74 turbines and related TSS and cables	86	3

Table 5.4: Offshore installation

5.6 Cable Landfall and Onshore Construction

5.6.1 Horizontal Directional Drilling

5.91 The offshore cables will be brought to shore via HDD bores, as previously described. Directional drilling is a steerable trenchless method of installing cables underground in a shallow arc along a prescribed bore path by using a surface launched drilling rig.

5.92 In the worst case scenario, in which every turbine requires a single cable and a dedicated cable bore, there would be 86 HDD bores required for the Project. However, the more likely scenario is that 3 cables sufficient for 3 turbines will pass through one bore. Construction of the HDD bores will be spread over the turbine installation programme. It is planned to terminate up to 3 separate HDD bores in a single shore pit in order to minimise the length of disturbed shoreline. Based on the above, there may be a requirement for between 10 and 29 HDD pits.

5.93 Directional drilling is carried out using a drilling fluid, typically bentonite, to lubricate the drilling process. All drill cuttings and associated drilling fluids are inert. Much of the equipment present on the site is to manage the drill fluid and cuttings which are returned to shore. Drill cuttings returned to shore will be reused, recycled or disposed of subject to consultation with Scottish Environment Protection Agency (SEPA).

5.94 Some drilling fluid/cuttings will be lost to the ocean at the offshore end of the bore during seabed breakthrough. It is estimated that the drill cuttings from the last 10m of the bore will be lost to sea.

5.95 No construction operations will be required in the intertidal zone.

5.96 Once started, drilling is a continuous process and 24 hour a day operation is required. Noise from the drilling rig and ancillary equipment will be kept below levels set under the conditions of consent for daytime and night-time activity. For safety reasons the HDD compound will be lit during the hours of darkness. The floodlights will be designed to minimise lighting spread.

5.97 A bunded fuel tank will be required for the HDD operation. This will be located away from and PCUB that has been built and any water courses on site to reduce fire and pollution risk. Appropriate procedures will be undertaken to ensure safety and minimal risk of pollution at all times whilst refuelling HDD equipment day tanks.

5.98 Following completion of the HDD bore, a bore liner will be installed and the cable(s) is pulled through the bore. It is intended to conduct the cable pull from the offshore end of the bore towards the shore. This will minimise the shore laydown area required and will facilitate onward cable laying towards the PCUBs.

5.99 It is intended that construction of the HDD bores will process concurrently with the other onshore works to minimise the total time required on site and level of disturbance.

5.100 The HDD works will require temporary construction compound and access roads off the permanent PCC access road. Construction works will be carried out using a light excavator and dumper truck. The topsoil on site will be stripped back to the bedrock and stored to prepare the temporary works area. Some rock breaking (by excavator breaker) may be required. The HDD compound will move to new positions to complete each different phase of drilling. A new compound area will be prepared for each phase and the old area reinstated.

5.101 HDD site preparation will only be during normal working hours.

5.102 Indicative layouts of the HDD area are presented in Figure 5.13 and Figure 5.14. The final position of the HDD pits will be determined following detailed design of the horizontal and vertical profiles of the bores.

5.103 For the purposes of volume of cuttings produced from the HDD operation, MeyGen has considered the options for 86 individual cable bores, 300mm diameter bores extending 2,000m from the shore and 29 multi-cable bores, 600mm diameter extending 700m from the shore.

5.104 Table 5.5 details drill cutting volumes associated with the drilling of the HDD bores. The numbers in bold represent maximum potential drill cuttings volumes returned to shore and discharged to sea.

Number of bores	Bore diameter (m)	Bore radius (m)	Cuttings returned to shore			Cuttings discharged to sea		
			Bore length (m)	Volume of cuttings per bore (m^3)	Total volume of cuttings (m^3)	Bore length (m)	Volume of cuttings per bore (m^3)	Total volume of cuttings (m^3)
86	0.3	0.15	1990	140.59	**12,091.04**	10	0.71	60.76
29	0.6	0.3	690	194.99	5,654.83	10	2.83	**81.95**

Table 5.5: Drill cutting volumes from HDD bores

5.6.2 Power Conversion Centre construction

5.105 The PCUBs, control building and access will be constructed using standard practices to minimise disturbance and pollution. Electrical components will be delivered pre-assembled to site for installation to limit the amount of laydown area required.

5.106 Construction of permanent access road, temporary hardstanding using a light excavator, dumper truck and roller. The topsoil will be stripped back to the bedrock and stored correctly before the PCUBs, control building, hard standing and access roads are constructed. Topsoil will either be used for landscaping purposes or removed from site to be re-used or recycled. Some rock breaking may be required to level the site for building foundations.

5.107 The PCUB and control building construction will include foundation and floor preparation, using a light excavator, dumper truck and roller. The steel structure will be erected and external cladding fitted using a single small crane and cherrypicker. PCC construction will only be during normal working hours.

[6] There will be a maximum of 20 turbines installed by the end of Year 2

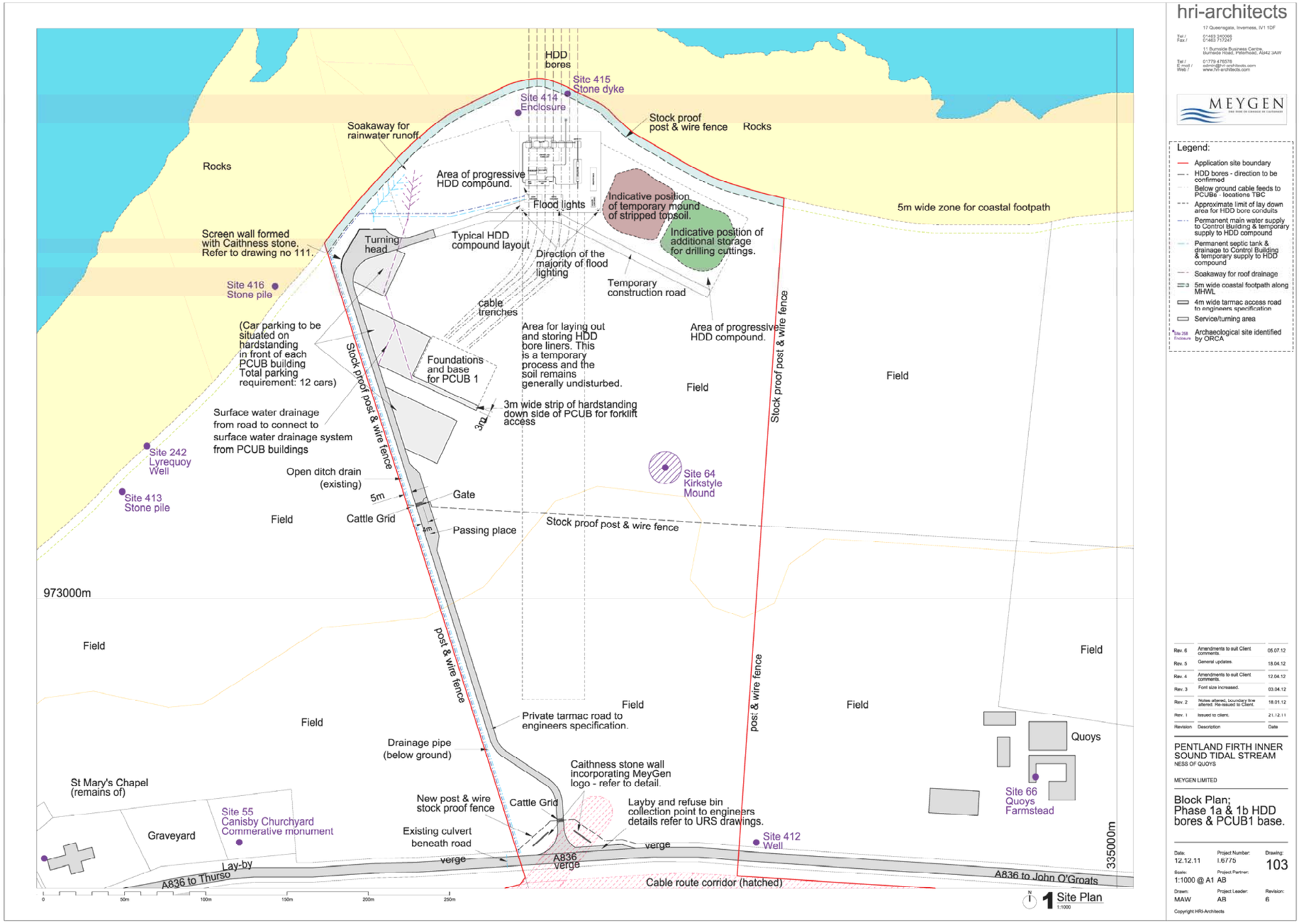

Figure 5.13: Indicative Ness of Quoys HDD site during construction phase

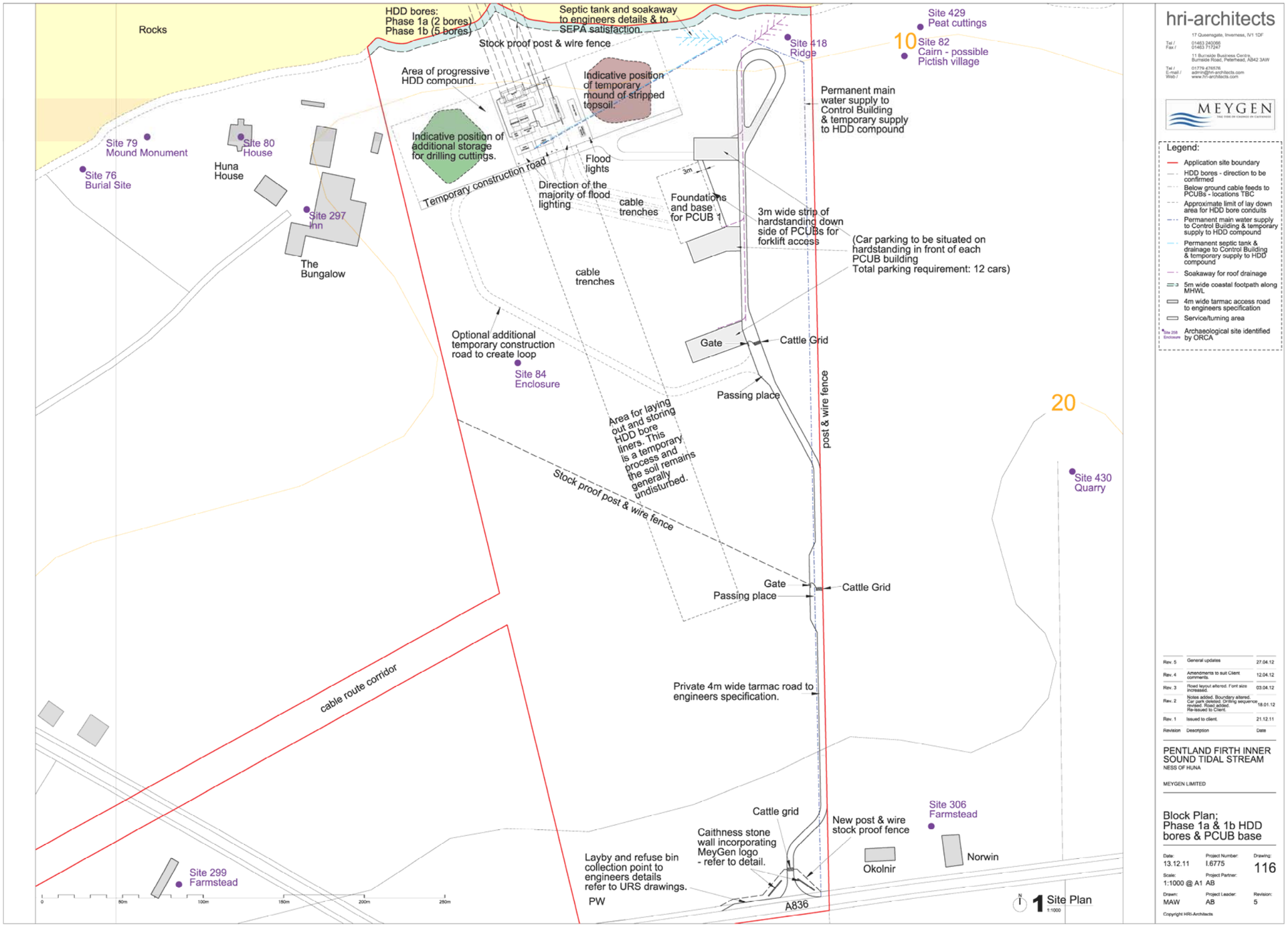

Figure 5.14: Indicative Ness of Huna HDD site during construction phase

5.108 Temporary works necessary for PCC construction include:

- Laydown area for equipment and materials;
- Fencing for public safety security;
- Storage of topsoil;
- Traffic management at entrance to work area; and
- Spoil and water management.

5.6.3 Grid connection works

5.109 Export cables from the PCC site to the grid connection will either be trenched using an excavation and back fill method, or using a cable plough.

5.110 If the cables are trenched then material will be stored and reinstated using the correct protocols. The cable corridor will be a maximum of 20m wide and require a total working width of 32m.

5.111 Water crossings may be required. Methods used for water crossings will depend on the exact location, the condition of the watercourse and other environmental constraints. MeyGen will use best available techniques and adhere to SEPA guidance for water crossings.

5.112 General considerations for the temporary works necessary to install the onshore cables are as follows:

- Laydown area for cable drums;
- Fencing for public safety and cable security;
- Storage of topsoil;
- Traffic management at entrance to work area;
- Interactions with other utilities – other services in the local area will be identified and mapped and the operator contacted; and
- Spoil and water management.

5.6.4 Construction programme

5.113 The Project will be build out over a number of years as described in Table 5.1. The onshore construction works will be completed in stages to match the build out of the offshore installation although some infrastructure will be built ready for future phases based on PCUB capacity. For example, for the initial 20MW (year 1 and 2) only one PCUB and the control building will be required (Table 5.6). The remaining 2 PCUB units will be required and constructed in year 3 of the Project.

5.114 In addition to the construction of the first PCUB and control building in year 1, the permanent access road and car park will be constructed for the Project. Other infrastructure such as hard-standing, fencing and lighting will be increased as the PCC footprint increases (Table 5.6).

5.115 The HDD bores will be completed in line with the requirements of the offshore programme and therefore each year new bores will be drilled from onshore.

5.116 All onshore construction activity will be carried out throughout the year.

Phase capacity (MW)	Total capacity (MW)	Onshore activity	Year
5 to 10MW	5-10MW	Construction of PCUB 1, control building, car park and permanent access road. Hard standing, fencing and lighting constructed for year 1 site only. HDD activity (max 2-10 bores). Temporary HDD site constructed. Cables trenched from HDD point to PCUB 1. Ground reinstated. SHEPD cable trenched to substation building.	1
10 to 20MW	15-30MW	HDD activity (max 4-20 bores). Temporary HDD site constructed. Cables trenched from HDD point to PCUB 1. Ground reinstated. 1 export cable trenched to SHETL substation, ground reinstated.	2
56 to 71MW	86MW	Construction of PCUB 2 and 3, Hard standing area increased, fencing and lighting constructed for complete PCC site. HDD activity (max 19-71 bores). Temporary HDD site constructed. Cables trenched from HDD point to PCUB 2 and 3. Ground reinstated. 2-4 export cables trenched to SHETL substation, ground reinstated.	3

Table 5.6: Onshore construction programme

5.7 Commissioning

5.117 In order to successfully commission the individual equipment and the entire power system, MeyGen will form a commissioning panel, the members of which will have defined roles and responsibilities. The commissioning process will be defined in detail by the commissioning panel and each stage would have appropriate certificates approved by competent personnel before the next stage commences.

5.118 MeyGen will appoint competent contractors to commission the tidal turbine array and the associated PCC in accordance with a written commissioning procedure. The key activities that will be undertaken during commissioning are:

- Health and safety management;
- Pre-commissioning inspection of all onshore and offshore equipment (will require survey with subsea camera);
- Off load commissioning testing;
- Pre-energisation inspection;
- Commissioning switching and on-load testing; and
- Post commissioning inspection/online monitoring.

5.8 Operations

5.119 The Project will have an operational life of 25 years. The turbines will be controlled using standard industrial power conversion equipment which is programmed to optimise the energy extracted or to control the power capture to a level dictated by the grid provider.

5.120 MeyGen will have remote access to the system for interrogation and data collection, but it is anticipated that the system will be unmanned and will run automatically. The control system is able to safely shut down turbines in emergency conditions.

5.9 Maintenance

5.9.1 Maintenance strategy

5.121 The maintenance requirements will necessarily escalate as the number of turbines increases over the installation phases. This will in turn dictate increased capacity requirements for infrastructure and services to support installation, maintenance and operations. The maintenance requirements for the turbines differ between the proposed candidate technologies. Based on recommendations from manufacturers, planned minor maintenance will take place every 2-5 years with a 10 yearly major maintenance intervention.

5.122 Full scale prototypes under test at EMEC and other facilities will provide information on reliability and failure mechanisms which will enable greater detailing of the maintenance strategy. Preliminary scheduling is a best estimate based on comparable experience of the types of components and their normally envisaged failure rates and inspection requirements. These schedules will then be continuously revised and improved based on actual findings from plant condition monitoring and data logging.

5.123 As well as planned maintenance, there may also be a requirement for unplanned maintenance interventions if turbines go offline. The level of unplanned maintenance required is difficult to quantify, however MeyGen recognises that with relatively new technology there will be this requirement. As the Project and technology develops the level of unplanned maintenance will reduce. The marine operations for unplanned maintenance are the same as for planned interventions.

5.124 The onshore equipment and facilities will also be maintained in accordance with manufacturers' recommendations, but pose fewer challenges as they are easily accessible.

5.9.2 Marine operations

5.125 Maintenance of the turbines requires a similar vessel as used in the initial installation of the devices. These vessels will recover the turbines from the TSS and transport them back to the maintenance facilities for onshore inspections and repairs. Repair work is unlikely to be feasible on board the vessels. Spare turbines may be used to immediately replace the retrieved devices to minimise the energy lost during down time in maintenance operations. Turbine retrieval for maintenance is planned to take place all year round, based on appropriate weather and tidal windows.

5.126 Based on a 2 year minor maintenance plan and with a predicted 95% availability for turbines, it is estimated that once the maximum 86 turbines are operational then maintenance activities will take place 2.5 times per week. Retrieval and deployment of a turbine will be completed in one slack water period.

5.127 The TSS will be designed such that they will not require to be recovered from the array site during the project lifetime, but ROV inspections may be carried out periodically to investigate the status of the corrosion protection systems in particular.

5.9.3 Port facilities

5.128 The Project requires significant supporting port and industrial infrastructure. Although the provision of these facilities is outside the scope of the EIA (and associated consent application), details of the likely requirements have been included here for completeness. Should there be any consenting requirements associated with any of these facilities they will be the subject of a separate application(s).

5.129 Logistics dictate that the chosen port facilities should be as close as possible to the array site to minimise vessel transit times and costs. It is likely that Scrabster, following the harbour's planned extension and improvement programme, would provide a suitable base for the early stages of the Project. However, additional capacity may ultimately be needed as the installation programme accelerates. Particular consideration must be given to the space required for the largest components, the TSS, and so further facilities, such as those at Wick and Lyness, may also be required. There may be the opportunity to use the Gills Bay harbour, which is very close to the array, for light support functions.

5.130 Throughout the offshore construction and installation period, the following facilities will be required at a local port facility:

- Final assembly areas for the turbine and TSS;
- Laydown area and marshalling yard close to a quayside;
- Quayside for installation vessels (for turbines and cables); and
- Quayside for offshore support services.

5.131 During the operations and maintenance period, an operations and maintenance base/quay will be required for the maintenance vessels with large sheds for maintenance of the turbines.

5.10 Transportation

5.132 Where practicable, MeyGen aims to carry out final assembly of large and heavy components at or close to the chosen harbour facilities to minimise the impact on the local transport infrastructure, whilst making use of existing and planned capabilities in the region. The facilities required for these assembly activities are not part of the present application/EIA.

5.133 However, there will remain a requirement to ship the component parts to the local assembly areas. The turbines used are a modular designs and so transport in sections is potentially achievable on the existing road infrastructure. Nonetheless, a detailed study of the constraints of the transport network is required to identify any areas of concern. In the event that large structures need to be transported to the mobilisation base from further afield, this can be done by sea.

5.134 Vessel movements in the area will necessarily increase when taking into consideration turbine transport, installation and maintenance activities. This will be primarily concentrated in the summer months to reduce the risk of operations in inclement weather conditions.

5.11 Decommissioning

5.135 MeyGen will develop a full decommissioning programme and strategy in compliance with both its statutory obligations and its obligations to the Crown Estate. Under the Energy Act 2004 MeyGen must submit a detailed decommissioning programme for approval to the Department of Energy and Climate Change (DECC) in respect of offshore works. Similar decommissioning requirements will apply to the onshore works under the onshore planning regime with The Highland Council.

5.136 All offshore infrastructure (turbines, TSS and cables) will be removed from the seabed. MeyGen will look to re-use, recycle all material. If neither option is available, MeyGen will dispose of the material in line with regulatory requirements.

5.137 If a piled TSS solution is used, piles will be cut at the seabed to allow the TSS to be removed. The bottom of the pile will remain in-situ.

5.138 Cables in the HDD bores will be removed and the bore openings capped.

5.139 All above ground onshore equipment will be removed from site. MeyGen will look to re-use, recycle all material. If neither option is available, MeyGen will dispose of the material in line with regulatory requirements. Following decommissioning, the onshore site will be reinstated to its former use.

6 STAKEHOLDER ENGAGEMENT

6.1 Background

6.1 There are a number of directives and policies dealing with consultation procedures for large infrastructure projects such as a marine renewable energy development. MeyGen has undertaken consultation in accordance with the relevant procedures, guidance and policies. In addition, from the commencement of the Project, MeyGen has been advocates of early consultation, maintaining full and open communications with stakeholders and other interested parties.

6.2 Under the Town and Country Planning (Development Management Procedure) (Scotland) Regulations 2008 an applicant is required to undertake pre-application consultation on "Major" development schemes before an application is submitted. The statutory consultation requirements are for a public meeting to be held locally, and notice of the application to be advertised and brought to the attention of local community councils. Guidance on community consultation is set out in the Scottish Government document Planning Advice Note PAN81 (Community Engagement) and PAN 2010/3 (Community Engagement).

6.3 The Marine (Scotland) Act 2010 contains similar provisions for certain types of marine development, although these are not yet a formal legal requirement.

6.4 Following submission of the application, formal consultation is also undertaken on the Environmental Statement (ES) with statutory consultees and the public.

6.5 Further to this MeyGen recognise the importance of early consultation that continues throughout the Project in order to integrate public and stakeholder concerns and opinions into the Project decision making process. Consequently, consultation with both statutory and non-statutory stakeholders has been an integral aspect of the Environmental Impact Assessment (EIA) process since the initial days of the Project. The primary aim of the consultation process is to facilitate two way communications about the Project to all relevant stakeholders. This allows any initial environmental concerns to be identified at an early stage and to be adequately addressed during the EIA process.

6.6 Alongside the consultation as part of the EIA process, consultation has also been undertaken for the Navigation Risk Assessment (NRA) and the Habitats Regulations Appraisal (HRA).

6.7 This section of the ES describes the overall consultation process that was undertaken for the Project. Detailed information on topic specific consultation is included in study specific sections throughout the ES.

6.2 Consultation Engagement

6.8 Since Atlantis Resources Corporation first visited the region in 2006, MeyGen has made numerous trips to the area and a number of meetings have taken place with both statutory and non-statutory consultees and the wider public.

6.9 MeyGen developed a stakeholder engagement plan early in the EIA process which set out their strategy for consultation and keeps records of all events and meetings that take place throughout the Project in a dedicated Project stakeholder database.

6.10 The consultation strategy for the MeyGen Tidal Energy Project includes a combination of activities to ensure that the Project team not only effectively communicate details of the Project to the stakeholders, but also, as appropriate, can incorporate stakeholders' comments and concerns into project decisions. These consultative activities have included face to face meetings with the consenting authorities and their statutory consultees, public events, development and continuous update of the MeyGen website, and specific communications and meetings with the local community council and Scottish Government policy makers. Social networking and the local, national and international media have also been used to disseminate project information.

6.11 All of the responses received during consultation were documented and appropriate actions identified. The consultation process identified a range of issues which were either directly associated with the Project or were more strategic issues. Each issue raised was considered and addressed by MeyGen and, where appropriate individual responses compiled and further meetings arranged. Issues raised contributed to finalising the detailed scope of the EIA.

6.3 Scoping Overview and Consultation

6.3.1 Background

6.12 Under EIA Regulations, the ES should describe the likely significant effects of the proposed project on the environment. Scoping of potential issues associated with physical and operational aspects of the project provides a basis for ensuring that the assessment is appropriately limited to issues of genuine potential significance. Under EIA Regulations, the developer of a project requiring EIA may before submitting their formal application ask the regulator, to state in writing their opinion as to the information to be provided in the ES.

6.3.2 Environmental Impact Assessment Scoping Report

6.13 In May 2011 MeyGen requested a formal EIA Scoping Opinion from the Scottish Ministers by submitting a EIA Scoping Report (and accompanying navigational Preliminary Hazard Analysis (PHA)) for the Project to Marine Scotland.

6.14 A formal EIA Scoping Opinion was received on the 30th September 2011. It details the views of the statutory consultees and what they deem necessary for consideration by the EIA and reported in the ES. As well as statutory consultees, the EIA Scoping Report was also distributed to a number of non-statutory bodies. Table 6.1 lists all the organisations that were sent a copy of the EIA Scoping Report. The EIA Scoping Report was also made available to the wider public via the MeyGen website.

Organisations sent a copy of the EIA Scoping Report	
Government, Regulators and Councils	
Marine Scotland	The Highland Council
Scottish Government Energy Consents Unit	Orkney Islands Council
Scottish Government Ports and Harbours	DECC (Department for Energy and Climate Change)
Scottish Government Planning	The Crown Estate
Marine Planning Partnerships	Dunnet and Canisbay Community Council
Marine Scotland Compliance	
HSE	
Health and Safety Executive	
Navigation and Transport	
Maritime and Coastguard Agency	Scrabster Harbour Trust
Northern Lighthouse Board	Wick Harbour Authority
Ministry of Defence (MoD) Defence Estates	Gills Bay Harbour Trust
Chamber of Shipping	Orkney Island Council Marine Services
British Ports Association	Pentland Ferries
RNLI	John o' Groats Ferries
Royal Yachting Association (RYA)	Northlink Ferries
Marine Safety Forum	CAA (Civil Aviation Authority)
The Cruising Association	NATS (National Air Traffic Service)
Transport Scotland	
Nature Conservation and Cultural Heritage	
SNH (Scottish Natural Heritage)	Historic Scotland

Organisations sent a copy of the EIA Scoping Report	
SEPA (Scottish Environmental Protection Agency)	Rural Scotland
JNCC (Joint Nature Conservation Committee)	The National Trust for Scotland
Scottish Wildlife Trust	Caithness Archaeology Trust
Royal Society for Protection of Birds (RSPB)	Castle of Mey
Scottish Association for Marine Science (SAMS)	The Prince's Foundation
Whale and Dolphin Conservation Society	Caithness Field Club
Marine Conservation Society	Caithness Sea Watching
Sea Mammal Research Unit (SMRU)	
Commercial Fisheries	
Association of Salmon Fisheries Board (ASFB)	Scottish Fishermen's Organisation
Scottish Fishermen's Federation (SFF)	Orkney Fisheries Association
Caithness District Salmon Fishery Board	Orkney Fishermen's Society
Association of Scottish Shellfish Growers	Salmon Net Fishing Association of Scotland
Scottish Fisheries Protection Agency	Scottish White Fish Producers' Association
Scottish Federation of Sea Anglers	Scottish Salmon Producers Association
Scottish Creelers and Divers	Scottish Pelagic Fishermen's Association
Scottish Fisheries Committee	Caithness Sea Angling Association
Seafish Industry Authority	Armadale Salmon Fishing
Caithness Static Gear Fishermen's Association	Energy Hunt Ltd
Industry and Academia	
Highlands and Islands Enterprise	Dounreay Site Restoration Limited
Caithness Chamber of Commerce	Dounreay Stakeholder Group
BT (Radio Network Protection Team)	Highland and Island Enterprise
Scottish and Southern Energy	National Grid
Scottish Water	Environmental Research Institute, Thurso
United Kingdom Cable Protection Committee	Heriot Watt University ICIT, Orkney
British Marine Aggregate Producers Association	Caithness and North Sutherland Regeneration Partnership
Forestry Commission	Marine5 Ltd
Joint Radio Company	
Recreation and Tourism	
Visit Scotland	Scottish Surfing Federation
Caithness Diving Club	Surfers against Sewage
Scottish Canoe Association	Scottish Coastal Forum
Scotways	Glasgow North College
Pentland Canoe Club	Glenmore Lodge

Table 6.1: EIA Scoping opinion consultees

6.3.3 Post EIA Scoping Report

6.15 Following receipt of the EIA Scoping Opinion each issue raised (of which there were over 250) was reviewed and implications to the overall Project, as well as the EIA, considered. Where appropriate, further meetings and discussions were held, generally on a topic specific basis, throughout the EIA. These were necessary in order to refine the scope of EIA studies being undertaken, based on the EIA Scoping Opinion received and / or results of EIA studies as they became available. This on-going consultation was an important aspect in ensuring the EIA addressed all issues required in the appropriate manner.

6.4 Consultation with the Local Community

6.16 The Public Participation Directive (Directive 2003/35/EC) was issued to provide members of the public in European member states with the opportunity to participate in consenting and ongoing regulation of certain activities within member states. The Directive makes specific changes to the way EIA is undertaken, and the EIA Directive has been amended to incorporate these requirements.

6.17 Planning Advice Note PAN 81: Community Engagement - Planning with People also provides guidance to local authorities and developers when engaging communities through the planning process.

6.18 Under the Development Management Procedure (Scotland) Regulations 2008 there is a statutory requirement to undertake pre application consultation on "major" development. MeyGen has undertaken this consultation, which is outlined in more detail in the pre application consultation report submitted with the onshore planning application.

6.19 Following discussions with Marine Scotland, MeyGen has undertaken a similar process for the Marine License in accordance with the Marine (Scotland) Act 2010.

6.20 MeyGen has been committed to community consultation from the start of the Project. MeyGen understands the importance and relevance of the marine environment and industries to the local community and has actively strived to develop relationships with the local community.

6.21 The local community have been regularly updated on the progress of the Project through a variety of media. One of the best media for reaching a high proportion of the local community is the local newspapers (Caithness Courier and John o' Groats Journal). MeyGen has also ensured that their website (www.meygen.com) is kept up to date with activities relating to the Project. The website also includes details on how to become involved with the supply chain and provides a means for asking questions regarding the Project.

6.22 As well as local media the Project has received national coverage in newspapers, on the radio and television and on the web.

6.23 A series of public events have been organised during the EIA. The first public event was held to inform the public of the current project design and timescales. It was held at Caithness Horizons, Thurso on 30th June and 1st July and Mey Community Hall on 2nd of July.

6.24 A second public event was held on the 6th and 7th December 2011 at Mey Community Hall to inform the public of the content of the ES prior to submission of the consent applications. This was done in accordance with the statutory pre-application consultation requirements.

6.25 Prior to the events notices were included in the local press, local radio and posters sent round numerous organisations and individuals within the local area. The events consisted of a series of mounted boards giving background to and details of the project design (as known at the time). Members of the public were able to attend the informal drop in sessions throughout the afternoon and early evening and had the opportunity to speak to members of the MeyGen Project team and the environmental consultants. Visitors were also invited to leave comments and fill out a questionnaire.

6.26 The results from these events have been documented and used to inform elements of the Project design, EIA and consent applications.

6.27 MeyGen has also taken part in The Crown Estate Pentland Firth and Orkney Waters (PFOW) community events. These have been designed to give maximum exposure of all the developers in the region to the public. An initial event to introduce the public to the Projects plans and staff was held in Thurso between 9-10th November 2010 and in Kirkwall between 12-13th November 2010. The events were attended by over 700 people.

6.28 A second PFOW public event was held in Thurso (28th November 2011) and Kirkwall (29th November 2011). The event included presentations and workshops to discuss key issues including environmental impacts and local supply chain.

6.29 The PFOW developers also began consultation with local fishermen and fisheries groups with presentations and a question and answer session held in Scrabster on 8th March 2011 and Kirkwall on 9th March 2011. In addition, MeyGen has undertaken its own consultation with local fishermen and fisheries groups, more details can be found in Section 16.

6.30 For the NRA consultation has been undertaken with the Marine and Coastguard Agency (MCA) and other shipping, navigation, recreational sailing and fishing interests that navigate through and within the Project area. Consultation has included a number of meetings and a Hazard Review Workshop with the MCA and other stakeholders. Through this process shipping and navigation features within the Project area and potential risks related to the Project have been identified. This information has been used to inform the risk assessment undertaken as part of the NRA.

6.5 Consultation with Government and Council

6.31 MeyGen has attended regular meetings with both Marine Scotland and The Highland Council in order to keep them directly informed and up to date with progress of the Project.

6.32 Meetings have included:

- General EIA and HRA updates;
- Consultation on EIA and HRA methodologies;
- Major Planning Application advice service (The Highland Council);
- Project consenting strategy, and
- Onshore design workshop (The Highland Council, and SNH).

6.6 Consultation beyond Application Submission

6.33 Consultation will continue beyond the submission of the ES. Assuming successful award of Project consent, licence condition implementation, including the development of appropriate environmental monitoring protocols, will generally require continuing engagement and consultation with the regulators and their statutory consultees. In addition, MeyGen will continue its communications with the local community and wider public to keep them informed of the Project process and key milestones.

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7 ENVIRONMENTAL OVERVIEW

7.1 Introduction

7.1 This section provides an overview of the environment in which the Project will be developed. More detailed descriptions of specific aspects of the environment are detailed in individual topic specific sections of the Environmental Statement (ES) (Sections 9 to 24).

7.2 Physical Characteristics

7.2.1 Offshore

7.2 The Pentland Firth is characterised by strong tidal currents, up to 5m/s with widespread and highly energetic tidal races, eddies, overfalls and areas of general turbulence. Water depths in the Project area range from 31.5 to 38m Lowest Astronomical Tide (LAT).

7.3 The wave climate in the area is dominated by the passage of low pressure systems from west to east across the North Atlantic. In general terms the highest waves approach the area from westerly directions. Wave periods of 4 seconds are typical of the Pentland Firth. Significant wave heights throughout the year are typically within the range of 1.75 to 2m and 1.25 to 1.5m within the Pentland Firth.

7.4 Mean sea surface temperature throughout the Pentland Firth is 7°C in winter to 12.5°C in summer. There is little evidence of thermoclines as there is strong mixing of currents.

7.5 The Pentland Firth represents the most extensive example of UK Biodiversity Action Plan (BAP) Priority Habitat 'tidal rapids'; consisting of sand-scoured bedrock and boulders. Despite this, the faunal communities are of low diversity and composed of common widely distributed scour tolerant species meaning the habitat is of low conservation importance.

7.6 The offshore Project area is underlain by rock of the Middle Old Sandstone which is Devonian in age.

7.7 The seabed in the vicinity of the Project consists of exposed rock with some crevices where sediment collects. There are pockets of shelly gravel, but none present in the actual proposed turbine deployment area. Between the turbine deployment area and the shore, kelp park/forest dominates. There are larger areas of sand deposits to the east and west of Stroma. The west of Stroma was surveyed and described as shelly medium sand with no infauna.

7.2.2 Onshore

7.8 From Cape Wrath to Duncansby Head the north coast of Scotland is comprised mainly of sea cliffs with pockets of sandy beaches, although these are usually small. In the vicinity of the Project along the coast of Gills Bay (Scottish mainland) and the south coast of the island of Stroma there is little evidence of littoral drift or sediment accretion. Beach and cliff erosion is minor, as is longshore drift.

7.9 The onshore Project area is underlain by the same Middle Old Red Sandstone as found underlying the offshore Project area.

7.10 The John o' Groats Site of Special Scientific Interest (SSSI) is located approximately 1.6km southeast of the Project. The SSSI is within the intertidal area and designated due to an exposure of sedimentary rock containing fossilised fish.

7.11 The majority of watercourses in the vicinity of the Project are small and many have been modified for drainage purposes. The two largest watercourses in the vicinity of the proposed onshore infrastructure are the East and West Burns of Gills. In their lower reaches both these burns are deeply incised with steep banks.

7.2.3 Landscape and seascape

7.12 The landform in the area is typical of the north Caithness zone; gently rolling with the vast majority being less than 100m above sea level. There is relatively little containment and views are both panoramic and extensive.

7.3 Biological Characteristics

7.3.1 Marine mammals

7.13 The Pentland Firth is utilised to varying degrees by a number of whale and dolphin species, 10 such species are either casual or regular visitors to the area, all of which are considered of conservation importance. Site surveys show that the Inner Sound is only visited regularly by one of these species (the harbour porpoise), although three other species were observed on occasions during the 2 year Project specific bird and marine mammal survey (minke whale, killer whale and Risso's dolphin). In terms of seals, two species use the Pentland Firth area and both of these (grey seal and harbour seal) are frequently recorded in the Inner Sound, although grey seals make up the majority of seal sightings.

7.14 No protected areas have been designated for marine mammals in the vicinity of the Project, although a number of important haulouts have been identified on the Caithness coast and island of Stroma for both grey and harbour seals.

7.15 Otters are present along the Caithness coastline, including the island of Stroma, and occur locally in both freshwater and marine environments. The Caithness and Sutherland Peatlands Special Area of Conservation (SAC) is located approximately 4km from the Project and is designated for supporting an otter population representative of northern Scotland. As European Protected Species (EPS), otters are afforded a high level of legal protection; otters and otter habitat are protected against disturbance. Additionally, otters are a Priority UK BAP species and are listed as a local species in the Caithness and Highland Local Biodiversity Action Plan (LBAP).

7.3.2 Birds

7.16 A number of nationally and internationally important seabird populations, consisting of a large number of species are found within the vicinity of the Project.

7.17 The North Caithness Cliffs Special Protection Area (SPA) which is designated for breeding populations of peregrine falcon, razorbill, northern fulmar, kittiwake, puffin and guillemot overlaps the offshore Project area.

7.18 The habitats affected by the onshore infrastructure are largely grassland and dry heath, with smaller areas of woodland, scrub and wet heath and bog. These habitats may provide important breeding and foraging habitats for terrestrial bird species, protected species and sites.

7.19 The Project area is within the Orkney to Shetland Important Bird Area (IBA). Whilst IBAs are not afforded any statutory protection, they provide a useful indication as to which areas of the UK are important to seabirds. Within the area, and in addition to the species mentioned above, shag, gannet, great skua, herring gull, great black-backed gull, cormorants, grebes, seaducks and tern are also present at some point during the year. The herring gull is listed as a UK Biodiversity Action Plan (UKBAP) priority species.

7.3.3 Fish

7.20 Scottish waters are estimated to support 250 fish species, with 166 species of commercial and non-commercial species recorded from the north-eastern coast of Scotland. Of the species expected to be present within the Inner Sound, herring, common skate and basking shark are all listed as UKBAP species, whilst, cod and haddock are listed on The World Conservation Union (IUCN) Red List of Threatened Species. No protected areas have been designated for finfish or shellfish species within the study area.

7.21 A number of species are known to use the Pentland Firth for spawning and nursery activities including spurdog, tope, thornback, sandeel and herring. The area has also been identified as part of a main nursery

area for blue whiting and anglerfish; and is also part of the nursery grounds for hake, mackerel, ling, sandeel, saithe, herring, haddock, lemon sole, whiting and cod. The specific location of nursery and spawning grounds may change from year to year depending on a number of environmental variables including the seabed conditions within specific areas.

7.22 The nearest salmon migration river is believed to be River Thurso which enters the sea at Thurso, approximately 21km from the Project. The River Thurso is a designated Special Area of Conservation (SAC) for Atlantic salmon, an Annex II species under the Habitats Directive. Migration routes for Atlantic salmon are not well understood and it is possible that salmon from rivers on the east and north coast of Scotland use the Pentland Firth as a migratory route.

7.4 Protected Sites and Species

7.23 There are a number of sites in the vicinity of the Project that are designated under national and international conservation law because of the presence of protected habitats or species. Details of these sites are considered in relevant sections of the ES (Section 9 to Section 24).

7.24 The entire area of the Project is located within the boundary of the North Caithness Cliffs SPA. The Caithness and Sutherland Peatlands SAC is located approximately 2km from the onshore Project area.

7.25 Under Annex IV of the Habitats Directive, all cetacean species have been identified as species of European Community interest and are afforded protection as European Protected Species (EPS). All EPSs are also fully protected under the Wildlife and Countryside Act (1981). For any EPS it is an offence to deliberately or recklessly capture, kill, injure or disturb any such animal. The EU Habitats Directive (1992) lists two species in Annex II: bottlenose dolphins and harbour porpoises, and requires that SACs are set up for their protection. Harbour porpoises are present in the study area, although the site is not covered by a formal designation for this species. Bottlenose dolphins from the Moray Firth SAC may occasionally be present within the study area. Otters, grey seal and harbour seal are also listed under Annex II and all are expected to be present in the Project area.

7.26 The UK Biodiversity Action Plan (UKBAP) also offers a level of protection for habitats and species. For many species, actions plans which set out priorities, actions, targets and reporting targets, have been created. Where relevant, the UKBAP has been discussed in the sections above.

7.27 Basking sharks, which are listed as 'vulnerable' on the IUCN red list are occasionally seen in the waters off the northern Scottish coastline and have been recorded in marine mammal surveys carried out in the Project area.

7.28 Under the Marine (Scotland) Act, Marine Scotland is in the process of establishing Marine Protected Areas (MPAs) for the protection and enhancement of marine biodiversity. Scottish MPA Selection Guidelines setting out the approach that will be taken when selecting MPAs in the seas around Scotland have now been published.

7.29 The Scottish Government is currently consulting on suitable areas for Nature Conservation MPAs. This has resulted in 30 locations identified for possible designation as MPAs. None of these include, or are adjacent to the Project; the closest is over 20km away, off the west coast of Hoy.

7.5 Human Environment

7.5.1 Settlements and transport network

7.30 The area is dominated by agricultural land composing mostly of grazing with some arable and peat moorland. Settlements are sparse and relatively scattered. The two main settlements in the vicinity of the Project are John o' Groats and Canisbay. John o' Groats is a dispersed village with an approximate population of 300. The hamlet of Canisbay is located approximately 2.5 miles south west of John o' Groats and has a population of less than 100.

7.31 The main road in the vicinity of the Project is the A836 which links Thurso to the A99 at John o' Groats via a number of small settlements including Castletown. The road provides the only access to the harbour at Gills Bay. A number of minor roads link the A836 to settlements dispersed throughout the area.

7.5.2 Socio-economics

7.32 The Highland area contains a growing population with the greatest increase in population anticipated to be in the over 65s. The most significant employment sectors are distribution, hotels and restaurants indicating the economic importance of tourism to the area. There are over 150 hotels and 48 visitor attractions located within a 30km radius of the onshore Project area. The Dounreay nuclear reactor located approximately 40km away is a large employer in the area, and although currently being decommissioned employs 1,900 people directly as well as numerous others through the supply chain.

7.5.3 Commercial fisheries

7.33 The inshore fishing fleet in the Orkney and Caithness region is made up of small creeling vessels targeting shellfish such as crabs, lobsters and scallops. The fishing fleet in the Inner Sound consists of four small local creeling vessels, which also fish in areas outwith the Inner Sound. Although larger vessels are known to transit through the Inner Sound they do not fish in the vicinity of the Project. Mariculture is not an active industry in the vicinity of the Project, the closest sites are salmon fish farms located in Scapa Flow, Orkney.

7.5.4 Cultural heritage

7.34 The onshore cultural heritage displays a late 18th to early 19th century historical landscape dominated by farming and crofting and rectilinear fields. Dominant buildings in the historic landscape include derelict Huna House, the B listed West Canisbay House and the A listed Canisbay Kirk and graveyard. Although outwith the Project area, the A listed Castle of Mey is included on the Historic Scotland inventory of designed landscapes and gardens and the castle and its gardens make a significant contribution to the local scenery. Sites earlier than the 18th century are known to exist, but few are prominent and the majority are not or are hardly visible on the surface.

7.35 Within the wider Pentland Firth, especially around Orkney, there are a number of coastal archaeological remains and submerged archaeology of interest. Within the vicinity of the Project, admiralty chart 1954 shows that there is one wreck off Mell Head, Stroma. Geophysical data available for the Project area indicates a large number of anomalies that may be of cultural heritage interest but are not yet proven.

7.36 Under the Marine (Scotland) Act, Marine Scotland is in the process of establishing MPAs some with the purpose of preserving of marine historic assets.

7.5.5 Shipping and navigation

7.37 The Pentland Firth is a busy sea lane regularly used for international navigation. The main shipping channel lies to the north of Stroma, between the island and Orkney. Larger cargo vessels and tankers transit the region using this route and so do not pass through the Inner Sound.

7.38 Ferries regularly traverse the Project area between Orkney and the Scottish mainland. There is a ferry port at Gill's Bay that provides a regular catamaran service to South Ronaldsay, with ferries passing through the Inner Sound to the east and west of Stroma.

7.39 To the west of the Project is the port of Scrabster which is frequented by fishing vessels, ferries and some cargo vessels. Although the ferries and cargo vessels using the port at Scrabster tend not to transit the site of the Project, fishing vessels en route to and from North Sea fishing grounds do transit through the Inner Sound.

7.40 There are two small harbours on the coast of Caithness adjacent to the Project. Gills Bay, as mentioned above, is the mainland port used by the Pentland Ferries service to Orkney. A small harbour at John o' Groats is used by boat tour operators, a number of small fishing vessels and a summer passenger service. There is also a small harbour on the southern coast of Stroma which is used for occasional island tour boats and the transport of cattle and sheep that are grazed on the island.

8 ENVIRONMENTAL IMPACT ASSESSMENT METHODOLOGY

8.1 Introduction

8.1 This section of the Environmental Statement (ES) describes the Environmental Impact Assessment (EIA) methodology. The approach described meets the requirements of the EIA Regulations.

8.2 It should be noted that the navigational aspects of the Project, as assessed in the Navigational Risk Assessment (NRA) have been conducted in accordance with the Marine Navigational Safety Risks of Offshore Wind Farms contained in the DTI/BERR publication – Guidance on the Assessment of the Impact of Offshore Wind Farms and is required to address the issues raised in the Maritime and Coastguard Agency's (MCA) Marine General Notice 371(M+F) – Proposed Offshore Renewable Energy Installations (OREI) – Guidance on Navigational Safety Issues. This assessment methodology is described within the NRA document and is summarised in Section 15.

8.2 Environmental Impact Assessment and Navigational Risk Assessment Process

8.2.1 Overview of Process

The EIA and associated NRA process require an understanding of the proposed installation, operation and decommissioning of the MeyGen Project and the environment upon which there may be an impact. Fundamental to the process is the systematic identification of issues that could impact the environment, including other users of the environment. Once identified, these issues have to be assessed to define the level of potential impact they present to the environment, so that measures can be taken to remove or reduce such effects through design or operational measures (mitigation). This process also identifies aspects of the proposed project that may require monitoring. Impacts are considered in a cumulative manner as well as in isolation.

8.3 Key stages of the EIA are detailed below:

- Defining the Project;
- Defining why is the Project required and what other alternatives there are;
- Identifying potential environmental issues associated with the Project;
- Scoping stage (EIA Scoping Report and Navigational Preliminary Hazard Analysis (PHA)) to identify the potential effects and how these should be assessed;
- Define the scope of the EIA and NRA based on the responses to the scoping stage;
- Describe the baseline environment and assess the sensitivity of the receptors / resources likely to be impacted;
- Carry out consultation throughout the EIA and NRA processes;
- Assessment of effects:
- Assess the magnitude of the possible environmental effects;
- Evaluate the significance of these predicted effects, i.e. consideration of sensitivity of receptors;
- Develop mitigation measures and establish how they are to be integrated into the Project;
- Evaluate the significance of the residual effects;
- Assess potential cumulative effects;
- Production of an ES and NRA reports covering all findings and summarise in a non-technical summary; and
- Implement mitigation measures and environmental monitoring as required.

8.4 The assessment process covers all stages of the Project from installation through to the decommissioning phase. All effects are taken into account throughout this period regardless of their duration (e.g. short-term vessel activities to longer term seabed modification effects). The environment is considered to include physical, ecological and socio-economic components and linkages between different aspects of the environment are also considered.

8.5 Impacts to one receptor that may affect another are considered where a clear pathway is identified between the two receptors. This connectivity between receptors has been considered within the assessments in Sections 9 to 24 in order to provide a holistic assessment that assesses all impacts, both direct and indirect. For instance impacts to some benthic species (e.g. crabs and lobsters) or fish species may have indirect effects to the fishermen that target them, affecting their ability to pursue their livelihood.

8.6 The initial impact is assessed in the section which deals with the receptor directly affected. In this example Section 13 Fish Ecology will deal with the direct impact to fish populations. The indirect impacts are assessed in the section relevant to the receptor of the indirect impact, such that the effect the impact on fish populations has on the fishermen that target them is assessed in Section 14 Commercial Fisheries.

8.7 The geographical extent of the environment considered will vary between identified impacts e.g. underwater noise impacts have the potential to cover a larger area than seabed habitat modification caused by the presence of the device.

8.8 The impact of effects has been considered for all three stages of the development. These are:

- The Construction and Installation Phase. This covers all offshore and onshore construction and installation activities associated with the Project;
- The Operational and Maintenance Phase. This phase begins after the installation phase has reached completion; and
- The Decommissioning Phase. The decommissioning of the Project after it has completed its operational life.

8.9 The EIA has not addressed impacts associated with the potential repowering of the Project. Repowering would be subject to a new lease and consent application and therefore falls out with the scope of this EIA.

8.2.2 Issues scoped out

8.10 During the EIA process a number of potential issues were identified but through stakeholder engagement or consideration during the EIA scoping, were considered to be of negligible significance. The following issues were therefore scoped out of this EIA:

- **Atmospheric Emissions** - vessels will have a very localised impact and will be rapidly dispersed. Additionally they will not occur in close proximity to coastal populations;
- **Oil and gas** - there are no pipelines or oil and gas installations within the vicinity of the Project;
- **Military activities** – early consultation with the MoD revealed no concerns with either Military Practise and Exercise Areas (PEXAs) or munitions contamination in regard to the Project; and
- **Waste disposal from vessels** – all waste be disposed of in line with legislative requirements and no waste will be disposed of overboard.

8.3 Significance of Effects

8.3.1 Overview of process

8.11 The regulations require that the EIA should consider the likely significant effects of the development on the environment. The decision process related to defining whether or not a project is likely to significantly impact on the environment is the core principal of the EIA process. The regulations themselves do not provide a specific definition of "significance". However the methods used for identifying and assessing effects should be transparent and verifiable. The method developed here is applicable to both terrestrial and marine based EIA and has been developed by reference to the principals and guidance provided by SNH in their handbook on EIA (SNH, 2009), the MarLIN species and ecosystem sensitivities guidelines (Tyler-Walters *et al*., 2001), the Institute of Ecology and Environmental Management (IEEM) guidelines for marine impact assessment (IEEM 2010), and the Equator Principles for determining, assessing and managing social & environmental risk in project financing.

8.12 After reviewing various approaches to the evaluation of significance, certain common policies exist which have been taken into account for each of the effects related to the proposed project. These include:

- Environmental significance is a value judgement based on professional experience;
- The degree of environmental significance is related to the specific impact;
- The significance of the impact is related to sensitivity of the receptor and its capacity to accommodate/recover from change;
- The amount of any type of change, (impact magnitude) includes timing, scale, size, duration and frequency / probability of impact;
- Potential effects of the proposed project may be wide ranging in nature, for example they could be direct, indirect; short, medium or long term, permanent or temporary and have positive or negative effects; and
- Even where a specific effect is unlikely to happen or the likelihood is uncertain; the significance may still be ranked high if the consequence is severe or irreversible.

8.13 As the determination of the significance of an impact is subjective, primarily based on professional judgement, this highlights the requirement for an extensive scoping and consultation process throughout the development of the Project. This is something that MeyGen has given particular attention to throughout the Project and details of the consultation strategy employed have previously been detailed in Section 6 of this ES.

8.14 Once the scope of the EIA studies has been established, it is particularly important to standardise the description and assessment of all the effects due to the development. Despite this being a subjective process, a defined methodology, outlined below, is used to make the assessment as objective as possible. As the environmental factors under consideration can vary considerably depending on what is being assessed, there is likely to be some variation in this process. This is evidently the case for this proposed project as effects will occur onshore and offshore, affecting the biological, physical and human environments.

8.15 The following assessments have used a process which has deviated from the standard approach:

- Shipping and Navigation;
- Marine Cultural Heritage;
- Landscape, Seascape and Visual;
- Onshore Cultural Heritage;
- Socio-economic and Tourism;
- Onshore Noise and Dust; and
- Accidental Events.

8.16 Definitions for the sensitivity of receptors and magnitude of change have been developed on a topic by topic basis and are described and presented in each topic section.

8.17 The sensitivity of a receptor to the proposed Project considers the specific nature of the receptor (or group of receptors) and it's (their) capability to accommodate change.

8.18 Assessment of the magnitude of change upon the receptor takes into account the timing, scale and duration of an impact as well as the time it takes for recovery from an impact to occur (as opposed to the ability to recover used to assess sensitivity). In addition, the frequency / probability of an impact taking place is also taken into account when assessing magnitude.

8.3.2 Sensitivity

8.19 Sensitivity is generally a subjective judgement, determined by a receptor's tolerance to an impact, its ability to recover from an impact and ability to adapt to the changes in the environment caused by the Project. Sensitivity may also consider a receptor's environmental designation, rarity, and whether the receptor provides an important ecosystem service (e.g. keystone species or important habitats). For socioeconomic receptors the consideration of value includes economic, cultural and amenity value. The value categories are receptor-specific and have been considered within the baseline sections of each topic specific section. In some instances, taking a precautionary approach, where stakeholder concern exists with regards to a particular receptor this is considered when assessing the sensitivity of the receptor to an impact. In some instances, this may result in a precautionary approach being taken and a higher sensitivity being considered within the assessment.

8.20 Where these aspects are considered within the sensitivity category they are outlined within the relevant criteria tables in each section. By way of illustration, in the marine mammals section the sensitivity categories are determined by the sensitivity of each marine mammal species to the impact being discussed, such as noise (i.e. the sensitivity of a marine mammal to underwater noise generated by tidal turbines).

8.21 It is important to note that the above approach to assessing sensitivity is not appropriate in all circumstances and in some instances professional judgement has been used in developing the sensitivity category used. For instance, there is a degree of uncertainty with regards the sensitivity of many fish species to electromagnetic fields (EMF) and as a result professional judgement based on the available information and previous impact assessments on EMF from other industries has been used to determine the sensitivity of the receptor.

8.22 The sensitivity of receptor categories are as follows:

- Very high;
- High;
- Medium;
- Low; and,
- Negligible.

8.3.3 Magnitude

8.23 For the purposes of this assessment the magnitude of an impact is determined by the duration, timing, scale, size, and frequency / probability of an impact. The timing of an impact will depend on the construction and installation timeline, or whether the impact occurs during construction and installation or during operation. The scale of the impact will be determined by the temporal (e.g. is the impact on a scale of months or years) and spatial scale (e.g. is the impact local, regional or site specific) over which the impact operates. The size of an impact is determined by the actual area the impact covers within the spatial scale that has been defined. This could be an area less than 1km within the Project area, or the number of months or years over which the impact occurs, such as 2 or 3 months. The duration of the impact will depend on how long the impact occurs, whether it is throughout the operational life of the Project or whether following construction the impact ceases to occur.

8.24 In some instances the frequency / probability of an impact is considered as part of magnitude and is used when we consider how often or likely an impact is to occur to a receptor or receptors. The frequency / probability will determine whether a receptor is exposed to an impact rarely, occasionally, intermittently or on a routine basis. For instance a receptor may be exposed to an impact of high magnitude. However, if the frequency / probability of the impact is low then the magnitude may be considered much lower. For biological receptors this may be applied to the proportion of the population that is exposed to the impact, particularly when an impact only affects a small proportion.

8.25 The overall magnitude of the effect is then determined by considering a combination of each aspect and applying professional judgment / past experience. Following this assessment the following magnitude categories are applied:

- Severe;
- Major;
- Moderate;
- Minor; and
- Negligible.

8.3.4 Consequence

8.26 The sensitivity of receptor and magnitude of impact are combined to define the consequence of the impact (Table 8.1).

Magnitude	Sensitivity				
	Very high	High	Medium	Low	Negligible
Severe	Severe	Severe	Major	Moderate	Minor
Major	Severe	Major	Major	Moderate	Minor
Moderate	Major	Major	Moderate	Minor	Negligible
Minor	Moderate	Moderate	Minor	Minor	Negligible
Negligible	Minor	Minor	Negligible	Negligible	Negligible
Positive	Positive	Positive	Positive	Positive	Positive

Table 8.1: Consequence rankings

8.3.5 Impact significance

8.27 The consequence of impacts is then considered by reference to the relevant criteria in the EIA Regulations. The significance of impacts in relation to the EIA Regulations is defined in Table 8.2.

Positive	Positive – to be encouraged	Positive
Severe	Intolerable risk and/or significance	Significant impact under EIA Regulations
Major	Highly significant and requires immediate action	
Moderate	Significant – requires additional control measures and/or management	
Minor	Not significant – however will require some management to ensure remains within acceptable levels	Insignificant impact under EIA Regulations
Negligible	Not Significant	

Table 8.2: Definitions of significance rankings

8.3.6 Presentation of impact assessment results in Environmental Statement sections

8.28 Impacts in the ES technical sections have been considered for each Project phase:

- Construction and installation;
- Operations and maintenance; and
- Decommissioning.

8.29 Each identified impact is described in terms of the sensitivity of the receptor under consideration, magnitude of potential impact and the overall consequence of the impact, which in turn determines whether the impact is significant or not under the EIA Regulations. Following this description the assigned ranking is summarised in a colour coded table. Where impacts are deemed as potentially significant and/or mitigation is required in order to ensure the impact remains insignificant this is summarised in the box under the colour ranking table. Residual impacts following mitigation (for potentially significant impacts only) are also summarised in a colour coded table.

8.4 Rochdale Envelope

8.30 MeyGen has adopted the established principle of the Rochdale Envelope for the purpose of preserving essential flexibility within some major elements of the Project. This principle applies a "worst case" approach to the assessment of the different impacts associated with the Project, as established through relevant case law[7] and has been endorsed by the Scottish Government[8]. These case precedents have established a custom and practice that has evolved in relation to Projects where the final design is not available at the consent application stage. This approach has been confirmed by the courts as enabling the legal requirements of the relevant EIA Regulations to be complied with and will not give rise to a likely significant effect on the environment which has not been assessed.

8.31 Flexibility in project design is required during the pre-application consultation stage (which MeyGen are undertaking for both the onshore and marine elements of the Project) and within the description of the Project in the application documents to allow for comments from stakeholders to be addressed if possible/required. The key drivers for flexibility and the need for Rochdale Envelope are:

- The ability to optimise projects in both design and economic terms to ensure that schemes are sufficiently attractive to investors to secure the significant capital that is required to bring projects through to delivery;

[7] R. v Rochdale MBC ex parte Milne (No. 1) and R. v Rochdale MBC ex parte Tew [1999] and R. v Rochdale MBC ex parte Milne (No. 2) [2000].
[8] Letter from Scottish Government to Heads of Planning dated 22 November 2007

- To allow for detailed design to be refined in the project procurement phase, notably taking into account the evolution of foundation and tidal technology available and variety of installation techniques; and

- An essential need to maintain competitive market behaviour in the supply chain without prejudicing legal procurement rules.

8.32 The Rochdale Envelope approach recognises that there may be areas of uncertainty when an application is submitted, although project proposals still need to be of sufficient detail to allow EIA and preparation of an ES. The regulating authority (in this case Marine Scotland and The Highland Council) must be assured that the environmental effects (including residual effects) of a proposal have been assessed; in the case of applying the Rochdale Envelope approach it must be ensured that the maximum potential adverse impacts of a project have been fully assessed and taken into account in the decision-making process.

8.33 An assessment of the variations of the proposed project needs to be included in the EIA as well as highlighting areas where certain matters remain unresolved. Potential variations within a project should be assessed in terms of the likely worst case scenario. The developer is required to deal with these possible variations within the project in a manner that aids decision making. The EIA should also outline the reasons why certain parts of the proposal are not yet finalised but ensure sufficient information is provided to allow potential likely significant environmental effects to be assessed.

8.34 To demonstrate the care and thoroughness with which the flexibility in the Project design has been assessed in the EIA, Section 5 Project Description summarises the potential development envelope which has been assessed, whilst also presenting the details of what is most likely in practice. Following definition of the Project parameters, each EIA study has given careful consideration to the range of potential impacts that may result from the proposed Project, for each parameter, and ensured that the assessment made for each potential impact is reflective of the realistic worst case scenario for the specific parameter under investigation. Each technical section throughout this ES (Sections 9 to 24) includes definition of what is considered the realistic worst case scenario, and why this is considered to be so. An assessment of the "realistic worst case scenario" in this ES is to be regarded as the same as the assessment of the "maximum potential adverse impact".

8.35 MeyGen has ensured that only ‘realistic’ development scenarios have been considered when defining these. For example, whilst turbines with two and three blades are under consideration, there will not be a realistic scenario where both of these would be deployed. This ensures that the level of information provided is sufficient to enable the likely significant effects on the environment to be described and where appropriate quantified and suitable mitigation measures and monitoring requirements identified.

8.36 Adopting this thorough approach has ensured that the development permutations which have not been expressly assessed could not give rise to a significant environmental impact above that which has already been assessed. Furthermore, it allows the assessment to remain concise and focused on the realistic worst case scenario (and therefore, likely significant impacts) whilst avoiding assessment of unrealistic project scenarios and unnecessary duplication of assessment effort.

8.5 Cumulative Impacts

8.5.1 Cumulative impact assessment overview

8.37 Cumulative impacts are considered throughout the EIA process and have been considered for all phases of the Project. MeyGen has in consultation with Marine Scotland and The Highland Council identified a list of other projects (MeyGen, 2011), which together with the Project may result in potential cumulative impacts.

8.38 The general principle for the cumulative impact assessment was to consider only those projects that were at EIA scoping stage (i.e. for which an EIA Scoping Report and requests for a EIA Scoping Opinion have been submitted) and beyond (as of August 2011). However there were other projects which were very close to submitting their EIA Scoping Reports and/or directly relevant to the proposed Project and a decision was been made to also include these in the cumulative impact assessment. SHETL is proposing a subsea cable between the west coast of Orkney and Caithness. However, there is very little information available in the public domain on proposed cable routes and the limited information that is available indicates that this potential project will have no direct relevance to the cumulative impact assessment for the Project.

8.39 Details of the projects to be considered for the cumulative impact assessment were provided to all EIA study leads (as listed in Section 2.5). The study leads then considered which of these projects could result in potential cumulative impacts with the Project. This decision was based on the results of the specific impact assessment together with the expert judgement of the specialist consultant undertaking the impact assessment.

8.40 Inevitably the assessment of these ‘future projects’ is dependent upon the level of information available on those projects at the time of undertaking the cumulative assessment. Due to the fact there were different levels of detail available for different projects, the cumulative impact assessment has been undertaking qualitatively. Sufficient data was not available in the public domain to allow a fully quantified cumulative impact assessment.

8.41 Each technical ES section contains a sub section which identifies the projects which are relevant on a cumulative basis and an assessment of the relevant cumulative impacts.

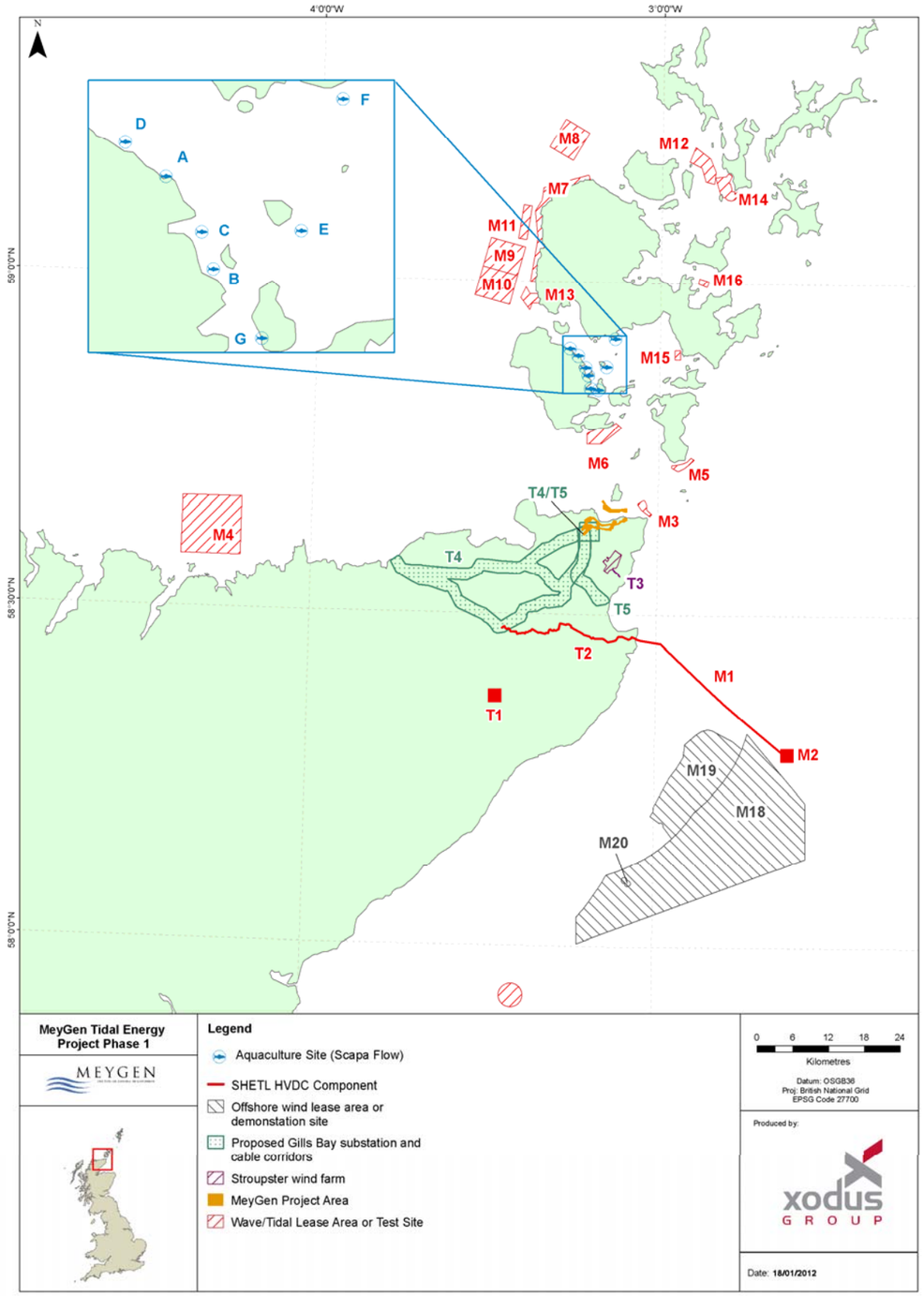

Figure 8.1: Locations of projects considered in cumulative impact assessment (reference numbers correspond to Table 8.3)

8.5.2 Projects considered in the cumulative impact assessment

Figure 8.1 illustrates the projects considered in the cumulative impact assessment. Table 8.3 provides a high level description of the proposed project and also project status as of August 2011.

Map ref	Project name	Project developer	High level description of project	Project status (as at August 2011)	
Onshore projects					
T1	Caithness HVDC Connection Converter station	Scottish and Southern Energy, Power Distribution	600MW converter station and associated substation	Pre-scoping	Pre scoping consultation ongoing; intended to be operational by 2015/16; no information available on when construction will commence
T2	Caithness HVDC Connection Cable	Scottish and Southern Energy, Power Distribution	HVDC buried cable connection to coast from proposed substation	Pre-scoping	Pre scoping consultation ongoing; intended to be operational by 2015/16; no information available on when construction will commence
T3	Stroupster Windfarm	RWE npower renewables	12 wind turbine; 30MW wind farm and associated substation	Consented	Granted consent 08/04/2010; no information is available on when construction will commence
T4	Gills Bay 132 kV / 33 k V Substation - Phase 1	Scottish and Southern Energy, Power Distribution	Connection of the Crown's Estates PFOW leased areas to the electricity network. Construction of a new enclosed substation	Pre-scoping	Pre scoping consultation ongoing; scoping request / report to be submitted October 2011; construction expected to begin April 2013
T5	Gills Bay 132 kV / 33 k V Substation - Phase 2	Scottish and Southern Energy, Power Distribution	New HVDC facility (HVDC converter station and a DC buried cable) connecting to subsea cable to Peterhead (projects T1 and T2 listed above and M1 and M2 listed below – see also map)	Pre-scoping	Pre scoping consultation ongoing; Phase 2 is dependent on the PFOW developers accepting their connection quote
Offshore projects					
-	MeyGen Tidal Energy Project Phase 2	MeyGen Limited	Development of a further 312MW of tidal energy and associated offshore infrastructure	Pre-scoping	Installation will commence in 2017
M1	SHETL HVDC cable	Scottish Hydro Electric Transmission Ltd (SHETL)	Moray Firth HVDC hub, located	Pre-scoping	Intended to be operational by 2015/16
M2	SHETL High Voltage Direct Current (HVDC) cable	Scottish Hydro Electric Transmission Ltd (SHETL)	Connection to the planned HVDC cable to an existing substation near Keith in Moray	Pre-scoping	Intended to be operational by 2015/16

Map ref	Project name	Project developer	High level description of project	Project status (as at August 2011)	
M3	Ness of Duncansby Tidal Energy Project	ScottishPower Renewables UK Limited	95 MW tidal energy development and associated onshore infrastructure	Scoping	EIA Scoping Opinion request submitted; no information available on when construction will commence
M4	Farr Point Wave Energy Project	Pelamis Wave Power	50 MW wave energy development and associated onshore infrastructure	Scoping	EIA Scoping Opinion request submitted; Phase 1 (15 MW) expected deployment date of summer 2014; 50 MW expected to be deployed by 2020
M5	Brough Ness	Sea Generation (Brough Ness) Limited	100 MW tidal energy development and associated onshore infrastructure	Pre-scoping	No information available on when construction will commence
M6	Cantick Head Tidal Energy Project	Cantick Head Tidal Development Limited	200 MW tidal energy development and associated onshore infrastructure	Pre-scoping	EIA Scoping Report in preparation; the majority of construction work is not anticipated to commence until after 2015
M7	Brough Head Wave Energy Project	Brough Head Wave Farm Limited	200 MW wave energy development and associated onshore infrastructure	Pre-scoping	EIA Scoping Report in preparation; construction of the initial phase to commence in 2015
M8	Costa Head Wave Energy Project	SSE Renewables Developments (UK) Limited	200 MW wave energy development and associated onshore infrastructure	Pre-scoping	EIA Scoping Report in preparation; no information available on when construction will commence
M9	West Orkney North Wave Energy Project	EON Climate & Renewables UK Developments Limited	50 MW wave energy development and associated onshore infrastructure	Pre-scoping	EIA Scoping Report in early stages of preparation; no information available on when construction will commence
M10	West Orkney South Wave Energy Project	EON Climate & Renewables UK Developments Limited	50 MW wave energy development and associated onshore infrastructure	Pre-scoping	EIA Scoping Report in early stages of preparation; no information available on when construction will commence
M11	Marwick Head Wave Energy Project	ScottishPower Renewables UK Limited	50 MW wave energy development and associated onshore infrastructure	Scoping	EIA Scoping Opinion request submitted; no information available on when construction will commence
M12	Westray South Tidal Energy Project	SSE Renewables Developments (UK) Limited	200 MW tidal energy development and associated onshore infrastructure	Pre-scoping	EIA Scoping Report in preparation; no information available on when construction will commence
M13	Wave Energy test site (Billia Croo, Orkney)	EMEC	Wave energy device test berths with subsea cable connection to an onshore substation	Operational	Operational
M14	Tidal energy test site (Fall of Warness, Orkney)	EMEC	Tidal energy device test berths with subsea cable connection to an onshore substation	Operational	Operational
M15	Intermediate wave energy test site (St Mary's Bay, Orkney)	EMEC	Intermediate wave energy test site providing more gentle conditions for testing than the main wave test site	Licence applications submitted	The majority of mooring points in position; EMEC awaiting final marine license prior to the first anticipated deployments in autumn 2011
M16	Intermediate tidal energy test site (Head of Holland, Orkney)	EMEC	Intermediate tidal energy test site providing more gentle conditions for testing than the main tidal test site	Licence applications submitted	The majority of mooring points in position; EMEC awaiting final marine license prior to the first anticipated deployments in autumn 2011
M17	Ocean Power Technologies (OPT) wave power ocean trial	OPL	Sea trials are currently underway for the PB150 PowerBuoy	Operational	Operational
M18	Moray Offshore Renewables Ltd (MORL) offshore windfarm	MORL	Approximately 1.4GW offshore windfarm development consisting of approximately 200 turbines	Scoping	EIA Scoping Report was submitted in 2010; application for consent application anticipated 2012; first generation anticipated 2016
M19	Beatrice Offshore Windfarm Ltd (BOWL) offshore windfarm	BOWL	Approximately 920MW offshore windfarm development consisting of 142 to 277 turbines	Licence applications submitted	EIA Scoping Report was submitted in 2011; application for consent anticipated 2011/2012; first phase of construction to commence 2014 and to be fully operational by 2016/17
M20	Beatrice offshore Windfarm Demonstrator Project	SSE and Talisman	Two 5MW wind turbines	Operational	Operational
Aquaculture projects					
A	Chalmers Hope salmon cage site	Northern Isles Salmon	Salmon farm	Operational	Operational
B	Pegal Bay	Northern Isles Salmon	Salmon farm	Operational	Operational
C	Lyrawa	Northern Isles Salmon	Salmon farm	Operational	Operational
D	Bring Head	Scottish Sea Farms	Salmon farm	Operational	Operational
E	Cava South	Northern Isles Salmon	Salmon farm	Consented	Planning granted
F	Toyness	Scottish Sea Farms	Salmon farm	Operational	Operational
G	West Fara	Northern Isles Salmon	Salmon farm	Operational	Operational

Table 8.3: Details of projects considered in cumulative impact assessment (reference numbers correspond to Figure 8.1)

8.6 Mitigation and Monitoring

8.6.1 Monitoring strategy

8.42 Where potentially significant impacts (i.e. those ranked moderate or higher) are identified mitigation measures have been considered. The intention is that such measures should remove, reduce or manage the impacts to a point where the residual significance is at an acceptable or insignificant level. For some impacts mitigation has been recommended where impacts are considered to be not significant (those ranked minor or negligible). In these instances mitigation is recommended to ensure that impacts remain not significant.

8.43 It should be noted that in some cases specific mitigation measures have not been developed due to the early stage of development of the tidal industry as a whole. It is proposed that if the impact cannot be reasonably mitigated or avoided a monitoring programme will be implemented to improve understanding of the processes involved. Monitoring is a key component of the 'Survey, Deploy and Monitor' strategy which will aid the development of the marine renewable industry under the Scottish Government whilst improving understanding of how individual technologies interact with the environment.

8.44 Monitoring is also considered an important post-consent tool. This will allow the effects of any mitigation measures to be monitored and also study the accuracy of predicted effects.

8.6.2 Strategic research

8.45 Marine Scotland, SNH and The Crown Estate have commissioned a number of research studies that are aimed at informing potential impacts from the emerging marine renewable energy industry. Many of these relate to SNH's Research Strategy 2010 – 2013, and more specifically to Research Priority 5.1, 'Understanding the potential impacts of marine renewable developments on the marine environment'. Strategic research covers the following areas:

- Developing guidance on survey and monitoring;
- Supporting monitoring of deployed devices;
- Commissioning or contributing to resource surveys, to inform site selection and subsequent assessments;
- Supporting development of techniques or technologies to detect and record species present around turbines;
- Supporting the development of locational guidance;
- Understanding the significance of potential impacts upon species and habitats and their conservation status; and
- Identifying approaches for device management and operation that will minimise or avoid environmental impacts.

8.46 Where relevant, and where published information is presently available, this strategic research has been used to inform the EIA for the Project. However it should be noted that many of the studies are still ongoing and as yet there are limited published results. MeyGen has used the best available from this strategic work data available at the time of conducting the EIA.

8.7 Habitats Regulations Appraisal Process

8.47 To tackle the continuing deterioration of natural habitats and the threats to certain plant and animal species, the European Community adopted Council Directive 92/43/EEC on the conservation of natural habitats and of wild flora and fauna. This Directive, known as the Habitats Directive, is transposed into Scots law by the Conservation (Natural Habitats and &c.) Regulations 1994 as amended.

8.48 Under the 1994 Regulations, (which are relevant for projects located onshore and in Scottish territorial waters out to 12 nm), a project which could affect a Natura 2000 site (Special Areas of Conservation (SAC) or Special Protection Area (SPA)), must be assessed as to whether it will have a likely significant effect on the integrity of a Natura 2000 site or any of its qualifying interests by the 'competent authority' (in this case Marine Scotland on behalf of Scottish Ministers for the offshore works and The Highland Council for onshore works). The competent authority must consider whether a plan or project has the potential to have an adverse effect on the integrity of a Natura 2000 site. This process is known as Habitat Regulations Appraisal (HRA). Under the Regulations, 'Appropriate Assessment' (stage two of the HRA) is required for a plan or project, which either alone or in combination with other plans or projects, is likely to have a significant effect on a Natura 2000 site and is not directly connected with or necessary for the management of the site. The HRA is separate to the EIA process and is based solely on addressing the impacts in relation to the integrity of a Natura 2000 and its qualifying interests.

8.49 The Habitats Directive applies the precautionary principle to these sites and plans and projects can only be permitted when it is ascertained through the four stages of the HRA process (SNH, 2010) that there will be no adverse effect on the integrity of the site(s) in question:

- Screening initially identifies likely impacts from a project or plan, either alone or in combination with other projects or plans and considers whether these impacts may be significant. It is important to note that the burden of evidence is to show, on the basis of objective information, that there will be no significant effect. If there is the potential for significant effects, or the potential is not known, this will trigger the need for Appropriate Assessment;
- Appropriate Assessment is the detailed consideration of impacts on the conservation objectives and structure and function of the Natura 2000 site from the project or plan, either alone or in combination with other projects or plans. The Appropriate Assessment process determines whether there is objective evidence that adverse effects on the integrity of the site can be excluded. This stage also includes the development of mitigation measures to avoid or reduce any possible impacts;
- A process of assessing alternative solutions examines alternative ways of achieving the objectives of the project or plan that would avoid adverse impacts on the integrity of the Natura 2000 site. This stage is undertaken in the event that avoidance or mitigation measures would be unable to cancel out adverse effects; and
- Further assessment is undertaken where no alternative solutions exist and where adverse impacts remain. Plans and projects may still be permitted if there are no alternatives to them and there are Imperative Reasons of Overriding Public Interest (IROPI) as to why they should go ahead. At this stage an assessment is made as to whether IROPI is applicable. If this is the case then compensatory measures may be required to ensure maintenance of the coherence of the Natura 2000 network.

8.50 It is important to note that where priority habitats or species are present, the imperative reasons for IROPI to be applied need to be "…*reasons relating to human health, public safety or beneficial consequences of primary importance to the environment, or other reasons which in the opinion of the European Commission are imperative reasons of overriding public interest*". For non-priority habitats and species, imperative reasons of a social or economic nature may be acceptable but they must be considered to be sufficient to override any harm that may be caused to the site.

8.51 More detailed consideration to determine whether a significant effect is likely to arise as a result of the proposed development should consider, in addition to the specific features and environmental conditions of the protected site, other factors which will have been addressed as part of the EIA process. These may include risk of accidents, quality and regenerative capacity of the natural environment, extent of the impact, duration, frequency, scale and reversibility of the impact (EC, 2000).

8.52 The process for determining 'significant' effects on Natura 2000 sites should be carried out in relation to the specific features and environmental conditions of the protected sites concerned. Determination of what is a 'Likely Significant Effect' should be considered on a site by site basis taking into account whether a qualifying feature is likely to be directly or indirectly affected. In either case there is a presumption that a

significant effect is likely. A Likely Significant Effect is any effect that may reasonably be predicted as a consequence of a plan or project that may affect the conservation objectives of the features for which the site was designated, but excludes trivial or inconsequential effects.

8.53 An HRA report has been prepared by MeyGen to accompany the ES and the consent applications. Data gathered as part of the EIA surveys and studies has been used to inform the HRA and provide the information that is used to undertake the assessment. The requirement for an Appropriate Assessment will be determined by the competent authority (Marine Scotland/The Highland Council), following assessment of the information presented in this ES and the HRA report submitted alongside the consent applications. The HRA report contains sufficient information to enable the competent authority to carry out an Appropriate Assessment should it determine that one is required.

8.8 References

European Commission (2000). Guidance on the provisions of Article 6 of the 'Habitats' Directive 92/43/EEC.

MeyGen (2011). Projects for consideration in the cumulative (and in combination) impact assessment.

SNH (2010). Natura sites and Habitats Regulations. How to consider proposals affecting SACs and SPAs in Scotland. The essential quick guide. http://www.snh.gov.uk/docs/C284286.pdf (Accessed October 2011).

9 PHYSICAL ENVIRONMENT AND SEDIMENT DYNAMICS

9.1 The table below provides a list of all the supporting studies which relate to the physical environment and sediment dynamics assessment. All supporting studies are provided on the accompanying CD.

Details of study	Location on supporting studies CD
Benthic survey for Phase 1 of the MeyGen tidal stream energy project, Inner Sound, Pentland Firth (ASML, 2011)	OFFSHORE\Seabed interactions
MeyGen EIA Coastal Processes Modelling – Modelling setup, calibration and results (DHI, 2012)	OFFSHORE\Seabed interactions
Report of Survey for Atlantis Resources Corporation for Site Survey Stroma. JN3475 (IXSurvey, 2009)	OFFSHORE\Seabed interactions

9.1 Introduction

9.2 This section assesses the effects of the Project on the physical environment and sediment dynamics. The specialists that have contributed to this assessment include:

- Danish Hydrological Institute (DHI) – sediment morphology modelling; and
- Xodus – baseline description, general impact assessment and the Environmental Statement (ES) section write up.

9.3 During the array construction there will be a physical disturbance of the seabed associated with turbine installation, including effects from drilling activities. During the operation and maintenance phase, it is likely that the presence of the turbines will cause local changes to the tidal stream speed and wave regime, which in turn could modify the sediment dynamics of the area.

9.4 Effects on the physical environment and coastal processes may result in indirect effects on benthic ecology, marine cultural heritage, navigation and shipping. Any such effects have not been discussed here, but are addressed in Section 10, Section 16 and Section 15 respectively.

9.2 Assessment Parameters

9.2.1 Rochdale Envelope

9.5 In line with the Rochdale Envelope approach, this assessment considers the maximum ('worst case') project parameters. Identification of the worst case scenario for each receptor (i.e. Environmental Impact Assessment (EIA) topic) ensures that impacts of greater adverse significance would not arise should any other development scenario be taken forward in the final scheme design. Table 9.1 describes the detail of the project parameters that have been used in this assessment and explains why these are considered to be worst case. The potential impact from alternative Project parameters has been considered in Section 9.10.

Project parameter relevant to the assessment		'Maximum' Project parameter for impact assessment	Explanation of maximum Project parameter
Turbines	Number	86 turbines	The physical processes model simulates energy extraction from an 86MW array based on 86, 1MW turbines (with 20m rotor diameter). The physical processes model uses a drag coefficient to simulate energy extraction by the turbine. The drag coefficient is based on the rotor diameter and rated capacity of the turbine. Due to the resolution of the model, using a small number of larger, higher rated capacity turbines to simulate an 86MW array would not influence the results.
	Layout	86 turbines; an indicative turbine layout has been used to inform the modelling (see Figure 5.6)	An indicative layout for 86 turbines has been used to inform the modelling. The indicative layout is based on 45m cross-flow spacing and 160m down-flow spacing.
	Rotor diameter	20m	The physical processes model simulates energy extraction from an 86MW array based on 86, 1MW turbines (with 20m rotor diameter). The physical processes model uses a drag coefficient to simulate energy extraction by the turbine. The drag coefficient is based on the rotor diameter and rated capacity of the turbine. Due to the resolution of the model, using a small number of larger, higher rated capacity and diameter turbines to simulate an 86MW array would not influence the results.
	Rated power of turbines	1MW	The physical processes model simulates energy extraction from an 86MW array based on 86, 1MW turbines (with 20m rotor diameter). The physical processes model uses a drag coefficient to simulate energy extraction by the turbine. The drag coefficient is based on the rotor diameter and rated capacity of the turbine. Due to the resolution of the model, using a small number of larger, higher rated capacity and diameter turbines to simulate an 86MW array would not influence the results.
	Number of blades per rotor	N/A	Number of rotor blades does not influence the physical environment and sediment dynamics impact assessment.
	Minimum clearance between sea surface and turbine blade tip	N/A	Sea surface clearance does not influence the physical environment and sediment dynamics impact assessment. As the physical processes model is depth averaged this parameter will not influence the modelling undertaken.
	Clearance of turbine blade tip to seabed	N/A	Seabed clearance does not influence the physical environment and sediment dynamics impact assessment. As the physical processes model is depth averaged this parameter will not influence the modelling undertaken.
	Decommissioning	All turbines removed at decommissioning	All turbines will be removed at decommissioning.
Turbine support structure	Maximum amount of drill cuttings released into the marine environment	86 monopile Turbine Support Structures (TSSs)	The drilled monopile TSS will result in the maximum release of drill cuttings to the marine environment. Assuming the maximum number of 86 TSSs, the maximum amount of drill cuttings that can be generated from turbine support installations is 17,200m^3 (total for 86 TSSs).
	Maximum seabed	86 Gravity Base	The GBS TSS will result in the largest seabed footprint.

Project parameter relevant to the assessment		'Maximum' Project parameter for impact assessment	Explanation of maximum Project parameter
	footprint	Structure (GBS) TSS	Each GBS TSS has a maximum footprint of 40m x 30m. The total footprint for 86 turbines is 0.103km^2.
	Operations and Maintenance	No removal of TSSs required for routine operations and maintenance	It is assumed that no replacement or major TSS overhaul involving removal is required during the operational life of the Project.
	Decommissioning	86 Monopile	86 Monopile TSSs will be cut at the seabed. The bottom of the piles below the seabed will remain in-situ.
Cable connection to shore	Maximum cable footprint on seabed	86, 120mm unbundled cables each 1,300m in length with split pipe armouring	The maximum physical area of the seabed occupied by the cables is 0.027km^2. Based on a maximum 1.3km of cable from Horizontal Directional Drill (HDD) bore exit to turbine, and a cable diameter of 120mm (x2 to account for split pipe armouring) for 86 turbines.
	Decommissioning	86, 120mm unbundled cables, each 1,300m in length	All cables laid on the seabed will be fully removed at decommissioning.
Cable landfall	Maximum amount of drill cuttings released into marine environment	29, 0.6m HDD bores, drilled from either Ness of Quoys or Ness of Huna	The majority of drill cuttings generated from the drilling of the HDD bores will be returned to shore and not discharged to sea; however it is estimated that the contents of the last 10m of each bore could be discharged to sea at seabed breakthrough. Of the two potential HDD scenarios, the greatest potential volume of cuttings discharged to sea at breakthrough will result from last 10m of 29 boreholes of 0.6m diameter (82m^3).
Onshore Project components	-	N/A	As there are no proposed works in the intertidal area along the coast the onshore aspects of the Project do not influence the physical environment and sediment dynamics impact assessment.

Table 9.1: Rochdale Envelope parameters for physical environment and sediment dynamics assessment

9.2.2 Area of assessment

9.6 It is also important to define the geographical extent of the area of assessment. The focus of the physical environment and sediment dynamics assessment is potential impacts in the Project area and adjacent waters, the surrounding coastline and seabed.

9.2.3 Modelling assessment

9.7 In order to undertake the assessment, a modelling study was undertaken. For full details of the modelling approach, see Section 9.4.4.

9.3 Legislative Framework and Regulatory Context

9.8 In addition to EIA guidance published by Marine Scotland and SNH there are no specific EIA guidelines yet developed for the assessment of physical environmental impacts from tidal stream projects. However, the physical environment and coastal processes EIA guidelines developed by the Centre for Environment, Fisheries and Aquaculture Science (CEFAS) for offshore wind farms (CEFAS, 2004) are largely applicable, as are those developed by COWRIE, also for offshore wind farms (COWRIE, 2009). Additional consideration should be given to potential turbulence and wake effects for tidal turbines. The CEFAS guidelines highlight that direct impacts on hydrodynamics and sediment dynamics should be considered, along with secondary effects including water quality and benthic ecology (Section 10).

9.4 Assessment Methodology

9.4.1 Scoping and consultation

9.9 Since the commencement of the Project, consultation on physical environment and sediment dynamics issues has been ongoing. Table 9.2 summarises all consultation relevant to the physical environment and sediment dynamics. In addition, relevant comments from the EIA Scoping Opinion are summarised in Table 9.3, together with responses to the comments and reference to the ES sections relevant to the specific comment.

Date	Stakeholder	Consultation	Topic / specific issue
7th April 2011	Marine Scotland and SNH	Pre-Scoping meeting	EIA surveys and studies required and the data needs for each EIA study.
26th May 2011	Marine Scotland and SNH	Submission of document for comment	Submission of proposed modelling scope of work for review and comment by Marine Scotland and SNH.
27th May 2011	Marine Scotland, statutory consultees and non statutory consultees	Submission of EIA Scoping Report	Request for an EIA Scoping Opinion from Marine Scotland and statutory consultees and request for comment from non statutory consultees.
30th June – 2nd July 2011	Local stakeholders	Public Event - EIA Scoping	Public event to collate information/opinions on proposed EIA scope.
6th July 2011	Marine Scotland	Teleconference	Scope of the coastal processes modelling. Discussion regarding the data inputs, proposed scenarios and expected outputs.
31st September 2011	Marine Scotland, The Highland Council, statutory consultees and non statutory consultees	Receipt of EIA Scoping Opinion	Receipt of response to EIA Scoping Report and other comments from non statutory consultees.
3rd October 2011	Marine Scotland	Project update meeting	Report on EIA progress including presentation of modelling results.
6th – 7th December 2011	Local stakeholders	Public Event – pre application consultation	Public event to communicate the findings of the EIA to local stakeholders.

Table 9.2: Consultation undertaken in relation to physical environment and sediment dynamics

Name of organisation	Key concerns	Response	ES section within which the specific issue is addressed
Marine Scotland	General comments relating to clarification of modelling approach and expected scenarios.	Modelling approach was approved by Marine Scotland prior to receiving EIA Scoping Opinion and commencement of modelling.	See Section 9.4.4 Modelling study.
Scottish Environmental Protection Agency (SEPA)	The ES should include information on the possible impacts of construction activities on water quality, as well as coastal processes in the longer term. Any potential impacts from suspended sediment should be compared to natural background levels and water quality standards (e.g. Shellfish Waters Directive).	There are not expected to be any impacts to water quality or coastal processes in the long term, because the scale of the development is not expected to alter the baseline hydrodynamic or wave regime significantly enough to cause any changes.	See Section 9.6 Impacts during Construction and Installation.
SEPA	If dredging is required, details should be provided in the ES.	Not proposed.	NA
SEPA	If coastal defences are required, details should be provided in the ES.	Not proposed.	NA
SEPA	There may be a need to address the	Cumulative impacts are	See Section 9.11

Name of organisation	Key concerns	Response	ES section within which the specific issue is addressed
	cumulative effects of devices/arrays on coastal processes depending upon array density and location with respect to existing renewable and coastal developments.	considered, but due to the level of detail available from other projects, it is only possible to assess the potential impacts qualitatively. Changes to the hydrodynamics and waves outside of the Project area are negligible and as a result it is extremely unlikely that significant cumulative impacts will occur.	Cumulative Impacts.
SEPA	If the Project includes impoundments or tidal barrage, detailed modelled must be undertaken.	Not proposed.	NA
SEPA	Coastal processes should be assessed as part of the ES, which should include a baseline assessment of coastal and sedimentary processes operating in the area, including sediments, hydrodynamics, sedimentary environment, sedimentary structures and typical suspended sediment concentrations.	A baseline assessment of coastal and sediment processes was compiled from a variety of sources, including a geophysical and bathymetric survey, current meter deployments, sediment sampling and other historical documents.	See Section 9.5 Baseline Description.
Royal Yachting Association (RYA)	In the EIA Scoping Document the maximum current speeds in the Inner Sound were much higher than expected (3.4-4.0ms^{-1}).	Current meters deployed in 2011 have confirmed that current flows in the Inner Sound regularly exceed 4.5ms^{-1}.	See Section 9.5.4 Currents.
Scottish Natural Heritage (SNH)	The ES should include an initial Environmental Mitigation and Monitoring Plan (EMMP).	The outline EMMP has been developed as part of the EIA and is presented in the ES.	See Section 25 EMMP.
SNH	The ES should include potential impacts from the operational and maintenance phase.	No significant impacts on the physical environment and coastal processes are identified from the operational and maintenance phase.	See Section 9.7 Impacts during Operations and Maintenance.
SNH	The ES should include potential impacts from the decommissioning phase.	No significant impacts on the physical environment and coastal processes are identified from the decommissioning phase.	See Section 9.8 Impacts during Decommissioning.
SNH	There is a recommendation that expert advice should be sought from an experienced coastal geomorphologist.	The modelling undertaken to support the EIA has been conducted by DHI whose staff includes a geomorphologist.	N/A

Table 9.3: Scoping comments relevant to physical environment and sediment dynamics

9.4.2 Desk based study

9.10 The study has been undertaken by researching and reviewing any documents and datasets relevant to the Inner Sound of the Pentland Firth. Data were collated from the following sources:

- Numerous oceanographic surveys within the Project area;
- Geophysical survey report of the Inner Sound, iXSurvey (2009);
- Admiralty Tide Tables, Admiralty Tidal Stream Atlases, UKHO (1986a, 1986b, 2005);
- UK Digital Marine Atlas Project (Version 3.00), BODC (1998);
- Atlas of UK Marine Renewable Energy Resources, BERR (2008);
- Wave and tidal modelling studies, DHI (2009a, 2009b, 2012);
- MeyGen Tidal Energy Project EIA Scoping Document, Xodus (2011); and
- Pentland Firth and Orkney Waters MSP RLG for Marine Renewable Energy, Marine Scotland (2009).

9.4.3 Field survey

9.11 A number of field surveys have been undertaken over the last few years which have enabled the Inner Sound to be characterised to a high degree. These have included surveys of water depth, geophysics, current regime, water levels, turbulence, benthic communities and sediment sampling. Further details are provided in Table 9.4.

Type of survey	Time period	Instrument used	Variables measured	Data collected by
Current	April 2009	300 kHZ Acoustic Doppler Current Profiler (ADCP) and moving vessel current transects	Current speed and direction at 1m bins throughout the water column.	Atlantis
Benthic	October 2009	TV tow and camera	Visual record of seabed.	Marine Scotland
Bathymetry, Geophysical	September 2009	Multi-beam echo sounder, side scan sonar, pinger sub-bottom profiler, magnetometer	Water depths, seabed composition, bedform profiles, depth of seabed sediment, and presence of anomalies.	Atlantis
Coastal geology field study	November 2009	Visual survey	Coastal geology field survey.	Atlantis
Benthic	May 2010	TV tow and camera	Visual record of seabed.	Marine Scotland
Current	October 2010 to July 2011	Vessel mounted 300 kHz RDI ADCP	Current speed and direction along transects.	ERI
Seabed structure	November 2010 and July 2011	Vessel mounted starfish 450F sidescan sonar	Image of the seabed.	ERI
Currents, waves and turbulence	July 2011	Bottom mounted RDI 1200 kHz ADCP Bottom mounted Acoustic Wave and Current (AWAC) 600 kHz ADCP	Current speed and direction throughout water column. Some quantification of turbulence. Wave heights.	MeyGen
Benthic	July 2011	Helley-Smith bedload sampler Petersen grab sampler Niskin bottle Video and still photography	Sediment bedload. Sediment particle size distribution. Suspended sediment.	MeyGen

Table 9.4 : Summary of oceanographic data collected in the Inner Sound to date

9.4.4 Modelling study

9.12 A sediment transport modelling study was adopted for this EIA because of the proximity of large-scale sediment features alongside the turbine deployment area, including mega-rippled sand banks, gravel waves and areas of accumulated sediment. These regions of sediment have the potential to impact other receptors indirectly if the installation of the array were to fundamentally change the flow patterns in the Inner Sound.

9.13 The mobility of the seabed is dependant on the local current and wave conditions, and the local sediment characteristics. The strong tidal currents are thought to be the main cause for the persistent sedimentary features in the Inner Sound, scouring any mobile sediment from the central channel, and tending to deposit it where the current speeds naturally decrease or where large eddies are formed, such as in the lee of Mell Head on Stroma. Large-scale sediment transport is likely to occur under storm conditions, when wave action increases turbulence near the bed, influencing sediment suspension.

9.14 The object of the modelling study was therefore to establish a calibrated baseline model capable of matching the existing current speed, direction and bedload sediment concentrations measured in the Inner Sound, which could then be used to quantify the effects on the physical processes brought about by the tidal array, under calm and storm conditions. Full details of the modelling study are provided on the supporting studies CD (DHI, 2011). The method can be broken down as follows:

- Build a calibrated hydrodynamic and morphological model, which is capable of accurately representing current speed and direction, and bedload samples within the Project domain (against surveyed currents);
- Build a wave model capable of running waves across the Project domain;
- Run the tide, wave and morphology models with no turbines, under both calm and storm scenarios, to establish a number of baseline cases which other model output can be compared to; and
- Run the tide, wave and morphology models having added a representation of the maximum 86 turbine array into the model, to see how flow patterns, wave heights and bedform features are influenced by the array, under calm and storm conditions.

9.15 The model scenarios shown in Table 9.5 were chosen following consultation with Marine Scotland, and represent the full suite of modelling carried out. An easterly, westerly and north-westerly storm event were chosen because these directions allow maximum wave propagation to the site. A calm scenario was not run for the wave model, because by definition, the calm scenario requires there to be no wind forcing, which is a fundamental component of the wave model.

Model	Existing baseline	86 turbines
Tidal	1 x calm 1 x easterly storm event 1 x westerly storm event 1 x north-westerly storm event	1 x calm 1 x easterly storm event 1 x westerly storm event 1 x north-westerly storm event
Wave	1 x easterly storm event 1 x westerly storm event 1 x north-westerly storm event	1 x easterly storm event 1 x westerly storm event 1 x north-westerly storm event
Sediment Transport	1 x calm (tide only) 1 x easterly storm event 1 x westerly storm event 1 x north-westerly storm event	1 x calm (tide only) 1 x easterly storm event 1 x westerly storm event 1 x north-westerly storm event

Table 9.5: Summary of coastal process modelling scenarios

9.16 It should be noted, the modelling carried out here is far-field modelling, so it will not capture small-scale processes including micro-eddies, turbulence, wake effects and other near-field effects associated with near-turbine processes. However, the purpose of the modelling study is not to investigate those small-scale processes; it is to investigate bulk sediment transport over the Project area, so the level of detail has been chosen accordingly. The model was calibrated against a selection of the surveyed currents and bedload samples described in Table 9.4, as recommended by the relevant guidelines (CEFAS, 2004; COWRIE, 2009).

9.17 It should also be noted that the model is depth-averaged, so the effective drag formulation used to represent the turbines in the tidal model will reduce the current speeds throughout the entire water column, not just to the depth of the turbine. In reality there is more than 8m of clear water above the turbines, so while it is likely that flow will be reduced in the lower two-thirds of the water column where the turbines sit, flow above the turbines may not be so impeded. This means that when compared to real surface currents, the predicted current increases and decreases may be a conservative overestimate.

9.4.5 Significance criteria

9.18 The EIA process and methodology are described in detail in Section 8. Each assessment section is, however, required to develop its own criteria for the sensitivity of receptor and magnitude of impact aspects since the definition of these will vary between different topics. For physical environment and sediment dynamics, the significance criteria used in this section is based on the methodology described in Section 8 but the sensitivity of the receptor and magnitude of impact are defined in Table 9.6 and Table 9.7 respectively.

9.19 The consequences of impacts are then considered by reference to the relevant criteria in the EIA Regulations. The significance of impacts in relation to the EIA Regulations is defined in Section 8, Table 8.2.

Sensitivity of receptor	Definition
Very High	▪ The physical environment has very little ability to absorb change without fundamentally altering its present character. ▪ Is of very high environmental value or of international importance (e.g. United Nations Educational, Scientific and Cultural Organisation (UNESCO) World Heritage Site (WHS)).
High	▪ The physical environment has little ability to absorb change without significantly altering its present character. ▪ Is of high environmental value or of national importance (e.g. Site of Special Scientific Interest (SSSI), Geological Conservation Review (GCR) site).
Medium	▪ The physical environment has moderate capacity to absorb change without significantly altering its present character. ▪ Is of moderate environmental value or of regional importance.
Low	▪ The physical environment is tolerant of change with only minor detriment to its present character. ▪ Is of low environmental value or of local importance.
Negligible	▪ The physical environment is tolerant of change without perceptible detriment to its present character or is of negligible environmental value.

[1] *GCR: Geological Conservation Review site, a non-statutory designation for geological and geomorphological sites of national or international importance for earth science conservation (JNCC, 2011).*

Table 9.6: Definitions for sensitivity of receptor

Magnitude of impact	Definition
Severe	▪ There would be fundamental changes to the baseline condition of the receptor. ▪ Little or no recovery anticipated. ▪ Impact highly likely to occur.
Major	▪ There would be a substantial but non-fundamental change to the baseline condition of the receptor.

	▪ Recovery anticipated after several years following decommissioning. ▪ Impact likely to occur.
Moderate	▪ There would be material but non-substantial changes to the temporary or permanent baseline condition of the receptor. ▪ Good recovery potential following decommissioning (approximately 2 years). ▪ Impact will possibly occur.
Minor	▪ There would be detectable but non-material changes to the baseline condition of the receptor (or a change that is temporary in nature). ▪ Temporary alteration or effects confined to a small percentage of receptor, with rapid recovery. ▪ Impact unlikely to occur.
Negligible	▪ An imperceptible and/or no change to the baseline condition of the receptor. ▪ Impact extremely unlikely to occur.
Positive	▪ An enhancement to the baseline condition of the receptor.

Table 9.7: Definitions for magnitude of impact

9.20 The receptors assessed in this topic are unconventional when compared against receptors in other topics, because they don't have any intrinsic sensitivity associated with them. They are most important for the secondary effects and significance they have to other receptors.

9.4.6 Data gaps and uncertainties

9.21 The geophysical survey which produced the seabed sediment maps covered the region local to the Project site. However, some sedimentary bedforms extended beyond the surveyed area, so their full extent is unknown.

9.22 The wave characteristics presented in this section have been derived from the best available data at the time, but better data will be available after the completion of a detailed wave modelling study of the Inner Sound which is ongoing at the time of writing. When available, this data will help inform extreme and average wave heights in the Inner Sound, which in turn will have an effect on sediment transport in storm conditions.

9.23 There is not yet a standard technique for representing turbine structures in current and wave models, so the best available method has been used here. Work is currently ongoing to develop a standard approach, but this was not available at the time of writing.

9.5 Baseline Description

9.5.1 Designations

9.24 Two statutory and two non-statutory designated sites relevant to this section lie within 5km of the study area, as detailed in Table 9.8 and shown in Figure 9.1.

Site name	Designation	Category	Distance & direction
John o' Groats	SSSI, GCR[I]	Palaeontology	2.5km, east
Duncansby to Skirza Head	GCR	Coastal geomorphology	4.5km, east
Duncansby Head	SSSI	Aggregations of breeding birds, coastal geomorphology, maritime cliff	4.5km, east

Table 9.8: Summary of designated sites within 5km of the Project area

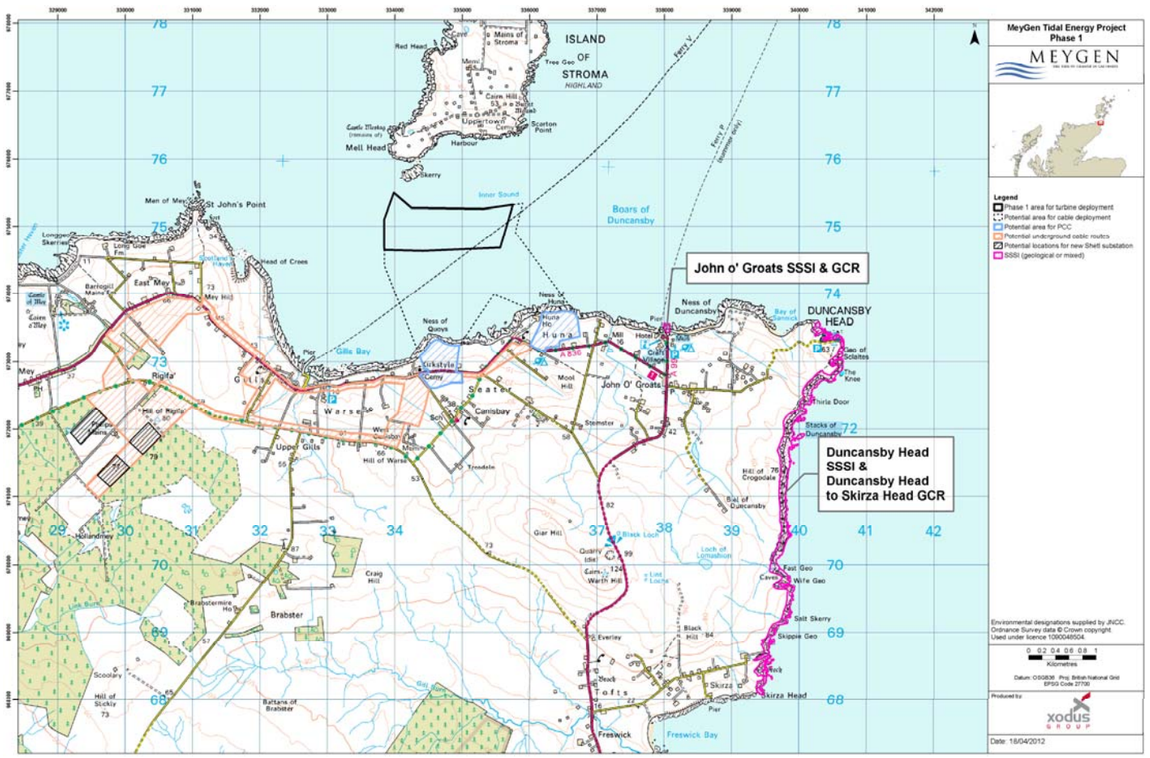

Figure 9.1: Geologically important designated sites within 5km of the study area

9.5.2 Bathymetry

9.25 Water depths within the turbine deployment area vary between approximately 31m to 49m below LAT (Gills Bay), as shown in Figure 9.2 and Figure 9.3. The vertical scale in Figure 9.3 has been exaggerated by a factor of fifteen to allow the bathymetric features to be identified more easily. The majority of the area is relatively flat having a water depth between 31.5 and 38m, but fissures in the bedrock up to 10m deep occur in the site, particularly at the western end south of Mell Head. The Admiralty contours plotted on Figure 9.2 are derived from a single-beam dataset collected in 1984, and agree well with the more recent 2009 multi-beam bathymetry survey.

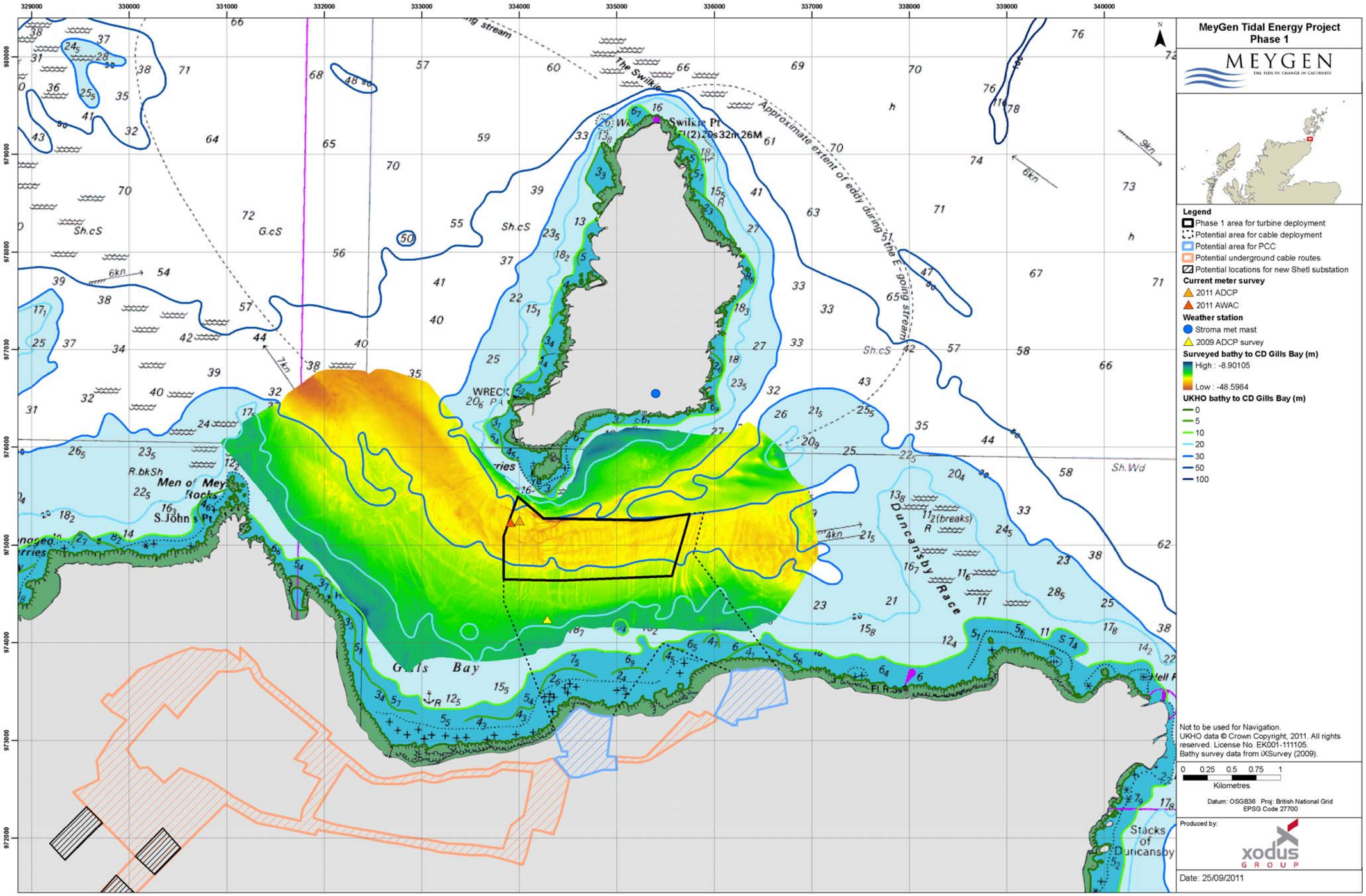

Figure 9.2: Bathymetry overview

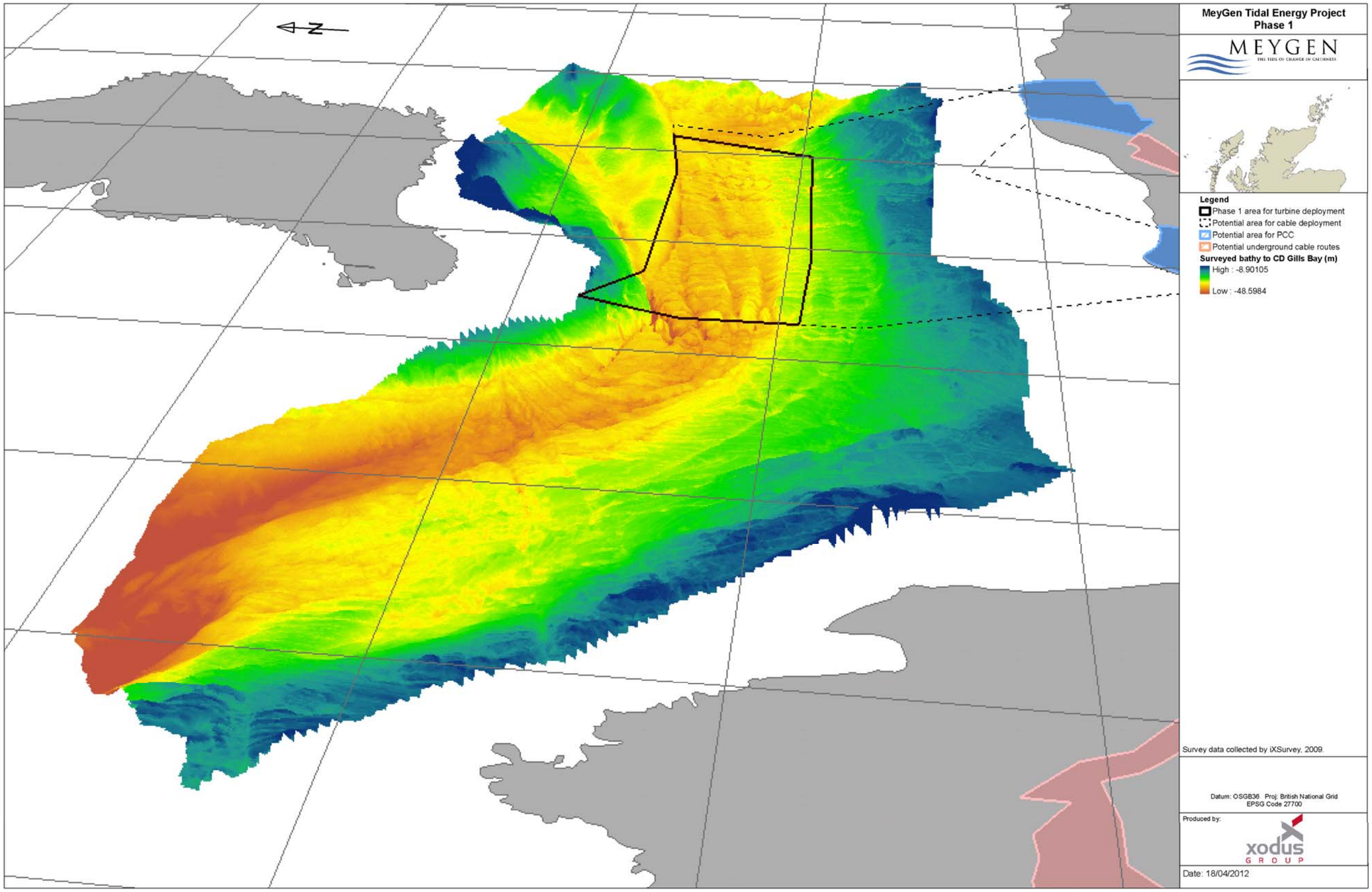

Figure 9.3: 3D bathymetry image

9.5.3 Water levels

Tidal

9.26 Water levels throughout the region are dominated by the semi-diurnal tide propagating from the North Atlantic. The mean spring tidal range within the Project area is approximately 3.0m, as summarised in Table 9.9, which combines data from Admiralty Tide Tables and the recent current meter survey carried out in 2011 (UKHO, 2005; EMU, 2011).

Tidal height (rel. to CD)	Wick (m)	Duncansby Head (m)	Stroma (m)	ADCP survey (m)	Gills Bay (m)	Scrabster (m)
Highest Astronomical Tide (HAT)	4	-	-	4.7	-	-
Mean High Water Spring (MHWS)	3.5	3.1	3.1	4.4	4.2	5
Mean High Water Neap (MWHN)	2.8	2.4	2.3	3.6	3.5	4
Mean Sea Level (MSL)	2	no data	1.9	2.9	2.7	3.1
Mean Low Water Neap (MLWN)	1.4	no data	1.3	2.2	2	2.2
Mean Low Water Spring (MLWS)	0.7	no data	0.9	1.4	1	1
Lowest Astronomical Tide (LAT)	0	-	-	0	-	-
Mean Spring Tidal Range (MSTR)	2.8	no data	2.2	3.0	3.2	4
Mean Neap Tidal Range (MNRT)	1.4	no data	1	1.3	1.5	1.8
CD to ODN	-1.71	no data	-	-	-2.19	-2.7

Table 9.9: Summary of water levels at nearby tidal ports (and from the 2009 ADCP survey)

9.27 The tidal wave floods from west to east through the Project site, before turning south and propagating down the North Sea coast of Scotland. The tidal wave slows down considerably as it passes through the Pentland Firth, such that despite the Agreement for Lease area only being 6km in length, High Water at the east end occurs approximately 20 minutes after High Water in the west (UKHO, 2005).

Storm surge

9.28 Storm surges occur at irregular intervals in response to meteorological forcing, particularly the passage of low pressure systems. A positive storm surge of about 1.5m (not taking into account tidal level) might be expected to occur in the area approximately once every 50 years (Marine Scotland, 2009).

9.29 It has not been possible to find any long-term storm surge data recorded within the Inner Sound, so tidal levels recorded at the nearby port of Wick are used to give an indication of the order of magnitude of storm surge heights. Long-term tide gauge data supplied by the British Oceanographic Data Centre (BODC) at Wick shows maximum surge heights of 1.11m over a 20-year period (the data were supplied by the BODC as part of the function of the National Tidal & Sea Level facility, hosted by the Proudman Oceanographic Laboratory and funded by the Environment Agency and the Natural Environment Research Council). The maximum values during this period have been summarised below in Table 9.10, which show that the maximum surge combined with the maximum tidal high water could produce a water level of 5.11m at Wick.

Variable	Tide (m)	Surge (m)	Surge + Tide (m)
Max	4.0	1.11	5.11
Min	0	-0.74	-0.74
All values recorded at Wick, and heights are relative to Chart Datum (CD)			

Table 9.10: Summary of extreme water levels at Wick

9.5.4 Currents

General description

9.30 The Pentland Firth lies close to the boundary between the North Atlantic and North Sea tidal systems. The incoming North Atlantic tidal wave reaches the Orkney Islands several hours before the North Sea tidal wave, causing a net flow of water from west to east on the flood tide. The interaction of the two tidal systems results in a dynamic and energetic tidal regime throughout the area of interest. However, this flow is strongly modified by local conditions of water depth and topography. This has the effect that the flood tide is not in the opposite direction to the ebb tide throughout the Project area (Dacre *et al*, 2001; Marine Scotland, 2009).

9.31 There are widespread and highly energetic tidal races, eddies and areas of general turbulence throughout the Firth. Just beyond the western end of the site off St John's Point on the Scottish mainland, the Merry Men of Mey is one of the most significant oceanographic features in the Firth. This is an area of tidal racing that occurs on the west-going ebb, particularly when opposed by westerly wind or waves. The feature can extend right across the width of the Firth, and is characterised by strong flows and significant standing waves which frequently break and have been reported to exceed 10m in height on occasion (UKHO, 1997; Marine Scotland, 2009). A similar race forms off Duncansby Head coincident with the beginning of the south-east-going current, known as the Duncansby Race.

9.32 Currents within the Inner Sound have a clear flood ebb pattern, while the Island of Stroma generates extensive eddies on its downstream side during both flood and ebb flows.

Surveyed currents

9.33 A number of sources of current meter data exist within the Inner Sound, as summarised in Table 9.11. These include three moored ADCPs and two sets of moving vessel ADCP transects.

Type	Data owner	Variable measured	Duration	Easting	Northing
Moored ADCP	Atlantis	Currents	01/04/2009 – 31/04/2009	334291	974238
ADCP transects	Atlantis	Currents	04/04/2009	Inner Sound	Inner Sound
ADCP transects	ERI	Currents	Various dates 2010 - 2011	Inner Sound	Inner Sound
Moored ADCP	MeyGen	Currents	21/06/2011-20/07/2011	334012	974919
Moored AWAC	MeyGen	Currents and waves	21/06/2011-20/07/2011	334307	974736

Table 9.11: Summary of current meter deployments

9.34 The current meters deployed by MeyGen in 2011 were placed at one of the highest flow regions within the Inner Sound, as shown in Figure 9.2 and Figure 9.4. This data has been harmonically analysed and re-predicted over a 20 year period, and can be used to obtain maximum current speeds at the site of the moored instruments. This data showed that the current flows in the Inner Sound regularly exceed 4.5ms^{-1} and may exceed 5ms^{-1} during an equinoxial tide (EMU, 2011).

9.35 The plot in Figure 9.5 shows current speeds recorded by the AWAC device during a neap tide, varying with depth and tidal state. The current speed profiles exhibit a fairly uniform pattern with depth, and show no evidence of stratification as would be expected in a region of such strong tidal flow. The speeds are greatest at the surface, and slowly decrease towards the bed, largely following the 1/7th power law (Soulsby, 1997).

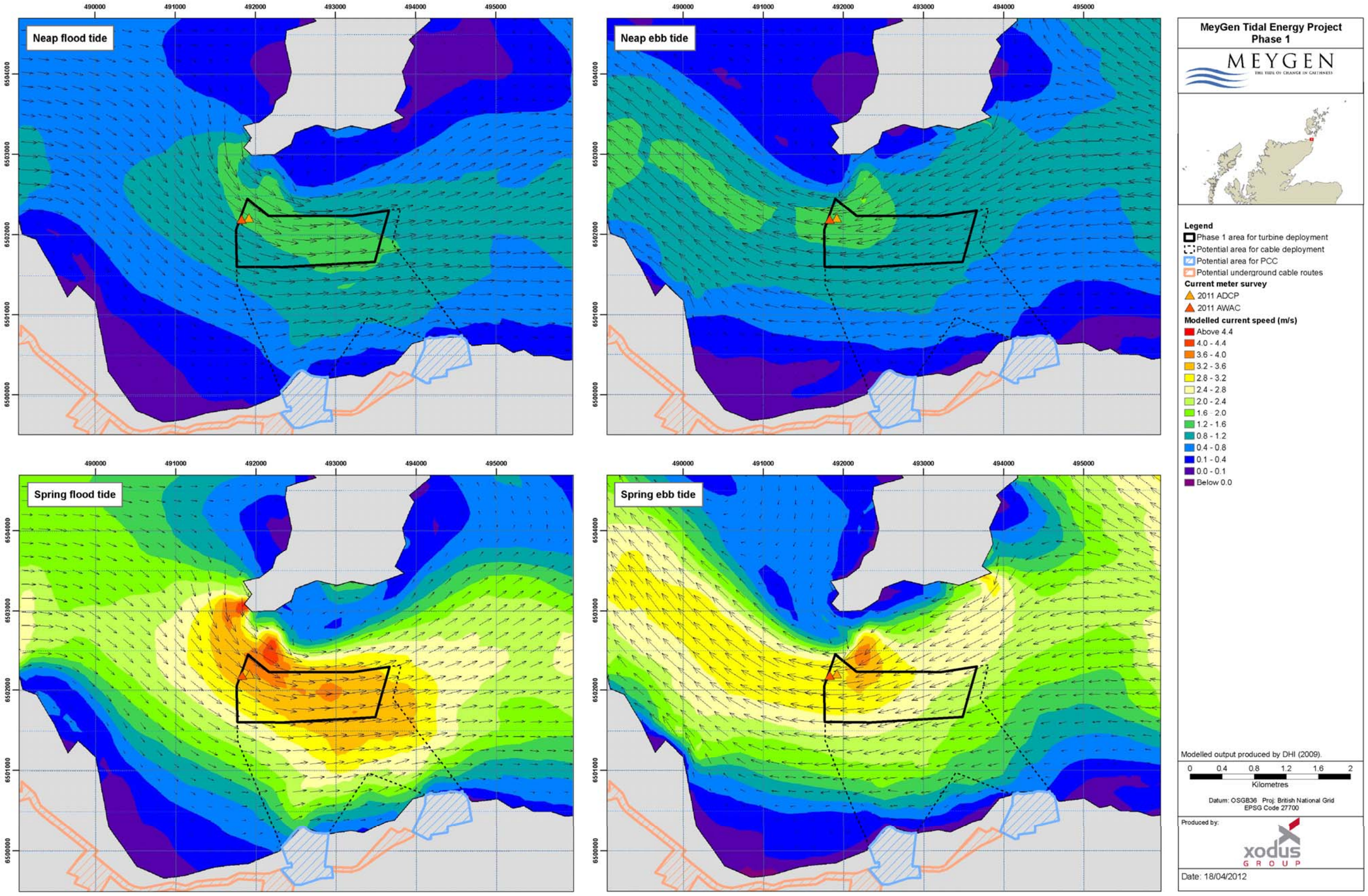

Figure 9.4: Hydrodynamic model of the Inner Sound – selected time steps

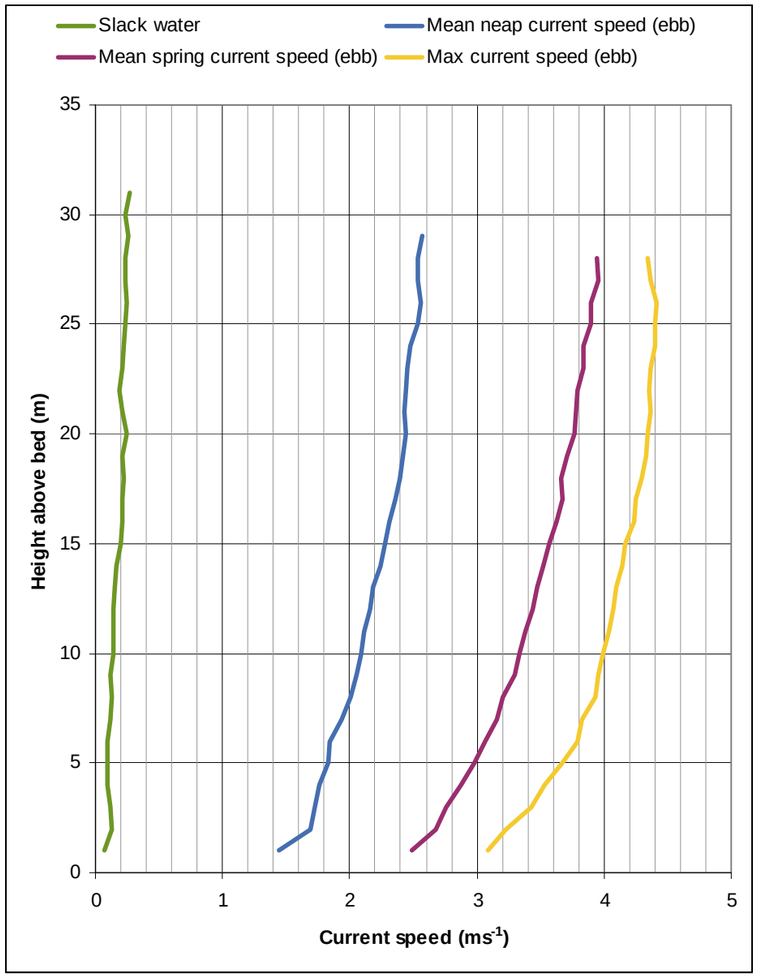

Figure 9.5: Range of current speeds at site of AWAC (EMU, 2011)

Hydrodynamic model

9.36 In order to understand the flow patterns and dynamics of the study area in greater detail, a hydrodynamic model was built covering the Pentland Firth and surrounding waters (DHI, 2009a). The model was calibrated using the moored 2009 and 2011 current meter data described in Table 9.11, and the plots in Figure 9.4 show peak flood and peak ebb timesteps for a neap and spring tide to show the detailed circulation patterns evident in the domain. The model is depth averaged, which is reasonable in this type of environment in which tidal flows are so dominant, and there is no vertical stratification of the water column (as shown in Figure 9.5).

9.37 A mean spring and a mean neap current speed, direction and water elevation time series, as extracted from the model at the location near the AWAC, are shown in Figure 9.6 and Figure 9.7 respectively.

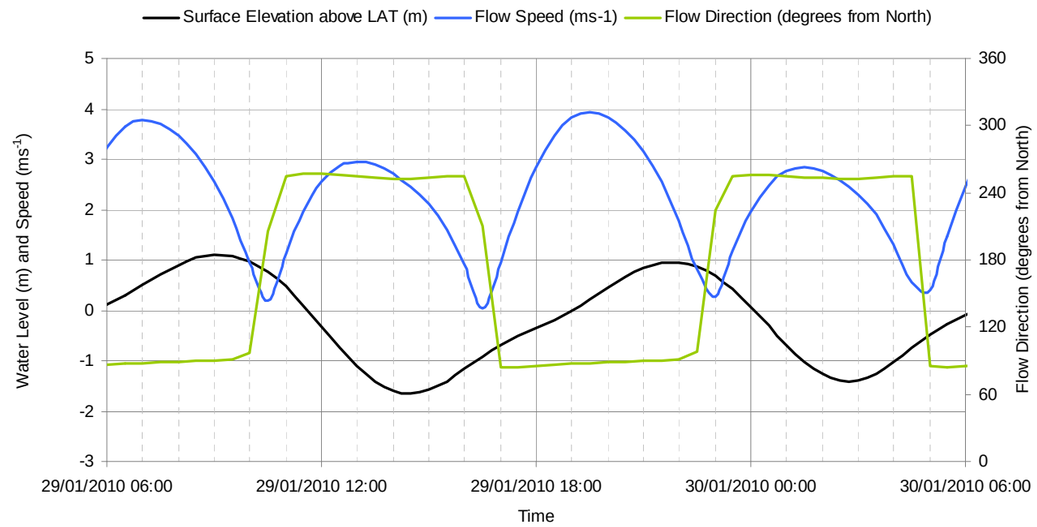

Figure 9.6: Mean spring tidal current

Non-tidal currents

9.38 Current flow within the area of interest is dominated by the semi-diurnal tide, but other, non-tidal flows will occur. The main components of non-tidal current flows are summarised below.

9.39 Storm surge currents are water movements driven by the passage of intense low pressure systems. In the area of interest, surge currents are most likely to travel from west to east along the north coast of the mainland, although the area may also be affected by southward-moving surges in the North Sea. Surge currents are unpredictable (outwith the timescales of accurate weather forecasts) and irregular in nature. They are usually assessed by considering the magnitude of current likely within a given return period. By way of indication, surge currents as high as 1.4m s^{-1} may occur in the Pentland Firth with a return period of 50 years. Along the north coast of the mainland and in the northern Orkney Islands, 50-year surge currents of 0.6 – 1.0m s^{-1} are more typical. As with tidal currents, surge currents will be strongly modified by local water depth and topography (Marine Scotland, 2009).

9.40 Surface wind-drift currents are caused by the entrainment of the surface water layers (typically only the top few metres) by the wind. These flows are different to general circulatory flows, which are caused by weather systems over larger space and time scales. Wind-drift currents will typically grow to no more than 2 or 3% of the wind speed (HSE, 2002) (i.e. a maximum of approximately 0.6ms-1 for a strong wind speed of 20ms-1). It is also likely that, since wind-drift currents only affect the top layer of the water column, they will be broken down by wave mixing (particularly if the waves are breaking) or strong three-dimensional flow features. These conditions are known to occur within many areas of the Pentland Firth, such as the Merry Men of Mey between Hoy and the Scottish mainland, and in the many races and eddies that occur around the Firth's islands and headlands at different stages of the tide (Marine Scotland, 2009).

9.41 General circulation currents cause a net transfer of water clockwise around the north coast of the UK. However, associated speeds are generally low, typically no more than 0.1 – 0.2ms^{-1} (HSE, 2002), so this component is relatively insignificant compared to the tidal currents in the Pentland Firth. Circulatory flows can vary considerably over short distances, and are usually greatest within a few kilometres of significant topographic features such as headlands, islands and banks (Marine Scotland, 2009).

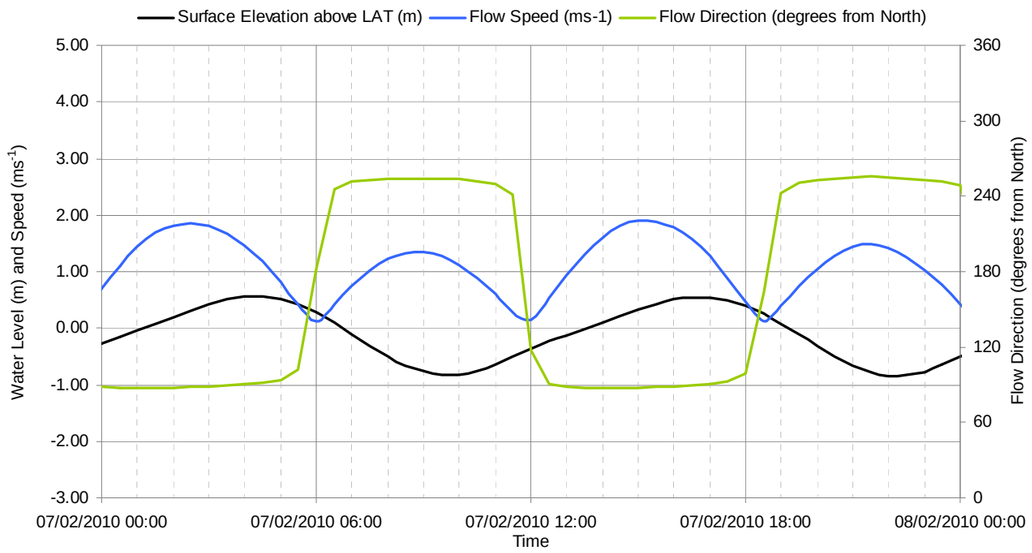

Figure 9.7: Mean neap tidal current

9.5.5 Waves

General description

9.42 The wave climate in the vicinity of the Project area is dominated by the passage of low pressure systems from west to east across the North Atlantic. Wave conditions are most severe (i.e. the wave field contains the greatest energy) in the exposed coastal areas to the west of the site, but although the highest and most frequent waves approach the Inner Sound from the west (UKHO, 2005), the coastal features and bathymetry of the Inner Sound are likely to cause these westerly waves to largely dissipate by the time they reach the Project site. Waves from the North Sea are less severe because a spit of shallower water extends north-east from Duncansby Head across the eastern end of the Inner Sound thus reducing their energy, but the open coastline on the eastern side of the Sound allows these waves to penetrate more easily into the Project area.

9.43 Waves are typically described in terms of a significant wave height, H_s (which is the average height of the highest one third of the waves in a given sea state), the wave period, T (which is the time taken for two successive wave crests to pass the same point), and the dominant wave direction.

9.44 There are very few known records of measured wave data along the North coast of Scotland, and there are no known records within the Inner Sound. Conclusions about the wave climate within the Inner Sound must therefore be drawn from data collected nearby and published reports. It should be noted that it is difficult to reach conclusions with a high degree of accuracy using this kind of approximation, because water depth and seabed topography both have important effects in modifying incoming waves. A detailed wave modelling study of the area is being undertaken at the time of writing, but results are not yet available.

Wave height and direction

9.45 A number of different data sources are presented to build a picture of likely wave heights in the Inner Sound.

9.46 Firstly, maps produced by BERR (BERR, 2008) present the mean significant wave height (H_s) across UK waters at different times of the year based on hourly model hindcast values over 7 years. The data is relatively coarse (the model resolution is 12km), but it still useful for showing that the most severe wave conditions are found to the west of the Inner Sound. The data from these maps has been summarised for the Inner Sound in Table 9.12, however it is important to recall that the constrained nature of the Sound and the local bathymetry are likely to significantly alter the wave heights presented, since waves passing from deep water to shallower water interact with the seabed, thereby changing the wave height.

Time of year	Mean significant wave height (H_s)
Annual	1.5m
Spring	1.5m
Summer	1.0m
Autumn	1.6m
Winter	1.9m

Table 9.12: Significant wave height summary in the Inner Sound (BERR, 2008)

9.47 Secondly, maps provided by the BODC (BODC, 1998) present the significant wave height (H_s) exceeded for different percentages of the year in UK waters, and support the data shown in Table 9.12.

9.48 Localised modelling of the offshore wave climate was also conducted offshore of Gills Bay (HR Wallingford, 1990) which calculated significant heights for a range of extreme wave conditions up to a 1 in 100 year return period. The largest wave conditions were found to occur from the north-west, with a significant wave height of 14.6m for a 12 hour duration event (SNH, 2000).

9.49 More recently, a basic wave model covering the Inner Sound was developed, driven by long-term wave statistics at the east and west model boundaries, to better understand the extreme wave heights in the area (DHI, 2009b). A selection of results from the modelling study is presented in Figure 9.8. They show the maximum wave trough height (H_T), which is the distance between the lowest water level reached during a storm and the still water level. H_T was estimated conservatively (DHI, 2009b), so is likely to be an overestimate, but can be converted to maximum wave height using $H_{max}=2H_T$. The findings of the wave modelling study are summarised for the Project area in Table 9.13, but it should be recalled these values are the result of a fairly coarse study, and will be superseded by the extreme wave modelling study being undertaken at the time of writing.

Description	Modelled H_{max} in Project area
1 in 100 yr storm	18m
1 in 1 yr storm	13m

Table 9.13: Summary of wave model extreme wave heights

9.50 Maps provided by BODC (BODC, 1998) illustrate the most common (modal) wave period around UK waters. Periods of 6s are common to the west and north of the Orkney Islands, while shorter periods of 4s are more typical of the Pentland Firth and east of the Orkney Islands (Marine Scotland, 2009).

9.51 However, these modal periods do not indicate the contribution from long-period swell waves. The dominant direction for swell waves is from the west (i.e. propagating from the North Atlantic), so they will have the greatest impact in those areas most exposed to the west. Swell wave periods of 10-16s are typical, and significantly longer periods of up to 40s have been measured. Swell wave climates tend to exhibit more regular periods and directions, and a narrower range of wave heights, than locally generated wind waves (Marine Scotland, 2009).

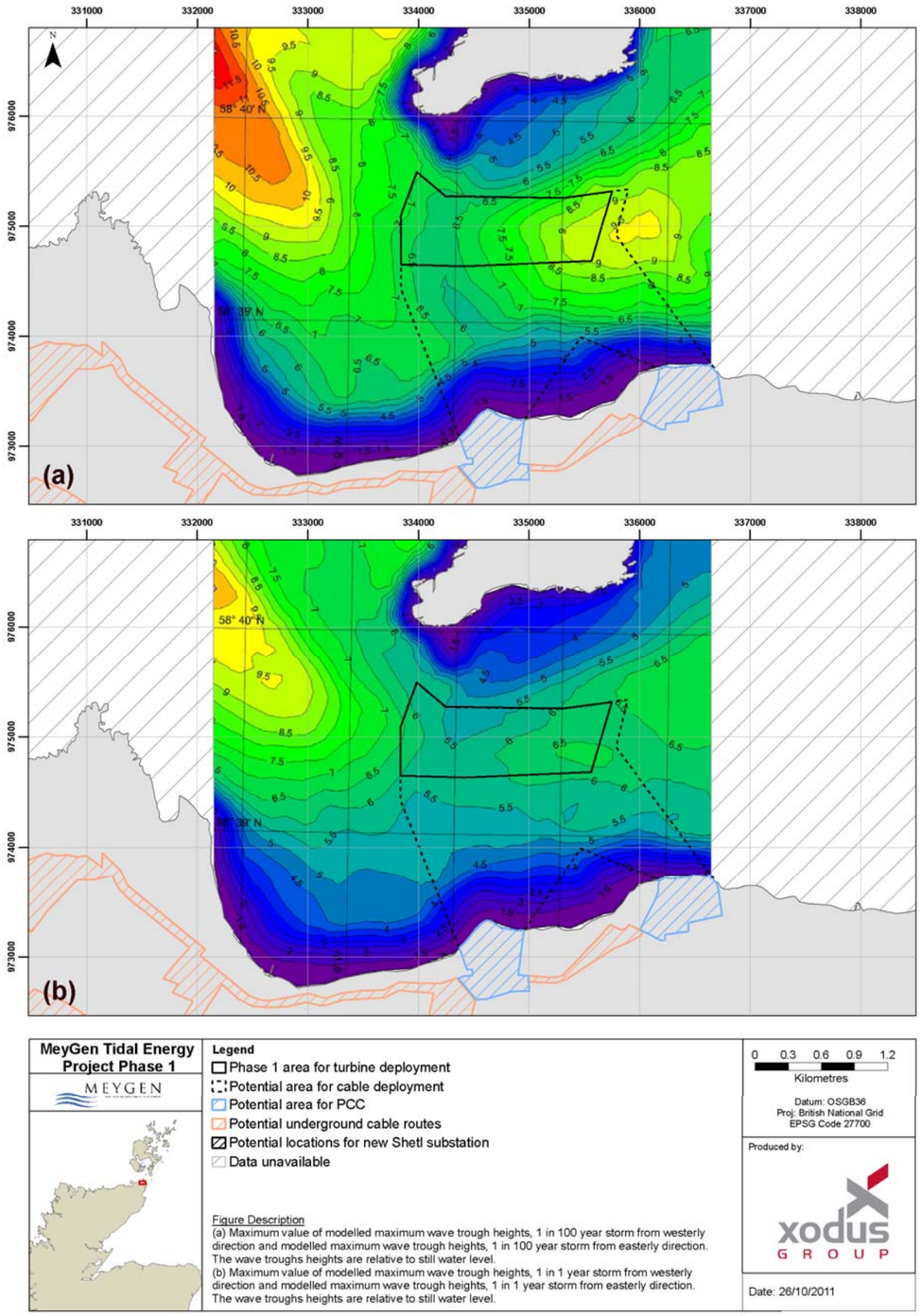

Figure 9.8: Wave modelling results

Extreme wave summary

9.52 Having reviewed data from all available sources and applying judgement based on general physical principles, the following preliminary wave criteria have been established for the MeyGen Agreement for Lease (AfL) area, as shown in Table 9.14. The extreme wave is specified as being from the east in Table 9.14 because the contours in Figure 9.8 show the extreme waves which impact on the Project area as coming most dominantly from the east.

Description	Estimated H_{max}	Estimated T_p
1 in 100 year wave from east	13.5m	14.5s
1 in 10 year wave from east	12.5m	13.0s
1 in 1 year wave from east	11.5m	11.5s

Table 9.14: Derived extreme wave heights for Agreement for Lease area

9.53 An additional analysis has been carried out to derive wave occurrence data for the turbine deployment area (Table 9.15).

Wave height H	Wave period T (at water depth 28m)	Percentage occurrence in 12 months
0.6m	3.3s	65.2%
1.4m	5.0s	20.4%
2.2m	6.3s	8.47%
3.1m	7.6s	3.59%
4.0m	8.9s	1.45%
4.8m	10.0s	0.578%
6.6m	12.7s	0.290%
9.2m	16. 8s	0.0363%
12.7m	22.4s	0.000926%

Table 9.15: Derived wave height, period and frequency statistics

Wave depth of influence

9.54 Wave orbital motions are the oscillatory currents associated with the passage of waves. These cause forwards and backwards movement associated with the passage of crest and trough respectively. Waves typically do not cause a net transport of water but can cause strong instantaneous loads on submerged structures. Wave orbital motions are aligned in the direction of wave propagation.

9.55 The strength of these currents is primarily dependent on the height and length of the wave and the depth of the water. Typically, higher and longer waves will induce orbital motions at greater depths within the water column. The strength of the motion for a given wave diminishes with depth. There are a three established criteria relating the water depth to wavelength, to establish the depth of wave influence (OU, 2008).

9.56 Assuming L=wavelength and d=water depth:

1. $d < L/20$ Shallow water – wave will have significant interaction with bed.
2. $L/20 < d < L/2$ Intermediate water – wave will have some interaction with bed.
3. $d > L/2$ Deep water – wave will not interact with bed in any way.

9.57 The wavelength of a water wave is generally larger for waves of longer wave period, and becomes shorter as the water depth decreases. These two effects are expressed by the following dispersion equation, which allows the wavelength to be calculated from the wave period (where g = 9.81 m s^{-2}, and T is the wave period), following the method of Soulsby (1997).

$$\left(\frac{2\pi}{T}\right)^2 = g\frac{2\pi}{L}\tanh\left(\frac{2\pi d}{L}\right)$$

9.58 Taking the wave criteria which have been established above, estimates have been made of the depth of influence of waves of differing periods in Table 9.16. The lower value T_s = 4s is a typical wave period for the Pentland Firth, while the higher value T_s = 40s is more representative of less frequent long-period swell wave. This is intended to summarise the best and worst case conditions for depth of influence of typical and extreme waves.

Wave period	Water depth throughout lease area (m)		
	d_{max} = 48m	d_{av} = 38m	d_{min} = 28m
$T_{s,min}$=4s	Calculated *L*=25m, therefore water is considered "deep" ([48 > 13], i.e. no wave interaction with the bed).	Calculated *L*=25, therefore water is considered "deep" ([38 > 13], i.e. no wave interaction with the bed).	Calculated *L*=25 therefore water is considered "deep" ([28 > 13], i.e. no wave interaction with the bed).
$T_{s,max}$=20s	Calculated *L*=399m, therefore water is considered "intermediate" ([20 < 48 < 199], i.e. wave will have some interaction with bed).	Calculated *L*=361m, therefore water is considered "intermediate" ([18 < 38 < 181], i.e. wave will have some interaction with bed).	Calculated *L*=316m, therefore water is considered "intermediate" ([16 < 38 < 158], i.e. wave will have some interaction with bed).
$T_{s,max}$=40s	Calculated *L*=850m, therefore water is considered "intermediate" ([43 < 48 < 425], i.e. wave will have some interaction with bed).	Calculated *L*=760m, therefore water is considered "intermediate" ([38 < 38 < 380], i.e. wave will have some interaction with bed).	Calculated *L*=655m, therefore water is considered "shallow" ([28 < 33], i.e. wave will have significant interaction with bed).

Table 9.16: Summary of depth of influence of waves of differing period

9.59 The cells coloured yellow in Table 9.16 show that most waves typical to the Pentland Firth will not cause any oscillatory motion at the seabed, because the water is deeper than the depth of influence of these short-period waves. The cells coloured blue shows that longer period waves will cause some oscillatory motion at the seabed, while the cell coloured grey shows that in the shallowest sites in the Project area, very long period waves will cause significant interaction. However, these waves will occur very infrequently (see Table 9.15).

9.5.6 Wind

9.60 On average, the northern and western parts of Scotland are the windiest in the UK, being fully exposed to the Atlantic and closest to the passage of areas of low pressure. The frequency and depth of these depressions is greatest in the winter half of the year, especially from December to February, and this is when mean speeds and gusts are strongest (Met Office, 2011).

Measured winds

9.61 A Met Mast is maintained on the Island of Stroma by the Environmental Research Institute (ERI), which records wind speed and direction. The location of the station is shown on Figure 9.2. Wind speed and direction data has been analysed from October 2010 and October 2011, and is shown in Figure 9.9.

9.62 At Stroma in the summer months, the average wind speed is in the region of 5ms^{-1}, while peak gusts of up to 27ms^{-1} were measured. In the winter months, the average wind speed is closer to 8ms^{-1}, while peak speeds of up to 36ms^{-1} were measured. The prevailing winds are from the south and west, as shown in Figure 9.9. Between October 2010 and October 2011, the average wind speed was 6.9ms^{-1}, and calm winds were recorded for 0.1% of the time.

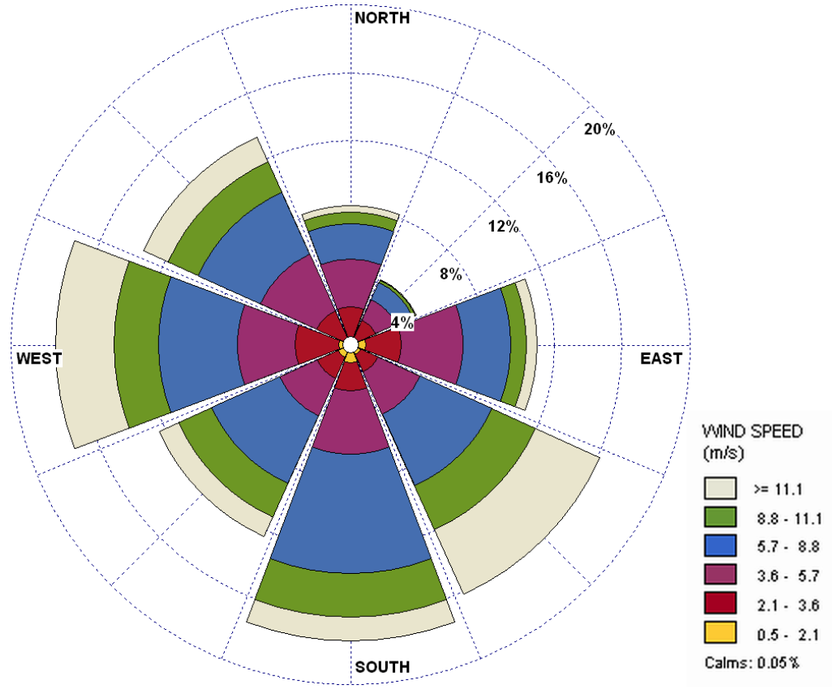

Figure 9.9: Wind rose from the Stroma met mast

Modelled winds

9.63 Maps showing modelled wind speeds throughout UK waters were produced by BERR (BERR, 2008) for the offshore wind industry, using wind data based on hourly model hindcast values over 7 years. The maps show wind speed at a reference height of 100m, which is useful for estimating wind resource, but needs modifying to represent wind speeds at lower heights. This modelled mean wind speed at 100m within the Inner Sound is summarised in Table 9.17 below, but the data is presented for general context to try and illustrate the scale of seasonal variations, rather than to give comparative absolute values.

Time of year	Modelled mean wind speed at 100 m
Annual	8.1m s^{-1}
Spring	8.1m s^{-1}
Autumn	8.7m s^{-1}
Winter	9.4m s^{-1}

Table 9.17: Summary of mean wind speed (BERR, 2008)

9.5.7 Seabed description

Overview

9.64 The British Geological Society (BGS) report that the geology of the Inner Sound is composed largely of exposed Devonian Old Red Sandstone bedrock (RPS, 2009). The 2009 geophysical survey confirmed this, while providing further detail that the majority of the seabed is comprised of current scoured bedrock with patches of sand, megarippled sand and sandbanks with coarse gravel in isolated patches both directly south and southwest of Stroma (iXSurvey, 2009).

Survey summary

9.65 A number of recent surveys have been carried out which can provide insight into the detailed geology and bedform structures of the site. They are summarised as follows:

- Video tows and associated still images taken by Marine Scotland in 2009 and 2010, which provide good general background on the benthic fauna and bed type (Moore, 2009; Moore, 2010);
- A geophysical site survey was undertaken in the Inner Sound in September 2009. A detailed report was produced to accompany the collected data, providing images and interpretation on the side scan sonar and sub-bottom profile records. The salient findings of that report have been summarised in the following text and in Figure 9.12. Further details can be found in iXSurvey (2009); and
- MeyGen commissioned a benthic and seabed sediment survey of the AfL area which was undertaken in 2011. It included collecting sediment grab samples, suspended sediment samples and bedload samples. The quantitative results from this survey are summarised in Table 9.18, Table 9.19 and Table 9.20.

Seabed description

9.66 Within the Inner Sound survey area 70% (7.8km^2) of the seabed is current scoured bedrock exhibiting a sawtooth profile, comprising folded and tilted sedimentary sandstone, flagstone and siltstone. Subrock, defined as rockhead at or near the seabed surface but intermittently covered in thin sediment, forms a further 13% (1.4km^2) of the survey area. A further 10% (1.1km^2) is made of isolated mega-rippled sand or sandbanks with coarse gravel forming 7% (0.8km^2) of the remaining sediments (iXSurvey, 2009). The distribution of these features is shown in Figure 9.12.

9.67 Deep fissures within the bedrock are found throughout the site, most notably in the central and western parts of the survey area. These fissures are up to 10m deep, and they are at their most extensive towards the centre of the survey area south of Mell Head (see Figure 9.12).

9.68 Areas of shell sand accumulation are present in the north-eastern regions of the survey area as well as a localised area in the north-west. These sand bodies rest upon underlying bedrock which is otherwise exposed at the seabed in the remainder of the site. These regions commonly exhibit mega-ripples, of lengths up to 20m and heights of between 0.2 and 0.5m.

9.69 In the far north-east of the survey area two discrete sand waves occur within a large sand bank, with wavelengths up to 140m and heights of 10m. The maximum thickness observed at this sandbank was approximately 15.5m. Likewise in the lee of Mell Head on the Island of Stroma sediments have accumulated to form an extensive sand bank, as shown in Figure 9.10 below.

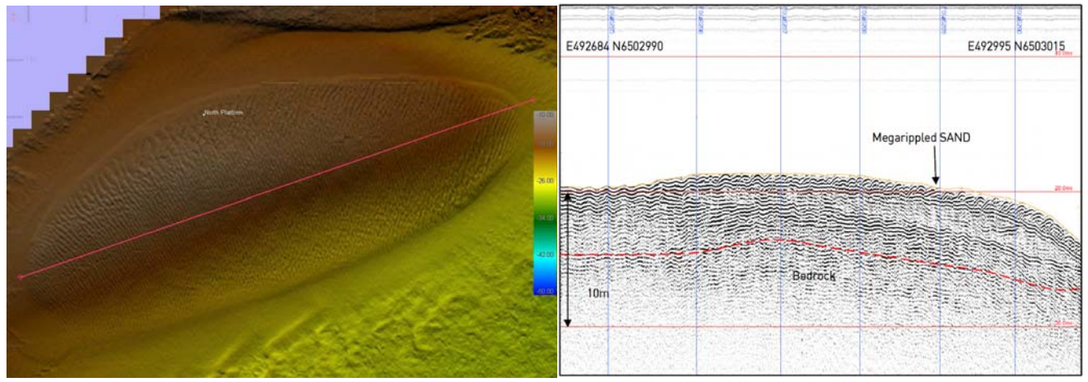

Figure 9.10: Images showing sandbank south of Mell Head (iXSurvey, 2009)

9.70 Deposits of coarse gravel are present in the north-western, north-eastern and eastern parts of the survey area. These deposits directly overlay bedrock and vary in thickness from a veneer, to 5m deep ridges in the far east of the survey area, as shown in Figure 9.11.

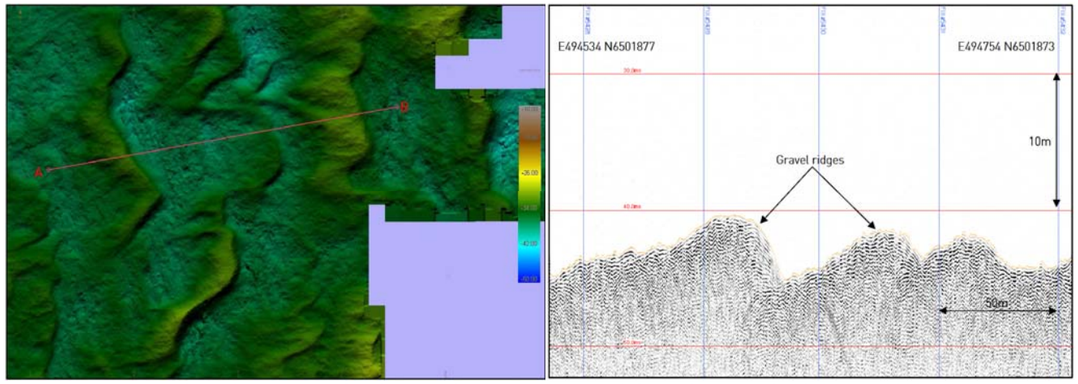

Figure 9.11: Images showing gravel waves to the east of the Project area site (iXSurvey, 2009)

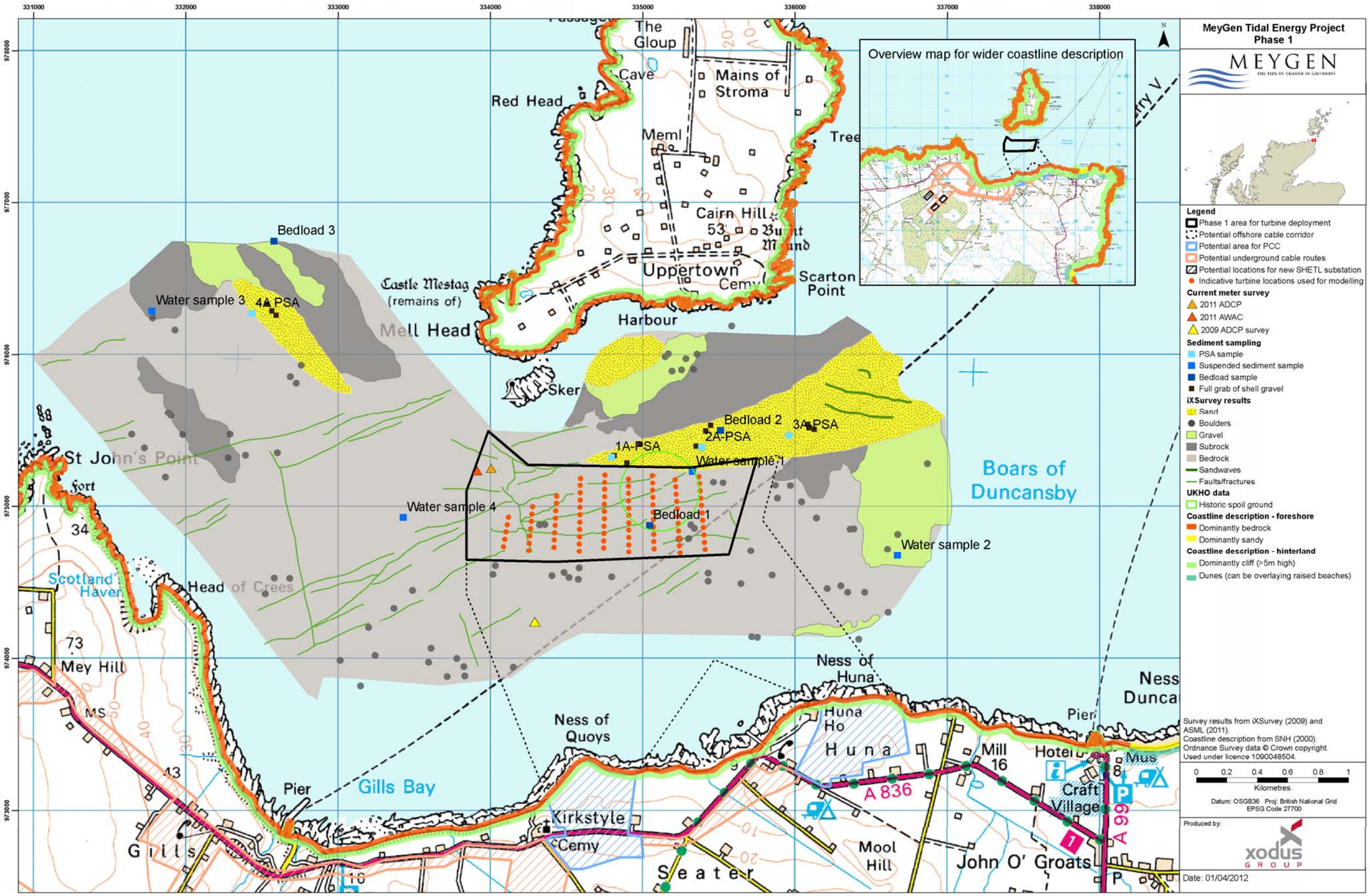

Figure 9.12: Summary of seabed morphology and sampling locations

9.71 The benthic survey included a drop-down video and photographic survey to map the substrata and the epibenthic biotopes, and a selection of images useful for visualising the seabed are shown in Figure 9.13 (ASML, 2011).

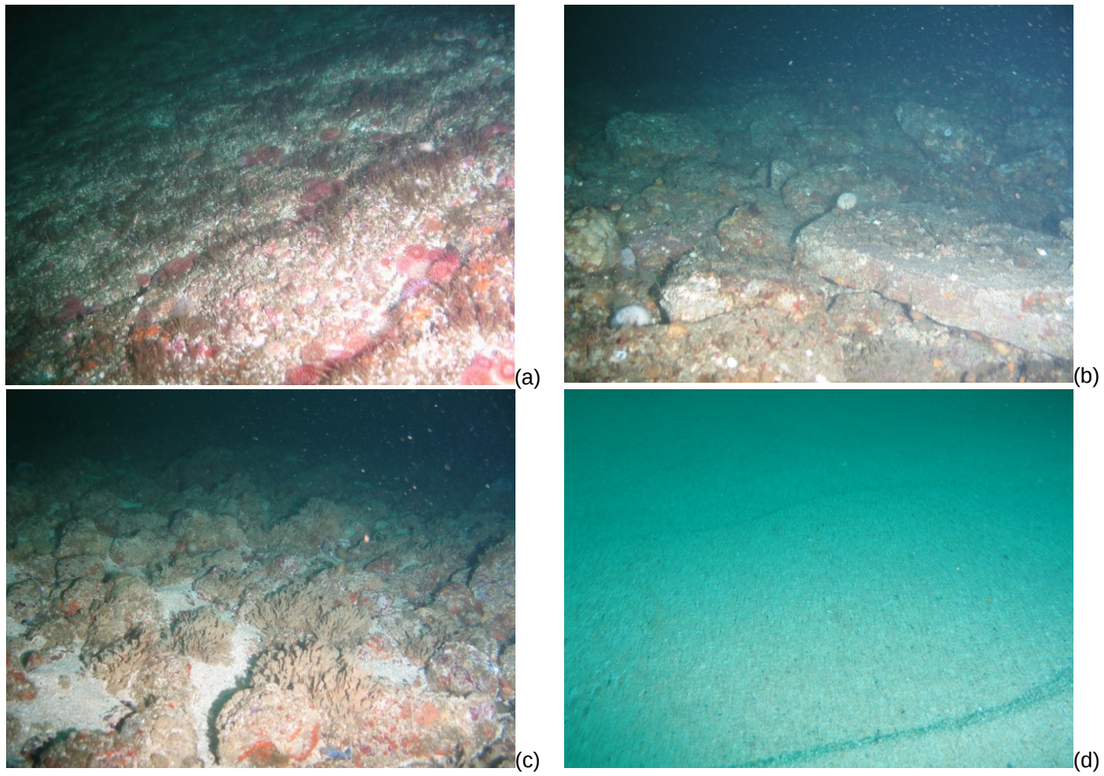

Figure 9.13: Photos of the seabed showing (a) bedrock platform, (b) broken bedrock and boulders, (c) small boulders and cobble and (d) the shell sand bank (ASML, 2011)

Seabed processes and sediment transport

9.72 The Project area is generally devoid of superficial sediments, with the exception of the north-eastern and north-western regions of the site. Where found, sediments range from a coarse gravel veneer to larger mobile accumulations of coarse shell sand. A series of grab samples were taken from the large sediment wedge towards the north-east of the site, and the far west of the survey area as shown in Figure 9.12. These samples were found to consist of very clean shell gravel with little or no organic matter and a particle size distribution dominated by shell granules and very coarse shell sand (ASML, 2011). The results of the particle size analysis undertaken at each site is summarised below in Table 9.18.

Sediment type	Size	Phi	1A-PSA (W sand wedge)	2A-PSA (M sand wedge)	3A-PSA (E sand wedge)	4A-PSA (W sand bank)
			See Figure 9.12			
Medium pebble (gravel)	>8mm	< -3	5.3 %	0%	0%	8.4%
Small pebble (gravel)	4-8mm	-2 to -3	21.52 %	2.46%	8.82%	20.93%
Granule (very fine gravel)	2-4mm	-1 to -2	50.66 %	36.8%	44.03%	45.26%
Sand (very coarse)	1-2mm	0 to -1	22.47 %	56.07%	43.8%	24.77%
Sand (coarse)	500-999µm	1 to 0	0.02 %	4.59%	3.31%	0.61%
Sand (medium)	250-499µm	2 to 1	0.01 %	0.04%	0.02%	0.02%
Sand (fine)	125-249µm	3 to 2	0.01 %	0.01%	0.01%	0.01%
Sand (very fine)	63-125µm	4 to 3	0 %	0.01 %	0.01%	0.01%
Silt & Clay	<63µm	>4	0 %	0.01 %	0%	0%
d50 (estimated)	-	-	4.8mm	2.7mm	3.2mm	4.8mm

Table 9.18: PSA grades for samples throughout Project area (ASML, 2011)

9.73 At higher current speeds, and in coarser sediments, somewhat larger bed forms known as megaripples are produced. The shape of bedform crests are related to flow conditions. Where flows are relatively slow and/or the water is deep, bed forms are linear with long straight crests. At higher current speeds or in shallower water, the crests become progressively more indented until eventually they are broken up into short, curved sections. Fluctuating flows can lead to the superposition of smaller bedforms on larger ones.

9.74 The sand waves and ripples in the Inner Sound are thought to be current-induced. Firstly, because the water depth at the site makes it unlikely waves typical of the region would have any influence at the seabed (Table 9.16). Secondly, the ripples seem to be asymmetric on plan view, which is usually evidence of current-induced ripples (wave-induced ripples tending to be symmetrical on plan view) (OU, 2008).

9.75 This conclusion is strengthened by the findings of the bedload sampling. This survey element was carried out during neap tides, in conditions of relatively low current speeds for the Inner Sound, at various times throughout the tidal cycle. Depth-averaged currents at a nearby moored current meter (shown on Figure 9.12) did not exceed $2ms^{-1}$ throughout the neap period, whereas spring currents can exceed $4.5ms^{-1}$. Weather conditions were benign during the survey, measuring light breezes at most, which means local wind driven waves would have been low at this time.

9.76 A number of bedload samples were collected during benign current conditions above three different types of seabed feature as summarised in Table 9.19, including: the large sand wedge south of Stroma, subrock with a veneer or sediment, and scoured bedrock. As would be expected under normal to low flow conditions, there is very little bedload transport recorded in the samples above bedrock and subrock. Above the sandbank however, there is a measureable flux of sand grains travelling across the sandbank ($28gm^{-1}s^{-1}$). Given the currents at the bed are likely to be in the region of $1ms^{-1}$, this movement of particles supports the theory the sediment features are formed by currents, and are therefore a stable feature within the Sound, rather than temporary storm induced structures.

9.77 Gravel waves are found where the currents are very strong, typically $1.5ms^{-1}$, so the gravel waves in the east of the Sound are also thought to be current-induced (Pugh, 1996).

9.78 Finally, to confirm the generally stable nature of the sediment features within the Inner Sound, a comparison was made between the geophysical survey carried out in 2009, anecdotal evidence of a previous survey carried out in 2008, and the Admiralty Chart bathymetry which was collected in 1984. The comparison indicated that the large sand body in the north-east of the site had not migrated to any significant degree (iXSurvey, 2009). A large storm event might cause a short term disturbance of the sediment distribution, but the large scale characteristics of the Sound including the high current scouring and the relatively reduced currents in the lee of Mell Head, are likely to redistribute the sediments bedforms to their pre-storm state (Easton, 2011).

Variable	Bedload 1 (bedrock)	Bedload 2 (sand wedge)	Bedload 3 (gravel bank)
	See Figure 9.12		
Date and time of sample	25/07/2011 16:28	25/07/11 16:52	27/07/11 13:49
Depth averaged current speed at AWAC	$1.7ms^{-1}$	$1.7ms^{-1}$	$1.9ms^{-1}$
Approximate current speed 1m above bed	$1.1ms^{-1}$	$1.1ms^{-1}$	$1.1ms^{-1}$
Depth-averaged current direction at AWAC	124°N (flood)	124°N (flood)	268°N (ebb)

Sample time relative to high water (HW)	HW-2	HW-2.5	HW-7 (or LW+1)
Current description	Approaching peak flood	Approaching peak flood	Leaving peak ebb
Mass of particles with diameter <63µm	0.0685g	0.0134g	0.0257g
Mass of particles with diameter >63µm	2.3619g	713.3778g	3.9887g
Bedload transport ($gm^{-1}s^{-1}$)	$0.25gm^{-1}s^{-1}$	$28.20gm^{-1}s^{-1}$	$0.30gm^{-1}s^{-1}$

Table 9.19: Bedload concentrations measured in the lease area (ASML, 2011)

9.5.8 Coastline

9.79 Much of the coastal section around the Project area is marked by cliffs between 5 to 10m high, with a platform of nearly flat-lying slabs exposed in the littoral zone at the cliff foot, as summarised in Figure 9.12. The cliff sections are usually vertical to sub-vertical, with a sloping vegetated bank section at the top, and include good exposure of the local bedrock.

9.80 Beyond the eastern end of the Project area on the mainland are the sheer cliffs at Duncansby Head, which are cut in Old Red Sandstone and rise up to 70m in height. Natural coastal erosion at these cliffs has produced stacks, sea arches and caves. Similar cliffs are seen to the west of the site at Dunnet Head, which reach over 90m in height.

9.81 In areas where cliff exposures are absent, the back wall of the beach is formed by a usually steep, vegetated bank of between 2 and 15m in height. These areas tend to have more beach development, composed largely of cobbles and boulders up to 2m in length.

9.82 Despite the Caithness coast having some of the most abundant sand dune systems in the UK, there are no identified coastal sand dunes flanking the Project site. The shoreline is relatively uniform, with minor indentations caused by local erosion along the lines of joints, faults or dykes (Barne *et al*, 1996).

9.83 At the eastern end of the coast particularly between the Bay of Sannick and Gills Bay, beach areas have developed in between breaks in the rock platform and rock reefs which outcrop in the intertidal zone. Beach sediments here are sparse with thin sand beaches formed in gaps between the intertidal rock platforms. The beach material is predominantly derived from shell material. At present shell material still provides a very slow feed of sediment to these beach areas. There is little sand offshore of the regions, as any glacial deposits have been swept off the seabed by the strong tidal currents; hence there has not been a suitable supply of beach material from offshore glacial deposits to allow larger beaches to form along this coastline (SNH, 2000b).

9.84 The beaches around the Project area are relatively stable with respect to long term processes. Storm erosion will periodically occur but sediment will remain within the beach system (SNH, 2000b).

9.85 For further details on coastline description, see Section 17 and the report of Flett Brown (2009).

9.5.9 Water quality

9.86 The marine and inshore water quality in Scotland is considered to be generally good. The nearest bathing water sites to the proposed development are Dunnet and Thurso, both of which are classified as having excellent water quality (SEPA, 2011).

9.87 Fish farming can cause elevated concentrations of certain compounds and organic enrichment in seawater and seabed sediments. However, there are no shellfish or aquaculture sites near the Inner Sound (Xodus, 2011).

9.88 Suspended sediment samples were taken at a mid-depth in the water column above four different types of seabed feature, including the large sand wedge south of Stroma, the gravel bank at the east of the site, subrock with a veneer or sediment, and scoured bedrock, as summarised in Table 9.20. Despite each sample being collected at a different state of the tide and above a different seabed feature, all the samples show consistent absence of any significant suspended sediment concentration, the maximum being $14mgl^{-1}$. To put the results in context, the limit of detection of the sampling equipment is $1mgl^{-1}$. The particles in suspension are likely to be very fine, since the concentrations are consistent across the survey area, and do not settle out as the current speed decreases.

Variable	Water sample 1 (SS) (sand wedge)	Water sample 2 (SS) (gravel bank)	Water sample 3 (SS) (subrock)	Water sample 4 (SS) (bedrock)
	See Figure 9.12			
Latitude (WGS84) (deg)	58.6601 °	58.6553 °	58.669 °	58.6570 °
Longitude (WGS84) (deg)	-3.1164 °	-3.0931 °	-3.1779 °	-3.14907 °
Date and time	25/07/11 17:20	26/0711 08:29	26/07/11 15:10	27/07/11 12:10
Depth averaged current speed from AWAC	$1.5ms^{-1}$	$0.5ms^{-1}$	$0.3ms^{-1}$	$2.0ms^{-1}$
Approximate current speed at 1m above bed	$1.1ms^{-1}$	$0.2ms^{-1}$	$0.2ms^{-1}$	$1.ms^{-1}$
Depth-averaged current direction from AWAC	126°N (flood)	144°N (flood turning to ebb)	206°N (ebb turning flood)	270°N (ebb)
Sample time relative to high water (HW)	HW-1.5	HW+1	HW-5	HW+4
Current description	Peak flood speed	Approaching slack water	Slack water	Approaching peak flood
Water depth of sample (to CD)	35m	32m	34m	31m
Approximate depth sample taken at	17m	16m	17m	16m
Suspended Sediment Concentration	$10mgl^{-1}$	$14mgl^{-1}$	$11mgl^{-1}$	$12mgl^{-1}$

Table 9.20: Suspended sediment concentrations measured in the Project area (ASML, 2011)

9.89 The disused Gills Bay disposal site is located within the area of the proposed MeyGen development (see Figure 9.12). The site was once used for the disposal of dredge spoil, predominantly sandy material, following maintenance/capital dredging at the nearby ports of Scrabster and Gills Bay. The high current velocities and scoured rock topography of the region suggests that the spoil is likely to have dispersed rapidly (RPS, 2009), and the 2009 geophysical survey confirmed that there were no identified deposits relating to the disposal site (iXSurvey, 2009).

9.90 Munitions contamination within the proposed development is considered unlikely. The study area does coincide with the WWII Northern Mine Barrage area between the northern coast of Scotland and the Orkneys / Faeroes. The entire area was comprehensively swept for mines at the end of the war. However, as some mines were fitted with a clock, which after a pre-determined time caused a scuttling charge to be detonated and sink the mine, the possibility that some mines which scuttled themselves are still on the seabed in the region where the barrage coincides with the study area cannot be entirely discounted (Xodus, 2011).

9.91 The Dounreay nuclear site, located approximately 40km to the west by sea from the proposed MeyGen development, was responsible for the release of an unknown quantity of nuclear particles between the 1950s and 1970s. These particles have been identified in seabed sediments as far away as Dunnet Beach, approximately 15km to the west of the Inner Sound.

9.92 The main source of information on environmental radioactivity is the series of reports on Radioactivity in Food and the Environment (RIFE) published by the various UK Environment Agencies. The most recent report (RIFE, 2010) shows typical levels of gross alpha activity of the order of 100-600 $Bqkg^{-1}$ and gross beta activity of 400-1500$Bqkg^{-1}$ in UK coastal sediments. These compare to the results in the Inner Sound grab samples summarised in Table 9.18 of <55$Bqkg^{-1}$ (gross alpha) and <100$Bqkg^{-1}$ (gross beta). It can be seen that the results presented are well below typical national figures, due to the high level of shell in the sediment (Davidson, pers. com. Centre for Radiation, Chemical and Environmental Hazards, Health Protection Agency, Monitoring Services Manager).

9.93 The gamma spectrometry indicates the levels of caesium-137 are below 0.1$Bqkg^{-1}$. From this result, combined with the low gross alpha and gross beta results, it can be concluded that there is no evidence of contamination in any of these samples from artificial radioactivity (Davidson, pers. com. Centre for

Radiation, Chemical and Environmental Hazards, Health Protection Agency, Monitoring Services Manager).

9.6 Impacts during Construction and Installation

9.94 The impact assessment is based on the worst-case construction and installation options. For seabed morphology, this is the drilled monopile TSS for 86 turbines, and 86 HDD bores.

9.6.1 Impact 9.1: Change in bed morphology from drill cuttings discharge

Pile drilling

9.95 Mono-pile drilling operations will generate rock cuttings and these will be discharged from the drilling rig into the marine environment. Drilling operations will take approximately 4 hours per pile and a total of 30 hours to complete the preparations for each TSS. Seawater (with no additives) will be used as the drilling fluid to lubricate the drill bit and aid in the removal of cuttings from the hole. A compressor will be used to pump air into the drilled holes in order to lift the cuttings clear as required. This compressor will use a lubricant which will be discharged to sea along with any cuttings to a maximum 17,200m^3 for all 86 turbines installed over a 3 year period.

HDD drilling

9.96 The cables to shore will be routed through bores directionally drilled through the cliffs onshore. Assuming a worst case scenario of 29, 600mm bores, 700m in length. These will generate approximately 195m^3 of drill cuttings per bore; a total volume of 5,655m^3 for 29 bores. These will be collected from the bore at the drilling site onshore. As drilling is occurring from the onshore end, there may be some loss of cuttings to the marine environment upon breakthrough to the seabed. In the worst case scenario, the final 10m of the bore will be lost into the marine environment; a total of 82m^3 for all 29 bores.

9.97 The consequence of both HDD and monopole drilling operations is that the largest and heaviest particles will settle relatively quickly to the seabed in the close vicinity of the drilling centre, while the finer particles will be swiftly transported and dispersed by the highly energetic currents and waves in the Inner Sound. It is likely any particles with a settling velocity greater than the resupension and lift forces exerted by the tidal currents will be transported away under storm conditions. Drill cuttings' modelling has not been carried out as part of this EIA, because the environment is known to be so dispersive.

9.98 Under calm weather conditions, the prevailing current flow and the distance to shore means it is very unlikely the cuttings will be washed ashore. There will also be a length of time between each pile being drilled which will allow for dispersion time between each discharge event.

9.99 The dynamic environment (resulting from intense wave action and tidal activity) into which the operational discharge will be released means that drill cuttings will be dispersed into the wider marine area; the Pentland Firth is one of highest energy coastal environments in the UK. The lack of sediment across the Project installation area and the likely cable corridors indicates a dynamic environment on which solids are unlikely to accumulate. Indeed, anecdotal evidence that spoil has been dispersed from the disposal site in the centre of the site further confirms this. Natural turbulent conditions should ensure any deposition on the seabed is quickly dispersed and does not accumulate into large deposits. Naturally occurring material (including rock and other debris) is constantly moved around by tide and wave action ordinarily and, as such, the addition of rock debris is unlikely to be an unusual event. The bedload information collected by ASML (2011) and presented in Section 9.5.7 confirms the presence of such material under normal conditions.

9.100 Evidence from shallow waters of the southern North Sea, where wave and tidal movements greatly influence the marine environment, suggests that erosion rates are greater than natural sedimentation rates and that cuttings piles are dispersed (e.g. Kjeilen *et al.*, 1999).

9.101 In summary, drill cuttings piles will disperse rapidly, any short-term increases in suspended sediment concentration or scattered rock fragments on the seabed is not considered a significant impact to the physical environment or local sediment dynamics. The increased debris levels are only likely to be present for a short period of time before dispersion and transport processes return concentrations to their baseline condition. The main channel of the Inner Sound is known to be scoured bedrock, exhibiting deep fissures and cracks which have been generated through natural processes. This indicates that the spoil from any piling activities will also be dissipated.

9.102 The sensitivity of the receptor to the discharge of drill cuttings and fluid is assessed as negligible as the environment is considered to be highly tolerable of change. The impact will be of short term duration and due the dynamic environment dispersing any discharges relatively rapidly any changes will be imperceptible in comparison to the baseline conditions. Therefore, the magnitude of the impact is also considered to be negligible.

Impact Significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Negligible	Negligible	Negligible	Not Significant

MITIGATION IN RELATION TO IMPACT 9.1
▪ No mitigation measures proposed as no significant impact predicted.

9.6.2 Impact 9.2: Displacement of sediment resulting in alteration or loss of bedform and morphology

9.103 Sediment and existing bedforms may be disturbed during any of the following construction activities:

- Monopile or pin pile drilling for the TSS;
- HDD bore breakthrough; and
- Cable laying.

9.104 There is very little sediment in the Project area (see Figure 9.12), the seabed is largely current scoured bedrock, so there are not expected to be any indirect effects through sediment resuspension from piling activities. The nearest bedform to the turbine array is the large sand wedge which borders the north-eastern edge of the Project area, formed where the current speeds decrease significantly away from the main channel through the Sound. In their present nominal location, some turbines will be less than 50m from this sand wedge. Grab samples taken from nearby regions of the sand wedge found coarse sediments ranging from very coarse sand to small pebbles (on the Wentworth, 1922 scale). Any sediment displaced as a result of piling is likely to rapidly return to the seabed and settle within meters of the disturbance.

9.105 The HDD bores will not be emerging near any known bedforms, so there is not expected to be any impact from that process.

9.106 There is the potential for the installed cables to alter any seabed bedforms on the site via alteration of near bed hydrodynamic and sedimentary processes. However, the cable corridor is largely composed of exposed bedrock and nearer shore, kelp forests. The only known sedimentary feature near the cable corridor is a small (0.03km^2) patch of gravel approximately 500m north of the Ness of Huna. The coarse grain size of this gravel (4-8mm) means that any sediment displaced as a result of the cable laying process is likely to rapidly return to the seabed and settle within meters of the disturbance. To provide additional cable stability, MeyGen intend to lay the cable as much as possible within the natural fissures and crevices in the site bedrock. A consequence of this is that the cable will present the smallest possible ridge obstruction to near-bed hydrodynamics and bed processes, thereby reducing potential impacts.

9.107 The sensitivity of the receptor to the displacement of sediment resulting in alteration or loss of bedform and morphology is assessed as negligible as the environment is considered to be highly tolerable of change. The impact will be of short term duration and due to the dynamic environment little sediment will

be present in the Project area that will be displaced. Any changes will be imperceptible in comparison to the baseline conditions. Therefore, the magnitude of the impact is also considered to be negligible.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Negligible	Negligible	Negligible	Not Significant

MITIGATION IN RELATION TO IMPACT 9.2
▪ No mitigation measures proposed as no significant impact predicted.

9.6.3 Impact 9.3: Change in water quality

9.108 Suspended sediment concentrations may increase or bedforms may be disturbed and resuspended into the water column increasing suspended sediment concentrations, as described in Impact 9.1 and Impact 9.2, during any of the following construction activities:

- Pin pile or monopile drilling for the TSS;
- HDD bore breakthrough; and
- Cable laying.

9.109 The large tidal resource of the area means that any increases in suspended sediment will be quickly dispersed into the wider marine area, as described in Impact 9.1 and Impact 9.2.

9.110 The environment is considered to be tolerable of changes to water quality due to its dynamic nature. As a result the sensitivity of the receptor is assessed as low. The impact will be of short term duration during construction and while it will be a detectable change the change would be temporary and would cease on completion of construction activities. Therefore, the magnitude of the impact is considered to be minor.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Low	Minor	Minor	Not Significant - however will require some management to ensure remains within acceptable levels

MITIGATION IN RELATION TO IMPACT 9.3
▪ Although no significant impact has been identified, mitigation measures have been provided on a precautionary approach to ensure this remains the case. ▪ Minimise as far as practicable the depth and diameter of the turbine foundation piles (without compromising technical performance); ▪ Minimise as far as practicable the volume of drill cuttings released into the marine environment during breakthrough of HDD bores, by implementing a closed loop recycling system to return drill cuttings and fluid from the HDD to shore.

9.7 Impacts during Operations and Maintenance

9.111 The impact assessment is based on the potential 'maximum' operation and maintenance parameters. For the physical environment, this is 86 turbines.

9.7.1 Impact 9.4: Change in hydrodynamics

9.112 Once the turbines are fully installed and operating, the hydrodynamic modelling study shows that there would be a flow separation around the tidal array. Current speeds will marginally increase to the north and south of the array, while through the array itself speeds will decrease.

9.113 The plots in Figure 9.14(a)-(c) show under calm conditions (a) mean current speed before array installation, (b) mean current speed after 86 turbines installed, (in which the flow separation around the array is clear), (c) the difference between the mean currents before and after array installation. The small region of blue running through the middle of the Sound shows how the modelled mean flows in this region are reduced by between 0 and 0.4ms^{-1} after the installation of the array, while the yellow patches to the north and south indicate that the mean flow is expected to increase here by between 0.1 and 0.2ms^{-1}.

9.114 The plots in Figure 9.14(d)-(f) show under calm conditions (d) max current speed before array installed, (e) max current speed after 86 turbines installed (in which the flow separation around the array is clear), (f) the difference between the max currents before and after array installation. The large region of blue running through the middle of the Sound shows how the maximum modelled flows in this region are reduced by between 0 and 1ms^{-1} after the installation of the array, while the yellow patches to the north and south indicate that the maximum flow is expected to increase here by between 0.1 and 0.8ms^{-1}.

9.115 The same patterns can be observed in Figure 9.15(a)-(f) which shows the mean and max currents from a worst case easterly storm, and Figure 9.16(a)-(f) which shows the mean currents from a worst case westerly storm. The conclusions are much the same as for the calm condition, except that as would be expected, the extent and magnitude or the differences are greater under storm conditions.

9.116 It is worth recalling (from Section 9.4.4) that the model is depth-averaged, so the predicted current speed increases and decreases presented here are likely to be conservative for surface currents, since the model does not consider the vertical flow fields and the fact that there will be a minimum of eight meters of clear water above the turbines.

9.117 In conclusion, the hydrodynamic model runs "with turbines" do not show an overall increase or decrease in current speeds through the Inner Sound, rather a relocation of the regions of higher and lower speed. It is important to make this point, because although the high flow channels may be displaced once the array is installed, the overall flow extremes should not change significantly.

9.118 The environment is considered to be tolerable of changes in hydrodynamics and the sensitivity of the receptor is assessed as negligible. There would be a material change to the hydrodynamics of the environment. However, the change would not be substantial as the overall hydrodynamic environment is not altered and the there is no overall significant increase or decrease in current speeds through the Inner Sound. Therefore the magnitude of the impact is considered to be moderate.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Negligible	Moderate	Negligible	Not Significant

MITIGATION IN RELATION TO IMPACT 9.4
▪ No mitigation measures proposed as no significant impact predicted.

9.7.2 Impact 9.5: Change in wave height

9.119 It is possible that the once the turbines are operating, they will effect the wave regimes within and around the Project site.

9.120 The introduction of the array is not predicted to have a significant effect of the overall significant wave height (H_s) in and around the Project site. The wave modelling study predicts that H_s will marginally increase to the north and south of the array, while over the array itself H_s is predicted to decrease.

9.121 The plots in Figure 9.17(a)-(c) show for a two day continuous storm coming from the west: (a) max H_s before array installed, (b) max H_s after 86 turbines installed, (c) the difference between max H_s before and after array installation. The large region of blue to the west of the array in (c) shows that during a westerly storm, the presence of the full 86 turbine array is predicted to relocate part of the wave field, leading to an apparent decrease in incoming wave heights by between 0 and 2m, due to wave-current interaction. Equally, a region of higher waves is predicted to be relocated to the eastern side of the array, because the array is expected to reduce current speed downstream of the turbines, and while the currents are propagating with the waves the waves tend to become flattened, so a reduction in the ambient current speed will reduce this flattening effect causing the wave height to increase.

9.122 The plots in Figure 9.17(d)-(f) show for a two day continuous storm coming from the east: (a) max H_s before array installed, (b) max H_s after 86 turbines installed, (c) the difference between max H_s before and after array installation. The same redistribution of H_s is seen as described above.

9.123 It is worth noting that the storm conditions modelled here are extremely conservative, that is 14 days of continuous strong wind, waves and currents, which will give an extreme worst case storm result. Some of the wave heights output from the modelling study are comparable to heights which are expected for less than 0.05% of the year in the Inner Sound (Table 9.15), which shows the infrequency of these expected events.

9.124 In terms of overall impact, the conclusions of the wave modelling are very similar to those from the hydrodynamic modelling. There is no overall increase in max H_s throughout the Sound, the region of max H_s just moves north and south of the array, without changing much in magnitude. It is important to make this point, because although the location of max H_s may change once the array is installed, the overall wave extremes should be largely unaffected. Similarly, any such changes in the wave regime would only be noticeable over the short period for which the storm event occurred.

9.125 The environment is considered to be highly tolerable of changes in wave height and the sensitivity of the receptor is assessed as negligible. The modelling demonstrates there would be a material change to the wave heights in the area but the change would not be substantial as there is no overall increase or decrease in wave heights within the Inner Sound. Therefore the magnitude of the impact is considered to be moderate.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Negligible	Moderate	Negligible	Not Significant

MITIGATION IN RELATION TO IMPACT 9.5
▪ No mitigation measures proposed as no significant impact predicted.

9.7.3 Impact 9.6: Change in sediment dynamics

9.126 It is possible that the once the turbines are operating, they will effect the hydrodynamic and wave regimes enough to change the sediment dynamics of the Project site.

9.127 The morphology modelling study predicted that there will be no significant impacts to the sediment dynamics and bedforms following the installation of the tidal array. There is a natural movement of sediments as would be expected in a site exposed to strong tidal currents, but the array is not predicted to affect these processes significantly. A study exists which concludes that most of the bedforms in the Inner Sound change shape between flood and ebb tide, so some movement is normal (Easton, 2011).

9.128 The plots in Figure 9.18(a)-(c) show under calm conditions (a) erosion/sedimentation before array installed, (b) erosion/sedimentation after 86 turbines installed, (c) the difference between the erosion/sedimentation before and after array installation. The interpretation of Figure 9.18(a) is that even under calm conditions and with no turbines, the bedforms show evidence of movement, but not in a way which is significant. The pattern of red and yellow patches is characteristic of sand simply shifting backwards and forwards under the flooding and ebbing tide, but there is no evidence of bedform migration or net sediment transport.

9.129 The key plot here is Figure 9.18(c), which shows that under calm conditions, the addition of the array is predicted to make little or no difference to the existing bedform structures. The large characteristic sand wedge bordering the north-eastern extent of the Project area does not migrate, there are just small (±0.2-0.5m) differences in bed height, which are normal for a dynamic sediment bedform up to 15m deep in places.

9.130 The plots in Figure 9.18(d)-(f) show under calm conditions (a) mean bedload transport before array installed, (b) mean bedload transport after 86 turbines installed, (c) the difference between the mean bedload transport before and after array installation. The interpretation of Figure 9.18(d) is that even under calm conditions and with no turbines, bedload transport is predicted to occur, as the bedload sampling indicated (see Section 9.4.7 and DHI, 2011). The orange, yellow and green patch just north of the Project area shows that, as would be expected, sand enters suspension above the sand bank. However, it is not transported away from the bedform, it is simply shifted backwards and forwards under the flooding and ebbing tide. There is no evidence of net bedload transport away from the existing bedforms.

9.131 The same patterns can be observed in Figure 9.19(a)-(f) which shows the bed change and bedload transport from a worst case easterly storm, and Figure 9.20(a)-(f) which shows the bed change and bedload transport from a worst case westerly storm. The conclusions are much the same as for the calm condition, except that as would be expected, the extent and magnitude of the differences are greater under storm conditions. Any sediment displaced during storm activity is expected to return to its equilibrium state after a few days, as also found in an independent modelling study (Easton, 2011).

9.132 In conclusion, the erosion/deposition and bedload transport results do not show any significant impacts on the existing sediment dynamics. Sediment movement is normal under storm conditions.

9.133 The environment is considered to be highly tolerable of changes in sediment dynamics due to a lack of net sediment transport in the Project area. Therefore, the sensitivity of the receptor is assessed as negligible. The modelling demonstrates there would be little change to the sediment dynamics regime and any changes would be non-material changes. As a result the magnitude of the impact is considered to be minor.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Negligible	Minor	Negligible	Not Significant

MITIGATION IN RELATION TO IMPACT 9.6
▪ No mitigation measures proposed as no significant impact predicted.

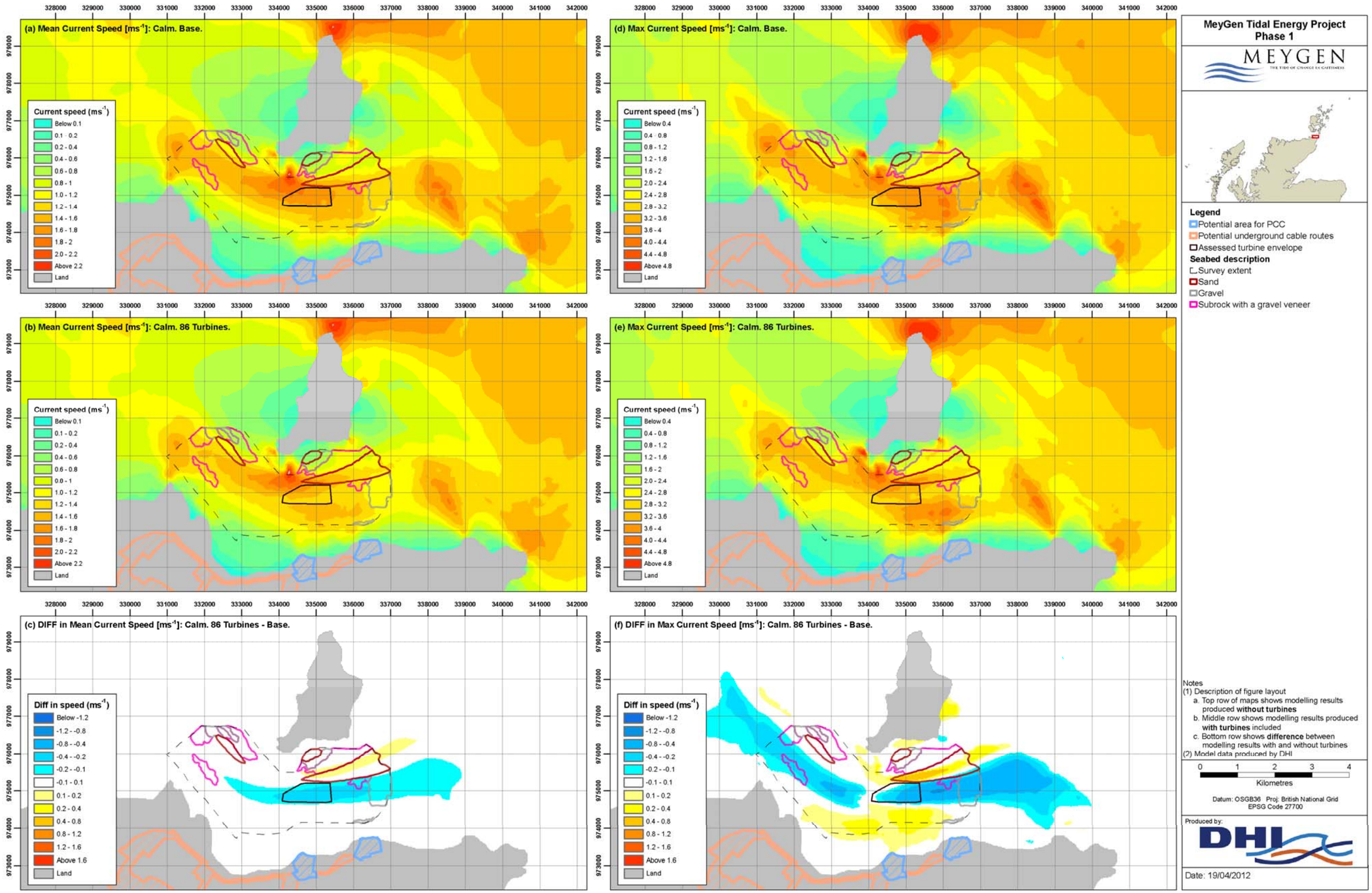

Figure 9.14: Modelling results showing difference in current speeds after the addition of the 86 turbines, calm scenario, (a), (b) and (c) mean current speed, (d), (e) and (f), max current speed

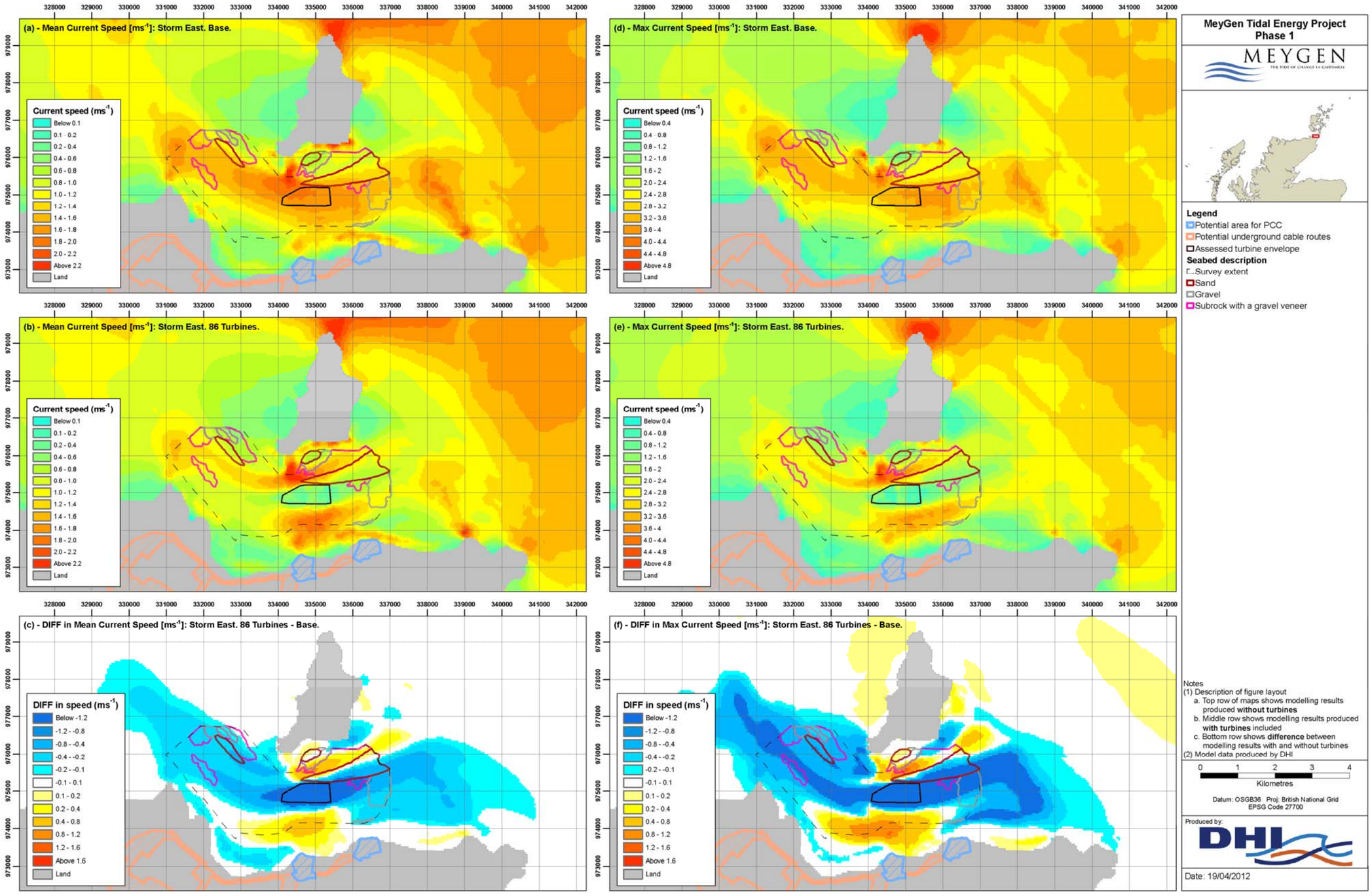

Figure 9.15: Modelling results showing difference in current speeds after the addition of the 86 turbines, easterly storm scenario, (a), (b) and (c) mean current speed, (d), (e) and (f) max current speed

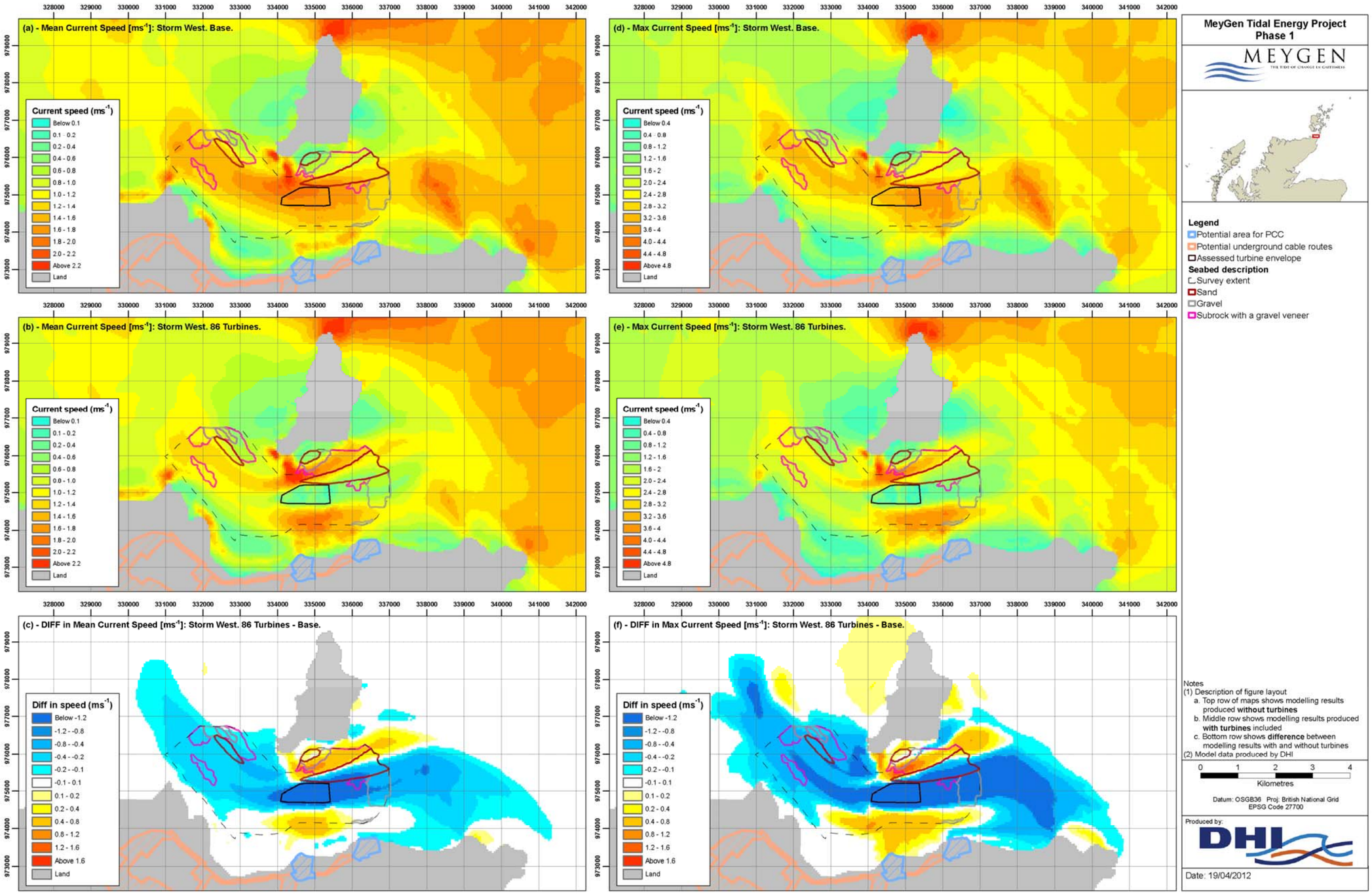

Figure 9.16: Modelling results showing difference in current speeds after the addition of the 86 turbines, westerly storm scenario, (a), (b) and (c) mean current speed, (d), (e) and (f) max current speed

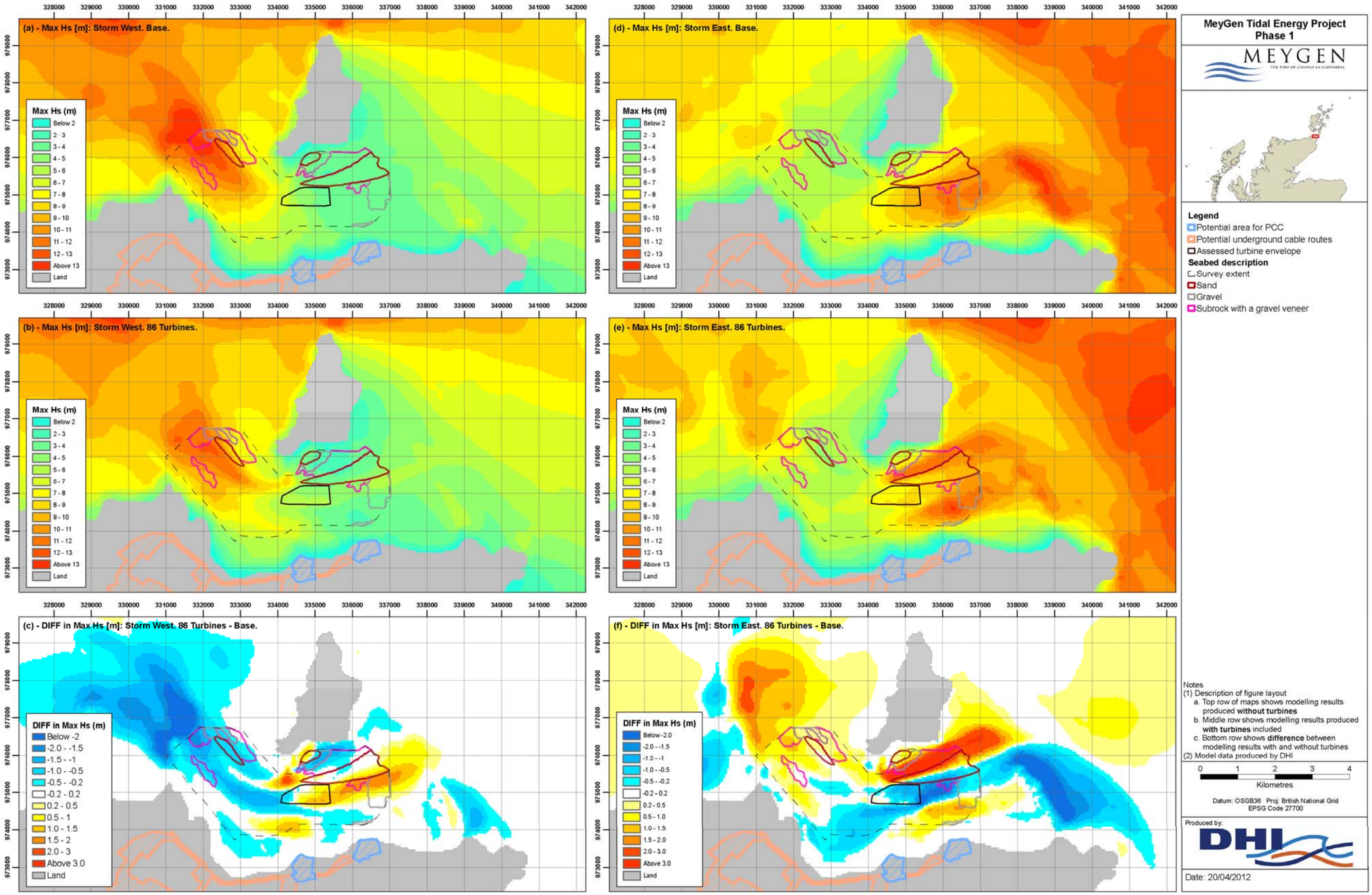

Figure 9.17: Modelling results showing difference in max wave height H_s after the addition of the 86 turbines, (a), (b) and (c) westerly storm scenario, (d), (e) and (f) easterly storm scenario

9.7.4 Impact 9.7: Erosion of the coastline

9.134 There are two sites of coastal importance near to the Project area, John o' Groats SSSI and GCR, and Duncansby Head SSSI and GCR. It is possible that the installation of the tidal array could change the hydrodynamics and waves at these designated sites, and increase coastal erosion.

9.135 The morphology modelling study predicted that there will be no significant impacts to the coastline following the installation of the tidal array.

9.136 The changes to the hydrodynamic and wave regime described previously (Impact 9.3 and Impact 9.4) largely occur in the channel area of the Inner Sound, and do not impact the coastline (see Figure 9.11 (c) & (f), Figure 9.12 (c) & (f) and Figure 9.13 (c) & (f)), therefore no changes at the coastline should be expected. The morphology results confirm this (see Figure 9.14 (c) & (f), Figure 9.15 (c) & (f) and Figure 9.16 (c) & (f)).

9.137 Both sites are undergoing natural coastal erosion due to the high energy environment they are exposed to. The installation of the array is not expected to increase or decrease the rate of erosion of these natural processes.

9.138 The John o' Groats SSSI and GCR, and Duncansby Head SSSI and GCR are of high environmental value and are therefore considered to be of high sensitivity. The modelling demonstrated that there would be no changes to the coastline once the tidal array is operational and the magnitude of the impact is considered to be negligible.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
High	Negligible	Minor	Not Significant

MITIGATION IN RELATION TO IMPACT 9.7
▪ No mitigation measures proposed as no significant impact predicted.

9.8 Impacts during Decommissioning

9.139 The potential impacts during decommissioning are expected to be, at worse of the same nature and magnitude as those during the installation and construction phase.

9.8.1 Impact 9.8: Displacement of sediment resulting in alteration or loss of bedforms and geomorphology

9.140 Sediment and existing bedforms may be disturbed during any of the following construction activities:

- Removing the TSS from seabed.
- Cable retrieval.

9.141 The impacts described here will be the same as those described in Impact 9.2.

9.142 There is no change anticipated to the status of the geomorphology of the sound both at the coast and on the seabed as a result of Decommissioning. The magnitude of impacts on geomorphological processes will be low with a possible short term localised disturbance to existing bedforms.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Negligible	Negligible	Negligible	Not significant

MITIGATION IN RELATION TO IMPACT 9.8
▪ No mitigation measures proposed as no significant impact predicted.

9.9 Impacts to Designated Sites

9.143 Referring back to Section 9.5.1, the following designated sites were identified as being within 5km of the Project site:

- John o' Groats SSSI and GCR;
- Duncansby to Skirza Head GCR; and
- Duncansby Head SSSI.

9.144 All of the designated sites which were identified are coastal, so in keeping with the fact that no impacts are predicted at the coastline, none of the designated sites are predicted to be impacted.

9.10 Potential Environmental Variances

9.145 The impact assessment above has assessed the worst case Project options with regards to impacts to the physical environment and sediment dynamics. This section provides a brief overview of the potential variances between the worse case Project option assessed and alternative Project options.

9.146 Not considered worst case for the physical environment and sediment dynamics was the option of a pin pile TSS. The installation methods for pin pile TSS would have a lesser impact compared to the installation of the monopile TSS since it would produce less drill cuttings.

9.147 The modelling carried out for this study was undertaken to understand the implications of 86 turbines rated at 1MW. There is the potential that turbines of up to 2.4MW may be used to obtain the 86MW for the Project or a combination of different rated powers may be utilised. However, the modelling demonstrates that extracting 86MW of power from the tidal stream does not have a significant impact on the environment. Whether this 86MW consists of 36 devices of 2.4MW or a combination of devices will not significantly affect the results of the modelling. Therefore, it is unlikely that they will be any variation beyond the predictions presented in Section 9.7 (DHI, 2012). As a result the impact will remain not significant.

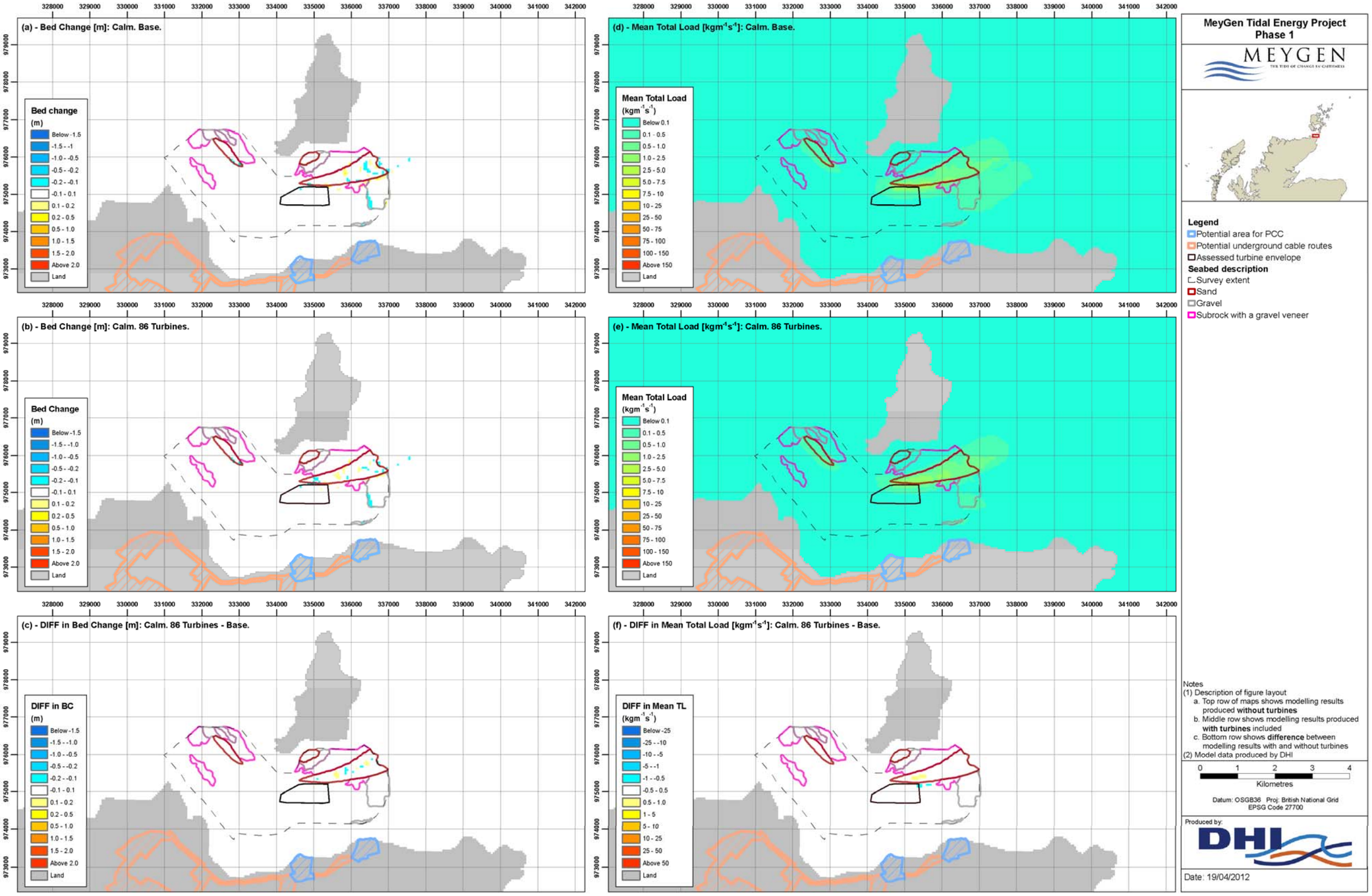

Figure 9.18: Modelling results showing difference in morphology after the addition of the 86 turbines, calm scenario, (a), (b) and (c) bed change, (d), (e) and (f) bedload

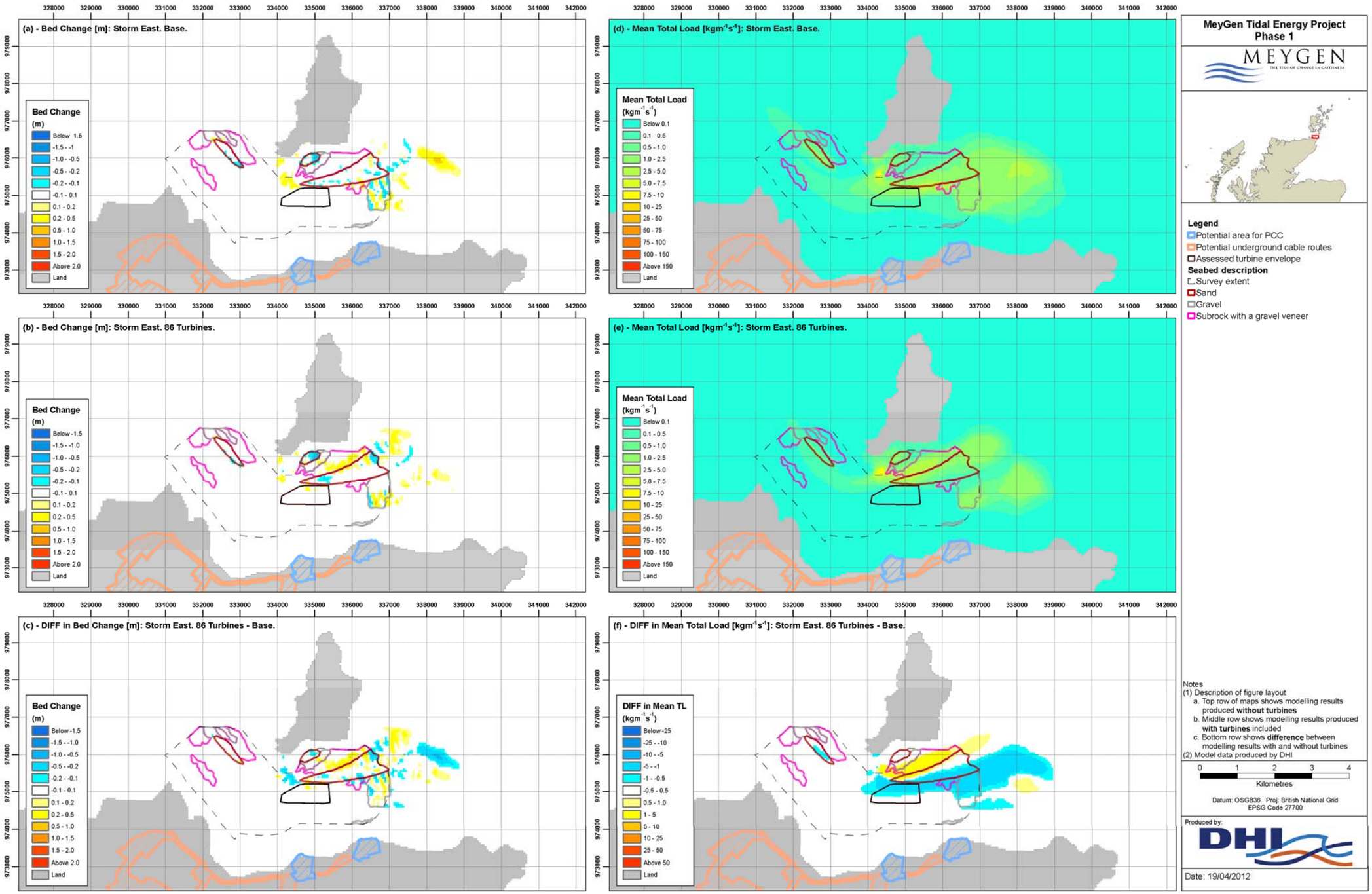

Figure 9.19: Modelling results showing difference in morphology after the addition of the 86 turbines, easterly storm scenario, (a), (b) and (c) bed change, (d), (e) and (f) bedload

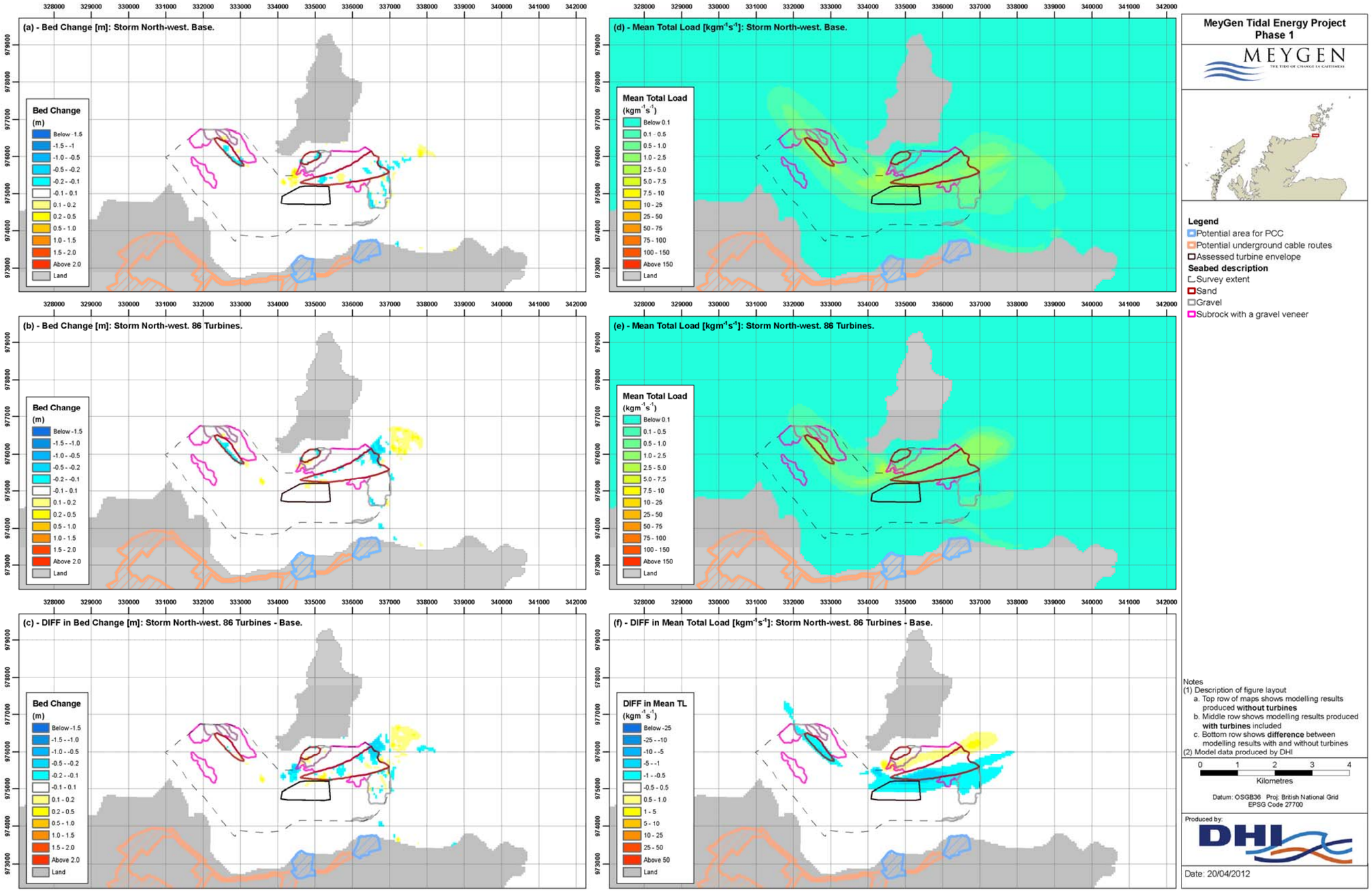

Figure 9.20: Modelling results showing difference in morphology after the addition of the 86 turbines, north-westerly storm scenario, (a), (b) and (c) bed change, (d), (e) and (f) bedload

9.11 Cumulative Impacts

9.11.1 Introduction

9.148 MeyGen has in consultation with Marine Scotland and The Highland Council identified a list of other projects (MeyGen, 2011) which together with the Project may result in potential cumulative impacts. The list of these projects including details of their status at the time of the EIA and a map showing their location is provided in Section 8; Table 8.3 and Figure 8.1 respectively.

9.149 Having considered the information presently available in the public domain on the projects for which there is a potential for cumulative impacts, Table 9.21 indicates those with the potential to result in cumulative impacts for the physical environment and sediment dynamics perspective. The consideration of which projects could result in potential cumulative impacts is based on the results of the project specific impact assessment together with the expert judgement of the specialist consultant.

Project title	Potential for cumulative impact	Project title	Potential for cumulative impact	Project title	Potential for cumulative impact
MeyGen Limited, MeyGen Tidal Energy Project, Phase 2	✓	SHETL, HVDC cable (onshore to an existing substation near Keith in Moray)	×	OPL, Ocean Power Technologies (OPT) wave power ocean trial	×
ScottishPower Renewables UK Limited, Ness of Duncansby Tidal Energy Project	✓	Brough Head Wave Farm Limited, Brough Head Wave Energy Project	×	MORL, Moray Offshore Renewables Ltd (MORL) offshore windfarm	×
Pelamis Wave Power, Farr Point Wave Energy Project	×	SSE Renewables Developments (UK) Limited, Costa Head Wave Energy Project	×	SSE and Talisman, Beatrice offshore Windfarm Demonstrator Project	×
Sea Generation (Brough Ness) Limited, Brough Ness Tidal Energy Project	×	EON Climate & Renewables UK Developments Limited, West Orkney North Wave Energy Project	×	BOWL, Beatrice Offshore Windfarm Ltd (BOWL) offshore windfarm	×
Cantick Head Tidal Development Limited, Cantick Head Tidal Energy Project	×	EON Climate & Renewables UK Developments Limited, West Orkney South Wave Energy Project	×	Northern Isles Salmon, Chalmers Hope salmon cage site	×
SSE, Caithness HVDC Connection - Converter station	×	ScottishPower Renewables UK Limited, Marwick Head Wave Energy Project	×	Northern Isles Salmon, Pegal Bay salmon cage site	×
SSE, Caithness HVDC Connection - Cable	×	SSE Renewables Developments (UK) Limited, Westray South Tidal Energy Project	×	Northern Isles Salmon, Lyrawa salmon cage site	×
RWE npower renewables, Stroupster Windfarm	×	EMEC, Wave Energy test site (Billia Croo, Orkney)	×	Scottish Sea Farms, Bring Head salmon cage site	×
SSE, Gills Bay 132 kV / 33 k V Substation Phase 1: substation and overhead cables (AC)	×	EMEC, Tidal energy test site (Fall of Warness, Orkney)	×	Northern Isles Salmon, Cava South salmon cage site	×
SSE, Gills Bay 132 kV / 33 k V Substation Phase 2: HVDC converter station and new DC buried cable	×	EMEC, Intermediate wave energy test site (St Mary's Bay, Orkney)	×	Scottish Sea Farms, Toyness salmon cage site	×
SHETL, HVDC cable (offshore	×	EMEC, Intermediate tidal energy	×	Northern Isles Salmon, West	×
Moray Firth)		test site (Head of Holland, Orkney)		Fara salmon cage site	

Table 9.21: Summary of potential cumulative impacts

9.150 The following sections summarise the nature of the potential cumulative impacts for each potential project phase:

- Construction and installation;
- Operations and maintenance; and
- Decommissioning.

9.11.2 Potential cumulative impacts during construction and installation

9.151 Cumulative impacts arising from installation of multiple marine renewable projects at the same time as the proposed installation are not anticipated as the majority of impacts are expected to be localised (e.g. release of drill cuttings[1], modification of local bedforms). The Ness of Duncansby Tidal Energy project is the only project that may potentially be constructed at the same time as the MeyGen Tidal Energy Project, Phase 1 and would not act in combination to cause significant impacts.

9.11.3 Potential cumulative impacts during operation and maintenance

9.152 Of those projects listed in Table 9.21, only the MeyGen Tidal Energy Project, Phase 2 and the Ness of Duncansby Tidal Energy Project have the potential to lead to cumulative impacts on the physical environment. The Cantick Head and Brough Ness tidal projects are too far away to be impacted, and although the Farr Point wave project will remove wave energy from the area local to it, it is extremely unlikely that it will have an impact on the bulk of wave propagation from the north-east Atlantic

9.153 The erosion/deposition and bedload transport modelling does not show any changes which extend into the Ness of Duncansby site under either calm or storm conditions. Even if there were further sedimentary bedforms outside of the Project area which have not been modelled here, the changes to the hydrodynamics and waves are negligible and as a result it is extremely unlikely they would be modified.

9.154 The MeyGen Tidal Energy Project, Phase 2 may introduce a further 312MW into the Inner Sound. The exact turbine number, location and layout within the Agreement for Lease area is not yet defined and will incorporate lessons learned from technology advancements beyond Phase 1 of the Project. These factors will influence the potential, nature of and significance of any cumulative impacts. However, following the results of the Phase 1 modelling study, the additional 312MW will probably have a similar effect on the hydrodynamics and waves, but their area of influence will be greater. It is possible the flow separation seen in the Phase 1 results will extend closer to the coastline, so may cause increased current speeds at the coastline, but given that the chief coastal erosion mechanisms along that stretch of coast are driven by storms, these differences are unlikely to cause a significant difference. If the flow speeds continue to slow within the array following the introduction of the next phase of turbines, it is possible some sediment will begin to collect on the surface of what is currently scoured bedrock, but the sensitivity of the seafloor as a receptor is considered low, so this is not considered significant.

[1] Cumulative impacts from discharges of drill cuttings would only be a potential impact if other developers used piled foundations.

9.155 With regards to the Ness of Duncansby site, once the array is fully installed, the modelling results under calm conditions do not show any changes which extend into the Ness of Duncansby site. Under storm conditions, only small changes extend into the Ness of Duncansby site (very small changes in current speed, and decreases in wave height of up to 1.5m), which are thought to be negligible in storm conditions.

9.11.4 Potential cumulative impacts during decommissioning

9.156 Although it is possible that a number of the impacts that may occur during decommissioning (e.g. stirring up of existing sediment bedforms) could act cumulatively with other developments, it is highly unlikely that the Ness of Duncansby development (the only development other than MeyGen Phase 2 expected to offer the potential for cumulative impact) would be decommissioned at the same time as this development, or that of the MeyGen Phase 2 development (which would likely be decommissioned at the same time as the proposed development). Baseline conditions would quickly return following decommissioning.

9.11.5 Mitigation requirements for potential cumulative impacts

9.157 No mitigation is required over and above the Project specific mitigation.

9.12 Proposed Monitoring

9.158 MeyGen propose to deploy at least 1 ADCP with the initial turbines. Data collected will be used to validate the hydrodynamic modelling undertaken to inform the physical environment and sediment dynamics impact assessment. The sediment erosion/deposition and bedload transport results produced during this modelling study are directly dependant on the quality of the hydrodynamic and wave models, so by validating those underlying models, the morphology results will be partially validated by proxy.

9.13 Summary and Conclusions

9.159 An assessment has been carried out of the likely effects of the proposed Project on the physical environment and sediment morphology. The assessment has considered construction and installation, operations and maintenance, and decommissioning of the Project.

9.160 The potential effects on the physical environment and coastal processes that have been considered are:

- Change in bed morphology from drill cuttings;
- Displacement of sediment resulting in alteration or loss of bedform;
- Change in water quality;
- Change in hydrodynamic regime;
- Change in wave regime;
- Change in sediment dynamics; and
- Erosion of the coastline.

9.161 The mobility of the seabed is dependant on the local current and wave conditions, and the local sediment characteristics. The strong tidal currents are thought to be the main cause for the sedimentary features in the Inner Sound, the fast currents scouring any mobile sediment from the central channel, and tending to deposit it where the current speeds naturally decrease.

9.162 The installation of up to an 86 turbine array is not expected to disturb the hydrodynamics significantly enough to change any of the existing processes. The region of highest flow within the Inner Sound may be separated north and south of the tidal array and there will be a small net decrease of current speed over the array. Likewise, there may be local changes to the regions of higher waves, but they are likely to be negligible in the context of the existing high energy environment.

9.163 The study found that none of the scenarios are likely to have a significant impact on the physical environment or sediment morphology, so no mitigation is required.

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10 BENTHIC HABITATS AND ECOLOGY

10.1 The table below provides a list of all the supporting studies which relate to the benthic habitats and ecology impact assessment. All supporting studies are provided on the accompanying CD.

Details of study	Location on supporting studies CD
Benthic survey for Phase 1 of the MeyGen tidal stream energy project, Inner Sound, Pentland Firth (ASML, 2011)	OFFSHORE\Seabed interactions
MeyGen EIA Coastal Processes Modelling – Modelling setup, calibration and results (DHI, 2011)	OFFSHORE\Seabed interactions
Report of Survey for Atlantis Resources Corporation for Site Survey Stroma. JN3475 (IXSurvey Limited, 2009)	OFFSHORE\Seabed interactions

10.1 Introduction

10.2 This section assesses the effects of the Project on benthic habitats and ecology. A number of different specialists have contributed to this assessment:

- Aquatic Survey and Monitoring Limited (ASML) – seabed survey, video footage analysis, biotope mapping, seabed survey reporting;
- Hebog Environmental Limited - macrobenthic analysis Particle Size Analysis (PSA) and Loss on Ignition analysis;
- Health Protection Agency laboratory (Radiation and Environmental Monitoring Scotland) - assessment of radioactive contamination; and
- Xodus Group – baseline description, impact assessment and Environmental Statement (ES) section write up.

10.2 Assessment Parameters

10.2.1 Rochdale Envelope

10.3 In line with the Rochdale Envelope approach, this assessment considers the maximum ('worst case') Project parameters. Identification of the worst case scenario for each receptor (i.e. Environmental Impact Assessment (EIA) topic) ensures that impacts of greater adverse significance would not arise should any other development scenario be taken forward in the final scheme design. Table 10.1 describes the detail of the project parameters that have been used in this assessment and explains why these are considered to be worst case. The potential impacts from potential alternative Project parameters have been considered in Section 10.9.

Project parameter relevant to the assessment		'Maximum' Project parameter for impact assessment	Explanation of maximum Project parameter
Turbine	Physical parameters	N/A	Physical turbine parameters do not directly influence benthic ecology, however potential effects on water flow from the presence of the turbines is considered under the physical processes and sediment dynamics impact assessment and the results of this impact assessment are used to inform the benthic ecology impact assessment.
	Oil fluid inventory	1,500 litres	The tidal turbines will contain an inventory of fluids including oil, hydraulic fluid and coolant. Turbine inventories will be between 645 and 1,500 litres.
Turbine support structure	Maximum amount of drill cuttings released into the marine environment	86 monopile Turbine Support Structure (TSS)	The drilled monopile TSS will result in the maximum release of drill cuttings to the marine environment. Assuming the maximum number of 86 TSSs, the maximum amount of drill cuttings that can be generated from turbine support installations is 17,200m^2 (total for 86 TSSs).
	Maximum seabed footprint	86 Gravity Based Structure (GBS) TSS	The GBS TSS will result in the largest seabed footprint. Each GBS TSS has a maximum footprint of 40m x 30m. The total footprint for 86 turbines is 0.103km^2.
	Operations and Maintenance	No removal of TSSs required for routine operations and maintenance	It is assumed that no replacement or major TSS overhaul involving removal is required during the operational life of the Project.
	Decommissioning	86 Monopile	86 Monopile TSSs will be cut at the seabed. The bottom on the piles below the seabed will remain in-situ.
	Maximum amount of compressor lubricant released into the marine environment	86 monopile TSS	Monopile drilling operations will take approximately 4 hours per pile. A compressor is used to pump air into the drilled holes to lift cuttings clear. The lubricant will be discharged to sea along with the cuttings at a maximum rate of 5 litres per hour, i.e. 20m^3 per monopile and 1,720m^3 for all 86 installed over 3 years.
Cable connection to shore	Maximum cable footprint on seabed	86, 120mm unbundled cables each 1,300m in length with split pipe armouring	The maximum physical area of the seabed occupied by the cables has been calculated as 0.027km^2. Based on a maximum 1.3km of cable from Horizontally Directional Drilled (HDD) bore exit to turbine, and a cable diameter of 120mm (x2 to account for split pipe armouring) for 86 turbines. This assumes that the cables will emerge from the bores 700m from the shore.
	Decommissioning	86, 120mm unbundled cables, each 1,300m in length	All cables laid on the seabed will be fully removed at decommissioning.
	EMF (Electromagnetic Fields)	0.013km^2 of 6.6kV cables	The maximum area of the seabed affected by the magnetic field of the cables is 0.013km^2. Based on a maximum 1.3km of cable from HDD bore exit to turbine and maximum cable diameter of 120mm for 86 turbines.
Cable landfall	Maximum drill cuttings released into marine environment	29, 0.6m HDD bores, drilled from either Ness of Quoys or Ness of Huna	The majority of drill cuttings generated from the drilling of the HDD bores will be returned to shore and not discharged to sea; however it is estimated that the contents of the last 10m of each bore could be discharged to sea at the seabed breakthrough. Of the two potential HDD scenarios, the greatest potential volume of cuttings discharged to sea at breakthrough will result from last 10m of 29 boreholes of 0.6m diameter (82m^2).
Onshore Project components	-	N/A	As there are no proposed works in the intertidal area along the coast the onshore aspects of the Project do not influence the benthic habitats and ecology impact assessment.

Table 10.1: Rochdale Envelope parameters for the benthic habitats and ecology assessment

10.2.2 Area of assessment

10.4 It is also important to define the geographical extent of the assessment area. The focus of the benthic habitats and ecology assessment is potential impacts on seabed habitat and ecology of the offshore Project area and adjacent seabed (see Figure 10.2).

10.5 It should be noted that at the time of undertaking the assessment the exact distance from shore at which the HDD bores would emerge was considered to be between 700 and 2,000m, although the exact distance was unknown. The assessment here is based on the worst case where the cables emerge 700m from the shore.

10.3 Legislative Framework and Regulatory Context

10.3.1 Legislation

10.6 In addition to the EIA Regulations, the following legislation is relevant to the assessment of benthic habitats and ecology:

- Marine (Scotland) Act 2010;
- EU Habitats Directive (Directive 92/43/EEC);
- The Habitats Regulations 1994 (as amended in Scotland) implements species protection requirements of the Habitats Directive in Scotland, on land and in inshore waters; and
- UK Biodiversity Action Plan (UKBAP) – the UK Governments Response to the Convention on Biological Diversity (CBD), which the UK signed up to in 1992 in Rio de Janeiro.

10.7 The following sections provide further details on the specific types of marine habitats covered by the above list of conservation and management legislation.

10.3.2 European Habitats Directive

10.8 The European Habitats Directive lists 13 marine habitats and eight marine species in Annexes I and II respectively. To meet the requirements outlined in Article 3 of the European Habitats Directive, Special Areas of Conservation (SACs) have been designated in UK waters to contribute to the European network of important high-quality conservation sites that will make a significant contribution to conserving these species and habitats. Of those benthic habitats and species listed in Annex I and II of the Directive, there are three that have the potential to occur in the vicinity of the MeyGen Inner Sound Crown Estate Agreement for Lease (AfL) area:

- Sandbanks which are covered by sea water all the time;
- Large shallow inlets and bays; and
- Reefs (rocky and biogenic).

10.9 There are no SACs within a 40km radius of the MeyGen Inner Sound AfL area in the Inner Sound that have been designated for the presence of benthic habitats or species.

10.3.3 UK Biodiversity Action Plan (UKBAP)

10.10 The current list of UK Biodiversity Action Plan (UKBAP) priority habitats was published following a two-year review of the BAP process and priorities (Maddock, 2008). The Orkney Local Biodiversity Action Plan 2002-2007 (OLBAP) has been reviewed following its expiration and a further Plan (2008-2011) has been published which sets out to guide the conservation and enhancement of key features of biodiversity in Orkney over the coming years (OLBAP Steering Group, 2008). In addition a Caithness Local Biodiversity Action Plan (CLBAP) was published in 2003 by the Caithness Biodiversity Group (2003), where it states that “the plan attempts to set out what can be done in the next five to ten years”.

10.11 Those habitats and species previously recorded in the vicinity or with the potential to occur in and around the Pentland Firth include:

- Littoral caves and overhangs;
- Fragile sponge and anthozoan communities on subtidal (sublittoral) rocky habitats;
- Subtidal (sublittoral) sands and gravel;
- Tide-swept channels;
- Wave surge gullies and caves
- Blue mussel (*Mytilus edulis*) beds;
- Fan mussel (*Atrina fragilis*);
- Horse mussel (*Modiolus modiolus*) beds;
- Maerl beds;
- The molluscs *Devonia perrieri, Hydrobia elongata, Manzonia crassa* and *Simnia patula*;
- The sea-slugs *Hancockia unicinata* and *Okenia leachii;* and
- Native oyster (*Ostrea edulis*).

10.3.4 Priority Marine Features

10.12 The Marine Working Group of the Scottish Biodiversity Forum, responsible for the coordination of action in Scottish waters, was keen that the work already undertaken at a UK level (through the UKBAP review) be developed further. Scottish Natural Heritage (SNH) has reviewed a large number of marine habitats and species to identify those considered to be of greatest marine nature conservation importance in Scottish territorial waters; these have been termed Priority Marine Features (PMF). A draft list of PMF in inshore Scottish waters, including those for which future Marine Protected Areas (MPA) will be designated under the Marine (Scotland) Act 2010, has recently been drawn up and circulated for consultation (SNH, 2011). The list, which is provisional and thus subject to future revision, includes a number of marine habitats that may be present in the region of interest:

- Blue mussel beds;
- Burrowed mud;
- Flame shell beds;
- Horse mussel beds;
- Kelp and seaweed communities on sublittoral sediment;
- Maerl beds;
- Maerl or coarse shell gravel with burrowing sea cucumbers;
- Native oyster beds;
- Northern seafan communities;
- Seagrass beds;
- Shallow tide-swept coarse sand with burrowing bivalves; and

- Tide-swept algal communities.

10.3.5 The Convention for the Protection of the Marine Environment of the North East Atlantic

10.13 The Convention for the Protection of the Marine Environment of the North East Atlantic (OSPAR) is the mechanism by which 15 governments of western Europe work together to protect the marine environment of the North-East Atlantic. In 2003, the UK government committed to establishing a well-managed, ecologically coherent network of Marine Protected Areas (known as the OSPAR MPA commitment). Marine SACs designated under the European Habitats Directive have been submitted as the UK's initial contribution to the OSPAR network. A list of marine habitats and species considered to be under threat or in decline within the north-east Atlantic has been produced by OSPAR (OSPAR, 2008) and a number of the marine habitats and species on the list may also be present in the Pentland Firth area:

- Maerl beds;
- *M. modiolus* beds;
- *Ostrea edulis* beds;
- Sea-pen and burrowing megafauna communities; and
- Zostera beds.

10.4 Assessment Methodology

10.4.1 Scoping and consultation

10.14 Since the commencement of the Project, consultation on benthic ecology and habitats issues has been ongoing. Table 10.2 summarises all consultation relevant to benthic ecology and habitats. In addition, relevant comments from the EIA Scoping Opinion are summarised in Table 10.3, together with responses to the comments and reference to the ES sections relevant to the specific comment.

Date	Stakeholder	Consultation	Topic / specific issue
7th April 2011	Marine Scotland and SNH	Pre-Scoping meeting	EIA surveys and studies required and the data needs for each EIA study.
6th May 2011	Marine Scotland	Teleconference	Conference call to discuss scope of the baseline survey and potential requirements for future monitoring. Including consideration of aligning the baseline survey with future monitoring needs.
27th May 2011	Marine Scotland, statutory consultees and non statutory consultees	Submission of EIA Scoping Report	Request for EIA Scoping Opinion from Marine Scotland and statutory consultees and request for comment from non statutory consultees.
30th June – 2nd July 2011	Local stakeholders	Public Event - EIA Scoping	Public event to collate information/opinions on proposed EIA scope.
23rd June 2011	Marine Scotland	Marine Licence for seabed survey	Application for a Marine Licence to undertake a seabed survey. Licence (04233/11/0) received 22nd July 2011.
7th July 2011	Marine Scotland and SNH	Submission of document for comment	Submission of proposed seabed survey scope for review and comment by Marine Scotland and SNH.
22nd July 2011	Marine Scotland and SNH	Receipt of comments on seabed survey scope	Receipt of comments on the seabed survey scope from Marine Scotland and changes made to scope in order to address comments.
25th July 2011	Marine Scotland and SNH	Submission of response to seabed survey	Response to comments received on the seabed survey, addressing specific issues and responding to issues raised by Marine Scotland and SNH.
		comments	
31st September 2011	Marine Scotland, The Highland Council, statutory consultees and non statutory consultees	Receipt of EIA Scoping Opinion	Receipt of response to EIA Scoping Report and other comments from non statutory consultees.
3rd October 2011	Marine Scotland	Project update meeting	Report on EIA progress including presentation of seabed survey results.
6th – 7th December 2011	Local stakeholders	Public Event – pre application consultation	Public event to communicate the findings of the EIA to local stakeholders.

Table 10.2: Details of consultation meetings undertaken in relation to benthic habitats and ecology

Name of organisation	Key concerns	Response	ES section within which the specific issue is addressed
Scottish Environment Protection Agency (SEPA)	A baseline assessment of existing subtidal (sublittoral) habitats and species should be submitted. This should include any UK Biodiversity Action Plan habitats and species.	Baseline subtidal (sublittoral) habitats survey undertaken to include UKBAP species and habitats.	Section 10.5 Baseline Description
SEPA	The ES should consider how the risks of introducing marine non-native species (MNNS) will be minimised.	MNNS will be considered within the ES and if required appropriate mitigation measures identified.	Section 10.6.5 Impact 10.4: Marine Non-Native Species (MNNS)
Scottish Natural Heritage (SNH)	Other potential impacts which should be considered include disturbance due to EMF and the barrier effect. Benthic and demersal species are more likely to be vulnerable to the potential barrier effects of EMF than pelagic species and should be considered accordingly. The ES should consider the vulnerability of different species (e.g. benthic/demersal/ pelagic/migratory), their likely levels of sensitivity, and to what extent cable protection or armouring can limit exposure to EMF.	Impact assessment includes consideration of EMF impacts, including reference to ongoing Marine Scotland research. Results form the research is currently unavailable and so have not been used to undertake the impact assessment.	Section 10.7.1 Impact 10.5 Electro-Magnetic Effects
SNH	We recommend that benthic ecology survey methodologies are submitted to Marine Scotland (MS) and Scottish Natural Heritage (SNH) for comment. The applicant should check for Annex I habitats, and/or Priority Marine Features during survey work as well as any BAP habitats and species.	Benthic survey undertaken and proposed scope sent to Marine Scotland and SNH for comment prior to the survey. Any annex I habitats and priority marine features highlighted through survey work have been considered.	Section 10.4.6 Aquatic Survey and Monitoring Ltd (ASML) Survey Section 10.5 Baseline Description
SNH	Consideration should be given to future seabed monitoring during the phasing of the proposed development. The ES should identify and where possible seek to mitigate any significant negative impacts on any protected habitats and species identified.	Mitigation measures and future seabed monitoring strategies will be presented in the ES.	Section 10.6 Impacts During Construction and Installation Section 10.7 Impacts during Operation and Maintenance, Section 10.8 Impacts during Decommissioning
SNH	Bedrock, boulder and cobble reefs would fit under Annex I 'reefs' and a major element of the benthic survey should be establishing the flora and fauna associated with these areas.	Comment noted and taken into account during the impact assessment.	Section 10.4.6 Aquatic Survey and Monitoring Ltd (ASML) Survey Section 10.5 Baseline Description

Name of organisation	Key concerns	Response	ES section within which the specific issue is addressed
SNH	We recommend that the ES presents clear information on, and identification of, the main biotopes found on-site. We note that MS survey details were not available for inclusion in the EIA Scoping Report. Key results and interpretation of data from this survey should be included within the ES.	Biotope map has been produced and will be used to inform ongoing design/array layout. The Marine Scotland data is now available for use and has been used to inform the EIA.	Section 10.5.3 Species and Biotopes

Table 10.3: Scoping and consultation relevant to benthic ecology

10.4.2 Desk based study

10.15 To inform both this assessment and the scope of the seabed survey that feeds into this assessment, a desk-based review of existing data sources was conducted. The ultimate aim of this exercise was, in association with significant local experience of the area, to provide advice on the habitats and species that may be present in the Project development area and wider region. This review has been used as the basis of the summary of key sensitivities provided in the Baseline Description (Section 10.5). This review relied on a number of published data sources, which include:

- Preliminary assessment of the conservation importance of benthic epifaunal species and habitats of the Pentland Firth and Orkney Islands in relation to the development of renewable energy schemes (Moore, 2009, 2010);
- Assessment of the conservation importance of species and habitats identified during research cruises within the Pentland Firth and Inner Sound (Moore and Roberts, 2011);
- Marine Scotland Interactive (Marine Scotland, 2011);
- Scottish Marine SEA (Scottish Executive, 2007); and
- UKSeaMap interactive map (JNCC, 2010).

10.4.3 Field studies

10.4.4 Marine Scotland

10.16 To support the development of wave and tidal energy developments in the Pentland Firth and Orkney waters, the Scottish Government through Marine Scotland conducted a number of seabed surveys in the area. These include a number of surveys conducted by the Fisheries Research Services (FRS), now Marine Scotland Science, in the Pentland Firth and Orkney Waters between 2006 and 2008, where both video footage and stills images were collected (Hayes, 2009). Analysis of the footage and photographs was reported by Moore (2009; 2010) and Moore and Roberts (2011). Footage taken by FRS is available to download from the Marine Scotland Website (Marine Scotland, 2011) and view through Google Earth. The coverage of these surveys is shown in Figure 10.1.

10.4.5 iXSurvey

10.17 In addition to these wider surveys of the Pentland Firth, Atlantis Resources Corporation (a Joint Venture partner within MeyGen) contracted iXSurvey Limited to undertake a geophysical site survey of the Inner Sound (iXSurvey, 2009). The results of this survey have been used to provide an indication of the seabed substratum present in the Project development area (Section 9, Figure 9.12, Figure 10.4).

10.4.6 Aquatic Survey and Monitoring Ltd (ASML) Survey

10.18 MeyGen appointed Aquatic Survey and Monitoring Ltd (ASML) to undertake a benthic seabed survey. The survey approach was based on a combination of remote video/stills photography, grab and dredge sampling, developed using the geophysical survey outputs (iXSurvey, 2009), from which the benthic habitats and species of the Project development area could be described using the biotope classification system of Connor *et al* (2004). The survey comprised the following:

- A drop down video and photographic survey to note seabed type (substratum) and the epibenthic biotopes present by collecting information from a number of video transects and drops, This approach was used over the whole survey area, and in particular those areas known from iXSurvey (2009) to consist predominantly of rock and which could therefore not be sampled in any other way;
- A grab survey to sample the infaunal community types in any sediment that exists in the vicinity and to determine baseline sediment particle size distribution. Additional grabs were also taken to collect sediment samples for analysis of radioactivity;
- A qualitative pipe-dredge survey was undertaken in locations where gravel beds were predicted, in order to sample any epifauna and interstitial fauna present in these 'hard to sample' substrates; and
- Collection of sediment bedload samples (along with water samples) for analysis and reporting by the DHI.

10.19 The geographical extent of the survey in relation to the offshore Project development area is shown in Figure 10.2. The shallowest depth reached during the survey was 15m. The survey area covers the whole of the turbine deployment area and extends to the point at which the boreholes for the export cables will emerge form the seabed (700m offshore) if the worst case scenario is considered[1].

[1] Worst case in this context refers to the shortest distance to the shore at which cables may emerge. Working with this shortest distance results in the longest possible length of cable and thus the largest likely area of seabed impact.

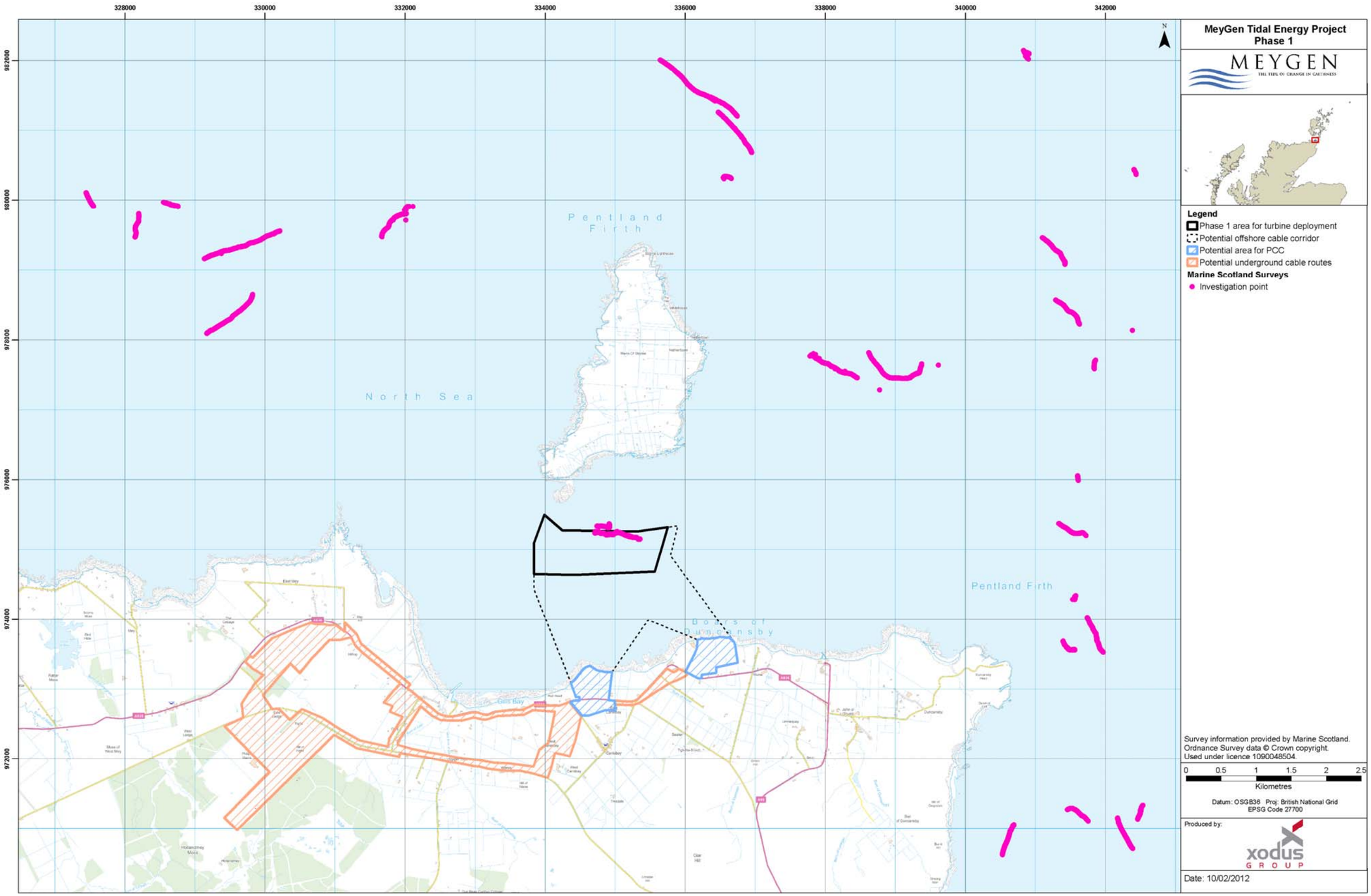


Figure 10.1: Coverage of the Marine Scotland surveys in relation to the offshore Project development area (Marine Scotland, 2011)

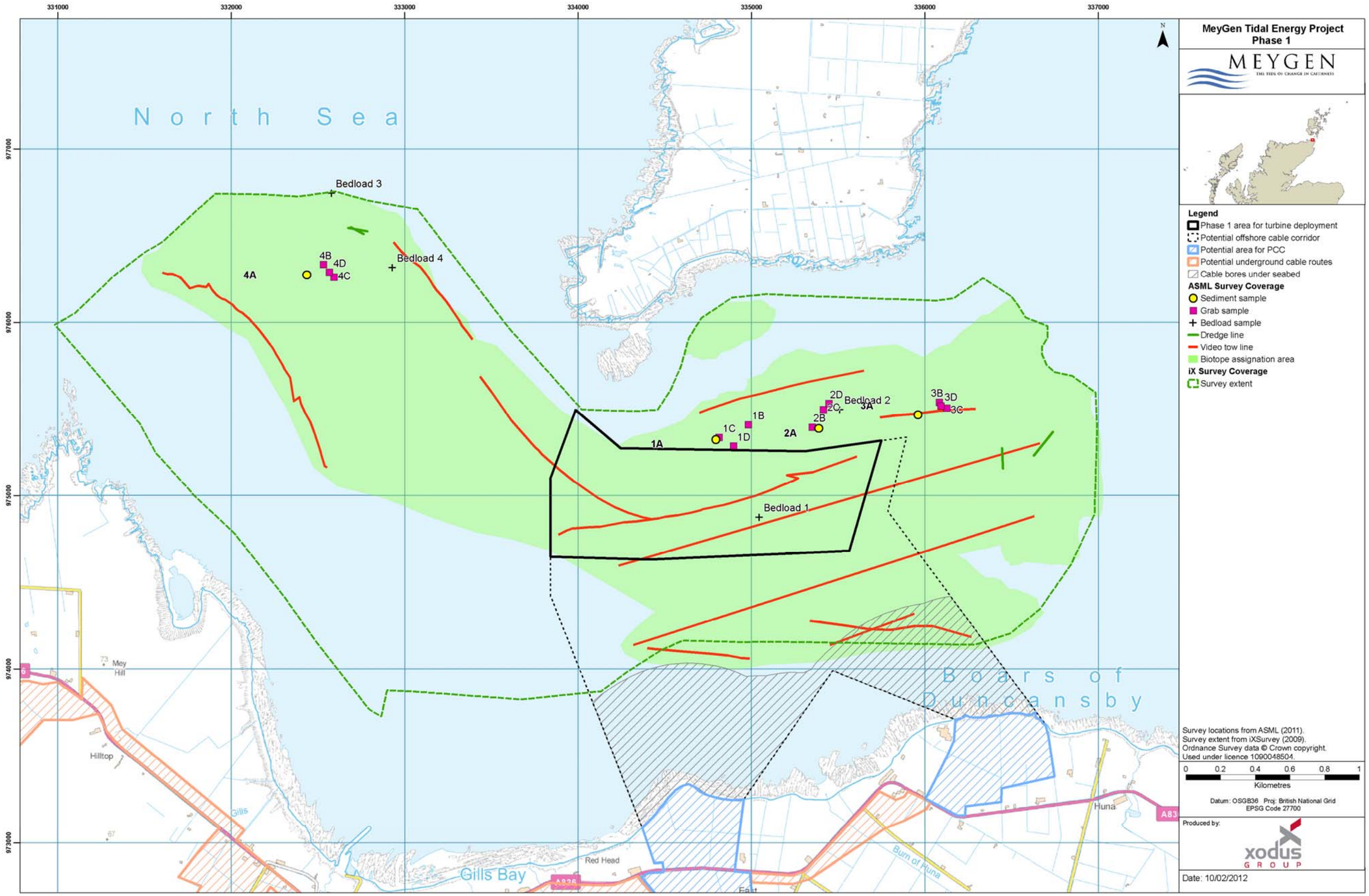


Figure 10.2: Extent of benthic environmental survey coverage and sample stations (ASML, 2011)

10.4.7 Significance criteria

10.20 The EIA process and methodology are described in detail in Section 8. Each assessment section is, however, required to develop its own criteria for the 'sensitivity of receptor' and 'magnitude of impact' aspects since the definition of these will vary between different topics. For benthic ecology, the significance criteria used in this section is based on the methodology described in Section 8 but the sensitivity of the receptor and magnitude of impact are defined in Table 10.4 and Table 10.5 respectively.

10.21 The consequences of impacts are then considered by reference to the relevant criteria in the EIA Regulations. The significance of impacts in relation to the EIA Regulations is defined in Section 8, Table 8.2.

Sensitivity of receptor	Definition
Very High	▪ Sites of international designation (e.g. SAC) or species/assemblages which form qualifying interests of internationally designated sites. ▪ Globally threatened species or habitats (e.g. IUCN list). ▪ Species which are considered to be present in internationally important numbers or habitats comprising an internationally important proportion of that habitat. ▪ Site contains high density of numerous PMF species or habitats.
High	▪ Nationally important sites (e.g. SSSI) or species/assemblages which form qualifying interests of nationally designated sites. ▪ Species/assemblages which contribute to an international site but which are not listed as qualifying interests. ▪ Ecologically sensitive species/habitat (e.g. rare) or present in nationally important numbers/area. ▪ Site contains moderate density of numerous PMF species or habitats.
Medium	▪ Sites of local value. ▪ Presence of Annex I habitats or Annex II species of the European Habitats Directive. ▪ Species present in regionally important numbers. ▪ Species/assemblages which contribute to a national site but which are not listed as qualifying interests. ▪ Species occurring within international/national sites but are not crucial to the integrity of the site. ▪ Species listed as priority species in the UKBAP. ▪ Site contains one or more PMF species or habitats.
Low	▪ Sites not containing features that would meet the criteria for sites of local value, but nevertheless having some biodiversity value. ▪ Any other species of conservation interest (e.g. LBAP species).
Negligible	▪ Habitat/species of no conservation concern.

Table 10.4: Definitions for sensitivity of receptor

Magnitude of impact	Definition
Severe	▪ Widespread total loss or very major alteration to species and habitat such that the condition of features of qualifying interest will be fundamentally altered. ▪ Little or no recovery anticipated. ▪ Impact highly likely to occur.
Major	▪ Widespread change to characterising species or lasting change to habitat leading to medium-term damage. ▪ Recovery anticipated after several years following decommissioning. ▪ Impact likely to occur.
Moderate	▪ Change to benthic species in a localised area (confined to project footprint and immediate locality) for project duration, but no lasting change to habitat. ▪ Good recovery potential following decommissioning (approximately 2 years). ▪ Impact will possibly occur.
Minor	▪ Change from baseline conditions measurable but within scale of natural variability, and confined to project footprint. ▪ Temporary alteration or effects confined to a small percentage of available habitat, with rapid recovery likely. ▪ Impact unlikely to occur.
Negligible	▪ Imperceptible or no changes to the baseline condition. ▪ Impact extremely unlikely to occur.
Positive	▪ An enhancement of an ecosystem or population parameter.

Table 10.5: Definitions for magnitude of impact

10.4.8 Data gaps and uncertainties

10.22 The seabed of much of the Inner Sound was surveyed to provide a comprehensive baseline, encompassing the maximum area possible for the offshore project footprint (for both direct and indirect impacts). The seabed survey was undertaken during neap tides to enable good quality data to be collected and to ensure maximum time available on location by suitably qualified and experienced consultants. It is therefore likely that the majority of species and habitats were visible and could be enumerated. However, the survey was constrained by the environmental conditions at the site, including poor weather conditions on the first day and the change in tidal conditions as the survey progressed.

10.23 Where tidal currents increased above a certain threshold the footage became less clear. However, in most instances it was still possible to identify the biotopes, species and habitats present. When the footage became unclear recording was stopped and a suitable tidal window was selected for restarting the survey. This constraint may have contributed to some limitations in the recording of habitats and species, with some biotopes surveyed in more detail than others.

10.24 The actual delineation of the different biotopes was made based on the seabed types recorded from the geophysical survey (iXSurvey, 2009) in combination with the footage from the benthic survey (ASML, 2011). Instead of being discrete boundaries between biotopes it is more likely that these boundaries represent broader transition zones. In addition, it is likely in some areas that the biotopes are a mosaic of two or more similar biotopes rather than the monoculture described from the benthic survey.

10.25 With regards to the impact assessment, information on the specific sensitivity of a number of the biotopes to a number of the possible impacts and on the recovery rates following impact is not available. Instead, a combination of expert knowledge and the known sensitivities of similar habitats have been used, with information from similar developments considered to corroborate conclusions on possible impact.

10.5 Baseline Description

10.5.1 Introduction

10.26 A desk-based review of existing data sources was conducted in order to identify habitats and species of conservation concern that may be present over the offshore Project development area and surrounding waters. Other publications and survey reports relevant to the region have also been reviewed which, when combined with the site-specific surveys, provide a comprehensive baseline of the offshore Project development area.

10.5.2 Seabed and sediments

Regional context

10.27 BGS (1990) indicates that the sea floor between Helmsdale (to the south) and Dunnet Head (to the west) slopes away from the coast to a depth of approximately 60m at a distance between 5km and 10km from

shore. RPS Energy (2009) indicates that the seabed depth ranges from 30m to 40m with a shallower slope angle on the Caithness shore than the Stroma shore. Depths greater than 30m are found within 500m of the Stroma shoreline.

10.28 Very little historical information exists to describe the seabed and sediments present in the offshore Project development area and surrounding waters. There are a number of wide scale sediment and habitat mapping programmes that have been conducted in UK, one of which is the JNCC UKSeaMap programme that provides an overview of the sediments and habitats likely to be present in areas of the North Sea and northern Scotland (JNCC, 2010), building upon previous datasets on sediment and habitats distribution from the MESH (Mapping European Seabed Habitats) programme. The predictive habitat mapping conducted by the UKSeaMap programme is not at a resolution that includes the Inner Sound. However, for the wider Pentland Firth JNCC UKSeaMap predictive habitats data (JNCC, 2010) suggests the habitat present to be composed of rock.

10.29 The high velocity tidal currents within the sound (maximum mean flow of four to five ms^{-1}) have scoured the Quaternary deposits and seabed soils from the study area. In consequence, seabed sediments are largely restricted to cobble and boulder grade sediments, which are too heavy to transport far (RPS Energy, 2009).

10.30 Following review of the Marine Scotland footage (Section 10.4.4) that was analysed and reported by Moore (2009; 2010) and Moore and Roberts (2011) analysis suggests that the seabed of the wider Pentland Firth consists of rock or a mix of bedrock and boulders, where the boulders often lie on coarse shelly sand (or gravel) or the coarse sediment is trapped between boulders.

Site-specific details

10.31 Five video transects and associated stills images were taken by Marine Scotland within the Inner Sound in 2009 and 2010 (Figure 10.3). A review of this footage indicates that the seabed at the northernmost stations (e.g. Gills Bay Run 2, Figure 10.3) is heterogeneous and composed of shell gravel with small outcrops of scour-polished rock. The more southerly stations (e.g. Gills Bay TV 1, Figure 10.3) show a markedly different seabed, with complex, uneven, fissured bedrock and boulders in gulleys and lows. Occasional pockets of sediment are present in these fissures with one extensive area of shell gravel with adjacent rock polished by scour. The Marine Scotland surveys are discussed further in the Physical Environment and Sediment Dynamics section (Section 9). Moore and Roberts (2011) analysed this data and the results demonstrated that the area mainly consisted of uneven, fissured bedrock with boulders collecting in gulleys and lows. There were also areas of shell gravel and coarse sand, with coarse material also collecting in rock fissures and lows. Rock adjacent to major sediment pockets was observed to be polished smooth by the scour.

10.32 The iXSurvey, the results of which are fully summarised in the Physical Environment and Sediment Dynamics section (Section 9), covered an area of 11.4km^2 between Duncansby Head and Stroma (Section 9, Figure 9.12). iXSurvey (2009) reported that the majority of the seabed comprised current-scoured bedrock that exhibits a “saw tooth” profile. Within the area surveyed, approximately 70% of the seabed (7.8km^2) consisted of bedrock with an irregular topography, considered to be a result of differing rock types and the different rates of erosion that these rock types show. This confirms the British Geological Society (BGS) report that the geology of the Inner Sound is composed largely of exposed Devonian (Old Red Sandstone) bedrock (BGS, 1990). This seabed type was present throughout the central portion of the survey area. Subrock, defined as rock at or near the seabed surface, contributed a further 12% (1.4km^2) of the seabed in the survey area. This seabed type was found in a number of patches both directly south of and to the southwest of Stroma. These results are similar to those gained from video and still images collected by Marine Scotland within the Inner Sound in 2009 and 2010.

10.33 As outlined above, the more detailed information from the geophysical site survey (iXSurvey, 2009) indicates that the majority of the seabed is comprised of current-scoured bedrock with patches of sand, megarippled sand and sandbanks with coarse gravel only present in isolated patches directly south and south-west of Stroma. Specifically, 10% (1.1km^2) of the seabed is made of isolated megarippled sand or sandbanks whilst coarse gravel forms the remaining 7% (0.8km^2) of the survey area (Section 9, Figure 9.12).

10.34 Areas of sand accumulation and migration are present in the north-eastern regions of the geophysical survey area (Section 9, Figure 9.12) as well as a localised area in the north-west. These sand bodies rest upon underlying bedrock which is otherwise exposed at the seabed in the remainder of the site. These regions commonly exhibit numerous megaripples, with wavelengths of up to 20m and heights of between 0.2 and 0.5m. In the far north-east of the survey area two discrete sand waves occur within a large sandbank, with wavelengths up to 140m and heights of 10m (Section 9, Figure 9.12). The maximum sediment thickness observed at this sandbank was approximately 15.5m. In the lee of Mell Head (Section 9, Figure 9.12) on the Island of Stroma sediments have accumulated to form an extensive sandbank.

10.35 Deposits of coarse gravel are present in the north-western, north-eastern and eastern parts of the survey area (Section 9, Figure 9.12). These deposits directly overlie bedrock and vary in thickness from a thin veneer, to ridges up to 5m deep in the far east of the survey area (Section 9, Figure 9.12). Numerous seabed anomalies were identified to occur throughout the survey area. These could be interpreted as either seabed irregularities or isolated glacial erratic boulders up to 1.1m in height (Section 9, Figure 9.12).

10.36 The seabed over the area where the current speeds are highest consists of scoured bedrock platform. There is a series of low ridges or steps within and around this area that comprise extensive areas of smooth, fissured rock which dipped down towards the east and had small vertical faces on the western side. The vertical faces of these are approximately 2m high and they had large numbers of crevices, fissures and overhangs likely to provide a variety of microhabitats for fauna. At the base of each face are boulders, cobbles and lumps of broken bedrock with occasional patches of clean shell gravel; these boulders generally cover the lower part of the next ridge. This seabed topography in the centre of the Sound (including the turbine deployment area) can be expected to create localised areas of shelter behind and below the rock faces whereas the tops of the ridges are exposed to the strongest currents.

10.37 The ASML survey (ASML, 2011) conducted in the offshore Project development area and surrounding waters collected sediment samples at four sites (Figure 10.2) and results of the associated analysis are presented in Figure 10.4 and Table 10.6. The results of the particle size analysis (PSA) suggest that the sediment at the sample sites is largely composed of very coarse sand or very fine gravel, with three of the four sites showing a predominance of gravel over sand. From observations made during sampling, the sediment collected for this analysis was made up completely of shell material (carbonate) and appeared devoid of organic matter. As the PSA samples consisted of clean shell fragments a very low organic content was expected; indeed, ASML (2011) state that laboratory techniques were unable to quantify the organic content due to the content of the sediment being so low. The ASML grab sampling (ASML, 2011) appears to confirm the interpretation of the geophysical data collected by iXSurvey (2009).

Sediment	Size	Phi	1A	2A	3A	4A
Medium pebble (gravel)	>8mm	< -3	5.3	0	0	8.4
Small pebble (gravel)	4 to 8mm	-2 to -3	21.52	2.46	8.82	20.93
Granule (very fine gravel)	2 to 4mm	-1 to -2	50.66	36.8	44.03	45.26
Sand (very coarse)	1 to 2mm	0 to -1	22.47	56.07	43.8	24.77
Sand (coarse)	500 to 999µm	1 to 0	0.02	4.59	3.31	0.61
Sand (medium)	250 to 499µm	2 to 1	0.01	0.04	0.02	0.02
Sand (fine)	125 to 249µm	3 to 2	0.01	0.01	0.01	0.01
Sand (very fine)	63 to 125µm	4 to 3	0	0.01	0.01	0.01
Silt & Clay	<63µm	>4	0	0.01	0	0

Table 10.6: PSA results from the benthic survey (ASML, 2011)

10.38 Preliminary suspended sediment results from the ASML survey data suggest a range of between 10 and 14mgl^{-1} (Table 10.7). The bedload (that is the particles transported along the seabed by water movement) is comprised almost exclusively of very fine sand upwards with a near absence of silt and clay (ASML, 2011).

Measurement	Station			
	1	2	3	4
Water Volume (ml)	2,000	1,930	1,895	1,960
Suspended sediment mass (mg dry weight)	20.9	26.5	21.5	23.1
Suspended sediment (mgl^{-1})	10	14	11	12

Table 10.7: Suspended sediment results from the benthic survey (ASML, 2011)

10.5.3 Species and biotopes

Regional context

10.39 The communities identified on rock (or a mix of bedrock and boulders) during the Marine Scotland surveys in the wider Pentland Firth area are generally of low diversity and are strongly dominated by current and scour-resistant species such as the acorn barnacle (*Balanus crenatus*) and the dahlia anemone (*Urticina felina*). The species distribution is strongly influenced by the variation in current conditions, creating a mosaic of assemblages. The communities to the west of Stroma (sampling stations for which are shown in Figure 10.1) presented an exception to the general pattern of extremely tideswept circalittoral rock communities in the main channel of the Pentland Firth. Here, the seabed is predominantly medium or coarse sand, often formed into waves and sometimes with a surface scatter of pebbles, cobbles and small boulders; these stations were assigned the biotope code of SS.SCS.CCS (circalittoral coarse sediment). In his analysis of the footage, Moore (2009, 2010) and Moore and Roberts (2011) recorded that the sand is likely to be highly mobile and that the video evidence suggests it supports little life. In this same area, where occasional large boulders were present, the sand-scoured habitat supported large *U. felina* as well as scattered patches of the bryozoan hornwrack (*Flustra foliacea*) and hydroid clumps, described by the biotope designation CR.MCR.ECCR.UrtScr (*U. felina* and sand-tolerant fauna on sand-scoured or covered circalittoral rock).

10.40 The communities reported by Moore (2009) to the west of Stroma were also identified by additional review and analyses of FRS footage to the west and east of Stroma by Moore (2010). One video to the west of Stroma (sampling stations for which are shown in Figure 10.1) was also assigned the biotope SS.SCS.CCS (circalittoral coarse sediment), where the substratum of shelly medium sand formed into waves had no evidence of infauna. Analyses of one video run approximately 2.5km to the east of Stroma found that the seabed consisted of sand-scoured bedrock outcrops and boulders on shell gravel (Moore, 2010). The community there was considered to be a patchwork of biotopes but most similar to CR.HCR.FaT.CTuB (*Tubularia indivisa* and cushion sponges on tide-swept turbid circalittoral bedrock). The biota varied according to localised differences in sand scour and current strength, but was characterised by profuse numbers of *U. felina*. Elevated upward facing rock was generally species-poor with a barnacle crust, scattered *U. felina*, bryozoans, hydroid clumps, *T. indivisa* and sparse occurrences of the sponge *Pachymatisma johnstonia*.

Site-specific details

10.41 The above surveys give a summary of what is present in surrounding waters and provides for an initial, crude assessment of what may be present in the offshore Project development area. However, it is only site-specific surveys that can confirm these initial hypotheses; the results of these surveys are described herein.

10.42 In addition to the footage interpreted and reported by Moore (2009; 2010) and described above, a further five videos and associated stills images were taken by Marine Scotland within the Inner Sound, south of Stroma. A review of this footage indicates that the seabed to the southeast of Stroma is heterogeneous in nature and consists of uneven, fissured bedrock with boulders collecting in gulleys and lows (Moore & Roberts, 2011). There are also extensive areas of shell gravel and coarse sand, with coarse material also collecting in rock fissures and lows, whilst rock adjacent to major sediment pockets was observed to be polished smooth by the scour (Moore & Roberts, 2011). Over most of the area the rock was dominated by a crust of *B. crenatus* (although mostly dead in places) and abundant *U. felina* (Moore & Roberts, 2011). Young *Cancer pagurus* was locally abundant[2] but *Nucella lapillus* was observed as sparse in distribution (Moore & Roberts, 2011). At some sites there was extensive coverage of the rock by a yellow encrusting sponge, with lesser quantities of other sponges such as *Esperiopsis fucorum* and *Hymedesmia paupertas* (possible) and a patchy bryozoan turf (Moore & Roberts, 2011). Apparently sparse members of the community included polyclinid cushions, dead men's fingers (*Alcyonium digitatum*) and hydroid patches (Moore & Roberts, 2011). Other more mobile fauna included the common sea urchin (*Echinus esculentus*), and the starfish *Asteroidea* spp. indet, and *Henricia* sp. The biotope has been referred to CR.HCR.FaT.CTub (*Tubularia indivisa* and cushion sponges on tide-swept turbid circalittoral bedrock), although the characterising species *T. indivisa*, appeared to be only present at low density (Moore & Roberts, 2011). Areas of coarse sediment SS.SCS.CCS (circalittoral coarse sediment) are expected to be highly mobile and show no evidence of life (Moore & Roberts, 2011).

10.43 The biotopes across the survey area have been defined and described based on the ASML (2011) data. A list of the biotopes found in the offshore Project development area, including title, description of the main species present, depth range and a photograph, is given in Table 10.10. The distribution of biotopes over the offshore development area and surrounding waters in Inner Sound is shown in Figure 10.5. As would be expected from the large areas of exposed bedrock, the largest biotopes by coverage are those associated with exposed and broken rock surfaces. The largest biotope by area in the offshore Project development area is CR.HCR.FaT.BalTub (*B. crenatus* and *T. indivisa* on extremely tide-swept circalittoral rock), which is very similar to the CR.HCR.FaT.CTub (*Tubularia indivisa* and cushion sponges on tide-swept turbid circalittoral bedrock) biotope found in the area by the Marine Scotland surveys. CR.HCR.FaT.CTub (*Tubularia indivisa* and cushion sponges on tide-swept turbid circalittoral bedrock) was also recorded by the ASML survey, although not in exactly the same areas found by the Marine Scotland survey; this is a result of the likely patchy nature of the biotopes in that the seabed will at times be a mosaic of two or more closely related biotopes, especially around the limits (e.g. depth, water flow) of the biotope. It does not signify any major difference in communities present and has no bearing on the conservation significance of the area. The SS.SCS.CCS (circalittoral coarse sediment) biotope recorded by ASML (ASML, 2011) in the north east of the Project area was also recorded from the wider area by the Marine Scotland surveys and is certainly not locally restricted to the AfL area. ASML (2011) report that the observations made from the five MarineScotland surveys by Moore & Roberts (2011) tallied very closely with those of the present survey.

2 Note that the Pentland Firth and Orkney Waters area has been identified as a possible important nursery ground for this species (Moore, 2009).

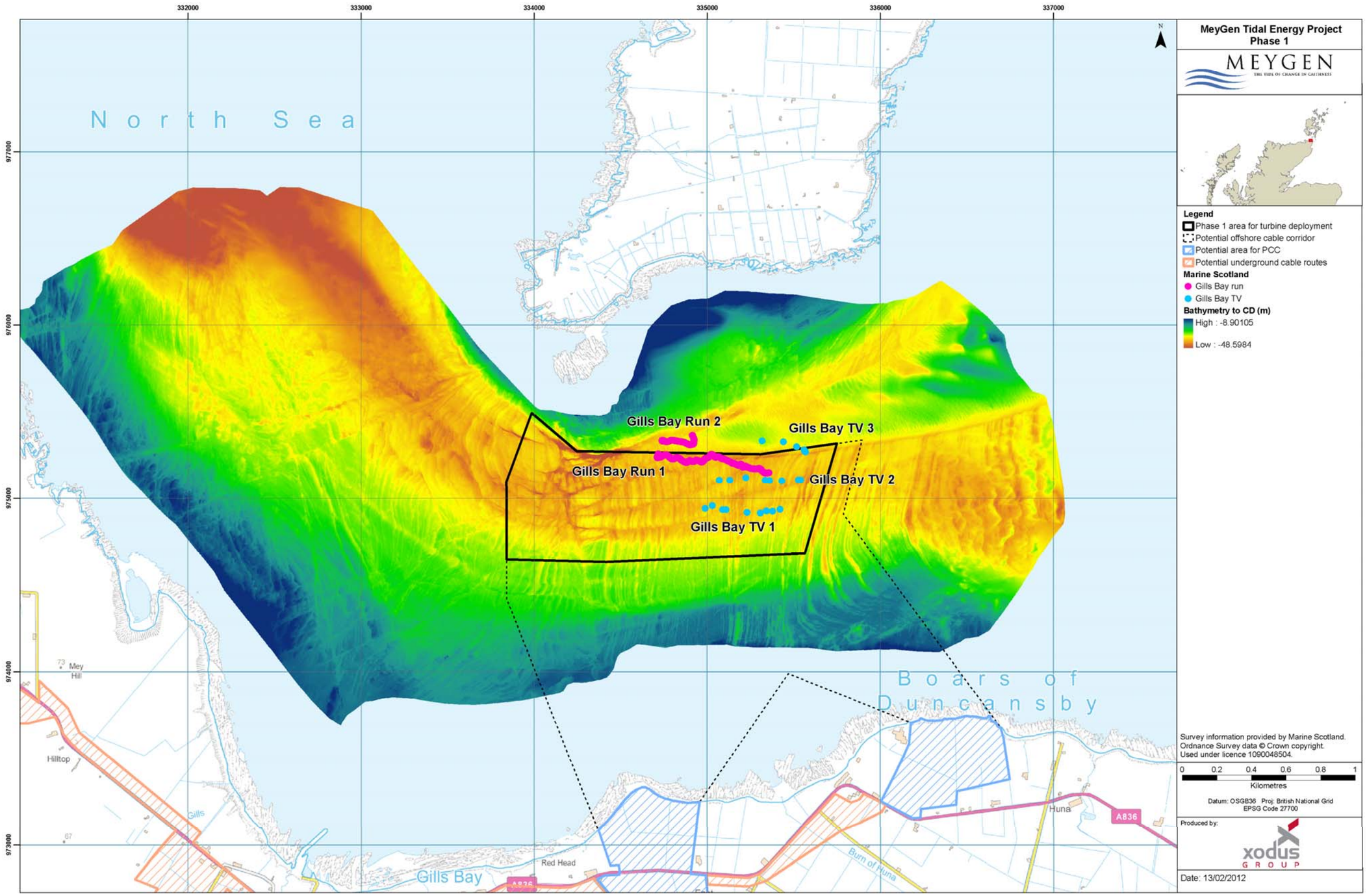


Figure 10.3: Marine Scotland coverage and relevant survey positions (Marine Scotland, 2011)

10.44 Within the cable corridor, south of the turbine deployment area where the seabed shoals towards the mainland shore, upward-facing bedrock and boulders becomes characterised by large brown seaweeds of the genus *Laminaria*, or kelp. The deepest water in which kelp was recorded was approximately 25m (ASML, 2011) but it will be the shallower waters within which the kelp plants form 'kelp forests' that are characteristic of exposed shallow waters in Scotland and much of the UK (note that the ASML survey did not differentiate between kelp forest and kelp park biotopes). The specific kelp biotope identified in Inner Sound (IR.HIR.KFaR.LhypFa) is found often on exposed and very exposed wave-surged, upper infralittoral bedrock and massive boulders. It is characterised by a dense forest of the kelp *Laminaria hyperborea* and a high diversity of seaweeds and invertebrates (Connor *et al*., 2004). The shallowest kelp plants are often short or stunted, while in deeper water the plants are taller with stipes[3] heavily covered with foliose red seaweeds, some of which are found on the rock below the canopy. Encrusting coralline algae can cover any bare patches of rock (Connor *et al*., 2004) in between kelp plants. The faunal composition of this biotope varies markedly between sites, but commonly occurring are the soft coral *A. digitatum* and the anthozoans *Sagartia elegans* and *Corynactis viridis* (Connor *et al*., 2004). The hydroid *Obelia geniculata*, the ascidian *Botryllus schlosseri* and the bryozoan *Membranipora membranacea* compete for space on the kelp fronds, whereas the bryozoan *Electra pilosa* can be found on the holdfasts and on the epiphytic foliose red algae. Similar 'kelp forest' biotope is found on suitable rocky habitat around the entire Scottish coastline but is particularly extensive around Skye and the adjacent mainland, along the west coast of the Outer Hebrides, and around Orkney and Shetland. The biotope is also found on the west coast of England, Wales and Ireland (JNCC, Undated).

10.45 Other biotopes have been described associated with the areas of boulders and sediment; these, along with the other biotope designations, are described in Table 10.10. The proportion of the Project area covered by differing biotopes and the percentage of the offshore Project area (turbine deployment and cable route areas) that is covered by each of the biotopes, as well as the infrastructure that may be coincident with those, is shown in Table 10.11. The conservation status of the biotopes is noted also. Results for macrofaunal analysis from the MeyGen commissioned environmental survey (ASML, 2011) show that nearly 8,000 individuals belonging to 104 species were recorded from 12 grab samples (Table 10.8), all from the SS.SCS.CCS (circalittoral coarse sediment) biotope. This biotope is the only sedimentary biotope found in the survey area and is only found in a small area in the northeast of the turbine and cable area. However, it is not found within the location within which the turbines will be deployed and as such, it can be used to consider the wider area but is not an indication of what will specifically be found at the turbine locations. An average of around 600 individuals and 23 species were found at each station, although the values at each ranged between 222 and 999 individuals and 16 and 38 species (Table 10.8). Of the 104 different species found, 30 belong to the annelids, 22 to the bryozoans and 18 to the crustaceans. Other notable contributions by species number included the molluscs (11) and cnidarians (8). The remainder (porifera, platyhelminthes, nemertea, nematoda, chaetognatha. chelicerata, echinodermata, tunicate and pisces) contributed up to three species to the overall total.

	Station												Average
	1B	1C	1D	2B	2C	2D	3B	3C	3D	4B	4C	4D	
Individuals	547	349	439	1,269	358	222	815	713	547	280	999	788	611
Species	29	21	19	24	25	22	18	16	17	19	38	31	23
Top five species by individual number	*Socarnes erythrophthalmus* Turbellaria *Saccocirrus papillocercus* *Spadella cephaloptera* Nematoda			Turbellaria *Saccocirrus papillocercus* *Spadella cephaloptera* *Socarnes erythrophthalmus* *Leptocheirus pectinatus*			*Saccocirrus papillocercus* Turbellaria *Leptocheirus pectinatus Spadella cephaloptera* Nematoda			Turbellaria *Liljeborgia pallida* *Microcharon harrisi* *Spadella cephaloptera* *Leptocheirus pectinatus*			

Table 10.8: Species results from the sediments surrounding the offshore Project development area (ASML, 2011)

3 The holdfast anchors the kelp plant to the seabed whilst the stipe extends upwards like a plant's stem and supports the fronds (leaf-like structures).

10.46 The communities in each of the grab samples were all found to be very similar, being dominated by interstitial organisms In numerical terms, the platyhelminthe Turbellaria (1,921 individuals) and annelid *Saccocirrus papillocercus* (1,662 individuals) dominated. Other characteristic species included unidentified nematoda, the arrow worm *Spadella cephaloptera*, the polychaete *Ophryotrocha* sp., the amphipods *Socarnes erythrophthalmus*, *Liljeborgia pallida*, *Leptocheirus pectinatus* and the isopod *Microcharon harrisi*. Most of these taxa are characteristic of coastal benthic habitats, and the amphipods and isopod in particular are known from coarse sandy and shelly substrata around the UK. In the UK, the polychaete genus *Ophryotrocha* has been associated with an opportunistic lifestyle in organically enriched areas of oil-contaminated sandy mud around oil and gas installations (e.g. Connor *et al*., 2004). Worldwide, this genus is also associated with opportunistic occurrence, often in high numbers in low diversity communities, in a variety of habitats (Thornhill *et al*., 2009). Its occurrence in the coarse tidally swept sediments of Inner Sound may be linked more to inhospitability of the habitat to most other species, than to organic enrichment.

10.47 Many small fragments of sponges, bryozoans and ascidians were also present, but these were assumed to be transient drift material and continually swept in from the nearby reef biotopes by the strong tidal currents in the Sound (ASML, 2011).

10.48 There were very few species recorded in each of the dredge samples, with a total of 51 species from nine phyla recorded (Table 10.9). The samples were dominated by bryozoans, particularly encrusting bryozoans on dead shells, crustaceans, hydroids and molluscs with one tunicate *Polyclinum aurantium* found in all the samples. Species found included the hydroid *Sertularia argentea*, an amphipod *Gammaropsis* sp., a small mussel *Modiolula phaseolina* and the encrusting bryozoans *Parasmittina trispinosa*, *Celleporella hyalina* and *Cellepora pumicosa*. The erect bryozoans *Flustra foliacea* and *Securiflustra securifrons* were both present in two samples in moderate quantities, confirming the video results

Phylum	Dredge Station				Total species
	D1A	D1B	D2A	D2B	
Cnidaria	1	6		1	6
Nemertea		1			1
Annelida		4	3	1	6
Chelicerata		1			1
Crustacea	2	9	5	2	13
Mollusca	3	4		5	7
Bryozoa	6	9	6	4	14
Echinodermata		2			2
Tunicata	1	1	1	1	1
Total species	13	37	15	14	51

Table 10.9: Species results from the dredge samples surrounding the offshore Project development area (ASML, 2011)

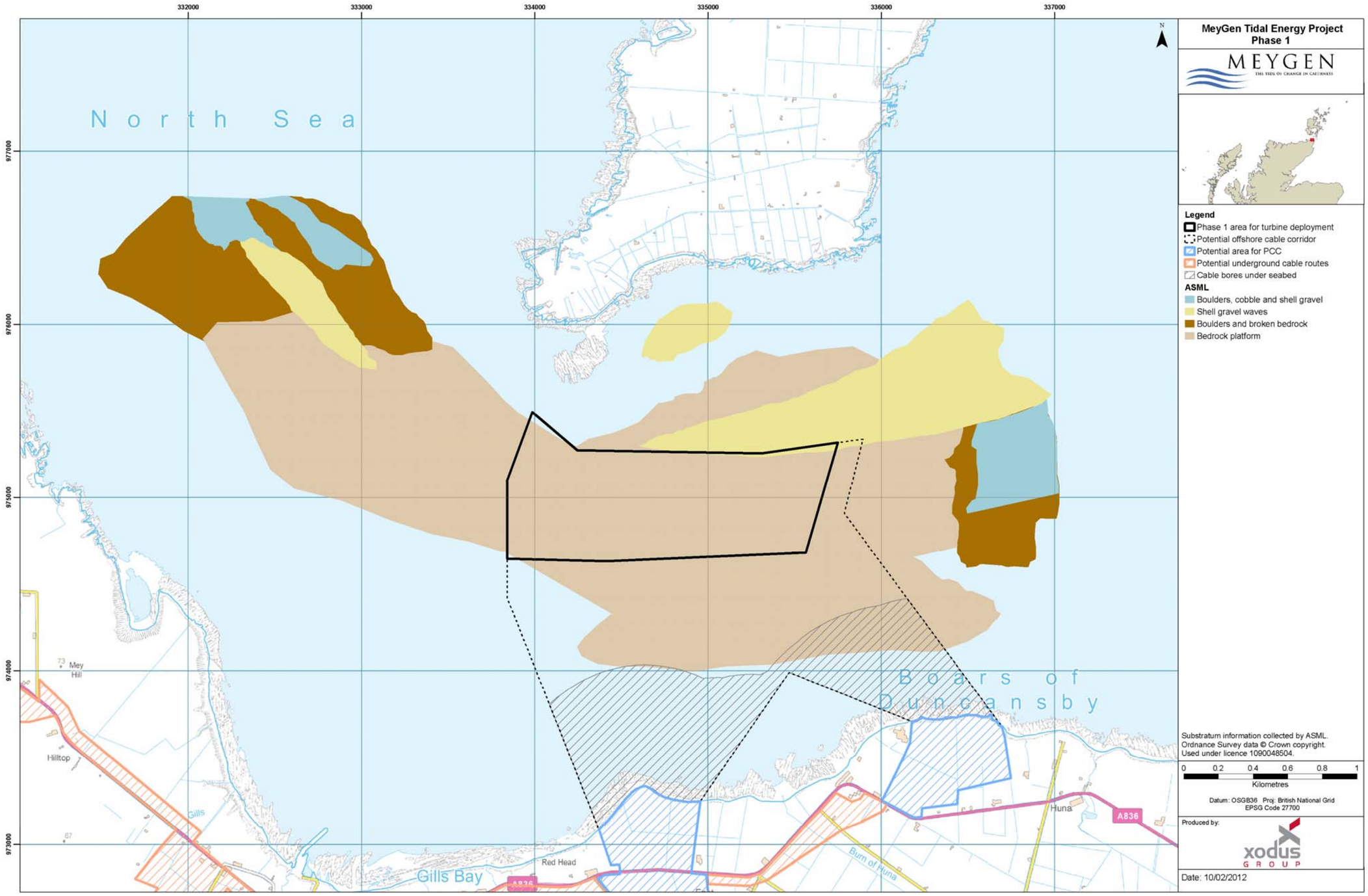


Figure 10.4: Substratum type for the offshore Project area and surrounding seabed (ASML, 2011)

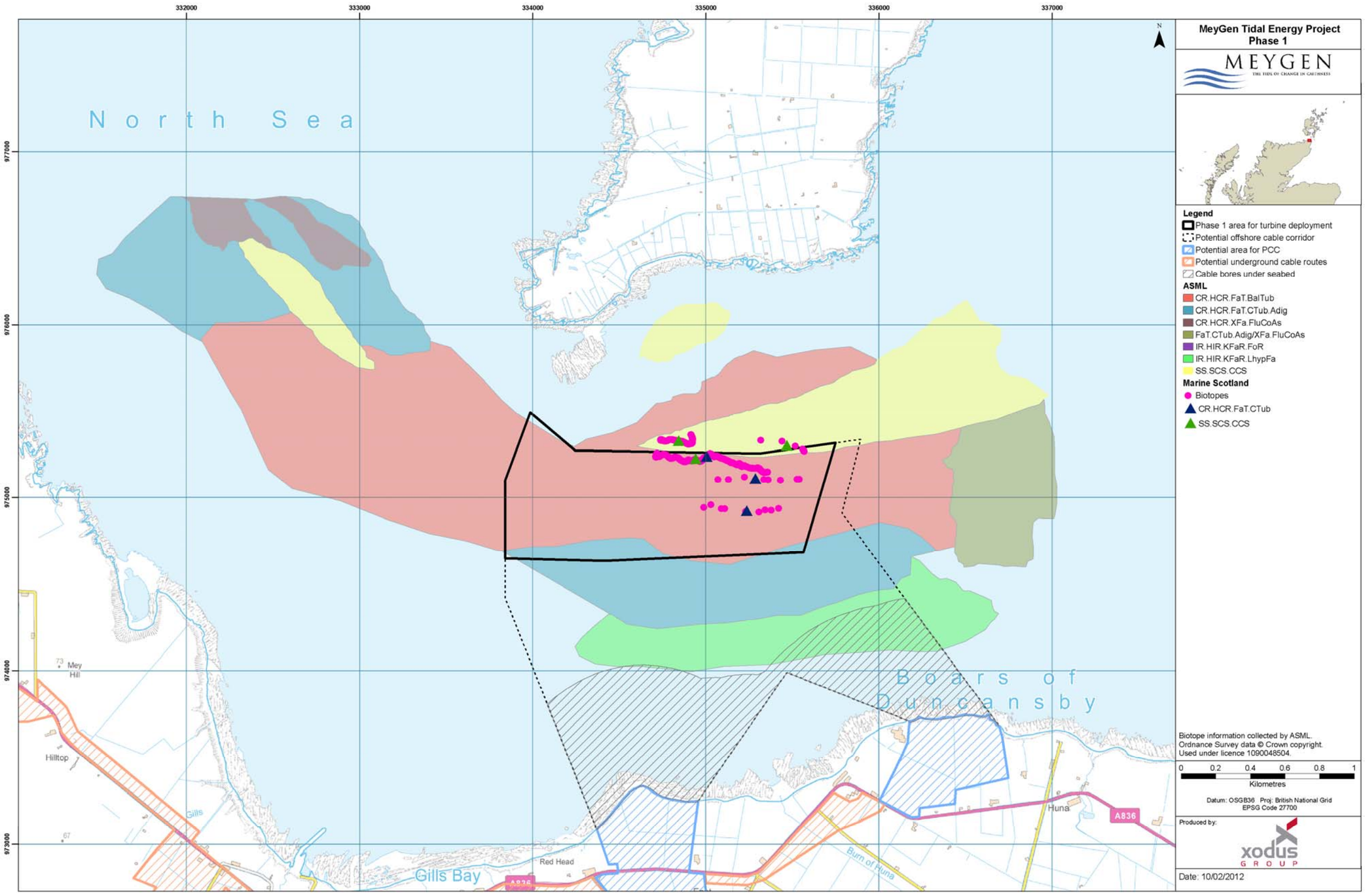
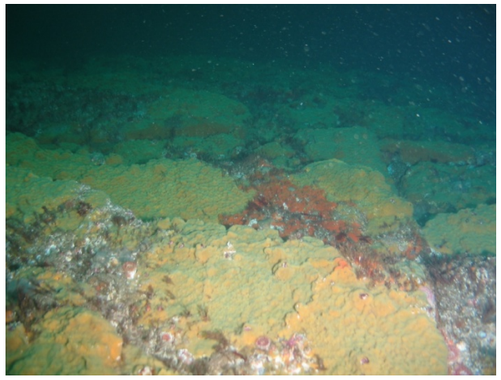
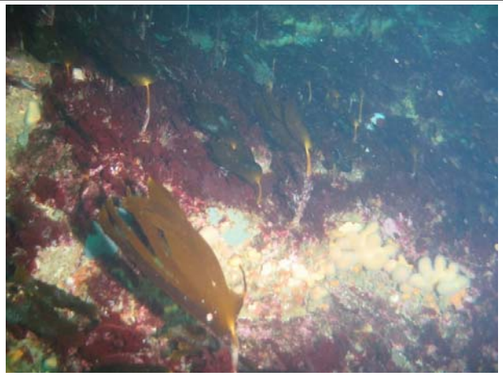


Figure 10.5: Biotope codes for the offshore Project area and surrounding seabed (ASML, 2011)

Biotope	Description	Project area images
CR.HCR.FaT.BalTub *B. crenatus* and *T. indivisa* on extremely tide-swept circalittoral rock Recorded at approximately 30 to 40m water depth	Scoured bedrock platform with steps, ledges and some broken rock and boulders. Coarse shell gravel patches and occasional cobbles and boulders. The rock platforms were tilted with a vertical face with crevices and overhangs running below the highest edge. Rock heavily encrusted with a rich scour-tolerant fauna. Dominant and highly characteristic species include *T. indivisa*, *B. crenatus*, *Chirona hameri/Balanus balanus*, superabundant *U. felina*, sheets of *Halichondria panicea*. Patches of foliose red algae on higher parts of rock platforms. *E. esculentus*, *A. rubens*, *Henricia* sp., *Cancer pagurus* all frequent. Numerous other ascidians, anemones, sponges, hydroids and bryozoans present. This biotope dominated the circalittoral rock platforms in the strongest tidal streams. There were pockets of other biotopes sheltered behind verticals or in small gullies.	 
CR.HCR.FaT.CTub.Adig *Alcyonium digitatum* with dense *Tubularia indivisa* and anemones on strongly tide-swept circalittoral rock Recorded at approximately 25 to 45m water depth	Broken and irregular bedrock, boulders and cobble with some bedrock platform. Coarse shell gravel patches. Rock heavily encrusted with a rich scour-tolerant fauna. Dominant *A. digitatum*, *T. indivisa*, *B. crenatus, U. felina*¸ *Sagartia elegans*, *Alcyonidium diaphanum*, *Polyclinum aurantium*, *Nemertesia* spp., *Flustra foliacea*, *Securiflustra securifrons*. Patches of foliose red algae on higher parts of rock platforms. *E. esculentus*, *A. rubens*, *Henricia* sp., *C. pagurus* all frequent. Numerous other ascidians, anemones, sponges, hydroids and bryozoans present.	

Biotope	Description	Project area images
	This biotope dominated more broken and irregular rock and was just out of the strongest tidal streams. It was particularly characterised by abundant *A. digitatum*.	
IR.HIR.KFaR.LhypFa *Laminaria hyperborea* forest with a faunal cushion (sponges and polyclinids) and foliose red seaweeds on very exposed upper infralittoral rock Recorded at approximately 15 to 25m water depth	Bedrock and boulders with dense kelp forest and park. Rock surfaces were completely covered with kelp forest/park, dense foliose red algae and encrusting fauna such as *A. digitatum*, *H. panicea*, anemones and sponges. The animal components were particularly prominent on vertical faces and kelp stipes. There was no division attempted in the mapping between kelp forest and kelp park, particularly as there is only one biotope available in the classification for this very tide swept habitat.	
IR.HIR.KFaR.FoR Foliose red seaweeds on exposed lower infralittoral rock Recorded at approximately 20 to 30m water depth	Bedrock and boulders with dense foliose red algae. It was difficult to distinguish individual species from the video and photographs. This biotope formed a zone along the deeper edge of the kelp park, to depths of about 20 to 29m. Smaller patches of the biotope, which were not mapped separately, were seen on the shallower parts of rock platforms within circalittoral biotopes.	No good photo/screen grab available

Biotope	Description	Project area images
SS.SCS.CCS Circalittoral coarse sediment Recorded at approximately 15 to 30m water depth	Clean shell gravel waves with little or no organic matter and a particle size distribution dominated by shell granules and very coarse shell sand. The fauna was dominated by interstitial organisms such as turbellarians, the polychaete *S. papillocercus,* amphipods such as *Socarnes erythrophthalmus*, *Leptocheirus pectinatus* and *Liljeborgia pallida* as well as the chaetognath *Spadella cephaloptera*. Many small fragments of sponges, bryozoans and ascidians were also recorded, but these are assumed to have been transient and swept in from the nearby reef by the constant strong tidal currents.	

Table 10.10: Biotopes observed in the offshore Project area (ASML, 2011)

10.49 It is important to reference the survey results against the conservation priorities identified in Section 10.2. The regional and site survey results suggest that the seabed on which the turbines and cables to shore will be placed could be classified as Annex I Rocky Reef. Indeed, three of the biotopes identified from these areas are listed under the European Habitats Directive as indicative of Reef habitat (Table 10.11).

10.50 Such rocky, tidally influenced habitat may fall under the UKBAP classification of 'tide-swept channels', especially when it is considered that the 'CR.HCR.FaT very tide-swept faunal communities' biotope (a higher level code containing two of the biotopes recorded from the surveys) is one of the illustrative biotopes for this designation. Similarly, the SS.SCS.CCS (circalittoral coarse sediment) biotope, found elsewhere in this region, is listed as illustrative of the subtidal (sublittoral) sands and gravel biotope. The presence of some sponges means that the UKBAP 'fragile sponge and anthozoan communities on subtidal (sublittoral) rocky habitats' may be found in the area. However, as sponges were found only occasionally (ASML, 2011) and as the UKBAP description notes this habitat as being dominated by sponges and sea fans, it is not considered that this biotope is present. No UKBAP species were recorded during the environmental survey (ASML, 2011). The Caithness LBAP does not list any marine species other than fish (detailed in Section 13) and consequently none of the species reported from the survey can be classified as LBAP species.

10.51 In terms of Priority Marine Features (PMF), the kelp biotope found during the survey does not match the specifics of the 'kelp and seaweed communities on sublittoral sediment' or that of the 'tide-swept algal communities' listed in Section 10.2.2.4 above. As such, no PMF habitats are likely in the area, and no PMF species have been recorded either. This concurs with the Marine Scotland survey results for this region. Similarly, none of the OSPAR habitats or species that could be present in the area have been recorded by any of the recent surveys that cover the AfL area and the wider area. The species observed were generally common and widespread (ASML, 2011).

Biotope	Area (km^2)	% of Area[4]	Conservation importance
Turbine deployment area			
CR.HCR.FaT.BalTub (*B. crenatus* and *T. indivisa* on extremely tide-swept circalittoral rock)	1.03	90.3	Indicative of Annex I habitat. Indicative of UKBAP tide-swept communities.
CR.HCR.FaT.CTub.Adig (*Alcyonium digitatum* with dense *Tubularia indivisa* and anemones on strongly tide-swept circalittoral rock)	0.09	7.9	Indicative of Annex I habitat. Indicative of UKBAP tide-swept communities.
SS.SCS.CCS (circalittoral coarse sediment)	0.02	1.8	None.
Cable route to shore			
CR.HCR.FaT.BalTub (*B. crenatus* and *T. indivisa* on extremely tide-swept circalittoral rock)	0.026	1.87	Indicative of Annex I habitat. Indicative of UKBAP tide-swept communities.
CR.HCR.FaT.CTub.Adig (*Alcyonium digitatum* with dense *Tubularia indivisa* and anemones on strongly tide-swept circalittoral rock)	0.418	30.07	Indicative of Annex I habitat. Indicative of UKBAP tide-swept communities.
IR.HIR.KFaR.FoR (Foliose red seaweeds on exposed lower infralittoral rock)	0.088	6.33	Indicative of Annex I habitat.
IR.HIR.KfaR.LhypFa (*L. yperborean* forest with a faunal cushion (sponges and polyclinids) and foliose red seaweeds on very exposed upper infralittoral rock)	0.689	49.57	Indicative of Annex I habitat.
Area not surveyed (but assumed to be CR.HCR.FaT.CTub.Adig and IR.HIR.KfaR.LhypFa)	0.169	12.16	Indicative of Annex I habitat. Indicative of UKBAP tide-swept communities.

Table 10.11: Biotope coverage and conservation status for the offshore Project development area (ASML, 2011)

10.5.4 Shellfish

10.52 Consultation with local fishermen has confirmed that the area of the Project is targeted for lobster (effort concentrated to the west of the Project area), brown crabs and velvet crabs. The strong and rapidly changeable tidal conditions in the turbine deployment area mean it is not intensively fished since fishermen are reluctant to use static gear in such conditions.

10.53 Given the largely rocky seabed found within the turbine deployment area and the known preference of scallops for mixed sediment habitats, along with the lack of targeted fishing (Section 14), it is unlikely that scallops will be encountered in significant numbers. There are no historic or active aquaculture sites located within the study site.

10.54 Both the benthic site survey (ASML, 2011) and the Marine Scotland regional surveys (Marine Scotland, 2011) have recorded the presence of the brown crab (ASML, 2011).

10.6 Impacts during Construction and Installation

10.6.1 Introduction

10.55 Some areas of significant sediment cover were found to be present by the geophysical survey (iXSurvey, 2009). Comparing the distribution of this shell and gravel material against the proposed layout of the potential 86 turbines suggests that only a small proportion of the turbine deployment area (1.8%) has any sediment (Table 10.11). This area is unlikely to be affected as turbines are to be located within the areas of bedrock which make up most of the turbine deployment area. It should also be noted that the models in Section 9 suggest that there is no net transport of sediment from these areas and the natural sediment transport within the Project area will be unaffected. As a result, issues related to sediment, such as sediment suspension and consequent smothering of benthic species through re-settlement, are not likely consequences of installation of the tidal turbines and discussion of such impacts are not considered necessary in this document. Similarly, the devices and cables will make use of the natural seabed topography and no seabed levelling, rock removal operations or trenching or dredging will be undertaken. This section will consequently focus on assessing the impact on the benthic environment (including

[4] 45% of the cable route corridor was surveyed for the biotope mapping as the shallowest area could not be covered. Considering the inshore location of this part of the cable route corridor, the biotopes here are likely to be a continuation of (or possibly variants of) the kelp biotope found in the 15 to 25m depth range further offshore. It should also be noted that the HDD bores will emerge on the seabed a minimum of 700m from shore (see Figure 10.2).

shellfish) of placing structures on the seabed and ensuring suitable attachment, as well as any clearance of kelp required along the cable routes. Considering the lack of sediment in the area, the footprint of the installation activities is therefore not expected to extend much outwith the area on which structures are placed. Where such impacts may occur, these will be related to the discharge of drill cuttings from the directional drilling of the cable bores and for pile drilling for the TSS and potential kelp clearance during cable installation, both of which are discussed below. In addition, the possible issue of non-native marine species introductions from vessels has been considered.

10.6.2 Impact 10.1: Direct physical impact and loss of habitat

10.56 The placement of the turbines and cables on the seabed will be likely to impact on any benthic species present within the footprint of the structures themselves, the areas of which are shown in Table 10.12. Any small sessile species present on the seabed on which such infrastructure will be placed would potentially be damaged or destroyed; more mobile species, including some of the shellfish species, retain the ability to move away from affected areas during the installation process. The placement of the turbines and cables onto the seabed will also exclude the seabed habitats directly beneath from use by species found in the region for the life of the development. As there is little sediment in the Project area then there are not expected to be any indirect effects through sediment suspension and re-settlement. As noted in the baseline description, the surveys in the Project area and wider AfL area showed that there are no species considered to be of specific conservation significance recorded at the site and that there are no large aggregations of species that would suggest elevated numbers compared to other sites in the vicinity of the survey area.

10.57 In addition, it may be necessary to clear the cable route of kelp to facilitate cable installation. Based on the ASML survey data, kelp habitats may extend to approximately 1km from the shore. To calculate a worst case value for this kelp clearance, it has been assumed, as above, that all 86 turbines will require a separate cable to shore and that this cable will pass through 300m of kelp biotope once it has emerged from the bore. Each cable will require a 1m corridor to be cleared of kelp within which the cable can be placed. With these assumptions an area of kelp of approximately 0.027km^2 would be cleared. Such an area of clearance corresponds to a very small percentage of the total kelp forest habitat available locally in the Pentland Firth and an even smaller percentage of that available regionally and nationally (as kelp forest and park biotopes are widespread on Scottish coastlines); indeed, it accounts for less than 4% of kelp in the area surveyed by ASML (2011). The presence of kelp (both forest and park) around the cables means that this habitat is certainly locally available to any species displaced by installation activities. Thus, a large area of undisturbed habitat will continue to be available directly adjacent to the cables to any species that relies on the kelp habitat. The kelp removal is also likely to be insignificant in comparison to available standing crop levels and natural loss processes; for example, storm events may dislodge up to 25% of standing kelp crop (Chapman, 1948) in some environments.

10.58 Regarding the fate of the kelp that is cut, the practical disposal route is to leave the cut plant on the seabed onsite in the vicinity of the cutting operation, where it can join the major storm cut weed pathway into the kelp/coastal ecosystem. This is likely to be the most environmentally sensible option, particularly when the cut kelp quantities are compared with the storm cut/cast weed from the area. This method will retain the detritus contribution to the forest environment rather than the energy/emission costs associated with shipping to shore for land use/disposal. Some of this cut kelp may be washed onto shore but the small volume of kelp likely to be cut against the loss of kelp that will occur from the wider area during storm events (up to 25% of standing crop) means any amount washed ashore is likely to be small and only temporary in nature.

Removal Reason	Dimensions	Area of seabed affected (km^2)
Maximum surface of 86 turbines	40m x 30m x 86 turbines	0.103
Surface area of export cables	1.3km x (120mm x2) x 86 turbines	0.027
Total	-	0.130
Assumptions	▪ The horizontally drilled bores that will carry the export cables beneath the littoral zone and much of the shallow sublittoral zone will breakthrough 700m from shore; ▪ The greatest distance from a turbine offshore to the start of the subsurface cable bores 700m from shore is approximately 1.3km, and this has been assumed for all cables; ▪ Some weighting (using cast iron split pipes) to ensure cable stability is required but the extent is currently unknown - to account for this, the diameter of all the cables has been doubled; and ▪ Turbines will require one cable each.	

Table 10.12: Estimated area of direct physical impact

10.59 Kelp, a perennial[5] with regard to the holdfast and stipe, experiences rapid blade growth between December and June when a completely new blade develops from the meristem[6] (UK Marine SACs Project, 2001). Plants that are damaged can therefore return to a viable state over a period of only months. In the first few years of the life of kelp, the blade area and stipe length increase each year until the kelp is over five years old (UK Marine SACs Project, 2001). The growth rate and length of the stipe is elevated in shallower waters relative to deeper waters (UK Marine SACs Project, 2001); the cable route will pass through such shallow waters (as well as deeper waters) and in some areas the recovery rates will therefore likely be at the upper end of the scale.

10.60 The tidal rapid habitat that dominates the Project area is reported to demonstrate a high degree of sensitivity in relation to habitat loss (Scottish Executive, 2007). For the kelp habitat through which the cables pass sensitivity is rated as moderate. The specific biotope that is likely to experience the largest impact by area from turbine placement is CR.HCR.FaT.BalTub (*B. crenatus* and *T. indivisa* on extremely tide-swept circalittoral rock), with CR.HCR.FaT.CTub.Adig (*Alcyonium digitatum* with dense *Tubularia indivisa* and anemones on strongly tide-swept circalittoral rock) and SS.SCS.CCS (circalittoral coarse sediment) experiencing some impact also. Where cables are concerned, it will be the same biotopes including IR.HIR.KFaR.FoR (Foliose red seaweeds on exposed lower infralittoral rock) and IR.HIR.KFaR.LhypFa (*L. hyperborea* forest with a faunal cushion (sponges and polyclinids) and foliose red seaweeds on very exposed upper infralittoral rock).

10.61 As the area of impact is so small and the shellfish recorded in the area are mobile, the impact on this species group is expected to be small.

10.62 Given the low level of conservation importance of the benthic habitats within the Inner Sound, the receptor sensitivity is defined as medium. Although direct impact will occur in the localised area of the development (that is, where structures are placed on the seabed) which would lead to a moderate ranking, the impact is not expected to extend outwith that immediate footprint to the wider Project area and, since recovery is expected to be rapid, the magnitude is therefore defined as minor.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Medium	Minor	Minor	Not Significant

[5] Lasting for more than one year.
[6] The point from which new growth emerges.

MITIGATION IN RELATION TO IMPACT 10.1
▪ Although no significant impact has been identified, mitigation measures have been provided on a precautionary approach to ensure this remains the case. ▪ The area of kelp that may need cleared will be restricted to as small as practicable around the cable and only larger plants will be removed if possible. ▪ Installation layout will be clearly defined and communicated to any personnel involved in kelp clearance.

10.6.3 Impact 10.2: Release of drill cuttings and fluid

Pile drilling

10.63 Monopile drilling operations will generate rock cuttings and these will be discharged from the drilling rig into the marine environment. Drilling operations will take approximately 4 hours per pile and a total of 30 hours to complete the preparations for each TSS. Seawater (with no additives) will be used as the drilling fluid to lubricate the drill bit and aid in the removal of cuttings from the hole. A compressor will be used to pump air into the drilled holes in order to lift the cuttings clear as required. This compressor will use a lubricant which will be discharged to sea along with any cuttings to a maximum of 5 litres per hour (i.e. 20m^3 per TSS, or 1,720m^3 for all 86 turbines installed over a 3 year period). The total volume of cuttings will be 17,200m^3 over a 3 year period.

HDD drilling

10.64 The cables to shore will be routed through bores directionally drilled through the cliffs onshore. Assuming a worst case scenario of 29, 600mm bores, 700m in length. These will generate approximately 195m^3 of drill cuttings per bore; a total volume of 5,655m^3 for 29 bores. These will be collected from the bore at the drilling site onshore. As drilling is occurring from the onshore end, there may be some loss of cuttings to the marine environment upon breakthrough to the seabed. In the worst case scenario, the final 10m of the bore will be lost into the marine environment; a total of 82m^3 for all 29 bores. Note that the loss of the entire bore is considered an accidental event and covered in Section 24.

10.65 The HDD drilling operation will use bentonite as a lubricant. Bentonite is non-toxic the main potential environmental impact is likely to result from the physical settlement of rock cuttings onto the seabed and associated biological communities.

10.66 The drill cuttings from the piles and HDD bores are likely to consist predominantly of a fluid paste (incorporating the finest silt and clay-sized particles) with occasional larger fragments up to pebble-sized flakes, all of which are mobile in the marine environment. The largest and heaviest particles will settle relatively quickly to the seabed in the close vicinity of the drilling centre, whilst in this energetic locality the finest particles will remain in suspension for some time.

10.67 The likely initial result of such discharges will most likely include physical disturbance and smothering of rocky habitat and associated species close to the discharge locations, together with raised turbidity levels in the water column over a slightly wider area. Turbidity levels will then decline following discharge, as the result of dispersion, dilution and gradual settlement of the finer fractions. As a result of the distance to shore and the high tidal flow rates through Inner Sound, there is little likelihood of the cuttings being washed ashore, although this will depend on prevailing sea and weather conditions at the time of discharge. There will also be a length of time between each pile being drilled which will allow for additional dispersion time between each discharge event.

10.68 The dynamic environment (resulting from intense wave action and tidal activity) into which the operational discharge will be released means that drill cuttings will be dispersed into the wider marine area; the Pentland Firth is one of highest energy coastal environments in the UK. The lack of sediment across almost all the turbine deployment area and the likely cable corridor indicates a dynamic environment in which solids are unlikely to accumulate. Natural turbulent conditions should ensure any deposition on the seabed is quickly dispersed and does not accumulate into large deposits. Naturally occurring material (including rock and other debris) is constantly moved around by tide and wave action ordinarily and, as such, the addition of rock debris is unlikely to be an unusual event. The bedload information collected by ASML (2011) and presented in Section 10.5 confirms that such material is present under usual conditions and that the introduction of small rock material (the cuttings) will not be a novel event.

10.69 Evidence from shallow waters of the southern North Sea, where wave and tidal movements greatly influence the marine environment, suggests that erosion rates are greater than natural sedimentation rates and that cuttings piles[7] are readily dispersed (e.g. Kjeilen *et al.*, 1999).

10.70 Should some localised accumulation of cuttings result in negative impacts to the benthic environment, affected species (as a group or individually) will regenerate successfully where damage has not been extensive. Where damage is such that recovery is not expected, species will be replaced through reproductive activity and inward migration or spread from the surrounding environment. Whilst it is possible that a thin layer of cuttings could inhibit attachment to the bedrock by such species, this is unlikely and cuttings are not expected to remain for any period of time. It is especially important to note that the suite of surveys undertaken in the Project area and the wider region (including the AfL area) have reported that the habitat within the offshore Project area is similar to that surrounding it. This is important as, in the unlikely event of negative impacts to the benthic environment of the offshore Project area, the resources for recovery exist in the surrounding area.

10.71 Although information is not available on the specific sensitivities of all the biotopes recorded from the site surveys, the sensitivity of the UKBAP habitat 'tidal rapids' that includes biotopes that cover around 61% of the Project area has previously been described. That review suggests that the vast majority of the Project area is unlikely to be affected by the release of the drill cuttings, demonstrating as it does low sensitivity to smothering, increased turbidity and changes in suspended sediment levels (Scottish Executive, 2007). With regards to the kelp habitat through which the cables may pass, this type of environment is not particularly sensitive to smothering (low) or an increase in suspended sediment (not sensitive) or turbidity (very low) (Hiscock, 2008).

10.72 As any increase in turbidity or suspended sediment levels is expected to be temporally and spatially restricted and as many of the shellfish species in the area are mobile, significant impact by this mechanism seems unlikely; the restricted element of any impact means that the number of sessile mollusc species impacted will be low, even though these species are generally more susceptible to increased sedimentation as the filter feeding apparatus can become clogged and ineffectual.

10.73 Given the lack of conservation importance of the benthic habitats within the Inner Sound, the receptor sensitivity is defined as medium. Although increased turbidity/suspended sediment levels may occur in the localised area of the development (that is, around where drilling operations occur) which would lead to a moderate ranking, the impact is not expected to extend outwith that immediate footprint to the wider Project area and, since recovery is expected to be rapid, the magnitude is therefore defined as minor.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Medium	Minor	Minor	Not Significant

MITIGATION IN RELATION TO IMPACT 10.2
▪ Although no significant impact has been identified, mitigation measures have been provided on a precautionary approach to ensure this remains the case. ▪ Minimise as far as practicable the depth and diameter of the turbine foundation piles (without compromising technical performance).

[7] These observations related to drill cuttings discharged during oil and gas industry drilling operations which generate significantly greater volumes of cuttings (>100x).

- Lubricant used in the compressor to drive air into the drilled piles will be non-toxic and seawater will be used as a drilling fluid, negating the need for any additional chemical input.
- Minimise as far as practicable the volume of drill cuttings released into the marine environment during breakthrough of HDD bores, by implementing a closed loop recycling system to return drill cuttings and fluid from the HDD to shore.

10.6.4 Impact 10.3: Release of sediment bound contaminants

10.74 The release of contaminated sediments during device and cable installation may cause potentially detrimental effects on species (and habitats) that are sensitive to contamination. However there is no indication that any of the limited sediments present in the Project area have been contaminated. There is a general lack of development in the wider area, with the Dounreay reactor representing the only major potential contamination pathway within the vicinity of the Project. Radiochemical analysis of grab samples from the benthic survey, showed no evidence of contamination from artificial radioactivity in any of the samples (ASML, 2011). There is a dredge spoil disposal site located in the proposed turbine deployment area but this has not been in use since the 1970s. The seabed surveys identified the whole area to be composed of bedrock, indicating that in the high energy tidal environment sediments disposed at the site have since dispersed away from the site.

10.75 The sediment adjacent to the turbine deployment area will settle very close to where it was disturbed as it consists of large sized particles that are likely to travel a very short distance. The models in Section 9 Physical Environment and Sediment Dynamics suggest that there is no net transport of sediment from the area and the natural sediment transport within the Project area will be unaffected. As a result it is unlikely that contaminated sediments (if, despite what available evidence suggests, they are present) will be disturbed in a manner that may affect the benthic species or habitats present in the Project area. The magnitude of impact is therefore defined as negligible.

10.76 The potential impacts on water quality have been discussed further in Section 9 Physical Environment and Sediment Dynamics.

10.77 Given the lack of conservation importance of the benthic habitats within the Inner Sound, the receptor sensitivity is defined as medium.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Medium	Negligible	Negligible	Not Significant

MITIGATION IN RELATION TO IMPACT 10.3
▪ No mitigation measures proposed as no significant impact predicted.

10.6.5 Impact 10.4: Marine non-native species

10.78 Invasive Marine Non-Native Species (MNNS) pose a significant threat to biodiversity as they may have negative impacts on native species and threaten regional ecosystems; SNH reports a growing problem with marine invasive non-native species in Scotland (SNH, 2011). Non-native species have the potential to be introduced in the Inner Sound environment through the use of vessels and equipment that has been used in other parts of the world; this is a particular risk with the use of ballast water. Should a non-native species be introduced into the marine environment of Inner Sound there is no guarantee that the species will be tolerant of the conditions and it is in fact more likely that the species will be unable to reproduce and initiate a local population. For such a population to develop the species would need to be tolerant of the environmental conditions of the Inner Sound (e.g. temperature, salinity, suspended sediment), make use of existing food sources (e.g. organic content of sediment, prey species) and be able to outcompete the native species. Alternatively it must be able to exploit a previously unfilled ecological niche. Where these conditions are met then the native populations may experience a reduction in numbers or a complete failure. Note that Hiscock (2008) reports some of the biotopes in the region to be a no risk from non-native species at all (e.g. the kelp habitat), although information is lacking in support of conclusions for other biotopes on which assessments have been made. Note that the use of local or UK-based installation vessels would limit the potential for introduction of non-native marine species.

10.79 Given the low level of conservation importance of the benthic habitats within the Inner Sound, the receptor sensitivity is defined as medium. The impact of MNNS could in theory extend, in the long term, over a large area. This could lead to a high ranking for magnitude of impact. However, the impact is considered extremely unlikely to occur and to balance the scale of impact against the likelihood of impact occurring, a magnitude of impact of minor is assigned.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Medium	Minor	Minor	Not Significant

MITIGATION IN RELATION TO IMPACT 10.4
▪ Although no significant impact has been identified, mitigation measures have been provided on a precautionary approach to ensure this remains the case. ▪ All vessels involved in all stages of the Project will adhere to all relevant guidance (including the IMO guidelines) regarding ballast water and transfer on non-native marine species.

10.7 Impacts during Operation and Maintenance

10.7.1 Impact 10.5: Electro-magnetic effects

10.80 The electricity produced by the turbines will be transmitted to shore using a series of cables laid on the seabed. The electric current that is carried in these cables generates magnetic fields that have the potential to interact with marine species and to affect their behaviour since, in addition to visual cues, some species also use the magnetic field of the earth to orient (Fisher & Slater, 2010). The magnetic component of EMF will be of similar strength to that of the Earth in close proximity to the cables, and so will have the potential to affect magnetosensitive species such as bony fish, elasmobranchs, marine mammals, sea turtles (Inger *et al*., 2009), barnacles and sea urchins (Fisher & Slater, 2010). Section 13 describes the possible effects of EMF in greater detail.

10.81 At a worst case the cabling for the array will include 1.3km of subsea cabling from the devices to the subsea boreholes which cover a maximum of 0.013km^2 of the Project area and a considerably smaller proportion of the wider Inner Sound. The cables to be used are up to 6.6kV significantly reducing the fields surrounding the cables when compared to the 132kV cables used in most offshore wind farms. This in itself will considerably reduce the EMF impacts compared to other offshore power cables. The cables are designed with a screen completely surrounding the conductor, resulting in the E-field being present between the conductor and the screen such that the i-field outside the cable will be zero. Directly surrounding the cable the magnetic field may be up to 6µT (micro tesla). However, at 2m from the cable this would decrease to approximately 2µT which is well below that of the earths magnetic field (which is between 30 and 70 µT) and may not be detectable. It is not known to what extent the exact magnitude of the iE-field emissions will be from the cables used for the array but it is considered likely to be below the predictions made in the COWRIE reports (CMACS, 2003, Gill *et al*., 2005).

10.82 Benthic and demersal species are more likely to be vulnerable to the potential barrier effects of the electromagnetic fields (EMF) than pelagic species as their lifestyle brings them into closer contact with the seabed cables. The species most sensitive to the EMF and most likely to be attracted or repelled by the electrical fields generated by submarine cables are the electrosensitive elasmobranchs, a species group which is dealt with in Section 13.

10.83 However, other benthic species are potentially still vulnerable. Bochert & Zettler (2004) report the outcome of experimental analysis on several benthic species (including a number of crustaceans) exposed to static magnetic fields of 3.7mT for an extended period of time. These results obtained no differences in survival rates between the experimental and control populations. Similarly, the mussel *M. edulis* exposed to the static magnetic fields for three months did not demonstrate recordable changes. Bochert & Zettler (2004) conclude thus: Static magnetic fields of power cable transmissions do not appear to influence the orientation, movement or physiology of benthic species. In addition, even under the influence of anthropogenic fields, no negative impacts have been observed in crustaceans; for example, no ill effects were detected in western rock lobster (*Panulirus cygnus*) after electromagnetic tags, emitting a 31kHz signal, were attached to them (Jernakoff 1987). Although there are studies that demonstrate some species may be susceptible (e.g. Rosario & Martin, 2010), the Marine Renewable SEA does not list any specific benthic species as having demonstrated a response to EMF.

10.84 As noted in Section 13, there are insufficient data available with which a judgement can be made about the potential for EMF to impact on a particular species but it can be concluded that the potential for impact is highest for species that depend on electroreception to detect benthic prey (CMACS, 2003); this will not be the case for any of the benthic species identified in the baseline description.

10.85 Given the low level of conservation importance of the benthic habitats within the Inner Sound, the receptor sensitivity is defined as medium. Although the impact of EMF could extend across part of the Project area, turbines will be operational for only approximately three quarters of the time, meaning that EMF will be present for only approximately three quarters of the time. Combined with the fact that the impact is, based on the discussion above, considered unlikely to occur, a magnitude of impact of minor is assigned.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Medium	Minor	Minor	Not Significant

MITIGATION IN RELATION TO IMPACT 10.5

- Although no significant impact has been identified, mitigation measures have been provided to ensure this remains the case.
- Where cables are not within boreholes attempts will be made to lay cables within natural crevices and cracks in the seabed to reduce cable wear. This will ensure that the majority of the cable is not exposed.
- The voltage of the cables will be up to 6.6kV (as opposed to the 132kV) which will considerably reduce the EMF emitted by the cables.
- The length of the drilled boreholes for the cable will be maximised (as far as technically and commercially practicable) to increase the length of cable under the seabed.
- Ongoing research by Marine Scotland and their advisors will be monitored for potentially successful mitigation strategies.

10.7.2 Impact 10.6: Hydrodynamic change

10.86 The introduction of structures into the water column has the potential to alter the movement of water in an area, both at a very local and more regional level. This possibility is increased when the structures installed are designed to capture the energy in the marine environment. Species will have flow tolerance limits within which they are able to exist; these will relate to the oxygen delivered by the water, by food availability or by simple flow forces moving animals from the seabed. A change in the water flow, be it an increase or decrease in rate or direction or some other consequence, could affect the species composition of an area if the species present had a small range of flow rates in which they could survive.

10.87 As noted above, although information is not available on the specific sensitivities of the biotopes recorded from the site surveys, the sensitivity of the UKBAP habitat 'tidal rapids' that includes biotopes that cover around 61% of the Project area has previously been described. This habitat exhibits low tolerance to a decrease in water flow and could consequently experience a degradation in quality should the water flow be affected by the tidal device (Scottish Executive, 2007). Modelling indicates that mean flow through Inner Sound during calm conditions could be reduced by between 0 and 0.4ms^{-1} after the installation of the final 86-turbine array (see Section 9, Figure 9.14). At the same time, the flow rates could be increased immediately to the north by between 0.1 and 0.2ms^{-1} for the final 86 turbine array. The conclusions are much the same for storm conditions except that, as would be expected, the extent and magnitude or the differences are greater under storm conditions. This small change in flow rates mean the impact is likely to be minimal and the magnitude of impact is therefore defined as negligible.

10.88 The above is backed up by findings of research associated with the SeaGen tidal turbine development in Strnagford Narrows, Northern Ireland (Royal Haskoning, 2011). CR.HCR.FaT.BalTub (*B. crenatus* and *T. indivisa* on extremely tide-swept circalittoral rock), dominant at the MeyGen site is the dominant biotope throughout the SeaGen tidal turbine development site in the Strangford Narrows, Northern Ireland (Royal Haskoning, 2011) whilst CR.HCR.FaT.CTub.Adig (*Alcyonium digitatum* with dense *Tubularia indivisa* and anemones on strongly tide-swept circalittoral rock) is also present at both sites. Studies associated with the SeaGen development indicate that although some changes were observed in the benthic community, these changes were as expected in a high energy environment (they were reflected in control stations away from the SeaGen device) and all of the available data support the conclusion that there appears to be no deleterious effect of the installation of the marine current turbine.

10.89 The two biotopes closest to shore, which the cables may pass through, should be unaffected by changes in water flow and both exhibit a low sensitivity in any case (e.g. Budd, 2008).

10.90 Given the lack of conservation importance of the benthic habitats in Inner Sound, the receptor sensitivity is defined as medium.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Medium	Negligible	Negligible	Not Significant

MITIGATION IN RELATION TO IMPACT 10.6

- No mitigation measures proposed as no significant impact predicted.

10.7.3 Impact 10.7: Sediments

10.91 The alteration in water flow across the area of the turbine installation (as outlined above) could affect suspended sediment levels in the water. If the effect was sufficiently large, then this could result in a change in sediment erosion and deposition patterns locally with follow-on changes to the habitats and species present. The impacts of increased sedimentation are described above but it should be noted that reducing the available sediment can also result in changes. For example, most polychaete worms burrow or build tubes from the available sediment; restricting this supply or causing changes in particle size could affect the ability of such species to undertake such tasks.

10.92 The morphology modelling study (detailed in Section 9) predicted that there would be no significant impacts to the sediment dynamics and bedforms following the installation of the tidal array. There is a natural movement of sediments as would be expected in a tidal flow receiving wave action, but the array is not predicted to affect these processes significantly. The results (given in Section 9) show that even under calm conditions and with no turbines the bedforms show evidence of movement, but not in a way which is significant. The sand present in the area will shift backwards and forwards under the flooding and ebbing tide, but with no evidence of bedform migration or net sediment transport. Under calm conditions, the addition of the array is predicted to make little or no difference to the existing bedform structures. The

conclusions for storm conditions are much the same as for the calm conditions except that, as would be expected, the extent and magnitude or the differences are greater.

10.93 For the habitats for which information is available, varying degrees of sensitivity to altered sediment levels in the water column are observed. For example, CR.HCR.XFa.FluCoAs (*F. foliacea* and colonial ascidians on tide-swept moderately wave-exposed circalittoral rock) shows intermediate sensitivity to increased sediment (Budd, 2008) but this biotope is found well away from the areas in which sediment load might be increased, being as it is well outside the Project and cable route areas. Kelp habitats show a high tolerance to increased sediment and are tolerant of decreases in suspended sediment (Hiscock, 2008); however, neither of these changes are expected in the areas where kelp is found. Overall the impact magnitude is considered to be negligible.

10.94 Given the lack of conservation importance of the benthic habitats in Inner Sound, the receptor sensitivity is defined as medium.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Medium	Negligible	Negligible	Not Significant

MITIGATION IN RELATION TO IMPACT 10.7
▪ No mitigation measures proposed as no significant impact predicted.

10.7.4 Impact 10.8: Introduction of new hard structures

10.95 The physical presence of the turbine structures will provide new, stable, hard substrata. In areas where the seabed is comprised of sediment then this would be presented as a novel habitat. However, these hard structures will be installed in rocky areas and will present a habitat similar to that already present, potentially being colonised by epifaunal and encrusting animals typical of the area. The presentation of additional hard structures into the environment will not change the type of habitat available and is thus unlikely to affect the species composition of the immediate or wider region.

10.96 Information from the SeaGen tidal device in Strangford Lough shows that some, but not all, of the hard structures below the surface experienced marine growth. Royal Haskoning (2011) report that the parts of the SeaGen device which most closely represented a seabed type habitat (the shoe structures on the seabed) have become colonised by the biotope CR.HCR.FaT.BalTub (*B. crenatus* and *T. indivisa* on extremely tide-swept circalittoral rock) which was found to be dominant prior to installation of SeaGen, indicating that the device (or at the least some parts of the device) present a similar habitat to that which exists pre-installation.

10.97 The cylindrical turbine structures (legs, struts and lower tower) were, however, colonised by the blue mussel biotope CR.MCR.CMus.CMyt (*Mytilus edulis* beds with hydroids and ascidians on tide-swept exposed to moderately wave-exposed circalittoral rock) (Royal Haskoning, 2011). This biotope was not recorded in the Narrows during previous SeaGen surveys. Royal Haskoning (2011) report that this biotope provides a food source for some fish species, echinoderms and crustaceans and that its addition to the Narrows is considered to be positive. Note that similar structures on the MeyGen devices are likely to be subject to antifouling measures (see Impact 10.9) and growth of this sort may be restricted.

10.98 The impact from colonisation of new hard structures is likely to be limited to the Project footprint, possibly extending to the surrounding area if the structures were to act as an artificial reef, promoting a raised density of species and out from which these species could move to settle. However, as colonising species are likely to be the same as already found in the Inner Sound and as some of the structures deployed for this Project are likely to be treated with antifouling to limit colonisation, a magnitude of impact of minor is assigned.

10.99 Given the lack of conservation importance of the benthic habitats in Inner Sound, the receptor sensitivity is defined as medium.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Medium	Minor	Minor	Not Significant

MITIGATION IN RELATION TO IMPACT 10.8
▪ No mitigation measures proposed as no significant impact predicted.

10.7.5 Impact 10.9: Antifouling

10.100 The introduction of new structures presents a second concern; the degree to which antifouling treatment will be applied which, by its nature, may be toxic to species found in the area. MeyGen recognises that the prevention of marine growth on the turbine structures is an important consideration, even in a fast flow environment. Different approaches, including antifouling paints and copper coatings, are being explored on the prototype devices at EMEC and this experience will inform the need for and type of antifouling system to be deployed. Any toxic effect of the antifouling treatment or impact from any other method of limiting biofouling (e.g. copper coating, water blasting) will be limited to the device itself and exert no effect on the surrounding marine environment and therefore the impact magnitude is defined as negligible.

10.101 Given the lack of conservation importance of the benthic habitats in Inner Sound, the receptor sensitivity is defined as medium.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Medium	Negligible	Negligible	Not Significant

MITIGATION IN RELATION TO IMPACT 10.9
▪ No mitigation measures proposed as no significant impact predicted.

10.8 Impacts during Decommissioning

10.102 The tidal turbines will be removed from the support structures to a DP vessel and returned to shore and no impact on the benthic environment is expected. The cables will be recovered to a vessel (with the potential for some destructive impact) as the cables are moved over the seabed and the HDD bores capped at the breakthrough location. If piled foundations are used, the piles will be cut at the seabed. Any impacts these operations may have on the seabed will occur in an area that experienced an effect during the installation operations and at similar or lesser magnitude the impacts described for the installation and operation phases.

10.103 Although information on the potential for recovery is not available for all the habitats found in the area, evidence that does exist for some of the habitats suggests a high or very high capacity to recover from all relevant impacts (e.g. Hiscock, 2008, Budd, 2008). Although this recovery may be delayed in some cases until after decommissioning (e.g. the recovery of the seabed onto which the devices will be placed), there will be a degree of recovery starting immediately following the installation of the devices (e.g. kelp recovery along the cable routes).

10.9 Potential Variances in Environmental Impacts

10.104 The impact assessment above has assessed the worst case Project options with regards to impact to benthic ecology. This section provides a brief overview of the potential variances between the worse case Project option assessed and alternative Project options.

10.105 Not considered worst case for benthic ecology was the option for pin pile TSS. The installation methods for pin pile TSS would have a lesser impact compared to the installation of the monopile TSS since it would produce less drill cuttings. It also has a smaller footprint than the GBS TSS and therefore the potential direct habitat loss would be lower.

10.106 In addition should the export cable boreholes be drilled closer to the array site (less than the worst case assessed) this has the potential to reduce the impact of loss of seabed habitat and reduce the area and volume of kelp that would need to be removed form the cable corridor. This would also reduce the potential for impact from EMF as the length of cable placed on the seabed would be lessened.

10.10 Cumulative Impacts

10.10.1 Introduction

10.107 MeyGen has in consultation with Marine Scotland and The Highland Council identified a list of other projects (MeyGen, 2011) which together with the Project may result in potential cumulative impacts. The list of these projects including details of their status at the time of the EIA and a map showing their location is provided in Section 8; Table 8.3 and Figure 8.1 respectively.

10.108 Having considered the information presently available in the public domain on the projects for which there is a potential for cumulative impacts, Table 10.13 indicates those with the potential to result in cumulative impacts from a benthic habitats and ecology perspective. The consideration of which projects could result in potential cumulative impacts is based on the results of the project specific impact assessment together with the expert judgement of the specialist consultant.

Project title	Potential for cumulative impact	Project title	Potential for cumulative impact	Project title	Potential for cumulative impact
MeyGen Limited, MeyGen Tidal Energy Project, Phase 2	✓	SHETL, HVDC cable (onshore to an existing substation near Keith in Moray)	×	OPL, Ocean Power Technologies (OPT) wave power ocean trial	×
ScottishPower Renewables UK Limited, Ness of Duncansby Tidal Energy Project	✓	Brough Head Wave Farm Limited, Brough Head Wave Energy Project	×	MORL, Moray Offshore Renewables Ltd (MORL) offshore windfarm	×
Pelamis Wave Power, Farr Point Wave Energy Project	×	SSE Renewables Developments (UK) Limited, Costa Head Wave Energy Project	×	SSE and Talisman, Beatrice offshore Windfarm Demonstrator Project	×
Sea Generation (Brough Ness) Limited, Brough Ness Tidal Energy Project	×	EON Climate & Renewables UK Developments Limited, West Orkney North Wave Energy Project	×	BOWL, Beatrice Offshore Windfarm Ltd (BOWL) offshore windfarm	×
Cantick Head Tidal Development Limited, Cantick Head Tidal Energy Project	×	EON Climate & Renewables UK Developments Limited, West Orkney South Wave Energy Project	×	Northern Isles Salmon, Chalmers Hope salmon cage site	×
SSE, Caithness HVDC Connection - Converter station	×	ScottishPower Renewables UK Limited, Marwick Head Wave Energy Project	×	Northern Isles Salmon, Pegal Bay salmon cage site	×
SSE, Caithness HVDC Connection - Cable	×	SSE Renewables Developments (UK) Limited, Westray South Tidal Energy Project	×	Northern Isles Salmon, Lyrawa salmon cage site	×
RWE npower renewables, Stroupster Windfarm	×	EMEC, Wave Energy test site (Billia Croo, Orkney)	×	Scottish Sea Farms, Bring Head salmon cage site	×
SSE, Gills Bay 132 kV / 33 k V Substation Phase 1: substation and overhead cables (AC)	×	EMEC, Tidal energy test site (Fall of Warness, Orkney)	×	Northern Isles Salmon, Cava South salmon cage site	×
SSE, Gills Bay 132 kV / 33 k V Substation Phase 2: HVDC converter station and new DC buried cable	×	EMEC, Intermediate wave energy test site (St Mary's Bay, Orkney)	×	Scottish Sea Farms, Toyness salmon cage site	×
SHETL, HVDC cable (offshore Moray Firth)	×	EMEC, Intermediate tidal energy test site (Head of Holland, Orkney)	×	Northern Isles Salmon, West Fara salmon cage site	×

Table 10.13: Summary of potential cumulative impacts

10.109 The following sections summarise the nature of the potential cumulative impacts for each potential project phase:

- Construction and installation;
- Operations and maintenance; and
- Decommissioning.

10.10.2 Potential cumulative impacts during construction and installation

10.110 Cumulative impacts arising from installation of multiple marine renewable projects at the same time as the proposed installation are not anticipated as the majority of impacts are expected to localised (e.g. increased turbidity, smothering and release of drill cuttings and fluids[8]). The Ness of Duncansby Tidal Energy project is the only project that may potentially be constructed at the same time as the MeyGen Tidal Energy Project, Phase 1 and would not act in combination to cause significant cumulative impacts.

10.10.3 Potential cumulative impacts during operations and maintenance

10.111 It is possible for cumulative and in-combination impacts to arise from operation and maintenance of the MeyGen Project and the construction, installation operation and maintenance of these other marine renewable projects in the Pentland Firth; the main impact in this respect will be the loss of currently available seabed habitat for the life of the developments.

10.112 The installation of additional marine renewable devices in the Pentland Firth has the potential to contribute to increased loss of seabed habitat and species associated with those lost areas. However, previous area wide surveys show Pentland Firth and Orkney waters coastline as displaying low diversity circalittoral tideswept rocky communities, dominated by a sessile fauna of *B. crenatus* and *U. felina* (although other predominantly sandy, sand-scoured rock or mixed substrates of sand and stones have been recorded). As the area in which we consider cumulative impacts expands and consequently the area of impact from marine renewables also increases, so does the habitat available and the relative magnitude of impact remains the same. As the current assessment rates the possible impact from this Project as minor, it is

[8] Cumulative impacts from discharges of drill cuttings would only be a potential impact if other developers used piled foundations.

expected that the cumulative impact from the various currently proposed projects would be insignificant also.

10.113 The installation of additional marine renewable projects in the Pentland Firth and their associated cabling increases the sources from which EMF could be emitted. However, as outlined above, the possible negative effects of EMF are considered to be extremely localised in nature and of little actual consequence to the benthic species found in the area. Similarly localised impacts predicted from the above assessment, such as on water flow and sediment transport and the introduction of hard structures and antifouling agents, have been assessed as applicable only to the immediate vicinity of the development and in a non-significant manner above and are not expected to act in any cumulative fashion with other developments.

10.114 The likelihood of the introduction of non-native marine species to the marine environment will increase with each additional project since the number of vessels entering and exiting the area will also increase. However, assuming that other projects in the area make the same commitments to follow relevant guidelines as made herein, that likelihood will remain low and there should be no cumulative impact.

10.10.4 Potential cumulative impacts during decommissioning

10.115 Although it is possible that a number of the impacts that may occur during decommissioning (e.g. noise emissions, seabed impact) could act cumulatively with other developments, there is limited scope for much of this since it is highly unlikely that the Ness of Duncansby development (the only development other than MeyGen Phase 2 expected to offer the potential for cumulative impact) would be decommissioned at the same time as this development, or that of the MeyGen Phase 2 development (which would likely be decommissioned at the same time as the proposed development).

10.10.5 Mitigation requirements for potential cumulative impacts

10.116 No mitigation is required over and above the Project specific mitigation.

10.11 Proposed Monitoring

10.117 Monitoring of benthic habitats and ecology is proposed in order to confirm impact predictions made in the ES in particular in relation to:

- Dispersion of drill cuttings from potential TSS pile installation and HDD bore breakthrough; and
- To detect any significant changes in habitats due to the presence of the turbines.

10.118 Surveys are expected to be required post installation and post decommissioning.

10.119 Based on current knowledge of the site (extensive baseline surveys and hydrodynamic modelling) and building on the pre installation surveys, it is likely that the benthic monitoring programme would be based primarily on drop down video upstream / downstream of the project such that potential changes to the biotope mosaic in the area could be detected. Reference areas to either side of the turbine array and cable routes could also be sampled.

10.12 Summary and Conclusions

10.120 The biotopes across the turbine deployment area are dominated by CR.HCR.FaT.BalTub (*B. crenatus* and *T. indivisa* on extremely tide-swept circalittoral rock), which is very similar to the CR.HCR.FaT.CTub biotope found in the area by the Marine Scotland surveys. The SS.SCS.CCS (circalittoral coarse sediment) biotope recorded in the turbine deployment area (ASML, 2011) was also recorded from the wider area by the Marine Scotland surveys and is certainly not locally restricted to the AfL area. As would be expected from the large areas of exposed bedrock, the largest biotopes by coverage are those associated with exposed and broken rock surfaces. Within the cable corridor, where the seabed shoals towards the mainland shore, upward-facing bedrock and boulders becomes characterised by large brown seaweeds of the genus *Laminaria*, or kelp. The deepest water in which kelp was recorded was approximately 18m (ASML, 2011) but it will be the shallower waters within which the kelp plants form 'kelp forests' that are characteristic of exposed shallow waters in Scotland and much of the UK. The specific kelp biotope identified form the cable route in Inner Sound (IR.HIR.KFaR.LhypFa Foliose red seaweeds on exposed lower infralittoral rock) is found often on exposed and very exposed wave-surged, upper infralittoral bedrock and massive boulders. It is characterised by a dense forest of the kelp *Laminaria hyperborea* and a high diversity of seaweeds and invertebrates (Connor *et al*., 2004).

10.121 Three of these biotopes are listed under the European Habitats Directive as indicative of Reef habitat (Table 10.11) whilst the rocky, tidally influenced habitat, is likely to fall under the UKBAP classification of 'tide-swept channels'. Similarly, the SS.SCS.CCS (circalittoral coarse sediment) biotope, found elsewhere in this region, is listed as illustrative of the subtidal (sublittoral) sands and gravel biotope. No UKBAP or LBAP species were recorded during the environmental survey (ASML, 2011) and no PMF habitats or species have been recorded either. This concurs with the Marine Scotland survey results for this region. Similarly, none of the OSPAR habitats or species that could be present in the area have been recorded by any of the recent surveys that cover the lease option area and the wider area. To summarise, although some of the habitats may represent those listed under various protection mechanisms, the areas do not represent outstanding examples of these habitats and are unlikely to qualify for any protection through site designation. In addition, these habitats are common throughout the wider Pentland Firth and Orkney waters.

10.122 A number of potential impacts associated with the construction, installation, operation, maintenance and decommissioning of the Project on benthic ecology have been assessed. This assessment identified a number of key issues including loss of habitat and associated species, removal of kelp, discharge of drill cuttings and the potential for the introduction of MNNSs.

10.123 The area of seabed habitat which will be impacted by the Project is considered to be extremely small and similar to that present in the Inner Sound and wider area. It is also expected to demonstrate a capability of recovery following the installation and decommissioning stages. The conservation importance of the habitats that may be directly impacted, although represented on some lists of conservation significance, is relatively low and there will be no impact on any areas of protected seabed habitat. The areas from which kelp may be removed and the volumes required to be cut are not expected to be significant in terms of that lost during storm events and natural renewal processes. Species which rely on the seabed habitats excluded from use or on the kelp that is removed will be able to relocate to identical habitats in the immediate vicinity of any impacted area.

10.124 The relatively small volume of drill cuttings and fluid associated with monopile drilling and the HDD bores at seabed breakthrough have been assessed as unlikely to significantly impact the marine environment into which they will be discharged, especially when the high energy nature of that environment is taken into account. Similarly, non-native marine species are unlikely to be a significant issue with regards to the Project.

10.125 Considering these conclusions, the installation of the turbines and associated cables is not expected to have a likely significant effect on the benthic environment.

10.126 With regards to the operation of the device, the EMF emitted by the cables has been noted as of concern to some marine species; the effect on benthic species, including shellfish, is, however, not expected to be significant in the case of the Project. Water flow and sediment transport will also be relatively unaffected by the operation of the devices and no impact on seabed habitats or species is therefore expected. The introduction of the turbines as possible hard substrate for colonisation by benthic species is of little concern since it presents a similar habitat to that already present in the turbine deployment area and parts of the cable corridor. The necessity of antifouling to combat any potential growth is also not considered to exert a negative impact since that area of habitat loss has been considered likely in the installation operation assessment and as the possible toxic effect of any antifouling solution will be limited to species making contact with the devices themselves.

10.127 Considering the conclusions, the operation of the turbines and associated cables is not expected to have a likely significant effect on the benthic environment.

10.128 Any impacts that decommissioning operations may have on the seabed will occur in an area that has experienced an effect during the installation operations and at similar or lesser magnitude than the impacts described for those installation and operation phases. In conjunction with an agreed decommissioning plan, the decommissioning of the turbines is not expected to impact significantly on the benthic environment.

10.129 The scale of the individual effects of the installation, operation and decommissioning of the devices are not expected to combine with those from other projects in the wider area to produce likely significant negative cumulative impacts.

10.130 MeyGen has committed to undertaking monitoring of the benthic environment to determine that the impact is as assessed above. This plan will be developed with the relevant authorities and will consider all available guidance and best practice.

10.131 Overall through the implementation of proposed mitigation strategies and commitments the impact of the proposed development on benthic habitats and ecology is considered to be not significant.

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11 MARINE MAMMALS

11.1 The table below provides a list of all the supporting studies which relate to the marine mammal impact assessment. All supporting studies are provided on the accompanying CD.

Details of study	Location on supporting studies CD
Distribution and abundance of marine mammals and basking sharks in the Inner Sound and wider Pentland Firth and Orkney waters (RPS, 2011a)	OFFSHORE\Marine Wildlife\Marine mammals
Analysis of towed hydrophone data collected for MeyGen (Ecologic UK, 2011)	OFFSHORE\Marine Wildlife\Marine mammals
Underwater noise baseline survey and acoustic emission propagation modelling (Kongsberg, 2012)	OFFSHORE\Marine Wildlife\Underwater noise
MeyGen tidal stream turbine array environmental impact assessment: modelling encounter rate between turbines and marine mammals (SRSL, 2012)	OFFSHORE\Marine Wildlife\Marine mammals

11.1 Introduction

11.2 As an integral part of the Environmental Impact Assessment (EIA) process, MeyGen must determine the potential impacts that deployment of the tidal turbines could have on marine mammals. This section assesses the potential for, and possible magnitude of, these impacts, as well as specifying appropriate mitigation measures where necessary. A number of specialists have contributed to this assessment:

- RPS – visual observation surveys and production of the baseline description (including input from Dr Caroline Weir);
- Dr Jonathon Gordon – acoustic monitoring survey;
- Scottish Association for Marine Science, Research Services Limited (SRSL) – marine mammal encounter modelling; and
- Xodus – Impact assessment and ES Section write up.

11.3 Although information on the interactions between marine mammals and novel tidal technologies is limited, this assessment draws upon a series of survey and technical reports prepared for MeyGen to better define this relationship, as well as considering expert opinion and the output from additional desk-based research. Where relevant there is consideration of the outcome of assessments undertaken to inform the consenting of other UK tidal energy projects at the European Marine Energy Centre (EMEC), in the Sound of Islay, in Strangford Lough and at the Skerries, off the coast of Anglesey, North Wales. Environmental monitoring of some tidal turbine prototypes is currently underway and where results are available these have been used (e.g. biannual reporting from Strangford Lough, MCT deployment in Northern Ireland and TGL deployment at EMEC). Information from the EMEC-based Reliable Data Acquisition Platform Tidal (ReDAPT) programme[1], which aims to deliver the most detailed environmental and performance information yet collected, is not available for inclusion in this Environmental Statement (ES) due to the programme being at an early stage[2]. The environmental information will be reviewed when made publicly available to ensure that this assessment and the associated mitigation measures are aligned with the most recent relevant data.

[1] The ReDAPT project is commissioned and funded by the Energy Technologies Institute and aims to install and test a 1MW tidal turbine at EMEC, delivering detailed environmental and performance information not previously achieved at this scale in real sea conditions. The performance data will be used to validate a variety of models and will provide substantial data on tidal resource and environmental assessment.

[2] TGL, the manufacturer of one of the candidate turbines is a key partner in the ReDAPT programme.

11.2 Assessment Parameters

11.2.1 Rochdale Envelope

11.4 In line with the Rochdale Envelope approach, this assessment considers the maximum ('worst case') project parameters. Identification of the worst case scenario for each receptor (i.e. EIA topic) ensures that impacts of greater adverse significance would not arise should any other development scenario be taken forward in the final scheme design.

11.5 Table 11.1 describes the detail of the project parameters that have been used in this assessment and explains why these are considered to be worst case. The potential impacts from alternative Project parameters have been considered in Section 11.9.

Project Parameter relevant to the assessment		'Maximum' Project parameter for impact assessment	Explanation of maximum Project parameter
Turbines	Number	86 turbines	The encounter modelling considers up to the maximum proposed 86 turbines.
	Layout	45m cross-flow spacing and 160m down-flow spacing	An indicative layout for 86 turbines has been used to inform the noise modelling. The indicative layout is based on 45m cross-flow spacing and 160m down-flow spacing. A layout was not required for the encounter modelling. There is presently a lack of knowledge / evidence on how marine mammals navigate through an array of tidal turbines.
	Number of blades per rotor	Three blades	Increasing the number of blades increases the area surface area which mammals may encounter.
	Rotor diameter	18/20m	As a general rule, increasing the rotor diameter increases the amount of water swept by the moving blades, increasing the likelihood of a mammal coming into contact with the blades. However, the encounter risk modelling shows that either 18 or 20m rotor diameter may be considered worst case (see Table 11.16) depending on which species is being considered, due to differences in depth distribution behaviour for different species.
	Maximum height of nacelle above seabed	14.5/16 m	This value is used to calculate the depth horizon swept by the turbine, which will have an effect on which species are likely to encounter it, since different species make different use of the water column. This value differs depending on whether the 18m or 20m diameter rotors are being considered. The encounter risk modelling shows that either 18 or 20m rotor diameter may be considered worst case (see Table 11.16) depending on which species is being considered, due to differences in depth distribution behaviour for different species.
	Minimum clearance between sea surface and turbine blade	8m	This value is used to calculate the depth horizon swept by the turbine, which will have an effect on which species are likely to encounter it, since different species make different use of the water column.
	Clearance from blade tip to seabed	5.5/6.5 m	The minimum clearance between the turbine blade tip and the seabed is 5.5m for the 18 m diameter rotors and 6.5 m for the 20 m diameter rotors. This value is used to calculate the depth horizon swept by the turbine, which will have an effect on which

			species are likely to encounter it. The encounter risk modelling shows that either 18 or 20m rotor diameter may be considered worst case (see Table 11.16) depending on which species is being considered, due to differences in depth distribution behaviour for different species.
	Blade thickness	0.3 m (average blade thickness)	The encounter model requires an average blade thickness as a model input. Blade thickness tapers towards the end of the blade and therefore the model uses average thickness across the length of the blade.
	Cut in flow speed	0.5m/s	The 18m and 20m diameter designs start operating in tidal flows of 0.5m/s. Cut in velocity influences the period of time during the tidal cycle when the turbine blades are rotating. This parameter is an input to the encounter model.
	Cut out flow speed	4.5m/s for 18m rotor diameter 4.5m/s for 20m diameter rotor	Either three bladed, 18m or 20m rotor diameter may be considered worst case in the encounter modelling depending on which species is being considered. As the two different turbines designs have slightly different cut out speeds, both are considered worst case parameters. The encounter risk modelling shows that either 18 or 20m rotor diameter may be considered worst case (see Table 11.16) depending on which species is being considered, due to differences in depth distribution behaviour for different species. Cut out velocity influences the period of time during the tidal cycle when the turbine blades are rotating. This parameter is an input to the encounter model.
	Rotational speed	8rpm (at cut in) to 14rpm (maximum) for 18m diameter, three blades 8rpm (at cut in) to 20rpm (maximum) for 20m diameter, three blades	Either three bladed, 18m or 20m rotor diameter may be considered worst case in the encounter modelling, depending on which species is being considered. As the two different designs have slightly different rotational speeds, both are considered worst case parameters. The encounter risk modelling shows that either 18 or 20m rotor diameter may be considered worst case (see Table 11.16) depending on which species is being considered, due to differences in depth distribution behaviour for different species. The speed of the turbine blades influences the relative velocity of the blades and marine mammal. This parameter is an input to the encounter model.
	Operational noise	36 x 2.4MW turbines for noise generation	The 2.4 MW turbine produces the highest noise and an array of 36 turbines of 2.4MW produces higher noise emissions than an array of 86 turbines of 1MW.
	Decommissioning	All turbines removed at decommissioning	All turbines will be removed at decommissioning.
Turbine support structure	Maximum drill cuttings released into marine environment	Monopile TSS	The drilled monopile TSS will result in the maximum release of drill cuttings to the marine environment. Assuming the maximum number of 86 TSSs, the maximum amount of drill cuttings that can be generated from turbine support installations is 17,200m^2 (total for 86 TSSs).
	Installation noise	Pin-pile TSS	Pin pile drilling produces higher noise output than monopole drilling based on available data. Pin pile source levels are 178 dB re 1 µPa at 1m.
	Maximum amount of compressor lubricant released into the marine environment	86 monopile TSS	Monopile drilling operations will take approximately 4 hours per pile. A compressor is used to pump air into the drilled holes to lift cuttings clear. The lubricant will be discharged to sea along with the cuttings at a maximum rate of 5 litres per hour, i.e. 20m^3 per monopile and 1,720m^3 for all 86 installed over 3 years.
Cable landfall	Maximum drilling cuttings released into marine environment	29, 0.6m HDD bores, drilled from either Ness of Quoys or Ness of Huna	The majority of drill cuttings generated from the drilling of the HDD bores will be returned to shore and not discharged to sea; however it is estimated that the contents of the last 10m of each bore could be discharged to sea and the seabed breakthrough. Of the two potential HDD scenarios, the greatest potential volume of cuttings discharged to sea at breakthrough will result from last 10m of 29 boreholes of 0.6m diameter 82m^2).
Vessels	Installation vessel physical presence	One Dynamic Positioning (DP) vessel for the duration of the installation for year one and two and two DP vessels for year three installation	Installation activities will be carried out by a single DP vessel during year one and two, all installation activities to be undertaken using a single DP vessel. If other smaller vessels used to undertake some of the work of the DP vessel, no concurrent multiple vessel activities will take place, i.e. no more than one vessel on site at any one time. Year three installation will require a maximum two DP vessels for TSS installation. These two vessels may be present on site at the same time during year three.
	Installation vessel noise	Tug vessel noise	Noise data for DP vessels are currently unavailable. Of the vessel noise data available tugs represent the noisiest vessels and are used to represent the highest possible noise source during installation operations. Tug source levels are 172 dB re 1 µPa at 1m.
	Maintenance vessel physical presence	One DP vessel present every 2.8 days	Based on a maximum 86 turbine array, one DP vessel will be present a maximum of 130 times (i.e. single slack tide operation) per year i.e. the DP vessel present on site every 2.8 days.
	Maintenance vessel noise	Tug vessel noise	Noise data for DP vessels are currently unavailable. Of the vessel noise data available tugs represent the noisiest vessels and are used to represent the highest possible noise source during maintenance operations. Tug source levels are 172 dB re 1 µPa at 1m.

Table 11.1: Rochdale Envelope parameters for the marine mammals assessment

11.2.2 Area of assessment

11.6 It is also important to define the geographical extent of the assessment area. The focus of the marine mammal impact assessment is potential impacts on marine mammals using the Project area and adjacent waters. There is variation in the area over which impacts occur and the area over which an impact may occur can vary significantly between species based on their ecology and range over which their populations can be found. Therefore, potential impacts have also been set in the context of a wider study area over which marine mammals encountered in the Project area are thought to range and in context of the regional populations for specific species.

11.3 Legislative Framework and Regulatory Context

11.3.1 Relevant legislation and guidance

11.7 In addition to the EIA Regulations the following legislation is key to the marine mammal assessment:

- EC Habitats Directive 92/43/EEC;
- Nature Conservation (Scotland) Act 2004;
- Wildlife and Countryside Act 1981;
- Conservation (Natural Habitats, &c.) Regulations 1994 (as amended);
- Bern Convention;
- The Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention); and
- Marine (Scotland) Act 2010 – Part 6 concerns the conservation of seals, and makes it an offence to kill, injure or take seals. The Act exempts activities for which a European Protected Species Licence has been granted (under Regulation 44 of the Conservation (Natural Habitats) Regulations 1994).

11.8 A review of all applicable legislation has been undertaken as part of the marine mammal baseline report (RPS, 2011a; available on the supporting studies CD) and is not repeated in full here.

11.9 The approach to the impact assessment has been developed with reference to the principals and guidance provided by Scottish Natural Heritage (SNH) on EIA (SNH, 2009), the MarLIN species and ecosystem sensitivities guidelines (Tyler-Walters *et al*., 2001) and the IEEM guidelines for marine ecological impact assessment (IEEM, 2010).

11.3.2 Conservation and management

Cetaceans (whales and dolphins)

11.10 All species of cetacean occurring in UK waters are protected under the Bern Convention and are listed in Annex IV (species of community interest in need of strict protection) of the EU Habitats Directive as European Protected Species (EPS) where the killing, disturbance or the destruction of these species or their habitat is banned (Article 12). Two species, the bottlenose dolphin *Tursiops truncatus* and the harbour porpoise *Phocoena phocoena*, are also listed in Annex II as species whose conservation requires the designation of Special Areas of Conservation (SAC). Cetaceans are listed in Schedule 5 of the Wildlife and Countryside Act 1981 which prohibits their deliberate killing, injuring or disturbance. The Nature Conservation (Scotland) Act 2004 makes amendments to the Wildlife and Countryside Act 1981 in Scottish waters, including the addition of 'reckless' acts to species protection which make it an offence to intentionally or recklessly disturb a cetacean. Selected species are also protected by the Bonn and OSPAR Conventions, and all toothed whales, or odontocetes, (except for the sperm whale) are protected under the ASCOBANS (Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas) Agreement.

11.11 Species of cetacean occurring regularly in UK waters are designated as UK Biodiversity Action Plan (UKBAP) species, and 18 species are included on the Scottish Biodiversity List. The conservation status of the species most frequently recorded in the Inner Sound is given in the baseline description (Section 11.5), whilst further information on the UKBAP and OSPAR lists is given in the Benthic Impact Assessment (Section 10). Seven cetacean and two seal species are listed on the Scottish Priority Marine Features List (PMF; SNH, 2011).

Pinnipeds (seals)

11.12 All pinniped species occurring in UK waters are listed in Appendix III of the Bern Convention and in Annex V of the EU Habitats Directive as species of community interest for which the taking in the wild and exploitation may be subject to management measures. Two species, the grey *Halichoerus grypus* and harbour *Phoca vitulina* seals, are also listed in Annex II as species whose conservation requires the designation of SACs. The harbour seal is a UK BAP priority species.

11.4 Assessment Methodology

11.4.1 Scoping and consultation

11.13 Since the commencement of the Project, consultation on marine mammal issues has been ongoing. Table 11.2 summarises all consultation relevant to marine mammals. In addition, relevant comments from the Scoping Opinion are summarised in Table 11.3, together with responses to the comments and reference to the ES sections relevant to the specific comment.

Date	Stakeholder	Consultation	Topic/specific issue
11th August 2009	SNH	Meeting	Site visit and meeting to discuss bird and marine mammal survey methodology.
24th September 2009	SNH	Submission of document	Survey methodology
17th November 2009	SNH	Submission of document	Revised survey methodology
24th December 2009	SNH	Receipt of consultation	Confirmation on survey methodology changes
7th April 2011	Marine Scotland and SNH	Pre-Scoping meeting	EIA surveys and studies required and the data needs for each EIA study.
27th May 2011	Marine Scotland, statutory consultees and non-statutory consultees	Submission of Scoping Report	Request for Scoping Opinion from Marine Scotland and statutory consultees and request for comment from non-statutory consultees.
6th May 2011	Marine Scotland and SNH	Submission of document for comment	Submission of interim survey report summarising the results from first 18 months of survey.
30th June – 2nd July 2011	Local stakeholders	Public Event - EIA Scoping	Public event to collate information/opinions on proposed EIA scope.
6th June 2011	Marine Scotland and SNH	Meeting	Presentation of survey results from first 18 months of survey and discussion on EIA and cumulative impact assessment scope and HRA scope.
8th August 2011	Marine Scotland and SNH	Submission of document for comment	Submission of HRA screening report.
30th September 2011	Marine Scotland and SNH	Letter	Response to HRA Screening report.
31st September 2011	Marine Scotland, The Highland Council (THC), statutory consultees and non-statutory consultees	Receipt of Scoping Opinion	Receipt of response to Scoping Report and other comments from non-statutory consultees.
3rd October 2011	Marine Scotland	Project update meeting	Report on EIA progress including presentation of survey results.
20th October 2011	Marine Scotland and SNH	Teleconference	Discussion on proposed scope of marine mammal encounter modelling.
2nd November 2011	Marine Scotland and SNH	Meeting	Discussion of proposed assessment methodology; data requirements; preliminary assessment results and HRA requirements.

Date	Stakeholder	Consultation	Topic/specific issue
6th – 7th December 2011	Local stakeholders	Public Event – pre application consultation	Public event to communicate the findings of the EIA to local stakeholders.
16th February 2012	Marine Scotland and SNH	Teleconference	Discussion of encounter modelling results and their interpretation.
2nd March 2012	Marine Scotland and SNH	Meeting	Final meeting to close out HRA approach to the Project.

Table 11.2: Consultation undertaken in relation to marine mammals

Name of organisation	Key concerns	Response	ES Section within which the specific issue is addressed
THC	Given the large ranging distance of cetaceans and other marine mammals, the cumulative impacts need to be considered regarding the potential effects with other proposed renewable developments	Dealt with as part of this ES Chapter; other developments as discussed with Marine Scotland have been included.	Section 11.10 Cumulative Impacts
Marine Scotland	The ES should show that the applicants have taken account of the relevant wildlife legislation and guidance. It needs to be categorically established which species are present on and near the site, and where, before the application is considered for consent. The presence of protected species such as European Protected Species must be included and considered as part of the application process.	All chapters reference relevant legislation and guidance. The presence of EPS has been considered within the relevant ES chapters.	Section 11.3 Legislation Section 11.5 Baseline Description
Marine Scotland	Will the applicant utilise information from surveys being undertaken in the area by the Scottish Government and The Crown Estate and how will it, or their own data, be analysed? Expected uncertainty in the estimates of populations or distributions should be presented.	Full details of the data collected and analysis undertaken are in the Abundance and distribution of marine mammals in the Inner Sound and adjacent waters report (RPS, 2011a). Baseline report addresses uncertainty in regional population numbers by presenting different survey estimates. Site density estimates numbers are presented with confidence intervals to quantify uncertainty. Scottish Government and The Crown Estate commissioned work has not been published within a timeframe to allow consideration of these data in this assessment, but as site specific data has been collected this is not considered a critical data gap.	Summarised in Section 11.5 Baseline Description Section 11.5 Baseline Studies and RPS (2011a) N/A
Marine Scotland/SNH	Will the encounter model be temporally resolved? Revise species list for encounter model based on baseline information. Avoidance rates need to be included and explained.	The model takes account of current velocity relating to tidal state where data allow Species list revised Avoidance rates included and full explanation given	SRSL Encounter Modelling (2012) All described in Sections 11.6, 1.7 and 11.8 Impact Assessment except cumulative impacts which are discussed in Section 11.10
	Are cumulative issues being dealt with in the encounter modelling itself and, if so, how?	Cumulative issues dealt with in the chapter but not explicitly in the modelling	
SNH	We support MeyGen Ltd.'s commitment to the draft Survey, Deploy and Monitor Policy. Considering the lease area is situated within a highly sensitive location (i.e. adjacent to known important seal haulouts and in an area of high sightings of cetaceans), it is likely that extensive pre-development device testing and monitoring, and site characterisation surveys would be required.	Site specific characterisation surveys have been undertaken and where results from prototype monitoring are available these have been used to inform this impact assessment. Further pre-development monitoring will become available prior to turbine deployment and MeyGen will, as necessary, consider the results of this.	Section 11.5 Baseline Description and Section 11.6 Impact Assessment
SNH	Within the proposed development area EPS may be present both in the marine environment and consideration of these species must be included as part of the application process.	The presence of EPS is considered within this (and other relevant) ES chapters	Conservation status (including EPS) in the assessment rankings throughout Section 11
SNH	With regard to seals we would draw attention to the SCOS 2009 report, the SNH report on harbour seal surveys in Orkney, and the recently published SNH report on the utilisation of space by seals in the Pentland Firth and Orkney waters. We highlight the sharp fall there has been in the UK population of harbour (common) seals and note that the applicant will need to consider this in their EIA. The harbour seal Potential Biological Removal (PBR) will need to be carefully considered in any assessment.	The data sources are noted and this impact assessment addresses the issues raised	Description of regional use by seals in Section 11.5 Baseline Description Impact related to population numbers and PBR in Sections 11.6, 11.7 and 11.8 Impact Assessment
SNH	Certain haulout sites have been identified for protection under the Marine (Scotland) Act 2010; it is an offence to harass seals at these sites and we recommend that any works that may cause potential disturbance to seal haulouts is considered in the ES. The island of Stroma is important for harbour and grey seals – particularly for grey seal pupping – and is included in the proposed list for designated haulouts.	MeyGen will have due regard to the ongoing consultation on seal haul-out sites under the Marine (Scotland) Act and seal haul out sites considered as part of the EIA.	Haulout locations presented in Section 11.5 Baseline Description and impact on haulouts described where relevant in Sections 11.6 - 11.8 Impact Assessment
SNH	Survey results should be used to inform the likelihood of disturbance to cetaceans during the various phases of the proposal. The ES should provide information on the acoustic properties of any 'significant underwater noise' generating activities and the frequency and duration at which these will occur. We recommend that the potential impacts on marine mammals from noise are carefully assessed in the ES. The ES should also provide appropriate mitigation measures to avoid any potential impacts. The noise monitoring data gathered at EMEC should be used to inform the ES for the proposed	The potential impact of noise generated during operation on marine mammal species passing through the development has been considered as part of the impact assessment. It was the intention for MeyGen to use underwater noise data measured from prototype candidate tidal turbines to inform the noise modelling and impact assessment. To date it has not been possible to record the underwater noise from candidate turbines operating. Alternative data sources were used to inform the impact assessment. MeyGen intends to use underwater noise data	Underwater noise baseline summary and acoustic emission propagation modelling has been undertaken (Kongsberg, 2012) and impact assessment presented in Sections 11.6, 11.7 and 11.8

Name of organisation	Key concerns	Response	ES Section within which the specific issue is addressed
	deployment.	collected for candidate turbines to verify the modelling work.	
SNH	Collision risk will also need to be assessed, and the monitoring work at EMEC for both the Atlantis and TGL device should be used to inform the ES.	Reference made to the outcome of strain gauge monitoring conducted by TGL at the Falls of Warness EMEC test site. The results of this monitoring will also feed into the monitoring strategy that MeyGen propose to employ.	Section 11.7 Impact Assessment for Operations and Maintenance
SNH	Vessel collision should be included in the impact assessment.	This impact has been assessed	Sections 11.5 Baseline Description and 11.6 Impact Assessment
SNH	Harbour seals are vulnerable to any impacts which could lead to their further population decline or prevent their recovery. We highlight, therefore, the report by SMRU on the preliminary findings of investigations in to the causes of the recent number of "corkscrew" injuries to seals. The injuries are consistent with the seals being drawn through a ducted propeller such as a Kort nozzle or some types of Azimuth thrusters.	This marine mammal impact assessment has included consideration of potential 'corkscrew' injuries	Section 11.5 Baseline Description Sections 11.6, 11.7 Impact Assessment

Table 11.3: Scoping comments relevant to marine mammals

11.4.2 Supporting studies

Baseline report (RPS, 2011a)

11.14 MeyGen commissioned RPS to prepare a marine mammal baseline report (RPS, 2011a; report provided on supporting studies CD) using a combination of a desk-based study of literature and available data sources, and an analysis of the baseline data collected during two years of MeyGen-commissioned boat- and shore-based surveys aimed at determining marine mammal distribution, abundance, seasonality and behaviour within the Inner Sound. The purpose of the report was to provide MeyGen with a robust understanding of existing marine mammal activity in and around the Inner Sound and thus establish a baseline against which the impact assessment can be undertaken.

11.15 Methods for boat and land based surveys were developed, trialled and refined in consultation with Marine Scotland and SNH. The boat-based surveys involved two approaches to data gathering; firstly, boat transect surveys based on modified European Seabird at Sea methods (Tasker *et al.*, 1984) collected distributional data and secondly, stationary boat surveys at fixed locations were used to collect behavioural data. All marine mammals encountered during the surveys (conducted between October 2009 and September 2011) were recorded along with details of species, numbers present, the precise time of day, direction of movement, and dive frequency/duration.

11.16 Land-based vantage point survey methods were adapted from approaches to terrestrial vantage point surveys; three vantage point locations on the Caithness coastline were selected and observations made during two to three visits each month over the same time period as the boat-based surveys. The area of sea scanned from each vantage point ranged out to a maximum distance of 2km. Marine mammal observations were recorded as per the boat-based surveys. The coverage of the boat- and land-based surveys is shown in Figure 11.1.

11.17 Sightings data gathered during boat-based transect surveys were mapped in a Geographical Information System (GIS) to show the distribution of sightings across the survey area and interpreted in conjunction with survey effort data. GIS plots were produced which displayed overall and seasonal animal relative abundance, showing marine mammal sightings overlying a 0.25km^2 grid in which cell shading indicates the number of animals sighted per km transect travelled.

11.18 Sightings data gathered during boat-based transect surveys were also analysed using DISTANCE software (Thomas *et al.*, 2009) to generate marine mammal density (number of animals per km^2) and abundance outputs. The number of sightings greatly effects how precise final estimates of density and abundance will be and therefore DISTANCE analysis was only relevant to those most frequently sighted marine mammals (harbour porpoise and grey seal).

11.19 Sightings data gathered during boat-based stationary point surveys and during land-based vantage point surveys were simply tabulated to show species occurrence in the survey area. It is envisaged that the dataset will provide a useful index against which to compare future monitoring data.

11.20 To provide a context to the site specific information, and to support the considerations given in the assessment to the distance over which species sighted in Inner Sound might range, RPS conducted a literature review on marine mammals of Orkney and Pentland Firth waters. Key literature reviewed included:

- Abundance and behaviour of cetaceans & basking sharks in the Pentland Firth and Orkney waters (Evans *et al*., 2010);
- Atlas of cetacean distribution in northwest European waters (Reid *et al*., 2003);
- SCANS I and II (Hammond *et al*., 1995, 2002, SCANS II, 2008);
- Special Committee on Seals (SCOS) reports (SCOS, 2009, 2010, 2011);
- Utilisation of space by grey and harbour seals in the Pentland Firth and Orkney waters (SMRU, 2011); and
- Strategic Environmental Assessment reports (Hammond *et al*., 2003, 2004, Scottish Executive, 2007).

Acoustic monitoring (Ecologic, 2011)

11.21 Harbour porpoises are small and undemonstrative cetaceans and thus can be difficult to sight at sea, especially when visual sighting conditions are not ideal. However, they vocalise frequently (Akamatsu *et al.*, 2007), producing characteristic 'click' vocalisation that can be detected at a range of several hundred metres using specialist acoustic detection equipment and acoustic analysis software. Towed hydrophone[3] systems for porpoises have been in development over the last few decades (Chappell *et al.*, 1996, Gillespie & Chappell, 2002, Gillespie *et al.*, In Press). Acoustic detection is generally less affected by weather conditions than visual detection and can continue in poor sighting conditions and at night, which are highly significant practical advantages. Previous extensive use has been made of Passive Acoustic Monitoring (PAM) during surveys for harbour porpoises in tidal rapid areas in Welsh waters where towed hydrophones have been reported as particularly useful for surveys in these habitats. They are unaffected by strong tidal currents which can lead to disturbed waters and poor sighting conditions even in good weather conditions.

[3] Hydrophones are microphones that detect sound underwater.

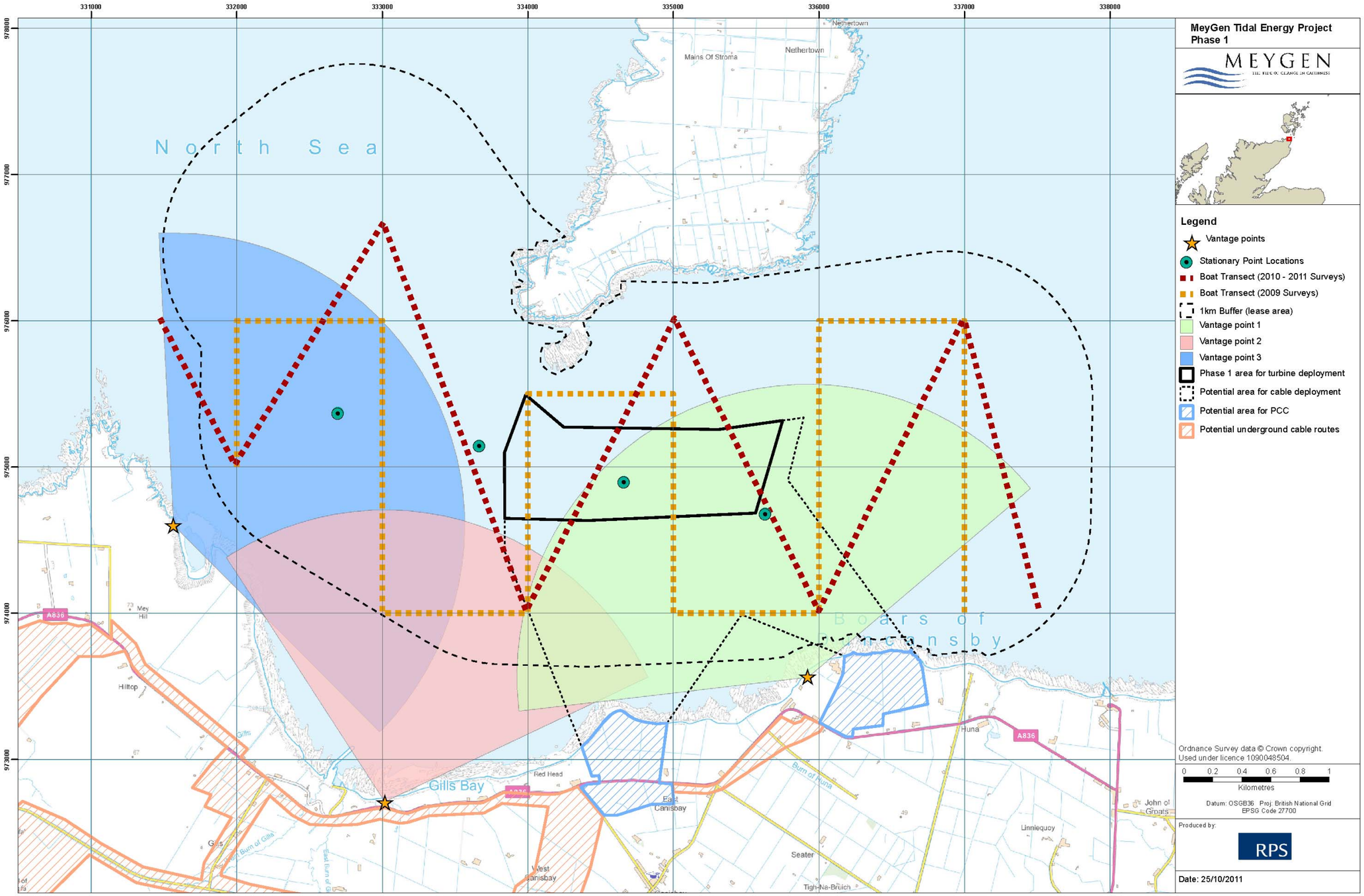

Figure 11.1: Boat survey route, static point locations and land based vantage point viewsheds for the Meygen Tidal Energy Project. The orange line indicates the boat route originally used (two surveys) which was then modified to the red route for all remaining ones

11.22 Ecologic UK was commissioned to undertake acoustic survey across the Inner Sound to trial the performance of PAM systems in the particular conditions encountered in the Inner Sound. The output data, in the form of acoustic detection rates, was used to make a qualitative assessment of the likely efficiency of the visual surveys for harbour porpoise detection. PAM was deployed on the final three marine mammal surveys; the survey methodology and data analysis techniques are presented in detail in a separate technical report produced by Ecologic UK (2011; provided on supporting studies CD) but the key results are included in this assessment.

Underwater noise (Kongsberg, 2012)

11.23 MeyGen commissioned Kongsberg to provide an assessment of the impact of underwater sound on marine mammals in the Inner Sound. Underwater sound arises during the installation, operation and decommissioning stages of the Project. Kongsberg identified pile drilling, turbine operation and vessel movements as requiring specific analysis. The noise generating activities were reviewed and the noise source characteristics discussed in terms of their source level[4] and frequency using data from the peer-reviewed literature (Kongsberg, 2012; provided on the supporting studies CD).

11.24 Kongsberg collected measurements of background underwater noise in the Inner Sound during August 2011 (Kongsberg, 2012) which demonstrated that, from an oceanographic perspective, the Inner Sound is a turbulent location. The results of this baseline noise survey are presented in Section 11.6.1.

11.25 Acoustic propagation modelling was undertaken using a suite of computer programs to investigate the underwater noise propagating along a set of transects radiating from the centre of the Project area. This took into account site-specific data relating to the bathymetry, oceanography and geo-acoustics of the Inner Sound. This allowed Kongsberg to determine how the noise emissions from the identified sources behave with increasing distance from the source. Acoustic impact modelling was subsequently carried out to determine the ranges over which acoustic impacts on various marine mammal species might arise.

11.26 The modelling programs themselves are based on mature and rigorous scientific methodologies that have been reviewed extensively in the international literature over a number of years. Kongsberg (2012) consider it of fundamental importance that acoustic modelling is based on peer-reviewed techniques.

11.27 Following consultation with Marine Scotland regarding the scope of the noise assessment, the scenarios that were modelled were as follows:

- Single source:
    - Drilling noise, reflecting the noise generated principally through the action of the drill bit on the seabed;
    - Vessel noise, reflecting the noise generated by the presence of a tug during installation, maintenance and decommissioning activities; and
    - Operational noise, reflecting the noise generated by 1 x 1MW turbine or by 1 x 2.4MW (based on the results, 2.4MW turbine considered the worst case in terms of noise emissions and thus carried forward into the assessment).
- Multiple source:
    - Drilling noise and the noise emitted by the DP installation vessel;
    - Operational noise for the first operational phase, covering noise emissions for 12 x 2.4MW operational turbines;
    - Operational noise for the first operational phase (12 x 2.4MW operational turbines) and installation noise for either one turbine or for two turbines concurrently; and
    - Operational noise for 36 x 2.4MW operational turbines.

11.28 The following list details the terms relevant to the noise assessment:

- The source level (SL) is the apparent strength of a sound source at (usually) 1m from the source;
- The received level (RL) is the strength of the acoustic field at a given depth and range relative to the source;
- The peak sound level is the maximum absolute value of the instantaneous sound pressure recorded over a given time interval (this applies to transient pressure pulses such as an explosion or a single pile hammer strike);
- The Root-Mean-Square (RMS) Sound Pressure Level (SPL) is used to quantify noise of a continuous nature, including shipping, sonar transmissions, drilling or cutting operations, or background sea noise; it is the mean square pressure level measured over a given time interval and represents a measure of the average sound pressure level over that time;
- The Sound Exposure Level takes account of the problems associated with the time period over which the SPL is averaged by summing the acoustic energy over a measurement period, effectively taking into account both the level of the sound and the duration over which the sound is present in the environment;
- M-Weighting frequency functions can be applied to the SEL to take account of the differences in marine mammal species' response to specific sound frequencies, effectively making the values used to determine responses species specific; and
- This has been taken a stage further where the underwater noise is compared with receptor hearing threshold across the entire receptor auditory bandwidth - this is termed dBht.

11.29 Using preliminary information from the marine mammal observation survey work, MeyGen identified a number of marine mammals on which Kongsberg focussed their assessment; these included the short-beaked common dolphin (*Delphinus delphis)*, harbour porpoise and minke whale (*Balaenoptera acutorostrata)* and the two pinnipeds the grey seal and harbour seal. Although site survey work did not show common dolphin as being users of the site, it offers a useful proxy for other similar dolphin species that were observed (e.g. Risso's *Grampus griseus*). In addition, Kongsberg considered a number of fish species in the report, the results of which have been discussed in Section 13.

11.30 Data are presented using underwater noise impact assessment metrics for generic species of marine animal, with impact zones calculated based on proposed criteria from various studies. The metrics themselves consist of unweighted metrics for fatality and physical injury through to the M-weighting metrics used to quantify audiological damage. Behavioural impacts are assessed using both unweighted metrics and the dB_{ht} technique. Kongsberg (2012) note that these criteria have had little or no validation under open water conditions and that auditory injury data from controlled tests with a few captive animals have been used as the basis for developing the auditory injury criteria. Observations of behavioural avoidance with concurrent acoustic measurements are sparse and the behavioural avoidance criteria must be considered speculative. Kongsberg (2012) make no judgement as to the validity of the impact criteria, simply applying the metrics to the predicted noise levels in order to determine the range over which the effect arises.

11.31 The diversity of thresholds considered by Kongsberg (2012) is shown in Table 11.4, along with a note on whether the thresholds have been used to determine impact in this assessment. Even for similar impacts, a number of different thresholds have been proposed by a range of authors. The main assessment sections discuss which of the behavioural thresholds are most appropriate for this project; where thresholds have been determined to be inappropriate for this project, a full explanation is given in the relevant assessment section.

11.32 The impact zones for the noise sources assessed have been used to inform the noise sections of this impact assessment (Sections 11.6 - 11.8); these consist of impact ranges for fatality, physical injury, audiological damage and behavioural impacts. The impacts relating to single types of noise operating in

[4] Source level is the effective level of sound at a distance of one metre from the cause of the noise - it can be viewed as a measure of how much energy a sound has and crudely how loud it is.

isolation are determined. Subsequently, cumulative impacts are assessed where multiple noise sources are operating and for which the impact zones from adjacent sources may overlap.

Potential impact	Threshold value proposed in the literature	Reference	Has this threshold been used to determine impact?
Cetaceans			
Injury or death			
Lethality	240dB re 1 µPa (Peak)	Yelverton and Richmond (1981)	Yes
Hearing damage (permanent or temporary)			
Onset of permanent change in hearing (permanent threshold shift, or PTS[5])	230dB re 1 µPa (Peak)	Southall *et al.* (2007)	Yes (but PTS not expected from the estimated noise levels)
Onset of temporary change in hearing (Temporary threshold shift; TTS)	224dB re 1 µPa (Peak)	Southall *et al.* (2007)	
Onset of temporary change in hearing (TTS) in harbour porpoise	193.7dB re 1 µPa (Peak)	Lucke *et al*. (2009)	Yes
Onset of permanent change in hearing (PTS)	215dB re.1µPa^{2}s SEL M-Weighted	Southall *et al.* (2007)	Yes (but PTS not expected from the estimated noise levels)
Onset of temporary change in hearing (TTS)	183dB re 1µ Pa^{2}s SEL M-Weighted	Southall *et al.* (2007)	Yes
Onset of temporary change in hearing (TTS) in harbour porpoise	164.3dB re 1 µPa^{2}s SEL	Lucke *et al*. (2009)	Yes
Onset of auditory injury	180dB re 1 µPa (RMS)	US NMFS, (1995)	Yes
Behavioural effects			
Aversive behavioural reaction in harbour porpoise (e.g. swimming away from the location of a sound source)	168dB re 1 µPa peak-peak	Lucke *et al*. (2009)	No - threshold not considered relevant to specific noise emissions - see Section 11.7.1
Aversive behavioural reaction in harbour porpoise	164.3dB re 1 µPa^{2}s SEL	Lucke *et al*. (2009)	No - threshold not considered relevant to specific noise emissions - see Section 11.7.1
Behavioural disturbance (termed 'Level B - Harassment')	160dB re 1 µPa (RMS)	US NMFS, (1995)	No - threshold not considered relevant as not species specific - see Section 11.6.1
'Low level' disturbance	140dB re 1 µPa (RMS)	HESS (1997)	No - threshold not considered relevant as not species specific - see Section 11.6.1
'Strong' behavioural reaction	90dB$_{ht}$ above species specific hearing threshold	Nedwell *et al.* (2005)	Yes
'Mild' behavioural reaction	75dB$_{ht}$ above species specific hearing threshold	Nedwell *et al.* (2005)	Yes
Pinnipeds			
Injury or death			
Lethality	240dB re 1 µPa (Peak)	Yelverton and Richmond (1981)	Yes
Hearing damage			
Onset of permanent change in hearing (PTS)	218dB re 1 µPa (Peak)	Southall *et al.* (2007)	Yes (but PTS not expected from the estimated noise levels)
Onset of temporary change in hearing (TTS)	212dB re 1 µPa (Peak)	Southall *et al.* (2007)	Yes
Onset of permanent change in hearing (PTS)	203dB re.1µPa^{2}s SEL M-Weighted	Southall *et al.* (2007)	Yes (but PTS not expected from the estimated noise levels)
Onset of temporary change in hearing (TTS)	183dB re 1µ Pa^{2}s SEL M-Weighted	Southall *et al.* (2007)	Yes
Onset of auditory injury	190dB re 1 µPa (RMS)	US NMFS, (1995)	Yes
Behavioural effects			
Behavioural disturbance (termed 'Level B - Harassment')	160dB re 1 µPa (RMS)	US NMFS, (1995)	No - threshold not considered relevant as not species specific - see Section 11.6.1
'Low level' disturbance	140dB re 1 µPa (RMS)	HESS (1997)	No - threshold not considered relevant as not species specific - see Section 11.6.1
'Strong' behavioural reaction	90dB$_{ht}$ above species specific hearing threshold	Nedwell *et al.* (2005)	Yes
'Mild' behavioural reaction	75dB$_{ht}$ above species specific hearing threshold	Nedwell *et al.* (2005)	Yes

Table 11.4: Summary of underwater noise impact criteria for cetaceans and pinnipeds

[5] PTS is a permanent elevation of the hearing threshold as a result of noise exposure having physically damaged the hearing apparatus. This 'deafness' can be frequency specific in that the recipient of the noise dose may only be affected at the specific frequencies that comprise the noise emissions to which they were exposed. TTS is a similar physiological reaction to noise as PTS but the elevation of the hearing threshold is a temporary reaction and the 'deafness' to the frequencies to which the recipient was exposed is reversible. Both, however, could represent an inability to detect some or all other noise sources.

Marine mammal encounter risk (SRSL, 2012)

11.33 Following consultation with relevant stakeholders (including Marine Scotland), MeyGen commissioned SRSL (2012; provided on the supporting studies CD) to provide an assessment of encounter rate between the turbines and marine mammals in the Inner Sound.

11.34 A full collision model is not yet possible because too little is known about the actual responses of animals to the presence of turbines. The encounter model is based on a 3-dimensional model for estimating encounter rates between pelagic marine animals and their pelagic predators (Gerritsen and Strickler, 1977). This model has been used in a number of studies of predator-prey interaction on many scales and was modified by Bailey and Batty (1983) and applied to predation between medusae and fish that depends upon passive collision rather than a directed attack, a process analogous to encounters between animals and turbine blades.

11.35 Encounter rate for a single predator can be simply expressed as the product of the volume swept by the predator per unit time and the density of prey.

11.36 The volume spent and the density of prey depend on a number of technical parameters related to the turbine dimensions (the values of which are set out in the Rochdale Envelope, Table 11.1, and described in further detail in SRSL, 2012) and characteristics of the physical environment (e.g. tides).

11.37 In addition, a number of biological inputs are necessary:

- Species selection
  - It is important to determine early on which species should be considered in the model, since different species use the water column differently, which can affect the encounter rate. Based on the survey information (presented in Section 11.5), four species (harbour porpoise, minke whale, grey seal and harbour seal) were selected as the focus of the modelling.
- Density
  - To determine the actual number of animals which may encounter the turbines, the model requires animal density in numbers per cubic metre. This is a function of surface density, the proportion of time spent in any depth range and the depth span of that depth range. If animals distribute their time evenly between depths then density per cubic meter is simply, surface density/depth.
  - Surface densities of the four species of interest were estimated using a combination of baseline survey data for the Inner Sound and a range of values from the scientific literature, where available. The methods for calculating these density estimates for each of the species considered are summarised in the Baseline Description (Section 11.5) and further explained in SRSL (2012).
- Depth distribution
  - At its deepest the turbine deployment area is a little less than 40 m deep and the entire seabed is therefore well within the diving capabilities of the species of interest. If the depth distribution of an animal, expressed as the proportion of time spent at different depths, is not known it can only be assumed that animals move at random within the vertical plane making equal use of all depths. Obviously animals do not use all depths equally and their actual depth distribution may lead to an increase or decrease in density within the depth range of a turbine relative to what may be assumed from random use of the water column.
  - Exploratory work conducted at SAMS has shown that it is possible to use summary reports of tagged animals to recreate information on time-depth allocation (i.e. the proportion of time a species spends in different depths).
  - The depth distribution for the species of interest is detailed in SRSL (2012), along with details of the sources used to inform this distribution (including dive data available for harbour seals diving within the Project site).
- Swimming speed
  - Although the velocity of the turbine blade dominates this type of encounter scenario, swimming speed also needs to be considered to determine relative velocity between the turbine blades and mammals; swimming speeds are detailed in SRSL (2012).

11.38 Following input of values for the parameters described above, the model outputs an encounter rate of number of animals per year, for one turbine. The Project will consist of many turbines operating as an array. SRSL (2012) have therefore scaled up the encounter rate for one turbine to cover the three stages of turbine installation:

- Maximum of 10 turbines by the end of year one;
- Maximum of 20 turbines by the end of year two; and
- Maximum of 86 turbines by the end of year three.

Other supporting studies

11.39 A number of other studies have been prepared during the course of this EIA which have been used to inform the marine mammal impact assessment:

- A desk based study has been carried out in order to provide information on the fish species present in the MeyGen study area and highlight those that have the potential to be impacted by the Project (Section 13). The results of the desk study will be used to determine how the Project is likely to affect the marine and migratory fish species and elasmobranch species (sharks and rays) that use the Inner Sound for feeding, breeding and nursery areas and during migrations. Marine mammal foraging behaviour has the potential to be impacted by changes in abundance, distribution or behaviour of prey fish species; and
- ASML (2011) have carried out a benthic survey to determine the characteristics of the seabed, the benthic species and biotopes present within the proposed Project area and its surrounds. The results of the survey have been presented in Section 10, alongside an assessment on how the Project may affect the benthic environment and the habitats and species (including shellfish) present in the study area. Marine mammal behaviour, feeding and habitat use may be impacted by changes in benthic species and habitats.

11.4.3 Significance criteria

11.40 The EIA process and methodology are described in detail in Section 8. Each individual assessment is, however, required to develop its own criteria for the 'sensitivity of receptor' and 'magnitude of impact' aspects as the definition of these will vary depending on the focus. For marine mammals, the significance criteria used in this section is based on the methodology described in Section 8.2.2 but the sensitivity of the receptor and magnitude of impact are defined in Table 11.5 and Table 11.6. The magnitude of the impact has been described with respect to the proportion of the regional population that may be affected by a specific impact. The magnitude and probability are combined to evaluate the environmental consequence of the impact.

Sensitivity of Receptor	Definition
Very high	▪ Species which form qualifying interests of internationally designated sites. ▪ Globally threatened species (e.g. high ranking on the IUCN list). ▪ Species present in internationally important numbers.
High	▪ Species which contribute to an international site but which are not listed as qualifying interests. ▪ Species which form qualifying interests of nationally designated sites. ▪ Species present in nationally important numbers.
Medium	▪ Species which contribute to a national site but which are not listed as qualifying interests. ▪ Species present in regionally important numbers. ▪ Species on Annex II of the European Habitats Directive. ▪ Species listed as EPS. ▪ Species listed in Schedule V of the Wildlife and Countryside Act. ▪ Species listed as priority species in the UKBAP.
Low	▪ Any other species of conservation interest (e.g. LBAP, PMF species).
Negligible	▪ Species of no conservation concern.

Table 11.5: Definitions for sensitivity of receptor

Magnitude of Impact	Definition
Severe	▪ Decline in abundance or change in distribution of the entire regional population. ▪ No/very slow return to baseline conditions anticipated following decommissioning. ▪ Impact highly likely to occur.
Major	▪ Decline in abundance or change in distribution of a majority of regional population. ▪ Return to baseline conditions anticipated to take many years following decommissioning. ▪ Impact likely to occur.
Moderate	▪ Decline in abundance or change in distribution of a large minority of regional population. ▪ Good potential for return to baseline conditions following decommissioning (up to a few years). ▪ Impact will possibly occur.
Minor	▪ Decline in abundance or change in distribution of a very small proportion of regional population. ▪ Return to baseline conditions likely within a year following decommissioning. ▪ Impact unlikely to occur.
Negligible	▪ No decline in abundance or change in distribution of regional population. ▪ Rapid return to baseline conditions following decommissioning. ▪ Impact extremely unlikely to occur.

Table 11.6: Definitions for magnitude of impact

11.4.4 Data gaps and uncertainties

11.41 With regards to the marine mammal baseline survey, effort was restricted to a degree as a result of poor weather conditions. However, only two surveys were unable to be completed (October 2010 and December 2010; 22 out of 24 months were completed) and overall survey conclusions are considered to be unaffected by this. As a result of the challenging sea conditions of the Inner Sound, it should be noted that some sightings of marine mammals could not be identified to species level, but the number of these sightings was low and is unlikely to affect the overall survey conclusions.

11.42 It should be noted that a key strategic source of data was not available to MeyGen during the period over which this EIA was conducted:

- Scottish Government and Crown Estate commissioned aerial survey data (birds and marine mammals) of the Pentland Forth and Orkney Waters (PFOW).

11.43 In the absence of data to confirm some of the information required to conduct the assessment, a number of assumptions have been made for marine mammal assessment:

- That the thresholds used to estimate the extent of injury or behavioural response are true thresholds (see Kongsberg 2012 for further discussion of thresholds);
- That animals will leave an area when TTS achieved (such that there is no PTS; see Table 11.4); and
- That the assumptions made regarding the noise modelling are accurate. As these are largely of a highly technical nature, they have not been repeated here but are described in detail with supporting information in the relevant technical reports (and summarised within relevant sections herein).

11.44 It should also be recognised the information used to inform the assessment of noise impacts is based on modelled information (Kongsberg, 2012) and that it has not been verified with measurements of operational turbines. As such, some variation in the values presented might be expected.

11.45 The potential for injurious collisions between large marine animals (such as marine mammals) and marine energy convertors are among the key areas of environmental uncertainty. The actual magnitude of the hypothetical issue is likely to become clearer as the sector develops, but because of the current low number of active devices and the few locations of established commercial scale deployments, data derived from monitoring programmes to directly quantify collisions and near misses are limited at this time.

11.46 A full collision model (providing estimates of collision rates) is not yet possible because too little is known about the actual responses of animals to the presence of turbines. However in order to inform this assessment it has been possible to undertake modelling in order to quantify how often marine mammals may 'encounter' the tidal turbines. The estimate of the potential interaction rate is intended to provide an understanding of the scale of the issue and sensitivity to physical and behavioural parameters. It is also important to note that while encounter rates can help gain a perspective on collision rates, especially when data on responsive movements eventually becomes available, collisions themselves are likely to result in a wide range injuries from trivial to fatal. The relationships between strikes and injury for marine mammals have yet to be considered in terms of tidal turbines. Thus when considering encounter rates it is important that it is not assumed that all encounters lead to collisions and that all collisions will result in the death or mortal injury of the animals involved (SRSL, 2012). The results of the work undertaken as part of this impact assessment provide valuable insight into the issues of most concern and also help inform what will be appropriate monitoring. This approach has previously been used to inform assessment in the Skerries Tidal Stream Array EIA. It was also presented as a proposed EIA approach in the Scottish Marine Renewables SEA (Scottish Executive, 2007).

11.47 One of the important inputs to the encounter modelling undertaken to inform this impact assessment is animal density per cubic metre. It was not possible to generate density estimates for all the species being considered in the model from the Project specific survey data. Therefore estimates were made using a combination of Project specific data and a range of values from scientific literature. Full justification of the density estimates used in the model is provided in SRSL (2012).

11.48 Having completed work in order to estimate the potential number of encounters there could be between marine mammals and tidal turbines, it is then necessary to gain an understanding of the number of interactions relative to the size of the source populations or stocks of the species under consideration. The abundance and trends of British and European marine mammal populations are currently not well defined. A variety of efforts are underway to clarify the situation (particularly for cetaceans) though these are ongoing and not yet available to inform this impact assessment. However, rather than ignore this issue pending future information, work has been undertaken in order to best estimate regional populations/stock sizes. Full details are provided in SRSL (2012).

11.5 Baseline Description

11.5.1 Key species

11.49 MeyGen commissioned RPS to undertake a review of marine mammal use of the proposed project area. This review is summarised below; for further information on species described here, or for other rare species, see the full technical report (RPS, 2011a), provided on the supporting studies CD. RPS (2011a) determined that 10 cetacean species are either casual or regular visitors to the Pentland Firth; these are the mysticete (baleen whale) the common minke whale, the odontocetes (toothed whales and dolphins) sperm whale *Physeter macrocephalus*, killer whale *Orcinus orca*, long-finned pilot whale *Globicephala melas*, Risso's dolphin, bottlenose dolphin, Atlantic white-sided dolphin *Lagenorhynchus acutus*, white-beaked dolphin *Lagenorhynchus albirostris*, short-beaked common dolphin and harbour porpoise and the two pinniped species the grey seal and the harbour seal (RPS, 2011a). Key notes relevant to these species are described in the following sections. Following completion of the work by RPS, some additional data relevant to the assessment was made available, in particular in relation to population estimates for specific marine mammal species. Where required, these data have been included and referenced.

11.5.2 Mysticetes (low-frequency marine mammals)

Common minke whale

11.50 The common minke whale is distributed throughout the northern Hemisphere in tropical, temperate and polar seas, although the highest densities occur in relatively cool waters over the continental shelf (<200m

depth) (Reid *et al*., 2003). The minke whale is the most frequently recorded baleen (or mysticete) whale species in British shelf waters (Evans, 2008), including the Orkney and Pentland region. The total abundance of minke whales in the entire SCANS II survey area[6] was 18,614 animals (SCANS II, 2008).

11.51 The Pentland Firth and Orkney region is seemingly of some importance for minke whales during the summer months (Hammond *et al*., 2003) and the species should be expected to occur throughout the area. In north Scotland, peak sightings occur between June and August (Weir *et al*., 2001, Evans *et al*., 2003); most minke whales are thought to move out of British waters during the winter, in a seasonal migration to offshore or more southerly waters (Hammond *et al*., 2003, Anderwald & Evans, 2008).

11.52 In Scottish waters, sandeels are the most important prey species for minke whales, comprising 62% of the diet by weight (Pierce *et al*., 2004). Clupeids (herring and sprat) account for around 30% of the diet (Pierce *et al*., 2004). They often forage in areas of upwelling or strong currents around headlands and small islands (Evans *et al*., 2010).

11.53 As population structuring in UK or European waters is not yet identified, current advice from JNCC is that the northeast Atlantic stock estimate of 80,487 provided by the International Whaling Commission (IWC) is relevant when considering the likely number of minke whale that may use the wider area. However, this is a relatively large area and so a further geographic restriction to the SCANS II total estimate for UK waters provides for a more regional population estimate. On that basis, it is considered that 18,614 may use the wider area at one stage or another.

11.5.3 Odontocetes (mid- and high-frequency marine mammals)

Sperm whale

11.54 The sperm whale has a worldwide distribution, inhabiting waters from the equator to the poles in both hemispheres (Evans, 1997, Reid *et al*., 2003). However, this species exhibits age and sex segregation, with only adult males occurring at the highest latitudes (Evans, 1997). As sperm whales are a deep-diving species their distribution in UK seas is centred in offshore waters to the north and west of Scotland where depth exceeds 200m. A population estimate of 363 sperm whales for offshore waters north and west of Scotland exists (MacLeod *et al*., 2009) but abundance has not been calculated for shelf waters where this species does not normally occur.

11.55 Sperm whales do not typically venture onto the continental shelf but the location of Orkney at the northern end of the UK and adjacent to the shelf edge means that the islands are occasionally (less than annually) visited by sperm whales that have strayed away from deep-water habitat. However, records of this species indicate that it is unlikely to occur in the Inner Sound site. Most sperm whale sightings are reported between July and December (Evans, 1997, Reid *et al*., 2003) but winter surveys in deep water have shown them to be present year-round (Weir *et al*., 2001),

11.56 Sperm whales primarily predate upon medium or large squid, but they also take octopus and deep-diving fish species such as rays, sharks, lantern fish and gadoids (Evans, 1997).

Killer whale

11.57 Killer whale distribution extends from the equator to the ice edges in both hemispheres, but within the UK they are most common off north and west Scotland. Killer whales are commonly sighted along the Caithness coast and around the Orkney and Shetland Islands (Bolt *et al*., 2009), which represents their main area of concentration in UK waters. The individuals that frequent Orkney and Shetland waters are known to range widely, with some of the same marked animals photographed off Shetland being resighted in the Outer Hebrides, around the Faroe Islands and in Iceland (Foote *et al*., 2010). Killer whale abundance was not calculated during the SCANS I[7] or SCANS II surveys due to lack of sightings but abundance estimates ranging from 4,413 animals (in Norway) to 26,774 (in Canada) have been declared; Foote *et al*. (2010) compiled images of 896 marked individuals from across the north-east Atlantic (Scotland, Iceland and Norway), but no abundance estimate has yet been calculated.

11.58 Killer whales are recorded throughout the year in UK waters, and their seasonal movements are likely related to prey. In the nearshore waters off northern Scotland they are primarily recorded in the summer from May to July (Evans *et al*., 2010).

11.59 Killer whales primarily prey on fish species such as herring, mackerel and cod, as well as cephalopods, but they will also take rays, sharks, seabirds, turtles, seals and other cetaceans (Jefferson *et al*., 1991). Around the Northern Isles, offshore killer whales associate with trawlers fishing for herring and mackerel suggesting predation on those fish species (Luque *et al*., 2006), while nearshore whales have been observed predating on common and grey seals, eider ducks, seabirds and mackerel (Bolt *et al*., 2009).

Long-finned pilot whale

11.60 In the North Atlantic, pilot whales are found from Mauritania northwards to Iceland, Norway and Greenland. Within UK waters, the pilot whale is primarily considered to be a deep-water species, with its main concentrations located along the continental slope and in oceanic areas to the north and west of Scotland (Weir *et al*., 2001, Evans *et al*., 2003, Reid *et al*., 2003). There are scattered records of this species throughout the Orkney Islands and in the Pentland Firth region but they are not considered to be a common species in nearshore waters of the region. Pilot whale abundance was not calculated during SCANS I or SCANS II surveys due to lack of sightings but an abundance estimate of 22,034 has been produced for offshore waters north and west of Scotland (MacLeod *et al*., 2009).

11.61 Data indicate that pilot whales inhabit UK waters throughout the year (Evans *et al*., 2003). Most sightings from Orkney and Pentland Firth waters have been recorded from May to August (Evans *et al*., 2010).

11.62 Long-finned pilot whales prey primarily on squid and a wide variety of deep-water fish species (Hammond *et al*., 2003, Evans *et al*., 2010).

Risso's dolphin

11.63 The Risso's dolphin is widely distributed in both north and south hemispheres and in north-west Europe it is found both on the shelf (less than 200m depth) and in slope waters along the Atlantic seaboard (Weir *et al*., 2001, Reid *et al*., 2003). Within the UK they are particularly concentrated in The Minch in north-west Scotland, in parts of the Irish Sea and off south-west Ireland (Reid *et al*., 2003) but they are regularly observed around the Northern Isles (Evans *et al*., 2010). No abundance estimates exist for Scottish waters, or for wider UK waters (Evans *et al*., 2003); Risso's dolphin abundance was not calculated during SCANS I or SCANS II due to a lack of sightings and the number of animals using the Pentland Firth region is unknown.

11.64 Risso's dolphins are observed regularly in the Orkney Islands and Pentland Firth region, though not in high numbers (Weir *et al*., 2001, Evans *et al*., 2010), with sightings occurring particularly along the west coasts of Hoy and the Orkney mainland. Evans *et al*. (2010) reported that the Caithness mainland coast and the Orkney Islands were used by Risso's dolphins for both feeding and for breeding purposes. Risso's dolphins may occur on a reasonably regular basis in the Inner Sound region but in small numbers.

[6] The SCANS-II (Small cetaceans in the European Atlantic and North Sea) survey was carried out in June and July 2005, and its objective was to estimate small cetacean abundance in the North Sea and European Atlantic continental shelf waters. It provides the most precise broad-scale estimates of cetacean abundance in UK waters. Vessel surveys (19,614km search effort) and aerial surveys (15,902km search effort) were combined to produce overall abundance estimates for the SCANS II region. Block J was the block comprising Orkney and Shetland, which included the Caithness and inner Moray Firth region but had been extended from SCANS I to include the outer Moray Firth.

[7] The SCANS I (Small cetacean abundance in the North Sea) survey was an intensive sightings survey for harbour porpoises and other small cetaceans in the North Sea and adjacent waters using line transect methods. It took place between June and August 1994 using a combination of ship and aerial surveys. The survey area was stratified into blocks based on logistics and expected cetacean occurrence, and aimed to calculate absolute abundance of cetacean species. Orkney/Shetland was surveyed as a combined Survey Block J (31,059km2), which included the Caithness and inner Moray Firth region. It was surveyed by aircraft between June and August 1994 but it received less coverage than hoped for due to adverse weather conditions. None of the effort was in favourable sighting conditions of sea state two or less, and only 47% of the total coverage was in sea state four or less. None of the transects went through the Pentland Firth, but three crossed through the Orkney Islands. For the aerial survey there were sufficient data to calculate abundances only for harbour porpoises.

11.65 The species is found in Orkney and Pentland waters throughout the year, with peaks in both sightings and number of individuals between May and September and particularly between June and August (Evans *et al*., 2010).

11.66 In British waters their diet comprises octopus, cuttlefish and small bottom-dwelling squid (Reid *et al*., 2003). In Scotland, the stomach contents of 11 stranded Risso's dolphins consisted almost exclusively of octopus (Pierce *et al*., 2007).

Bottlenose dolphin

11.67 Bottlenose dolphins have a worldwide distribution (Reid *et al*., 2003) and are distributed throughout UK shelf waters, often close to shore; two larger aggregations are found in the Moray Firth (north-east Scotland) and Cardigan Bay (Wales). The total abundance of bottlenose dolphins in the entire European shelf survey area was calculated as 12,645 animals (SCANS II, 2008) and the north-east Scotland population is thought to number around 200 animals (Thompson *et al*., 2011).

11.68 In northern Scotland this species is concentrated in the Moray Firth and it does not occur regularly along the north mainland coast or in Orkney and Shetland. Although there are some sightings of this species at Duncansby Head, Dunnet Bay and Thurso Bay on the Caithness coast and along the west coast of Hoy in Orkney it is unlikely to be common in Pentland Firth waters.

11.69 Bottlenose dolphins inhabit UK waters throughout the year but in most coastal areas the greatest numbers are recorded between May and October (Evans *et al*., 2003, Reid *et al*., 2003).

11.70 The bottlenose dolphin takes a wide range of benthic and pelagic fish species in addition to cephalopods; in Scottish waters the stomach contents of stranded animals indicate that the species preys primarily upon cod, saithe and whiting (Santos *et al*., 2001).

Atlantic white-sided dolphin

11.71 Atlantic white-sided dolphins inhabit cold temperate and subpolar waters of the North Atlantic and in the UK are predominantly found along the slope to the north and west of Scotland (Northridge *et al*., 1997, Weir *et al*., 2001, Reid *et al*., 2003). Atlantic white-sided dolphin abundance was not calculated during SCANS I or SCANS II due to lack of confirmed sightings, but a 1998 abundance survey calculated a total of 74,626 white-sided dolphins in waters to the north and west of Orkney (MacLeod, 2004).

11.72 In Orkney and the Pentland Firth region, sightings of this species are primarily along the west coasts of Hoy and the Orkney mainland. Although sightings are relatively scarce this species may occur annually in the region (and likely in large groups), but its core distribution is centred over deeper waters to the north-west. As such it should be expected in the Inner Sound site only on a very occasional basis.

11.73 White-sided dolphins inhabit Scottish waters throughout the year, but peak numbers are recorded between June and November (Weir *et al*., 2001). In Orkney and Pentland the majority of sightings are reported from July to September (Evans *et al*., 2010).

11.74 Atlantic white-sided dolphins feed on a variety of fish and cephalopod prey, particularly gadoids such as blue whiting, whiting, cod and hake, as well as herring, lantern fish, mackerel and horse mackerel (Reid *et al*., 2003).

White-beaked dolphin

11.75 White-beaked dolphins are endemic to the North Atlantic and range from the UK northwards to Greenland, Iceland and the Barents Sea. The species approaches the southern limit of its distribution within the UK, where it exhibits a distinctly northern occurrence centred around Scotland (Northridge *et al*., 1995, 1997, Weir *et al*., 2001, Reid *et al*., 2003, Canning *et al*., 2008). They typically inhabit shelf waters of less than 200m (Reid *et al*., 2003). The abundance of white-beaked dolphins in the entire SCANS II survey area was 22,664 animals (SCANS II, 2008) but in the waters surrounding Orkney and Shetland an abundance of 1,157 animals was calculated (Hammond *et al*., 1995, 2002).

11.76 The white-beaked dolphin is the most abundant dolphin species in Scottish shelf waters, and consequently it is one of the most commonly sighted cetaceans in the Pentland Firth (Weir *et al*., 2001, Reid *et al*., 2003). Sightings are widely distributed around the Orkney Islands and Pentland Firth region, with no obvious areas of concentration. This species should be expected to occur within the Pentland Firth region year-round, but probably not in large numbers.

11.77 White-beaked dolphins inhabit UK shelf waters throughout the year, although sightings are most numerous in coastal waters during the summer months between June and September (Weir *et al*., 2001, Evans *et al*., 2003, Reid *et al*., 2003, Weir *et al*., 2007, Canning *et al*., 2008).

11.78 Haddock and whiting were the most important prey items in the diet of white-beaked dolphins in British waters, representing 43% and 24% respectively of the total reconstructed weight (Canning *et al*., 2008). Cod, herring and mackerel were of some importance (Canning *et al*., 2008).

Short-beaked common dolphin

11.79 Common dolphins are amongst the most abundant of the world's cetacean species and are distributed worldwide (Evans *et al*., 2003, Reid *et al*., 2003), occurring most commonly in the British Isles along the Atlantic seaboard (Weir *et al*., 2001, Evans *et al*., 2003, Reid *et al*., 2003, Evans, 2008). It has become increasingly common in Scottish shelf waters, particularly along the west coast and east as far as the Moray Firth (MacLeod *et al*., 2008, Robinson *et al*., 2010). The total abundance of common dolphins in the entire SCANS II survey area was 63,366 animals but an abundance of 3,546 common dolphins has been reported for offshore waters north and west of Scotland (MacLeod *et al*., 2009).

11.80 Within Orkney and Pentland Firth waters the common dolphin is not currently considered to be numerous; to date, the species has been recorded only at scattered locations, particularly along the north coast of Caithness from Strathy Point to Duncansby Head.

11.81 The common dolphin occurs in British waters year-round but in Scottish waters numbers tend to increase during the summer and in North Sea waters it is recorded mostly between June and September (Reid *et al*., 2003). Most records in northern Scotland have been between May and November (Evans *et al*., 2010).

11.82 Common dolphins feed on a range of epipelagic and mesopelagic[8] fish, shrimps and squid, and especially schooling fish such as mackerel, sprat, pilchard and blue whiting (Reid *et al*., 2003).

Harbour porpoise

11.83 The harbour porpoise is distributed throughout temperate and subarctic waters of the North Pacific and North Atlantic oceans and is the most abundant cetacean to occur in north-west European shelf waters (Evans *et al*., 2003). It is the most frequently-sighted and widely-distributed cetacean species in UK waters, where the highest densities occur along the North Sea coast, around the Northern Isles and the Outer Hebrides and off Pembrokeshire in Wales (Northridge *et al*., 1995, Evans *et al*., 2003, Reid *et al*., 2003). The total abundance of harbour porpoises in the entire SCANS II survey area was 385,617 animals (SCANS II, 2008), with the density twice as high as estimated from SCAN I surveys (SCANS II, 2008).

11.84 Harbour porpoise are distributed widely all around the Orkney Islands and are also found throughout the Pentland Firth, including Thurso Bay, Dunnet Bay and Gills Bay. The waters around Stroma, including the Inner Sound, are used regularly by porpoises.

11.85 The harbour porpoise is found within UK and Irish waters throughout the year (Evans *et al*., 2003), including a year-round occurrence in the Orkney and Pentland Firth region (Northridge *et al*., 1995, Hughes, 1998). In the waters around Stroma annual peaks in harbour porpoise sightings are between July and September (Colin Bird, SeaWatch Foundation Group Co-ordinator, pers. comm., Sept 2011).

[8] Epipelagic fish are associated with the surface layers of the water body, generally the upper 200m. Mesopelagic species are associated with the middle layers of water bodies, where light still penetrates but at levels too low for photosynthesis to occur (200 - 1,000m).

11.86 In Scottish waters, 80% of harbour porpoise diet is comprised of whiting and sandeels (Santos *et al*., 2004). Other important prey categories are gadoids (haddock, saithe and Pollack), Norway pout and poor cod (Santos *et al*., 2004). Section 13, Fish Ecology demonstrates the majority of these prey species may be found in the Project area.

11.87 SRSL (2012) undertook an analysis of harbour porpoise data to generate a likely regional population estimate for harbour porpoise in the absence of such a figure being available in the literature or from advisory bodies. This combined information on the ranging behaviour of porpoises from a single site of capture in Danish waters with area-wide density estimates from the North Sea (SCANS-II). Based on this work it can be assumed that 55,276 harbour porpoise (95% Confidence Interval = 27,597 – 107,591) might be expected to reach, and at some point use, the Inner Sound. Further details are given in SRSL (2012).

11.5.4 Pinnipeds

Grey seal

11.88 Grey seals occur only in the north Atlantic and in the Barents and Baltic Seas, with their main concentrations located along the Canadian and US eastern seaboards and in north-east Europe (SCOS, 2011). The UK contains around 45% of the total world breeding population of grey seals, and 90% of those breed in Scotland with major concentrations in the Outer Hebrides and in Orkney (SCOS, 2011). The total UK grey seal population at the start of the 2009 breeding season was estimated at 119,400 animals (SCOS, 2011).

11.89 Grey seals breed during the autumn, with pupping occurring between August and December (SCOS, 2010), although in northern Scotland most pupping occurs between October and late November (Hammond *et al*., 2003). Moulting takes place between January and April (Hammond *et al*., 2003, SCOS, 2010). Seals spend more time ashore during the breeding and moulting seasons and at-sea densities will be lower at these times (Hammond *et al*., 2003). Pup production on the island of Stroma in 2008 was 1,397 animals, making it one of the most important grey seal breeding sites in northern Scotland.

11.90 Aerial surveys conducted in August 2008 estimated between 2,000 and 4,000 grey seals to be concentrated particularly at haulout sites at the Pentland Skerries, Stroma, south-west Hoy and the Scottish mainland coast around Thurso (SMRU Ltd., 2011). Their haulout distribution during the non-breeding period is different from during the breeding season, with more widespread use of the northern part of Orkney. Particular concentrations of seals occur within the Pentland Firth at this time, especially on the Pentland Skerries and Stroma, and along the Scottish mainland coast between Duncansby Head and Dunnet Head. Haulouts of key importance (as described in the recent Scottish Government consultation) are shown in Figure 11.2 (Scottish Government, 2011).

11.91 Grey seals feed mostly on the seabed on small demersal fish species, primarily in water depths of less than 100m. In the UK their diet includes sandeels, whitefish, flatfish and some cephalopods (SCOS, 2010).

11.92 Potential Biological Removal (PBR) is a widely used method of calculating whether current levels of anthropogenic mortality are consistent with reaching or exceeding a specific target population for a species. Using this tool, the Scottish Government issues limits on the number of seals that can be removed from a population before that population might be affected. For grey seals in the Orkney and North Coast (of Scotland) management area in 2012 this number is estimated to be 959 animals (Scottish Government, 2012).

11.93 A regional population estimate for the Orkney and North Coast Management Area of 15,976 grey seals exists. This region is the unit used by Scottish Government to assist with PBR calculations, which is based on the numbers of grey seals that are counted during August surveys of harbour seals. This summer count is more representative of the population of grey seals that spend the majority of the year in any particular area. This count is lower than the minimum number (Nmin) used in the PBR calculation because a large proportion of grey seals will be offshore when the August count is made. The count is corrected using data on the haul-out probability from seals tagged with GPS or ARGOS transmitters over the period the surveys are undertaken.

Harbour seal

11.94 Harbour seals have a circumpolar distribution with 30% of the European population found in UK waters. 80% of the UK population (around 25,650; SCOS, 2010) is distributed around the west coast, the Hebrides and the Northern Isles of Scotland (Duck *et al*., 2010). Until 2000, Orkney was the main stronghold for harbour seals in the UK, but a decline of approximately 67% has been noted since the late 1990s[9] (SCOS, 2010).

11.95 Harbour seals are present in UK waters year-round. Pups are born during the summer in June and July, and during this period they disperse and females spend a high proportion of time ashore with their pups (Hammond *et al*., 2003, SCOS, 2011). Around Orkney, most pups are born in June (Thompson *et al*., 2001). The annual moult occurs from late July to early September (peaking in August) (Hammond *et al*., 2003), and numbers at haulout sites are highest at this time. The main moulting haulouts in the Pentland Firth region are at Gills Bay, the south-western tip of Stroma and around Scapa Flow (SMRU Ltd, 2011). Harbour seal haulouts tend to be in sheltered, tidally exposed areas on sandbanks, mud flats and skerries. Haulouts of key importance (as described in the recent Scottish Government consultation) are shown in Figure 11.2 (Scottish Government, 2011).

11.96 Harbour seals are likely to use the Pentland Firth for foraging or while en route to other foraging areas, but there is a lack of published at-sea distribution data from the individual animals most likely to use this region.

11.97 Harbour seals take a wide range of prey species including small pelagic and demersal fish and cephalopods (SCOS, 2011). In Shetland, whiting, herring, sandeel and garfish are the most important prey species (Brown *et al*., 2001).

11.98 The PBR for harbour seals in the Orkney and North Coast (of Scotland) management area in 2012 is estimated to be 18 animals (Scottish Government, 2012).

11.99 A regional population estimate for the Orkney and North Coast Management Area of 2,979 harbour seals exists. This region is the unit used by Scottish Government to assist with PBR calculations. These estimates are made during the moulting season when individuals of this species aggregate. Outside of this time, including the breeding season when the animals segregate, the abundance and distribution of harbour seals in the Pentland Firth and Orkney region is not known.

11.5.5 Site-specific details (including species density and distribution in the water column)

Summary

11.100 Boat-based transect surveys (that is, where the boat moves along a pre-determined route; see Figure 11.1) recorded a total of 29 cetacean sightings and 142 pinniped sightings within the survey area, covering two species of cetacean and two pinnipeds (RPS, 2011a). The harbour porpoise dominated cetacean observations, with 27 sightings recorded. The minke whale, with one sighting, was the only baleen whale recorded. Sightings of dolphins during boat-based surveys were uncommon and species could not always be identified. Grey seals dominated pinniped observations, with 119 sightings recorded. Harbour seals were also observed, but on only 11 occasions. The distribution of all sightings made during the boat-based transect surveys is shown in Figure 11.3, which indicates marine mammal relative abundance (i.e. the number of sightings per km travelled, by boat). Sightings are distributed throughout the survey area, although sightings of cetaceans are more numerous in the western portion of the survey area and pinniped sightings show some concentration towards the east of the survey area.

11.101 Boat-based stationary point surveys (that is, where the boat remains at one location for a period of time; see Figure 11.1) recorded a total of 5 cetacean sightings and 37 pinniped sightings within the survey area; these were the same species as identified during the boat-based transect surveys and, as with transect sightings, the harbour porpoise dominated cetacean observations and the grey seal dominated pinniped observations.

[9] Disease, hunting, over-fishing and predation by killer whales have been proposed as reasons behind this decline but there is no clear understanding as to the cause.

11.102 Land-based vantage point surveys recorded a total of 95 cetacean sightings and 84 pinniped sightings within the survey area. Four species of cetacean and two pinniped species were positively identified. The harbour porpoise again dominated cetacean observations (89 sightings) but minke whale, killer whale and Risso's dolphin were also observed. Grey seals dominated pinniped observations, as predicted by the boat-based surveys, with 61 sightings recorded. The land-based surveys recorded a large number of individual seal records (grey and common seals were sighted on 81 occasions, representing 2,604 animals, including 26 occasions when a total of 1,400 individuals were observed on land) as a result of the survey area including seals hauled out on Stroma and adjacent rock outcrops[10].

11.103 Towed hydrophones were used to collect further data on harbour porpoise (Ecologic UK, 2011). Analysis of these data indicates that the overall acoustic detection rate for harbour porpoise was higher than the visual detection rate. This could suggest that the visual sightings rates may not accurately reflect actual levels of harbour porpoise activity in the Inner Sound. Acoustic detections made during surveys are shown against visual boat-based porpoise sightings in Table 11.7. The detection rate for the surveys has been considered when using density estimates for porpoise. In some cases, the density estimates have been compared to the regional means to give an indication of the potential variability in estimates for the site and region.

Survey (2011)	Acoustic survey		Visual survey	
	Recording (hours)	Acoustic detections (per hour)	Effort (hours)	Visual sightings
May	2.65	9.06	3.10	0
June	4.23	9.93	4.47	0
July	1.97	7.11	4.65	2
August	5.52	3.80	4.18	1
Total	14.37	7.03	16.40	3

Table 11.7: Summary of acoustic detection effort, harbour porpoise detections and detection rates (Ecologic UK, 2011)

Harbour porpoise

11.104 In accordance with regional distribution patterns and seasonal trends, sightings data indicates that the harbour porpoise is the most frequently-sighted and numerous cetacean species occupying the Inner Sound. Most boat-based sightings comprised either single animals (38%) or pairs (25%) with the largest group sighted comprised 12 individuals. Of the land-based sightings, 42% of sightings were of groups of 10 or more individuals, and the largest group sighted comprised approximately 100 individuals. Sighted animals were observed travelling, and in larger groups were seen foraging and breaching. Density estimates are shown in Table 11.8.

Number of harbour porpoise per km^2	
Mean density	Peak density
0.105	0.600
95% CI: 0.055 - 0.202	95% CI: 0.226 - 1.594

Table 11.8: Inner Sound harbour porpoise density estimates (RPS, 2011a).

11.105 Porpoises are widely distributed across the Inner Sound but densities appear to be highest across the western portion of the survey area in Gills Bay and off the south-western tip of Stroma (Figure 11.4). These sightings occurred throughout the year but peaked in late summer (July – September), although in summer were more evenly distributed throughout the survey area than in autumn where sightings were concentrated in the western portion of the survey area and in and around Gills Bay. The preference for the west of the area, at least at certain times of the year, appears to be confirmed by the acoustic survey which suggests that there are more animals towards the west of the study area (Ecologic UK, 2011).

11.106 Sightings of feeding animals indicate that the Inner Sound provides harbour porpoise with foraging habitat.

11.107 SRSL (2012) undertook analysis to estimate the time this species may be present at different water depths with reference to two previous studies (Westage *et al*., 1995 and Teilmann *et al*., 2007 as cited in SRSL, 2012). This analysis indicated that harbour porpoises make many dives that are not to the seabed which maybe when feeding on pelagic species and travelling.

Other cetaceans

11.108 Although the minke whale is the most frequently recorded baleen whale species in the Orkney and Pentland region (and the only baleen whale recorded in the survey area), they were sighted infrequently during the baseline surveys. Only three sightings were made during the 22 survey months, all of solitary travelling animals, and all in August or October, in line with regional patterns. It is considered unlikely that the Inner Sound comprises important habitat for this species.

11.109 Although unlikely to use the area with any regularity, this species was considered in the encounter risk model to cover a worst case scenario. The model requires a local density estimate which could not be calculated from the few sightings made during the boat-based visual transect surveys (RPS, 2011a). Instead, SRSL calculated densities based on SCANS-II survey results from the larger area (including the Pentland Firth) weighed the estimate by half (since the SCANS-II density was based on summer survey effort) to provide an annual mean density estimate of 0.011 minke whales per km^2. As no data is presently available to allow an estimate of the time this species may be present at different water depths, a random distribution throughout the water column has been assumed for the encounter modelling.

11.110 Two sightings of killer whales were made during land-based observations on consecutive days in May 2010, both recording groups of six to seven individuals with only one male in each (the remainder of the groups comprised females and juveniles). Sightings made during survey were in accordance with regional sightings data, which indicates that killer whales have a regular occurrence in the Pentland Firth and Orkney region and in the waters around Stroma during summer months. It is not thought that the Inner Sound provides important habitat for this species.

11.111 A single sighting of a Risso's dolphin was from land-based observations June 2010, when three animals (two adults and one juvenile) were recorded. Survey findings are in line with regional spatial and temporal distribution patterns, with Risso's dolphins present in the region on a regular basis but in small numbers. It is not thought that the Inner Sound provides important habitat for this species.

Grey seal

11.112 Grey seal were the most numerous and frequently sighted marine mammal species in the Inner Sound during the Project specific marine wildlife surveys, The majority of at-sea sightings were of single animals (mostly of adults, though some juveniles were observed) swimming, diving and feeding. Density estimates calculated from the boat based survey are shown in Table 11.9.

11.113 Additional to this significant numbers of animals were observed hauled out on the Stroma shoreline or on adjacent rock outcrops (over 1,000 individuals during the 2 years of survey). On six occasions more than 100 individuals were observed hauled out on Stroma, with a peak count of 268 individuals in a single sighting record, with both adults and juveniles observed.

Number of grey seal per km^2	
Mean density	Peak density
0.226	0.555
95% CI: 0.073 - 0.699	95% CI: 0.0122 - 25.286

Table 11.9: Inner Sound grey seal density estimates (RPS, 2011a)

11.114 The numbers of sightings, and the overall sightings rates, were slightly higher across the eastern half of the survey area between the Boars of Duncansby and Stroma (Figure 11.5).

11.115 At-sea grey seal sightings occurred throughout the year but numbers peaked in spring and again to a lesser extent in November. During the spring and winter peaks, sightings were concentrated across the eastern half of the survey area, though observations were made throughout the survey area. Land-based

[10] Note that survey coverage did not include haulout sites at Gills Bay

sightings similarly recorded grey seals throughout the year but, in contrast to the boat-based data, sightings data indicates a peak in sightings of at-sea seals during summer months (approximately 50% of all sightings were made between June and August). Sightings of large groups of seals (adults and pups) hauled out on land peaked in winter months; groups comprising more than 100 hauled-out individuals were observed on the Stroma shoreline in October and November.

11.116 With regard to how much time this species might spend at different water depths, there is no data available for the Inner Sound. SRSL (2012) report that for both grey and harbour seals, studies that are available report very similar patterns of underwater behaviour. Broadly speaking seals are expected to roam over a large area, but only undertake dives indicative of foraging (termed U dives in SRSL, 2012) in specific locations. Similarly there may be locations where no feeding takes place, but through which seals may pass on a regular basis (termed as V dives in SRSL, 2012). The encounter modelling has considered both types of dives profiles for grey seals.

Harbour seal

11.117 A total of 18 sightings of single harbour seals were made during boat-based surveys and seven sightings of a total of 21 individuals recorded during land-based vantage point surveys; five of these were of animals at sea and two of animals hauled out on Stroma. The majority of sightings were of adults, although three juveniles were recorded. Animals have been observed swimming and hauled out.

11.118 Boat-based sightings were distributed across the survey area, with no apparent concentration of sightings in a particular area (Figure 11.5). At-sea harbour seal sightings occurred throughout the year and sightings peaked in winter and spring. Land-based sightings also recorded harbour seal throughout the year. In contrast to the boat-based data, the number of sightings was highest (although still low) during June (two sightings) and August (two sightings), when adults and pups were observed. Given the small number of sightings it is not possible to discern any seasonal variation in spatial distribution within the survey area.

11.119 Although there were a relatively small number of sightings of animals at-sea in the Sound, there are known moulting haulout sites at Gills Bay and on the south-western tip of Stroma and the harbour seal would be expected to be encountered in the Inner Sound.

11.120 Insufficient sightings were made during the baseline survey work to reliably estimate local density. Since no published density estimates (in terms of animals per km^2) were available in the scientific literature for harbour seals for this area, SRSL (2012) estimated density for the site using shore based counts along northern Caithness (83 seals) and southern Orkney (754 seals; SMRU Ltd. 2011). Making the assumption that seals rarely travel beyond 30km from their haul-out site to forage (Tollit *et al*. 1998), the SMRU Ltd. (2011) data were used together with an estimated sea surface area of 30km around each haul-out site to estimate harbour seal density across the area as 0.202 seals per km^2. Following further consultation, MeyGen instructed RPS to conduct additional analysis of the baseline survey data to determine a crude density value for harbour seals per km^2. The value calculated, 0.169 seals per km^2, is close to (albeit slightly lower than) that calculated by SRSL (2012) but does not include corrections for weather conditions and sea-state. As such, the value calculated by SRSL (2012) has been taken through to the assessment sections below.

11.121 With regard to how much time this species might spend at different water depths, SRSL (2012) report that for both grey and harbour seals, studies that are available report very similar patterns of underwater behaviour. Broadly speaking seals are expected to roam over a large area, but only undertake dives indicative of foraging (termed U dives in SRSL, 2012) in specific locations. Similarly there may be locations where no feeding takes place, but through which seals may pass on a regular basis (termed as V dives in SRSL, 2012). Harbour seal data for Inner Sound was available from SMRU. These data indicated that harbour seals are predominately undertaking U dives and feeding in the Project area rather than transiting through it (SRSL, 2012). Therefore it was decided in consultation with Marine Scotland that the encounter modelling for harbour seal would only consider U dives, whilst the U and V dive scenarios would be run for grey seals.

Figure 11.2: Location of key seal haulouts (Scottish Government, 2011).

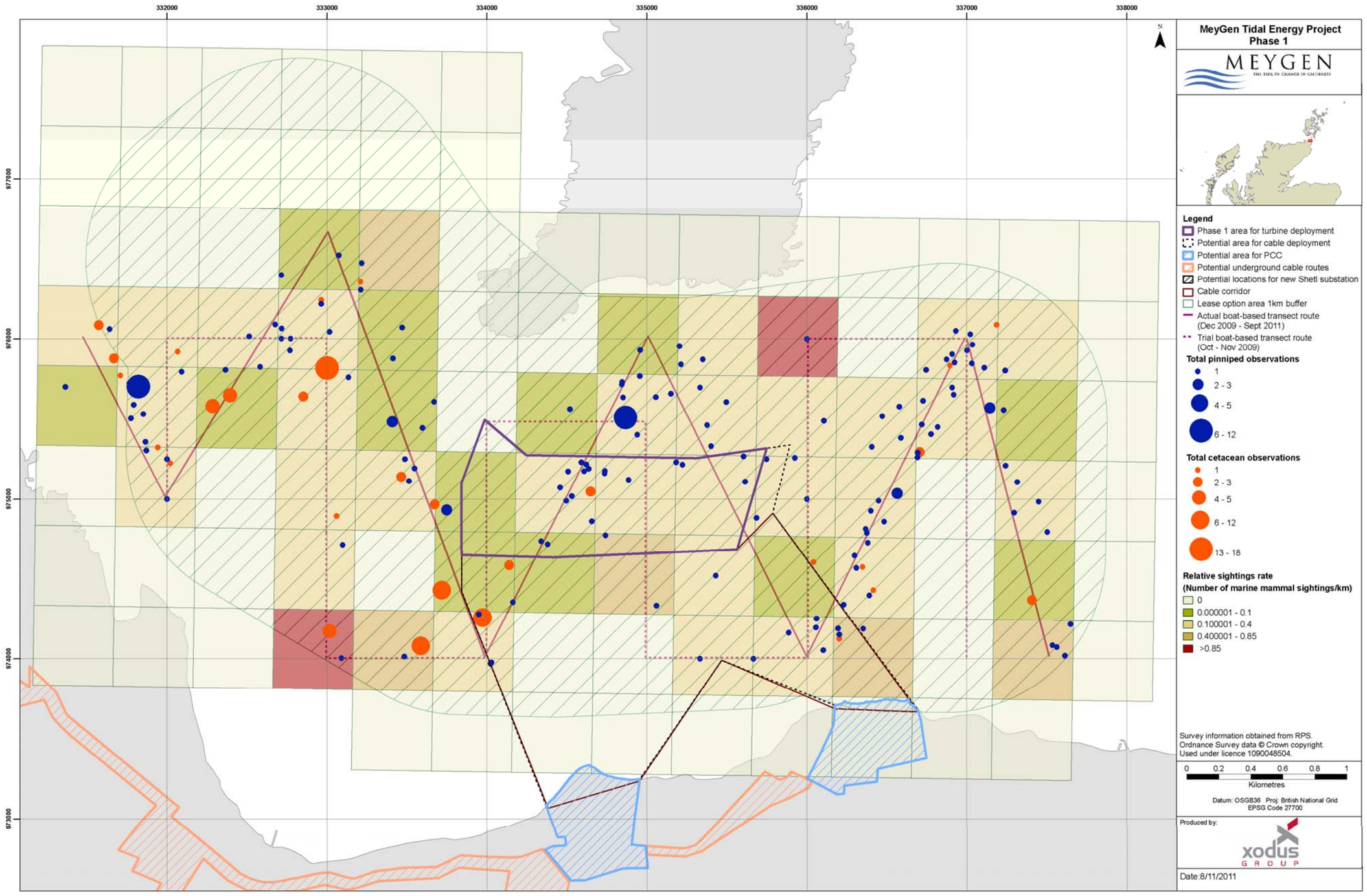

Figure 11.3: Location of marine mammal sightings during boat transect surveys within the survey area (RPS, 2011a)

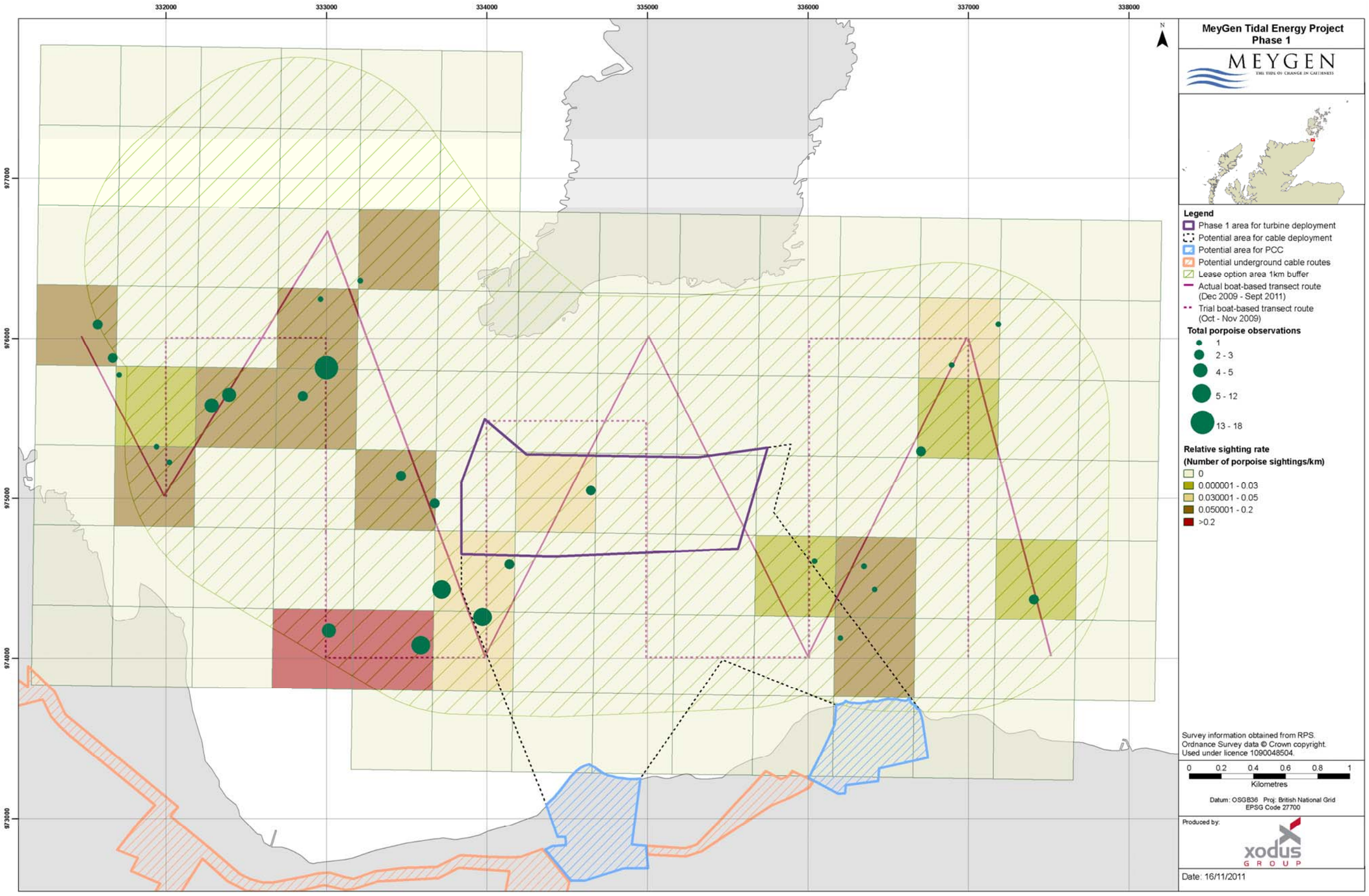

Figure 11.4: Location of harbour porpoise sightings during boat transect surveys within the survey area (RPS, 2011a)

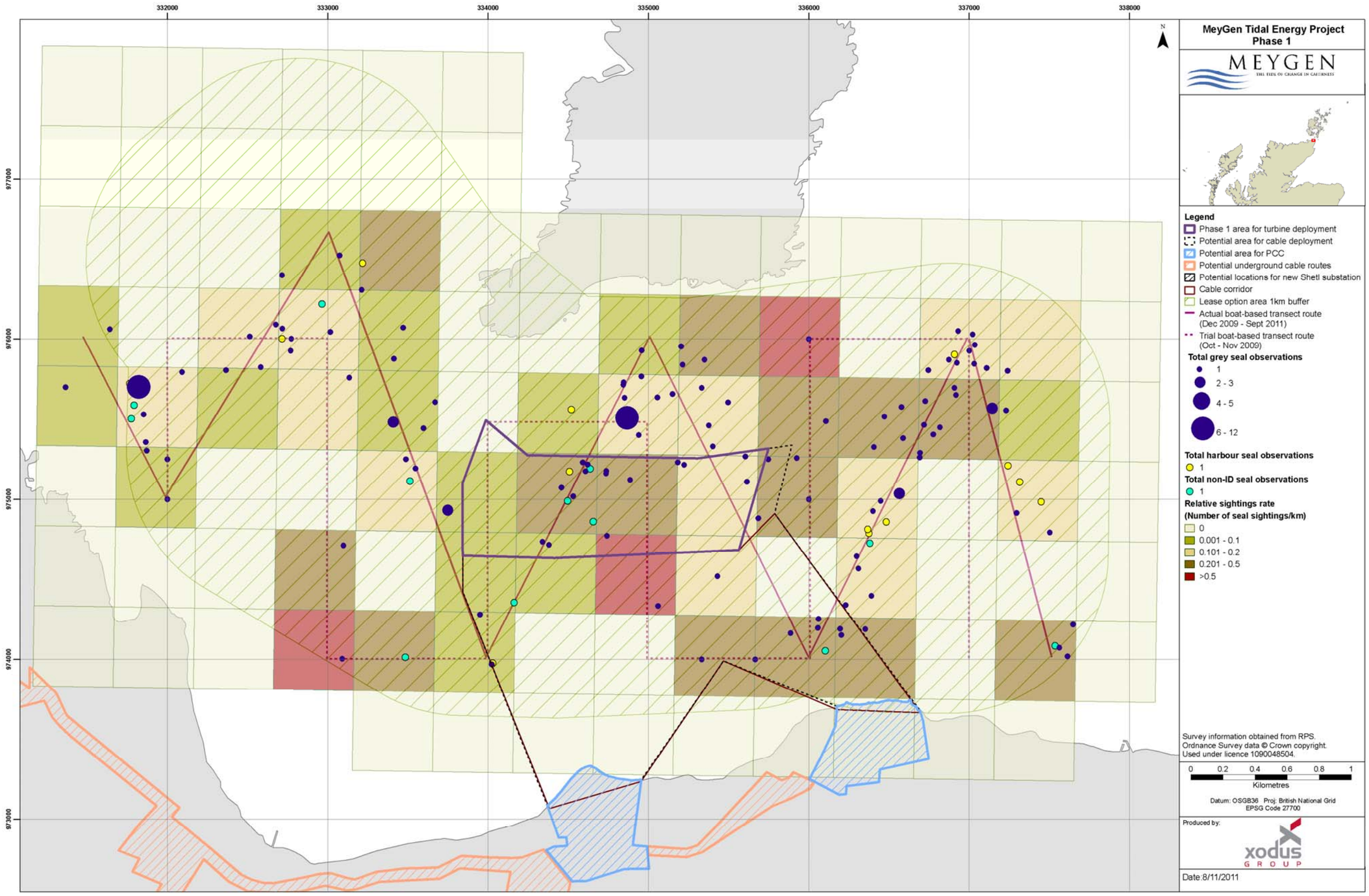

Figure 11.5: Location of seal sightings during boat transect surveys within the survey area (RPS, 2011a)

11.6 Impacts during Construction and Installation

11.122 The EIA process has identified a number of potential impact mechanisms relevant to marine mammals. With regards to the construction and installation periods of the Project, these are noise emissions, ship strikes, increased turbidity, indirect effects via prey species and accidental events.

11.123 The potential sensitive receptors are those species that have been identified by the RPS (2011a) baseline surveys (Section 11.5) as making use of the area:

- Harbour porpoise;
- Harbour seal; and
- Grey seal.

11.124 Other cetaceans, such as minke whale, killer whale and Risso's dolphin, may be sighted and are discussed where relevant.

11.6.1 Impact 11.1: Noise (TSS pile drilling, construction vessels)

Project environment

11.125 A number of species of marine mammal are regularly present in the Inner Sound area (Section 11.5); many of these species make use of underwater sound and have hearing that is highly tuned for the undersea environment (Richardson *et al*. 1995). Their susceptibility to impacts arising through the introduction of man-made noise into the marine environment is well-documented (e.g. Southall *et al.*, 2007). Such man-made sound for this Project could include vessels and drilling activity.

11.126 For each sound type and source of that sound, a short summary of the nature of the sound emitted is provided, followed by the results of the noise modelling conducted by Kongsberg (2012) and a conclusion on the range to which any auditory or behavioural impacts on marine mammals may extend. The extent that any impact may have at the population level is subsequently discussed.

11.127 To inform the noise assessment, MeyGen commissioned Kongsberg (2012) to undertake measurements of background underwater noise in the Inner Sound. From an oceanographic perspective, the Inner Sound is a turbulent location and the underwater noise data acquired indicates a generally high noise level environment; huge eddies many metres in diameter, seabed material being moved around under the influence of the tidal flow, movement of sand, larger stones rolling over the seabed, seal vocalisations, the Orkney Islands ferry *MV Pentalina* and smaller fishing vessels all contribute to noise levels.

11.128 Kongsberg quantified the background sea noise for the Inner Sound (Table 11.10) and took this information forward to the noise propagation modelling (Kongsberg, 2012).

Metric	Inner Sound
Background noise[11]	106 – 139dB re 1 µPa
Weighted for low-frequency marine mammals[12]	102 – 131dB re 1 µPa
Weighted for mid-frequency marine mammals	106 – 139dB re 1 µPa
Weighted for high-frequency marine mammals	106 – 139dB re 1 µPa
Weighted for pinnipeds	105 – 137dB re 1 µPa

Table 11.10: Summary of background sea noise measurements undertaken in the Inner Sound, August 2011 (Kongsberg, 2012)

[11] This has been measured over a period of time using root mean square sound exposure level.
[12] As different species can perceive the same sound as presenting a different 'loudness', the background levels have been 'corrected' to account for this.

Introduction

Drilling noise - introduction

11.129 Noise is generated during drilling principally through the action of the drill bit on the surrounding rocks. In comparison to hammered piles, the noise generated from the drilling of piles (as proposed for this project) is significantly less. The level of noise created is dependent on the degree to which the seabed rock is consolidated; a soft clay will produce lower levels of sound compared to that generated by a harder granite layer. It is known that sediment coverage of the seabed in the Inner Sound is sparse (see Benthic Habitats and Ecology, Section 10) so it is expected that considerable levels of sound may arise

11.130 McCauley *et al.* (1998) provide examples of noise levels recorded from an oil drilling rig in the Timor Sea, offshore north Australia. During drilling, the highest noise levels measured were around 115 - 117dB re 1µPa at distances of 100 - 400m from the rig, indicating a source level of around 144dB re 1 µPa at 1m, just above the background noise recordings detailed in Table 11.10. It is not clear whether the underwater noise was due entirely to the action of the drill bit on the seabed rock as additional noise may have been introduced into the water through equipment on the drilling rig. In addition, it is unknown whether oil drilling is representative of the drilling likely to be carried out in connection with the TSS installation programme at Inner Sound. Nedwell *et al.* (2010) report on underwater noise levels generated during foundation socket drilling at the EMEC tidal site, The Falls of Warness. In this case, source levels were found to be 178 dB re 1 µPa at 1m. Although the report does not give information on the seabed sediment type and coverage, it is known that The Falls of Warness site has similar sandstone bedrock to the Project site and as it is a strong tidal area there is likely to be only a thin covering of sand, if any. Kongsberg (2012) report that analysis of published drilling noise measurements indicate that limits of 144dB re 1 µPa at 1m to 178dB re 1 µPa at 1m may be considered representative for the drilling associated with TSS installation for the Project and it is these data that have been used in the analysis described in this report.

11.131 Kongsberg (2012) report that underwater drilling tends to be a low noise level operation, at least compared with piling activities. In a relatively noisy environment such as the Inner Sound, it may be assumed that the drilling noise will propagate over only short distances before it falls below background noise levels. The modelling undertaken for the Inner Sound confirms this, with drilling noise falling to background noise levels at a distance of 0.5km from the noise source.

Drilling noise - lethal injury

11.132 The source level for drilling activities (i.e. how loud it is) is considerably below the level at which lethal injury to marine mammals (cetaceans and pinnipeds) might occur (being 240dB) (Table 11.4) and it is therefore unlikely that any marine animals will be killed by the underwater noise from pile drilling.

Drilling noise - hearing damage

11.133 Source levels are also below those at which hearing damage might occur, even when taking into account more conservative criteria (being 193.7dB) (e.g. proposed by Lucke *et al*., 2009, for harbour porpoises and those put forward by the US NMFS, 1995; Table 11.4).

Drilling noise - changes in behaviour

11.134 Where injury is not likely, changes to behaviour become the most significant route for impact. There are a number of criteria that have been proposed for behavioural disturbance against which the drilling noise (and indeed other acoustic emissions are not likely to generate sound levels in excess of the 'Level B – Harassment' or 'Low Level Behavioural' thresholds (being 160dB and 140dB respectively) (described in Table 11.4).

11.135 Kongsberg (2012) note, however, that these threshold values are independent of which species is being considered (termed 'unweighted') and therefore may not reflect the true range of impact on behaviour. When species specific impact ranges are calculated, which compare the source noise with the actual hearing threshold of the target species, it is evident that these unweighted (non-species specific) ranges

are not appropriate. As such, the dB_{ht} metric, which makes use of such species specific hearing ability[13], is used in each noise impact assessment in this chapter when considering behaviour.

11.136 Using the species specific dB_{ht} model it is shown that drilling noise is of a sufficiently low level that all species of cetacean and pinniped would need to be within 1m of the drill to exhibit strong or even mild behavioural reactions (Table 11.11). As this distance is so small and as it is unlikely that animals would be able to approach within 1m of the source since the drill itself will be surrounded by a conductor sleeve of 2.8m diameter, there is effectively no likely impact on behaviour from the drilling activities.

Species group and impact receptor	Strong avoidance ($90dB_{ht}$)		Mild avoidance ($75dB_{ht}$)	
	Precautionary conditions	Typical conditions	Precautionary conditions	Typical conditions
Pinnipeds				
Vessel	<1m	<1m	14m	14 - 18m
Drilling	<1m	<1m	<1m	<1m
Odontocetes				
Vessel	<1m	<1m	28m	28m
Drilling	<1m	<1m	<1m	<1m
Mysticetes				
Vessel	56m	56m	1,176m	620 - 1,036m
Drilling	<1m	<1m	<1m	<1m

Table 11.11: Behavioural impact ranges for receptor groups during drilling and vessel operations[14]

Vessel noise - introduction

11.137 In addition to a noise model simply allowing assessment of the temporal and spatial nature of marine mammal avoidance behaviour within the study area, it is also possible to take the dimensions of the zones of possible impact and determine the numbers of animals likely to be present within those zones, based on the marine mammal density data derived from site-specific surveys or from published data where this information is not available. In the case of drilling, the zones of possible impact are so small and the local/regional density estimates so low that no animals are expected to be affected.

11.138 Noise from shipping is a major contributor to the overall noise in a given sea area due principally to the large numbers of ships present, their wide distribution and their mobility. Sound levels and frequency characteristics are related approximately to ship size and speed, but even amongst vessels of similar classes there can be variation.

Vessel noise - lethal injury

11.139 The source level for construction vessels is considerably below the levels at which lethal injury to species of marine mammal might occur (Kongsberg, 2012, use a value of 172dB re 1 µPa at 1m for vessels). No marine mammals will be killed as a consequence of this underwater noise.

[13] The dB_{ht} method has been developed based on work by Nedwell *et al.* (2005, 2007) and Parvin *et al.* (2006) where the underwater noise is compared with receptor hearing threshold across the entire receptor auditory bandwidth. This dB_{ht} criteria is behavioural based, where received sound levels of 90dB above hearing threshold are considered to cause a strong behavioural avoidance, and levels of 75dB above hearing threshold invoke a mild behavioural response.

[14] During the winter months, the sound speed tends to increase uniformly with depth leading to upwardly refracting profile by the month of February. During late spring and early summer, increased heating by the sun of the topmost layers gives rise to an increase in the sound speed over the top 10 - 20m. This is followed by a seasonal thermocline (rapid change in temperature over a small change in depth) which gives rise to a downwardly refracting profile. Given these two profiles, longer range acoustic propagation is more likely to occur during winter than during summer. In order to adequately characterise the environment acoustic propagation modelling has been undertaken using the February and August sound speed profiles as these two months are most likely to give rise to the maximum and minimum propagating conditions. Propagation distances for vessel and drilling operations in this table are based on physical conditions for summer months as this is when these operations are most likely to occur.

Vessel noise - hearing damage

11.140 Source levels associated with the vessels are also below the levels at which hearing damage might occur.

Vessel noise - changes in behaviour

11.141 Kongsberg (2012) report that vessel noise could remain audible out to ranges of 1 - 14km depending on the prevailing levels of background noise and operational status of the turbines. Considering species specific thresholds, pinnipeds might show a mild avoidance of noise levels within 14 - 18m of vessels and strong avoidance at <1m (Table 11.11). Similar values are the case for harbour porpoise and the dolphin species that may be found in the area, although mild avoidance could extend out to 28m (Table 11.11).

11.142 In terms of the mysticetes, which in the case of this Project extend to the infrequently sighted minke whale, strong avoidance may be experienced out to around 56m (Table 11.11). Mild avoidance is possible out to 1,036m from the vessel (Table 11.11).

11.143 However, the mild avoidance reaction is primarily a cognitive response, in that the animal will detect and be aware of the sound (Nedwell *et al.,* 2005), but it certainly does not represent a certain movement from an area. Indeed, Nedwell (2007) reports that habituation to these levels of noise is possible. Southall *et al*. (2007) also highlighted the fact that the interpretation of behavioural responses is very limited by uncertainty as to what constitutes biologically significant disturbance (i.e. disturbance that could affect feeding or breeding, for example). As such, mild avoidance is likely to be of little consequence to marine mammals in the Inner Sound and it is instead the strong behavioural response that is likely to be the relevant threshold for this Project; the area ensonified to the $90dB_{ht}$ threshold for strong avoidance will therefore be considered for assessment in this chapter.

11.144 Considering the area of strong behavioural impact for construction vessels, the zones of possible impact are so small and the local/regional density estimates so low that no animals are expected to be in those zones on most occasions and thus few, if any, negatively affected.

11.145 Licences issued for work at the EMEC tidal test facility in the Fall of Warness required an observation effort to be undertaken which focused on the detection of any large-scale temporal responses of Harbour seal behaviour to the operations. An observation programme was devised by EMEC in close conjunction with the Sea Mammal Research Unit and Scottish Natural Heritage to cover installation of a monopile foundation using a jack-up barge and a gravity-base foundation and nacelle from a DP vessel (EMEC, 2010). Although the responses by seals to such operations are variable, and although insufficient information was collected to allow statistical analysis of the results, it is clear that seals remained present at the site during such operations and that although some seals appeared to respond through movement to the operations, seals were also recorded showing no response at all other than to continue whatever behaviour they were engaged in previously (EMEC, 2010).

Drilling and vessel summary

11.146 Drilling and vessel noise emissions are not predicted to cause fatalities to any marine mammal species. Some behavioural changes may be observed but the distance within which this is predicted to occur are so small (matter of metres) that impacts are not expected to be significant. Note that the first 12 x 2.4MW turbines will be operational before the remaining 24 x 2.4MW turbines are installed and that the operational noise (these scenarios are detailed in Section 11.7.1) will render installation noise inaudible to marine species.

11.147 For the purposes of the noise assessments, it is assumed that once a marine mammal has been exposed to noise levels that could cause a temporary change in hearing ability (TTS) it will leave the vicinity of the activities and not return during the operation (note that evidence suggests that it is unlikely that an animal would choose to stay in close proximity to the source of a loud noise; Tougaard *et al*., 2003). In order to assess the potential for this to impact upon marine mammals at a population level, the number of marine mammals deemed to have 'left' the region can be placed in context with the number of animals expected to use the region over a set period (in this case the period of the installation operations). As no animals should be exposed to TTS from the installation operations, no animals are expected to leave the region and no population level impacts are therefore expected.

11.148 The marine mammal species that may be found at the site meet many of the criteria for medium sensitivity of receptor (e.g. some species are listed on Annex II of the EU Habitats Directive or are listed as EPS) and the sensitivity of receptor is therefore ranked as medium. However, as the noise levels are relatively low, are not considered loud enough to cause injury or mortality and the ranges for behavioural reactions are small compared to the likely range of most species; any impacts are likely to be limited in extent. Therefore, the magnitude of impact is considered to be minor.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Medium	Minor	Minor	Not significant

MITIGATION IN RELATION TO IMPACT 11.1
▪ No injury impact is expected due to the low levels of noise emissions and no marine mammal observer (the general role of which is to assist in mitigation of the injury impact) is therefore required. Note, however, that the principles of the JNCC guidance on protection of marine European protected species from injury and disturbance (JNCC, 2010) and of relevant guidelines on minimising the risk of injury to marine mammals will be adopted as necessary (for example, reducing the duration of noise emitting activities).

11.6.2 Impact 11.2: Ship strike (installation vessels) and ducted propellers

11.149 Increased vessel traffic during the installation phase presents an increased risk of marine mammals colliding with vessels. Wilson *et al*. (2007) identifies the main drivers in influencing the number and severity of strikes as a result of shipping as:

- Vessel type and speed;
- High levels of ambient noise resulting in difficulty in detection of approaching vessels;
- Weather conditions and time of navigation affecting the ability of crew to locate marine mammals; and
- Marine mammal behaviour, which is species-specific (but appears to affect juveniles and sick individuals more often than animals in good health as juveniles are inexperienced in how to respond to ship presence and sick animals may be unable to remove themselves from an impact situation and may be less able to recover).

11.150 Vessels travelling at $7ms^{-1}$ or faster are those most likely to cause death or serious injury (Wilson *et al*., 2007). Vessels involved in the installation of the tidal array are likely to be travelling considerably slower than this, and therefore collision risk is expected to be lower than that posed by commercial shipping activity. The period of greatest vessel presence will be during the installation of the tidal devices (turbine support structures and nacelles) but will be restricted to good weather months and continue for a 3 year period.

11.151 Severely damaged seal carcasses have been found on beaches in eastern Scotland, along the North Norfolk coast in England, and within and around Strangford Lough in Northern Ireland. All the seals had a characteristic wound consisting of a single smooth edged cut that started at the head and spiralled around the body which would have been fatal (Thompson *et al.*, 2010). The extremely neat edge to the wound strongly suggests the effects of a blade with a smooth edge applied with considerable force, while the spiral shape is consistent with rotation about the longitudinal axis of the animal (Thompson *et al.*, 2010).

11.152 Thompson *et al.* (2010) report preliminary findings of investigations into the causes of a number of these 'corkscrew' injuries to seals. The injuries are considered consistent with the seal being drawn through a ducted propeller such as a Kort nozzle or some types of Azimuth thrusters[15]. These systems are common to a wide range of ships including tugs, self propelled barges and rigs, various types of offshore support vessels and research boats and may be used on the installation vessels in this project. The Pentland Firth is a well-trafficked area (see Shipping and Navigation, Section 15) and the installation vessels are unlikely to be different to some of the existing vessels operating in the region. Thompson *et al.* (2010) report that all the other explanations of the injuries that have been proposed, including suggested Greenland shark predation are difficult to reconcile with the actual observations and, based on the evidence to date, seem very unlikely to have been the cause of these mortalities.

11.153 Two possible mechanisms that cause seals to interact with ducted propellers are attraction to concentrations of food associated with the vessel or an inappropriate response to an acoustic signal from the ship. However, at the time of writing, a link between this spiral injury phenomena and the use of vessels with ducted propellers has not been proven (Thompson *et al*., 2010) and no such injuries have been recorded during marine mammal observations at the EMEC Fall of Warness tidal test site (EMEC, 2010).

11.154 As this is an emerging issue and it is not clear yet the extent to which this may be occurring, it is difficult to quantify the potential level of impact, especially as the geographic spread is unknown and no regional estimates of this type of injury are available. Information presented by Thompson *et al.* (2010) shows 15 carcases showing corkscrew injuries having been recorded from Scotland at the point of report publication (13 harbour seals and two grey seals). Although these numbers are low, the uncertainty regarding the extent of the impact is such that the ease with which assessment rankings can be assigned is less than for other, better understood impacts. To ensure that the possible impact is appropriately captured in light of the lack of available data, and in line with the precautionary approach, it is considered that the magnitude ranking should be set artificially high, relative even to the worst-case scenario presented here. To that end, the magnitude of impact has been up-ranked to moderate. The marine mammal species that may be found at the site meet many of the criteria for medium sensitivity of receptor (e.g. some species are listed on Annex II of the EU Habitats Directive or are listed as EPS) and the sensitivity of receptor is therefore ranked as medium.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Medium	Moderate	Moderate	Significant

MITIGATION IN RELATION TO IMPACT 11.2
▪ It is understood that investigation is ongoing on the potential link between spiral injuries in seals and ducted propellers and that mitigation measures relevant to minimising the risk of seal spiral injuries and fatalities are currently being developed at an industry and regulator level. MeyGen commit to undertaking frequent reviews of the literature regarding this topic and to regularly discuss advances in understanding of this topic with relevant regulatory and advisory bodies. MeyGen will apply appropriate mitigation, as deemed necessary in consultation with Marine Scotland and SNH, should vessels with ducted propellers be found to be responsible for seal mortalities.

Residual impacts

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Medium	Minor	Minor	Not significant

[15] The Kort nozzle is a shrouded, ducted propeller assembly. An azimuth thruster is a configuration of ship propellers placed in groups that can be rotated in any horizontal direction, making a rudder unnecessary.

11.6.3 Impact 11.3: Disturbance due to physical presence of vessels

11.155 It is possible that the physical presence of vessels associated with the installation of the tidal devices or of the cables to shore could disturb seals hauled out on land (Scottish Executive, 2007). Noise is a key factor in the potential for disturbance (see Section 11.6.1 for noise modelling) but it has been highlighted that the physical presence of the installation vessels themselves may also cause a disturbance impact. Scottish Executive (2007) state that this impact would be most significant for breeding seals that were hauled out on the coast since the adults could exhibit flight reactions which result in them temporarily abandoning their young. In addition, seals that are undertaking the annual moult spend more time out of the water and if they are alarmed to the extent that they move into the water then they may lose condition as a result of additional energetic costs.

11.156 Brasseur and Reijnders (1994, in Scottish Executive, 2007)) suggest that vessels more than 1,500m from hauled out grey or harbour seals would be unlikely to evoke any reaction in the seals but that they could be expected to detect the presence at between 900 and 1,500m. At closer than 900m a flight reaction could be expected. These distances are similar to those described by Andersen *et al.* (2011, in Skeate *et al*., 2012) who noted flushing of harbour seal from a Danish haul-out into the water at distances of 510 – 830m at the approach of boats and Jansen *et al*. (2010, in Skeate *et al.*, 2012) who noted disturbance by cruise ships likely at less than 500m, with the chance of response increasing by 25-fold at less than 100m. The location of important haul out sites is shown in Figure 11.2; the shortest distance between these sites and the Project site, including cable route corridor to shore, is shown in. Table 11.12.

Site	Species	Distance from Project site	Within possible impact range?
Ness of Quoys	Harbour seal	Within possible cable route	Flight reaction possible
Mell head Skerry	Grey seal	0.3km north	Flight reaction possible
Gills Bay	Grey seal	0.6 km north	Flight reaction possible
Stroma north	Grey seal	2.75 km north	No
Muckle Skerry	Grey seal	10 km east	No
Pentland Skerries	Grey seal	10.5 km east	No
Switha	Harbour seal	14.8 km north	No

Table 11.12: Minimum distance between proposed designated seal haul out sites and the Project site

11.157 Skeate *et al*. (2012) report analysis of data collected during installation of the Scroby Sands offshore wind farm off the Norfolk coast (which was built close to a haul-out and breeding site for harbour seal) that showed a significant post-construction decline in haul-out counts. This decline was not thought to be related to the environmental factors considered (although cause and effect could not be unequivocally established) and Skeate *et al*. (2012) instead suggest that noise generated by the pile-driving of the wind turbine bases led to the displacement of the seals. This noise source will be absent from this Project, so the impact is likely to be much less than described by Skeate *et al.* (2012). However, it is important to note that the authors state that the failure of harbour seals to fully recover during the study was, at least in part, linked to that species sensitivity to vessel activity.

11.158 It seems possible, therefore, that seals at three of the sites above (Table 11.12) may demonstrate a flight response to the vessels involved in the installation activities. However, evidence from the installation of a tidal turbine in Strangford Lough MCT shows there to have been no major impact detected on harbour seals or grey seals; relative abundance of seals as measured by shore based visual surveys, annual counts of seals at haul out and breeding sites has not shown any detectable change which can be attributable to the SeaGen turbine (Royal Haskoning, 2011). The two important haul out sites in Strangford Lough are, at their closest within the 900m distance at which a flight response might be expected, suggest that the either the response zones described above are an over estimate, or a repetition of this action is not actually detrimental to the state of the population. Short-term marine mammal observations undertaken during installation of the foundations for a TGL tidal turbine at the Falls of Warness EMEC test site in Orkney (approximately 11 hours over three days) suggested that the seals that were observed were unaffected by the presence of the installation barge.

11.159 Scottish Executive (2007) state that a disturbance impact would be most significant for breeding seals. It is interesting therefore to note that Andersen *et al*. (2011, in Skeate *et al*., 2012) have shown that seals were more reluctant to leave a haul out site and that they returned much more quickly during the breeding season, limiting any possible impact.

11.160 Skeate *et al*. (2012) state that no effect of vessel activity was evident for grey seals, with the fact that numbers of this species were increasing demonstrating the species' tolerance of vessel activity. Interestingly, the authors also note that part of this site-specific tolerance may be linked to habituation of at least some animals to the single tourist vessel that regularly visited the site; numerous vessels pass through the Pentland Firth and Inner Sound, close by the haul out sites (Shipping and Navigation , Section 15).

11.161 The marine mammal species that may be found at the site meet many of the criteria for medium sensitivity of receptor (e.g. some species are listed on Annex II of the EU Habitats Directive or are listed as EPS) and the sensitivity of receptor is therefore ranked as medium. However, given that only a small percentage of the regional population of harbour seals is likely to be disturbed to any extent, and as the evidence suggests that grey seals are even less susceptible to such effects, the magnitude of impact is considered minor.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Medium	Minor	Minor	Not significant

MITIGATION IN RELATION TO IMPACT 11.3
▪ No mitigation measures proposed as no significant impact predicted.

11.6.4 Impact 11.4: Increased turbidity

11.162 Increased turbidity can occur during seabed disturbing installation activities, as fine particles travel further from the disturbed area, swept by tidal currents. Disturbance of seabed sediments could cause localised and short term increases in turbidity and therefore reduced visibility for marine mammals. Increased turbidity may affect the foraging ability of marine mammals, principally seals, who are dependent upon visual cues to track prey (Scottish Executive, 2007).

11.163 The magnitude of the impact will depend on the high number of variables involved in determining both background and project caused suspended sediment levels and turbidity. The turbines will be sited on a rocky seabed and thus there is likely to be very little sediment that could be moved into the water column. The main source of turbidity will instead be drill spoil from the drilled piles and the horizontally drilled cable boreholes. However, the turbines will be installed in a number of phases over three years and there will consequently be long periods of time between discharge events over which time the cuttings will settle out of the water column. Even when discharge is occurring, the rate is expected to occur at a rate of approximately only 5 litres per hour. At this rate it is likely, given the high energy environment into which they will be discharged, that cuttings will be dispersed rapidly and any elevated turbidity in the immediate vicinity of the discharge site will be very short lived.

11.164 The Benthic Habitats and Ecology impact assessment undertaken as part of this EIA (Section 10) has determined that any increase in turbidity or suspended sediment levels is expected to be temporally and spatially restricted, largely due to the small volumes released and the high energy environment of the Inner Sound.

11.165 Grey and harbour seals have been identified as having a high sensitivity to reductions in visibility, whilst cetaceans have a moderate sensitivity to this impact. However, many seals inhabit areas of almost persistent turbidity (such as the southern North Sea and The Wash and Thames Estuary on the south east coast of England) and it would seem unlikely that increased turbidity would be a significant issue. In

addition, whilst seals are known to use eyesight for finding prey and navigating, they can successfully hunt in turbid and unlit waters. Porpoises and dolphins use echolocation regularly when foraging and are unlikely to be impacted by temporary increases in turbidity.

11.166 The marine mammal species that may be found at the site meet many of the criteria for medium sensitivity of receptor (e.g. some species are listed on Annex II of the EU Habitats Directive or are listed as EPS) and the sensitivity of receptor is therefore ranked as medium. However, given that very little sediment exists to be moved into the water column and as any cuttings will be dispersed rapidly, any elevated turbidity in the immediate vicinity of the discharge site will be very short lived and the magnitude of impact is considered negligible.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Medium	Negligible	Negligible	Not significant

MITIGATION IN RELATION TO IMPACT 11.4
▪ No mitigation measures proposed as no significant impact predicted.

11.6.5 Impact 11.5: Indirect effects via prey species

11.167 The marine mammals that have been shown to use the Inner Sound prey on a variety of fish and shellfish species and it is possible that mammals may be affected if those prey species are negatively impacted by any of the installation activities. For example, potential impacts include loss of fish and shellfish habitat and disturbance from noise.

11.168 Assessing the biological significance of impacts to prey species is challenging but the dietary specialisations or opportunistic nature of a marine mammal may determine their ability to adapt to potential short-term or long-term changes in prey availability. Grey seals feed mostly on the seabed on small demersal fish species (sandeels, whitefish, flatfish and some cephalopods; SCOS, 2010), whilst harbour seals prey upon small pelagic and demersal fish and cephalopods. Harbour porpoise diet is comprised mostly of whiting and sandeels (Santos *et al*., 2004). Note that the diet of most marine mammals is varied and ordinarily comprised of a number of different species. As such, it is likely that they would be capable of filling a short term absence of one prey species with another that will be present in the area. Diet is described further in the marine mammal baseline report (RPS, 2011a).

11.169 The Fish Ecology assessment (Section 13) concluded that installation related impacts on each of these potential prey species are likely to be minor or negligible. In addition, the Benthic Habitat and Ecology assessment (Section 10) concluded that there would be no significant impact on shellfish resources in the area. Marine mammals that prey on these species should therefore be unaffected.

11.170 The marine mammal species that may be found at the site meet many of the criteria for medium sensitivity of receptor (e.g. some species are listed on Annex II of the EU Habitats Directive or are listed as EPS) and the sensitivity of receptor is therefore ranked as medium. However, as the species on which marine mammals are likely to prey will be unaffected to any significant extent by the Project, the magnitude of impact is considered to be negligible.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Medium	Negligible	Negligible	Not significant

MITIGATION IN RELATION TO IMPACT 11.5
▪ No mitigation measures proposed as no significant impact predicted.

11.6.6 Impact 11.6: Accidental spillage from vessels

11.171 The discussion around this impact focuses on the potential impacts associated with the release of a large inventory of fuel oil from a vessel. This is considered to be the worst case potential accidental pollution impact. Other significantly smaller inventories of polluting substances may be potentially released during the course of the Project. These impacts and their potential consequences are discussed further in Accidental Events (Section 24).

11.172 The total oil inventory for the large DP installation vessels is likely to be in the region of 6,000,000 to 8,000,000 litres of marine diesel stored in a number of separate tanks. The worse case spill from a single tank rupture is likely to be in the region of 600,000 litres of marine diesel released into the marine environment.

11.173 Oil spills can have a number of environmental impacts. Actual effects will vary depending on a wide range of factors including the volume and type of oil spilt and the sea and weather conditions at the time of the spill. Effects will also be dependent on the presence of environmental sensitivities in the path of the spill.

11.174 Even in the event that an oil spill resulted in the loss of inventory from a DP vessel, marine mammals are highly mobile and are able to detect these pollutants and as a result are expected to avoid areas where pollution has occurred. The main issue will be where this pollutant washes up and accumulates on haulout sites since an aversion by seals to the pollutant may displace them from preferred haulout sites. Such a situation will be more of a concern during the grey seal pupping season since juveniles do not initially have a waterproof coat and movement from a haulout site could negatively impact on pup survivability rates. As sensitivity is limited by species and time of year (grey seal pups are born from the end of September until mid December) it is unlikely that a total loss of inventory will affect directly affect marine mammal species in the area, especially as their mobility will allow them to move away from areas of pollution. It could affect marine mammals if prey species (fish and shellfish) were adversely affected by accidental release of contaminants, but the Fish Ecology assessment (Section 13) concludes that this is unlikely.

11.175 The marine mammal species that may be found at the site meet many of the criteria for medium sensitivity of receptor (e.g. some species are listed on Annex II of the EU Habitats Directive or are listed as EPS) and the sensitivity of receptor is therefore ranked as medium. In the event a large spill does occur the magnitude of impact is considered to be major. The potential for a loss of a large fuel oil inventory from a vessel is defined as extremely remote (see Impact 24.1, Section 24).

Impact significance (see Section 24 for impact ranking methodology)

Sensitivity of receptor	Magnitude of impact	Consequence	Likelihood *(See section 24)*	Impact significance *(See section 24)*	Significance (EIA Regs) *(See section 24)*
Medium	Major	Major	Extremely remote	Negligible	Not Significant

MITIGATION IN RELATION TO IMPACT 11.6
▪ Although the impact has not been identified as significant, additional control measures have been identified. ▪ All vessels associated with Project operations will comply with IMO/MCA codes for prevention of oil pollution and any vessels over 400 GT will have onboard SOPEPs. ▪ All vessels associated with Project operations will carry onboard oil and chemical spill mop up kits. ▪ Where possible vessels with a proven track record for operating in similar conditions will be employed. ▪ Vessel activities associated with installation, operation, routine maintenance and decommissioning will occur in suitable conditions to reduce the chance of an oil spill resulting from the influence of unfavourable weather conditions.

11.7 Impacts during Operation and Maintenance

11.7.1 Impact 11.7: Operational noise

Existing data

11.176 As with installation operations, it has been noted (e.g. Scottish Government, 2007) that the operational phase of tidal energy projects could impact upon marine mammals, with those impacts ranging from possible injury to behavioural effects.

11.177 Very few tidal turbines have been installed in UK waters and only data pertaining to the MCT turbine in the Bristol Channel is currently publicly available (Richards *et al*., 2007). The MCT turbine is a horizontal axis, single rotor turbine with an output of 300kW, much smaller than the maximum 2.4MW units proposed for the Inner Sound. Underwater noise was recorded at a number of ranges from the operational tidal turbine during March 2005 and Kongsberg (2012) have used the available information to calculate an estimated value for the larger Inner Sound turbines.

Turbine installation with 12 x 2.4MW turbines operational - introduction

11.178 Kongsberg (2012) predict that operational turbines are expected to give rise to higher levels of underwater noise compared with pile drilling activities but, even then, the background noise levels in the Inner Sound are variable and have the potential to drown out the operational noise from time to time; for example, when background levels are at their highest, operational noise may fall to background levels as close as 0.3km from the turbines. When background levels are at their lowest, this distance may increase to in excess of 14km; however, background noise levels will be at their lowest when the tide is not running and as the tidal turbines will be non-operational when the tide is not running, this distance is likely to be a gross overestimate.

11.179 Kongsberg (2012) modelled noise propagation for 12 x 2.4MW turbines (which are expected to emit noise with a source level of 178 dB re 1 uPa) together with the drilling operations for either one turbine or for two turbines concurrently. However, since the noise emissions from drilling are considerably lower than those generated during the operation of the turbines there is no discernible increase in sound levels over and above that of the operational noise of the 12 x 24MW turbines alone. Consequently, the impact ranges modelled for the operational impact of 12 x 2.4MW turbines apply also to the impact of 12 x 24MW operational turbines with drilling activity (Table 11.4).

Turbine installation with 12 x 2.4MW turbines operational - lethal injury or hearing damage

11.180 Fatal injury and temporary (TTS) or permanent changes in hearing (PTS) are not considered likely due to the low noise levels.

11.181 Hearing damage does have the potential to arise when the cumulative dosage of underwater sound builds up over a period of time. Kongsberg (2012) developed a simple 'dose' model to consider an animal entering the Inner Sound at a speed of $5ms^{-1}$, swimming due east on a constant bearing and approaching the operational turbine no closer than a distance of 1,000m. Under these conditions neither TTS nor PTS are likely to occur for either cetaceans or pinnipeds. The more precautionary TTS impact criterion proposed for harbour porpoise by Lucke *et al*. (2009) will not be exceeded either.

Turbine installation with 12 x 2.4MW turbines operational - behavioural changes

11.182 Kongsberg (2012) report that the threshold for aversive behaviour in harbour porpoise, also proposed by Lucke *et al*. (2009), is likely to be met after an exposure time of approximately 57 seconds. However, the values proposed by Lucke *et al*. (2009) have been derived from controlled experiments using impulsive airgun noise emissions, a very different noise source to that likely from operational turbines. Impulsive sound, such as that from air guns and hammered piling, is ordinarily received as loud bangs as the noise is emitted entirely over a very short period of time, to which animals may display a 'reflex' reaction, as a human might to a clap behind the head. Continuous noise, such as that likely from operation of the turbines, is not emitted in loud pulses in an ordinarily quiet environment (unlike the air guns detailed above). It seems therefore possible for the specific situation of operational turbines that these lower values (obtained from a very different type of activity) are unlikely to be particularly appropriate. As such, this threshold can be discounted, TTS concluded to be unlikely, and behavioural impact the ranges defined by the $75dB_{ht}$ and $90dB_{ht}$ values be considered.

11.183 The ranges within which these behavioural avoidance thresholds (defined by Nedwell *et al*., 2005) will be exceeded are shown in Table 11.13 and Figure 11.6).

Species group	Strong avoidance ($90dB_{ht}$)	Mild avoidance ($75dB_{ht}$)
Pinnipeds	8m	80m
Odontocetes	63m	1.3km
Mysticetes	266m	4.9km

Table 11.13: Behavioural impact ranges for species exposed to operational noise from 12 x 2.4MW turbines (this is the same as for 12 2.4MW turbines with installation of either one turbine or two turbines concurrently)

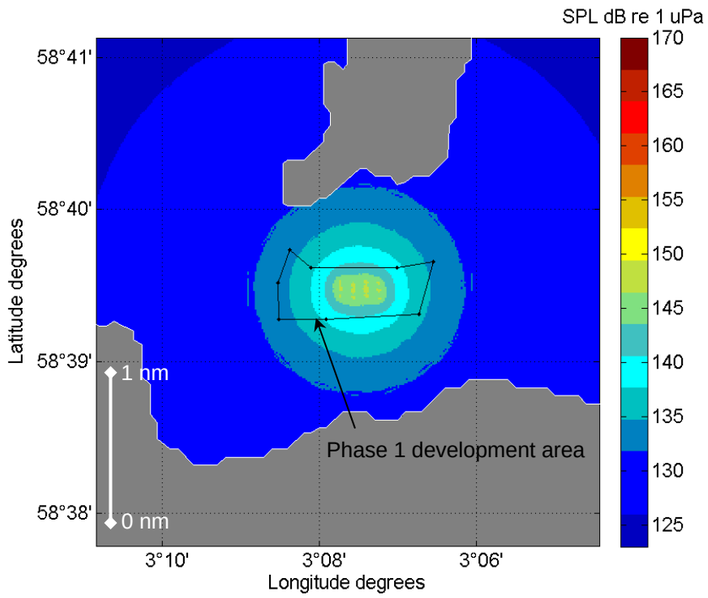

Figure 11.6: Effect of cumulative acoustic footprint for 12 x 2.4MW (this is the same as for 12 x 2.4MW turbines with installation of either one turbine or two turbines concurrently)

11.184 There is unlikely to be any impact on behaviour from 12 x 2.4MW operational turbines and drilling for either one or two turbines concurrently outwith 8m of the array for seals and 63m for odontocetes (including harbour porpoise, killer whales and Risso's dolphins). For mysticetes, this range might extend to 266m.

36 x 2.4MW turbines operational - lethal injury or hearing damage

11.185 As with installation activities and with 12 x 2.4M operational turbines, source levels for the full array of 36 x 2.4MW operational turbines are considerably below the levels at which lethal injury to species of marine mammal might occur and it is therefore unlikely that any marine animals will be killed as a consequence of the underwater noise from any of the activities associated with the Project. Similarly, neither PTS nor TTS are likely to occur in cetaceans or pinnipeds.

36 x 2.4MW turbines operational - behavioural changes

11.186 Using weighted impact criteria, that is those corrected for species hearing abilities, the area of possible impact on pinnipeds from 36 x 2.4MW operational turbine devices is expected to extend only to 38m for strong avoidance (Table 11.14, Figure 11.7). As has been noted from the baseline survey and data review, certain locations on the Inner Sound and Stroma coast are frequently utilised as seal haulouts (Figure 11.2). These impact ranges are in water and animals hauled out on land will not experience levels that are sufficiently high to cause any disturbance. If, however, animals were experiencing disturbance in the waters around the haulout then it may cause individuals to stop using that haulout. However, pinnipeds will not experience levels sufficiently high to cause strong avoidance anywhere near the haulouts as these are located above water and well beyond 38m from the turbines. The mild avoidance range may extend up to 168m from the turbine array and would also not overlap with waters around the haulouts. As the noise levels will not cause strong avoidance, the routes to the haulouts are unimpeded by noise levels and the noise will be undetectable in air, use of haulout sites throughout the Inner Sound is expected to remain unchanged.

Species group	Strong avoidance ($90dB_{ht}$)	Mild avoidance ($75dB_{ht}$)
Pinnipeds	38m	168m
Odontocetes	98m	2.9km
Mysticetes	588m	11.9km

Table 11.14: Behavioural impact ranges for species exposed to operational noise from 36 x 2.4MW operational turbines

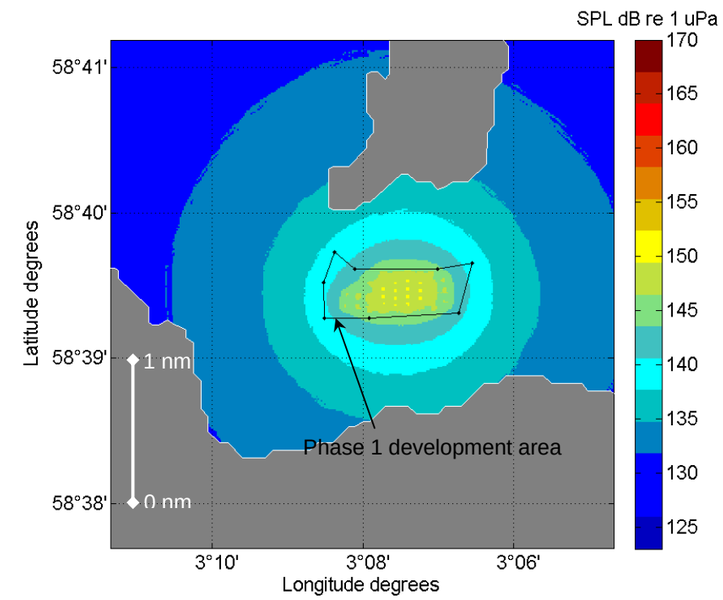

Figure 11.7: Effect of cumulative acoustic footprint for 36 x 2.4MW

11.187 When the weighted impact criteria for odontocetes are considered, strong avoidance might be expected up to 98m from the edge of the Project area (Table 11.14, Figure 11.7). For mysticetes, the strong avoidance distance is 588m (Table 11.14, Figure 11.7). As with pinnipeds, the mild avoidance behaviour extends to larger distances but it is expected to represent a detection and recognition of the noise source and not necessarily a sustained avoidance; where the noise level is this low and no injury or physical effect is manifest then the cetaceans might reasonably be expected to habituate to the noise and react no further. However, the same cannot be said for strong avoidance as for this level of noise emission, the limited available data suggest a strong avoidance reaction for most individuals experiencing that levels, to the extent that the reaction could be instinctive if sufficiently high. To that end, animals may be excluded from habitat where noise levels are sufficient to elicit strong behavioural avoidance. For pinnipeds, this could remove the tidal array area and 38m around it from use, assuming the animals did not tolerate the strong behavioural noise emissions. However, as grey seals may travel in excess of 100km and harbour seals over 20km from haulout sites to forage; the possible removal of a very small area of the Inner Sound is not considered significant.

11.188 For odontocetes (including killer whales and Risso's dolphins), the strong behavioural avoidance might be expected out to 98m from the array, removing a very small area of sea from use if these species will not tolerate the 'strong' behavioural avoidance noise emissions. A number of odontocete species are thought to use the wider area but most have been infrequently sighted in the Inner Sound and the area is unlikely to represent critical habitat for most species. The exception is for harbour porpoise which have been seen travelling, and in larger groups foraging and breaching and the area excluded area may represent a useful habitat for this species (as the rest of the Inner Sound and Pentland Firth may). Although direct evidence

is not available for UK harbour porpoise movement, tagged individuals from the Bay of Fundy, North America, covered a home range of 50,000km^2 and travelled hundreds of kilometres in a relatively short time period (Read and Westgate, 1997). In addition, evidence from genetic analysis suggests porpoises in the northeast Atlantic behaves as a 'continuous' population that widely extends over thousands of kilometres, although significant isolation by distance is seen to occur (Fontaine *et al*., 2007). Harbour porpoise sighted in Inner Sound will range widely in the Pentland Firth and Orkney Waters and likely much further as they form are part of a larger European population. Indeed, harbour porpoise density recorded within the Inner Sound from the marine mammal surveys shows that the areas of highest harbour porpoise density (Figure 11.4) are outwith the possible impact ranges (Table 11.14).

11.189 For mysticetes, much of the Inner Sound is likely to be ensonified to a level that could result in strong behavioural avoidance, such that these species may no longer use the Inner Sound (depending on the extent of the behavioural reaction). However, sightings data indicate an almost complete lack of mysticetes, with only three sightings of one minke whale in the entire 22 months of survey. As such, the possible area excluded is unlikely to be of any importance to such species and the impact likely to be very low.

11.190 It is possible to take the areas of possible impact defined by Kongsberg (2012) and determine the approximate numbers of animals likely to be present within the zones of strong behavioural influence; those numbers are shown in Table 11.15.

Species	Zone of possible impact (km^2)[16]	Density (animals/km^2)[17]	Number of individuals possibly present in zone of possible impact at one time
Pinnipeds			
Grey seal	1.35	0.699	0.94
Harbour seal	1.35	0.202	0.27
Odontocetes			
Harbour porpoise	1.68	0.202	0.34
Mysticetes			
Minke whale	5.20	0.011	0.06

Table 11.15: Approximate number of marine mammals that may be located within the 'strong avoidance' zone from 36 x 2.4MW operational turbines at any one time

11.191 It is expected that one or fewer of any species could be expected to experience strong behavioural avoidance at any one time during operation of 36 x 2.4MW turbines. Considering the regional population sizes of these species and the fact that the impact is not considered to be sufficient to interfere with vital life processes (e.g. foraging over a wide-spread area, hauling out where relevant), these numbers are likely of little concern at a population level.

11.192 Southall *et al.* (2007) present comments from Morton & Symonds (2002) and Harwood (2001) stating that in contrast to terrestrial mammals where there might not be alternative areas for the animals to move to (due to lack of connectivity between habitats), there will usually be adjacent areas for cetaceans to move to that are within the natural range of their populations, and hence compensate for the loss of, or displacement from, a particular area of habitat. This is almost certainly the case with pinnipeds as well, but it is thought that there may be a territorial element to such species use of feeding areas on the seabed. As such, an individual seal may that is excluded from an area may have to move further from the device (or noise ensonified area) to find suitable alternative feeding grounds. As noted, however, it is not considered that the Project area represents critical feeding habitat and the effect, if any, is likely to be limited to a small number of seals. The subsequent additional energy required (if any) to travel so further sites will be inconsequential at the population level.

11.193 It is interesting to note that monitoring evidence for the Strangford Loch site shows that both harbour porpoise and harbour seals are regularly sighted within areas around the turbines that the site noise modelling predicted they could be excluded from (Royal Haskoning, 2011). The impact ranges predicted for the Project are likely therefore to be worst case scenarios and the number of animals that may be affected and the range over which effects may be felt are likely to be an overestimate.

11.194 For the purposes of the noise assessments herein, it is assumed that once a marine mammal has been exposed to noise levels exceeding TTS it will leave the vicinity of the activities and not return. In order to assess the potential for this to impact upon marine mammals at a population level, the number of marine mammals deemed to have 'left' the region can be placed in context with the number of animals expected to use the region over a set period (in this case the period of the installation operations). Considering even the situation involving the swimming animal in the Inner Sound described by Kongsberg above (that is an animal that swims through the area at 5ms^{-1}), no cetaceans or pinnipeds should be exposed to TTS from the operation of the 36 x 2.4 MW turbines and thus none are expected to leave the region and no population level impacts are expected. The one exception described by Kongsberg (2012) from the modelling was that harbour porpoises could experience TTS when the lower Lucke *et al.* (2009) value is considered; as described above however, this threshold is considered too low to be realistic.

11.195 It should be noted that the threshold for aversive behaviour in harbour porpoise is likely to be met after 18 seconds exposure to the turbine noise emissions. However, as previously noted, this value is considered inappropriate for the type of turbine noise emissions and, instead, the avoidance behaviour defined by the 90dB$_{ht}$ value should be considered.

36 x 2.4MW turbines operational - noise barrier

11.196 In addition to the possibility that noise emissions could cause behavioural, or in limited cases auditory impacts, the noise emissions from the turbines could present a 'noise barrier' to movement if the levels were such that marine mammals could not (or would not) tolerate them and consequently fail to move into or through the area that they otherwise would have traversed. Noise emissions are considered sufficiently high to effect possible behavioural avoidance; if that avoidance was extreme then the animals may not enter the area of that noise level. As noted above, pinnipeds might show strong avoidance out to 38m around the turbines. As this group contains the most commonly observed species in Inner Sound (the grey seal), the noise barrier to the largest species group in the area will not extend much past the physical barrier of the turbines itself (the impact of which is assessed in Section 11.7.5). Even for odontocetes, this distance only extends to 98m around the turbines, leaving much of the Inner Sound (which is approximately 2 - 3km wide) available for through transit without possibility of noise-induced impact. Less of the Inner Sound would be available for minke whale and other mysticetes, but only three sightings of such species were made in 22 months of surveys and the Inner Sound does not therefore appear to represent an important, or even frequently used, passage.

11.197 Pinnipeds could choose to 'break through' the noise barrier to get to an area beyond; depending on the noise emissions and the time taken to pass through the area of increased noise, it is possible that injury could be expected. The 'dose' model described above shows that pinnipeds would not be expected to experience any impacts of noise regardless of the length of time which they spend submerged within the area (which extends only 38m around the edge of the turbine area).

11.198 For odontocetes, including the second most commonly sighted marine mammal the harbour porpoise, strong avoidance might be expected out to 98m from the turbine. If the strong avoidance means that the animals will not enter an area that is ensonified as such, this could present a noise barrier in the centre of the Inner Sound (representing the tidal turbine area and a 98m buffer around it) for all species of dolphin and for harbour porpoise (Table 11.14). Harbour porpoise are shown to use the north west of the 2 - 3km wide Inner Sound more than other areas. The establishment of a noise barrier in the middle of the Inner Sound of strong avoidance would not stop animals entering the Inner Sound from any direction using the most frequently visited area. In addition, animals could choose to 'break through' what noise barrier might exist to get to an area beyond; considering the noise emissions, the 'dose' model described above shows that injury would not be expected when passing through the noise 'barrier'.

[16] The zone of possible impact is based on a project area of 1.1km^2 in which avoidance is expected, plus a buffer round the project area which reflects the distances detailed in Table 11.14.

[17] Note that for harbour porpoise and grey seal this has been generated from site specific sightings and that this density is the maximum monthly density recorded and thus represents a worst case scenario for mammals impacted. For the remaining species, sightings were so low that density could not be estimated and thus regional values have been used. They are consequently higher than would be expected for Inner Sound and thus also represent a worst case scenario.

11.199 For mysticetes (including the minke whale) this barrier of strong avoidance could extend up to 588m out from the tidal turbine area (Table 11.14), far from forming a noise barrier across the 2 - 3km wide Inner Sound. This species group is not expected to use the area with any regularity (three sightings in two years of survey suggests the Inner Sound does not comprise important habitat for this species) and the actual presence of the noise barrier is unlikely to affect regional area use for mysticetes in general. Mysticetes could choose to 'break through' the noise barrier to get to an area beyond and, depending on the noise emissions and the time taken to pass through the area of increased noise, it is possible that injury could be expected. However, the 'dose' model described above shows that this is not the case for any mysticete.

11.200 Evidence defining barrier effects, or lack of such effects, from tidal turbines is currently not available as a result of the novel nature of tidal arrays. However, the SeaGen tidal turbine in the narrows of Strangford Lough, Northern Ireland, is an example of an individual turbine for which such information is becoming available. The turbine itself (comprising twin 16m diameter rotors) sits in the centre of a narrow tidal channel, a water body that is regularly traversed by a number of marine mammals, including harbour seals and harbour porpoise. SMRU Ltd conducted a tagging deployment on harbour seals within Strangford Lough to provide a description of the movements of the seals in relation to the Strangford Lough Narrows and wider coastline. Seal tracks were used to assess the extent to which movements have changed during the pre- and post-installation phases of the SeaGen project (Royal Haskoning, 2010). The tracks showed a large amount of individual variability, with some individuals remaining within the Lough and Narrows and others making long journeys to and from the Lough; although it is likely the case that animals will avoid the area of the turbine itself, the results indicate that there is no barrier effect as a result of SeaGen presence or operation for seals (Royal Haskoning, 2010). For harbour porpoise, acoustic loggers were deployed around Strangford Lough; although there were fewer detections of harbour porpoise during operation, there appears to be no difference in harbour porpoise detections north or south of the turbine, indicating that for this species the SeaGen device does not present a barrier to movement for this species either (Royal Haskoning, 2010). Although the specifics of the MeyGen project described herein differ from the SeaGen project, the results of the SeaGen monitoring programme seem to support the conclusion drawn above for the Project that the introduction of tidal turbines does not necessarily represent a barrier to movement between foraging, haulout or other important sites.

11.201 The marine mammal species that may be found at the site meet many of the criteria for medium sensitivity of receptor (e.g. some species are listed on Annex II of the EU Habitats Directive or are listed as EPS) and the sensitivity of receptor is therefore ranked as medium. However, as the noise levels are relatively low, are not considered loud enough to cause injury or mortality and the ranges for behavioural reactions are small compared to the likely range of most species, any impacts are likely to be limited in extent. Therefore, the magnitude of impact is considered to be minor.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Medium	Minor	Minor	Not significant

MITIGATION IN RELATION TO IMPACT 11.7
▪ Although no specific mitigation measures are proposed. Operational monitoring will be implemented in order to confirm the impact predications made here (see Section 11.12).

11.7.2 Impact 11.8: Maintenance noise

11.202 The main impact of maintenance activities is likely to extend to the noise emissions from the vessels involved in those activities. Taking a worst case scenario, the vessels would be the same as those used in the installation operations. The source (or noise) level would be below that at which lethal injury to species of marine mammal might occur, no marine mammals will be killed as a consequence of this underwater noise.

11.203 In this assessment, it has been assumed that once an animal experiences a temporary change in hearing (TTS) then the animal will leave to area. TTS is, however, not expected to occur from maintenance operations (e.g. vessel use), no animals are expected to leave the region and thus no population level impacts are expected because of this.

11.204 This vessel noise could remain audible out to ranges of 1 - 14km depending on the prevailing levels of background noise. However, source (or noise) levels associated with the vessels are below the levels at which hearing damage might occur. Maximum ranges for strong behavioural impact would be less than 1m for pinnipeds and odontocetes and less than 56m for mysticetes.

11.205 As undertaken for the installation operations, the number of animals that may experience noise levels above thresholds at which negative impact may be experienced can be calculated. As with the installation operations, however, the zones of possible impact are so small and the local/regional density estimates so low that no animals are expected to be in those zones on most occasions.

11.206 Note also that maintenance noise will generally only occur around slack water as this is when it is possible to remove the turbines. There will not therefore be vessels in the area during the fastest flowing stages of the tidal cycle, which is when turbine noise emissions will be at their are highest, and there will be therefore be reduced likelihood of any possible cumulative effect from these two noise sources.

11.207 The marine mammal species that may be found at the site meet many of the criteria for medium sensitivity of receptor (e.g. some species are listed on Annex II of the EU Habitats Directive or are listed as EPS) and the sensitivity of receptor is therefore ranked as medium. However, as the noise levels will be limited in spatial extent (an absolute maximum of 56m from vessels for even the most sensitive species) and will occur only during the installation period, the magnitude of impact is considered to be negligible.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Medium	Negligible	Negligible	Not significant

MITIGATION IN RELATION TO IMPACT 11.8
▪ No mitigation measures proposed as no significant impact predicted

11.7.3 Impact 11.9: Ship strike (maintenance vessels) and ducted propellers

11.208 Increased vessel traffic has been identified as presenting an increased risk to marine mammals, through collision between vessel and animal and through possible interaction between ducted propellers and individual animals.

11.209 Vessels associated with the maintenance activities are planned to be on-site for minor maintenance once every two years per turbine and for major maintenance once every 10 years per turbine. Unplanned maintenance may be required between these times. These vessels will be slow travelling when moving to the turbines and extremely slow or stationary when engaged in the maintenance activities. As such, these vessels are much less likely to cause death or injury through collision than commercial shipping activity.

11.210 However, the possibility that seals are interacting with ducted propellers has been raised and, as with the installation activities, MeyGen will apply appropriate mitigation, as deemed necessary in consultation with Marine Scotland and SNH, should they use vessels with ducted propellers.

11.211 As noted in Section 11.6.2 for installation vessels, the possible impact from the use of ducted propellers is currently difficult to quantify and it is necessary to take a precautionary view of the impact when assigning

magnitude levels. Using the same logic described in Section 11.6.2, the pre-mitigation magnitude has been assigned a higher ranking due to the uncertainty surrounding the possible impact.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Medium	Moderate	Moderate	Significant

MITIGATION IN RELATION TO IMPACT 11.9
▪ It is understood that investigation is ongoing on the potential link between spiral injuries in seals and ducted propellers and that mitigation measures relevant to minimising the risk of seal spiral injuries and fatalities are currently being developed at an industry and regulator level. MeyGen commit to undertaking frequent reviews of the literature regarding this topic and to regularly discuss advances in understanding of this topic with relevant regulatory and advisory bodies. MeyGen will apply appropriate mitigation, as deemed necessary in consultation with Marine Scotland and SNH, should vessels with ducted propellers be used, to avoid any significant impact.

Residual impact

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Medium	Minor	Minor	Not significant

11.7.4 Impact 11.10: Turbine collision

11.212 Risk of collision between a moving turbine blade and a marine mammal is thought to be a key potential effect of tidal turbine operation and it is considered that all species of marine mammals that use the Project area are at some risk of collision impact, which could ultimately result in death or injury. Whilst a distinction can be drawn between species that forage in the water column or at the seabed (a distinction which is made in the modelling below), they all must return to the surface to breathe and so regularly transit the water column.

11.213 A number of factors including the visibility, audibility, dimensions and rotation speed of the turbine blades, how important the location is for feeding or breeding and the extent of long range avoidance and close range evasion all interact to determine the likelihood of collision.

11.214 To support the Scottish Marine Renewables SEA Wilson *et al*. (2007) were commissioned to investigate collision risk between marine renewable energy devices and marine mammals. The study identified that:

- Collision risks are not well understood for any marine vertebrates;
- Man-made collision risks are more diverse and common than generally supposed (the rate of whale–ship strikes is a significant example);
- Underwater collision risks typically become well studied after they have become a conservation concern;
- Animals may appear to behave illogically when faced with novel situations;
- Subtleties of gear design (shape, colour etc.) as well as environmental conditions (turbidity, flow rate etc.) can markedly change collision rates;
- Objects in the water column will naturally attract fish and consequently their predators (e.g. marine mammals);
- The proximity and relative orientation to other objects will impact escape options and the combined collision risk while topography will impact escape options and animal approach angles;
- Collision risk will vary with age of the animal, with juveniles likely to be more at risk than adults because of reduced abilities or experience; and
- The potential for animals to escape collisions with marine renewable devices will depend on their body size, social behaviour, foraging tactics, curiosity, habitat use, underwater agility and sensory capabilities.

11.215 Collision risk can be assessed qualitatively by considering the behaviour and abundance of animals at risk in the location that devices are to be deployed. However, in order to make a more quantitative assessment, a collision risk model is required. It has not been possible, for this project or for any other tidal projects thus far, to develop a collision risk model because there is not sufficient information on the far-field or near-field behavioural responses of marine mammals to tidal turbines to enable a robust quantification of potential strike rates.

11.216 Since collision risk can be thought of as a function of encounter rate and the probabilities of marine mammal avoidance and evasion, modelling of encounter rates was considered an appropriate substitute to inform this EIA. MeyGen therefore commissioned SRSL to model marine mammal encounter rates (SRSL, 2012). This approach has previously been used to inform assessment in the Skerries Tidal Stream Array EIA. It was also presented as a proposed EIA approach in the Scottish Marine Renewables SEA (Scottish Executive, 2007). The approach also follows similar principles to those presented to ICES on seals by Davies and Thompson (2011).

11.217 For the species most likely to be recorded in the Project area, the number of animals likely to encounter each turbine each year has been calculated (Table 11.16). In consultation with Marine Scotland and SNH it was agreed to focus on four key marine mammal species; harbour porpoise, minke whale and the grey and harbour seals. For the two other cetacean species sighted during baseline surveys (killer whale and Risso's dolphin; see Section 11.5), sightings rates were extremely low and actual densities are likely to be much lower than for any of the species considered in the modelling. Encounter rates would also therefore be much lower. In addition, SAMS (pers. comm.) note that the unpredictable, transitory and occasionally extremely coastal behaviour exhibited by killer whales (for example, during seal hunting) takes encounter modelling beyond plausibility.

Encounter model

11.218 The details of how the encounter model was set up and the inputs used are given in Section 11.4.2 and in SRSL (2012) provided on the supporting studies CD.

11.219 Due to current uncertainty on exact turbine design, the encounter modelling was conducted to cover a range of turbine scenarios, including a turbine with two or three blades that exhibited an 18 or 20m rotor diameter. This allowed testing of the assumptions regarding which of these parameters was worst case (as shown in Table 11.1) to ensure that the worst case encounter rates are described herein. SRSL (2012) report that the dive types of seals differ between feeding and travelling events to the extent that encounter risk is likely to be very different. Whilst both dive types have been modelled for grey seals, evidence obtained for harbour seal dives in the Inner Sound (from SMRU Ltd) shows that dives most closely resemble the feeding dives and thus only this type of dive has been modelled for this species. Variable dive types are not considered to occur for the cetacean species of interest and thus only one dive type has been modelled.

Encounter probability and population effects

11.220 The model described above provides an output of encounter rate in terms of number of animals likely to encounter one turbine each year. However, the Project will see up to a maximum of 86 turbines installed over a 3 year period (maximum of ten turbines by the end of year one, maximum of 20 turbines by the end of year two). The number of encounters per turbine per year has therefore been multiplied by ten, 20 and 86 to provide an indicative encounter rate for the different stages of the array, on the assumption that the encounter rate increases linearly.

11.221 The results derived from the model and the inputs described above are shown in Table 11.16. The red highlighted cells represent the worst case encounter modelling results that have been taken forward for further assessment. Overall, encounter rates were higher for the three-bladed turbine than the two-bladed version. This is due to encounter rate being dependent on both relative velocity of turbine blade and animal and also the effective encounter radius. For all species considered, the turbine blade component of encounter radius is greater than that contributed by the animal itself. Although mean blade velocity will be lower for the three-bladed configuration, this is not sufficient to fully compensate for the greater encounter radius added by the extra blade. It must be stressed that this greater encounter rate for the three-bladed device may not carry through to a greater risk of collision because a two bladed device will present different sensory cues to an approaching animal than a three-bladed turbine, particularly in terms of fewer cues at close range. The lower velocities of the three bladed versions are also likely to result in more encounters being evaded. Encounter rates also varied between the 20m and 18m versions with differences between species due to their differing depth distribution behaviour which determines density per cubic metre within the depth range swept by the turbine blades.

Rotor diameter (m)	Number of blades	Animal density data source	Vertical distribution of animal in water column	Encounter rate (animals per year)	
Harbour seal				**Density from project specific survey data**	**Density estimate from HO counts**
18	2	Project specific survey Haul out counts	SMRU dive data	4.8	5.7
18	3	Project specific survey Haul out counts	SMRU dive data	**6.5**	**7.8**
20	2	Project specific survey Haul out counts	SMRU dive data	4.8	5.7
20	3	Project specific survey Haul out counts	SMRU dive data	6.5	7.7
Grey seal				**Density from project specific survey data**	**Upper 95% CI from project specific survey data**
18	2	Project specific survey	Non-random U dive	3.7	11.4
18	2	Project specific survey	Non-random V dive	16	49.6
18	3	Project specific survey	Non-random U dive	5.1	15.7
18	3	Project specific survey	Non-random V dive	22.1	68.3
20	2	Project specific survey	Non-random U dive	4.0	12.3
20	2	Project specific survey	Non-random V dive	16.2	50.1
20	3	Project specific survey	Non-random U dive	**5.4**	**16.8**
20	3	Project specific survey	Non-random V dive	**22.1**	**68.4**
Harbour porpoise				**Density from project specific survey data**	**Upper 95% CI from project specific survey data**
18	2	Project specific survey	Non-random	3.5	6.6
18	3	Project specific survey	Non-random	4.8	9.3
20	2	Project specific survey	Non-random	3.6	6.8
20	3	Project specific survey	Non-random	**4.9**	**9.4**
Minke whale				**SCANS II data**	
18	2	SCANS II	Random	2.9	
18	3	SCANS II	Random	**4.1**	
20	2	SCANS II	Random	2.9	
20	3	SCANS II	Random	3.9	

Table 11.16: Number of animals that may encounter a single turbine's blades (detail of modelling scenarios available in SRSL, 2012)

11.222 It is clear from the encounter modelling that numerous animals from each species type are likely to encounter turbines in the array each year. The extent to which this may impact on the regional population is not immediately clear, however, since encounter models do not predict the outcome of an encounter (i.e. injury or mortality); an encounter may lead to a collision but only if the animal in question does not take appropriate avoidance or evasive action. As they are highly mobile underwater, marine mammals have the capacity to avoid and evade marine turbine devices provided they have the ability to detect the objects, perceive them as a threat and then take appropriate action at long or short range (Gordon *et al*., 2011). Since there is no information on the degree to which marine mammals will actually make appropriate manoeuvres (Wilson *et al*., 2007), predicted encounter rates must be very carefully interpreted as a worst case scenario.

11.223 The affect that avoidance and evasion will have on the estimated encounter rate (shown in Table 11.16) can be investigated by applying a range of avoidance estimates ranging from 50 to 100%; the outcome of the application of these values is shown in Table 11.17, which shows a scaling up of encounter rate from one turbine to the 10, 20 and 86 turbine scenarios that represent the three phases of the Project. As well as providing an estimate of the percentage of the regional population that might be affected, it provides an estimate of the levels of avoidance that would be required to ensure that the PBR for grey and harbour seals would not be breached (the orange shaded cells in the table indicate where PBR numbers could be breached).

		Density data from Project specific data (except minke whale as sightings rate too low)						Other species density estimate (harbour seal haul out estimate, harbour porpoise and grey seal upper 95% CI from Project survey)					
Species	**Avoidance Rate**[18]	**10 turbines**		**20 turbines**		**86 turbines**		**10 turbines**		**20 turbines**		**86 turbines**	
		Encounter rate	% of Regional Population	Encounter rate	% of Regional Population	Encounter rate	% of Regional Population	Encounter rate	% of Regional Population	Encounter rate	% of Regional Population	Encounter rate	% of Regional Population
Harbour porpoise	50	25	0.04	49	0.09	211	0.38	47	0.09	94	0.17	404	0.73
	75	12	0.02	25	0.04	105	0.19	24	0.04	47	0.09	202	0.37
	80	10	0.02	20	0.04	84	0.15	19	0.03	38	0.07	162	0.29
	90	5	0.01	10	0.02	42	0.08	9	0.02	19	0.03	81	0.15
	95	2	0.00	5	0.01	21	0.04	5	0.01	9	0.02	40	0.07
	98	1	0.00	2	0.00	8	0.02	2	0.00	4	0.01	16	0.03
	99	0	0.00	1	0.00	4	0.01	1	0.00	2	0.00	8	0.01
	99.5	0	0.00	0	0.00	2	0.00	0	0.00	1	0.00	4	0.01
	100	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00

[18] Includes both far-field avoidance and near-field evasion.

Species	Avoidance Rate[18]	Density data from Project specific data (except minke whale as sightings rate too low)						Other species density estimate (harbour seal haul out estimate, harbour porpoise and grey seal upper 95% CI from Project survey)					
		10 turbines		20 turbines		86 turbines		10 turbines		20 turbines		86 turbines	
		Encounter rate	% of Regional Population	Encounter rate	% of Regional Population	Encounter rate	% of Regional Population	Encounter rate	% of Regional Population	Encounter rate	% of Regional Population	Encounter rate	% of Regional Population
Minke whale	50							21	0.11	41	0.22	176	0.95
	75							10	0.06	21	0.11	88	0.47
	80							8	0.04	16	0.09	71	0.38
	90							4	0.02	8	0.04	35	0.19
	95							2	0.01	4	0.02	18	0.09
	98							1	0.00	2	0.01	7	0.04
	99							0	0.00	1	0.00	4	0.02
	99.5							0	0.00	0	0.00	2	0.01
	100							0	0.00	0	0.00	0	0.00
Grey seal feeding	50	27	0.17	54	0.34	232	1.45	84	0.53	168	1.05	722	4.52
	75	14	0.08	27	0.17	116	0.73	42	0.26	84	0.53	361	2.26
	80	11	0.07	22	0.14	93	0.58	34	0.21	67	0.42	289	1.81
	90	5	0.03	11	0.07	46	0.29	17	0.11	34	0.21	144	0.90
	95	3	0.02	5	0.03	23	0.15	8	0.05	17	0.11	72	0.45
	98	1	0.01	2	0.01	9	0.06	3	0.02	7	0.04	29	0.18
	99	1	0.00	1	0.01	5	0.03	2	0.01	3	0.02	14	0.09
	99.5	0	0.00	1	0.00	2	0.01	1	0.01	2	0.01	7	0.05
	100	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Grey seal travelling	50	111	0.69	221	1.38	950	5.95	342	2.14	684	4.28	2941	18.41
	75	55	0.35	111	0.69	475	2.97	171	1.07	342	2.14	1471	9.21
	80	44	0.28	88	0.55	380	2.38	137	0.86	274	1.71	1176	7.36
	90	22	0.14	44	0.28	190	1.19	68	0.43	137	0.86	588	3.68
	95	11	0.07	22	0.14	95	0.59	34	0.21	68	0.43	294	1.84
	98	4	0.03	9	0.06	38	0.24	14	0.09	27	0.17	118	0.74
	99	2	0.01	4	0.03	19	0.12	7	0.04	14	0.09	59	0.37
	99.5	1	0.01	2	0.01	10	0.06	3	0.02	7	0.04	29	0.18
	100	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Harbour seal	50	33	1.09	65	2.18	280	9.38	39	1.31	78	2.62	335	11.26
	75	16	0.55	33	1.09	140	4.69	20	0.65	39	1.31	168	5.63
	80	13	0.44	26	0.87	112	3.75	16	0.52	31	1.05	134	4.50
	90	7	0.22	13	0.44	56	1.88	8	0.26	16	0.52	67	2.25
	95	3	0.11	7	0.22	28	0.94	4	0.13	8	0.26	34	1.13
	98	1	0.04	3	0.09	11	0.38	2	0.05	3	0.10	13	0.45
	99	1	0.02	1	0.04	6	0.19	1	0.03	2	0.05	7	0.23
	99.5	0	0.01	1	0.02	3	0.09	0	0.01	1	0.03	3	0.11
	100	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00

Table 11.17: Number of animals that may encounter the blades of the turbines based on a range of possible avoidance rates (orange highlights show where the PBR is exceeded).

Avoidance and evasion

11.224 What the encounter rates and evidence of avoidance capability means to the actual risk of collision can be explored by studying avoidance (medium to long range aversion to the presence of turbines) and evasion (short range avoidance of turbine components). Wilson *et al*. (2007) report that responses to the tidal devices are likely to occur on two spatial scales; at long range the marine mammals have the option to avoid the area of device placement (i.e. swim around) and at closer range they can evade the particular structures (i.e. dodge or swerve). Little is known yet about behavioural reactions but detection distances can be determined (Wilson *et al*., 2007). Given the audibility of the operating turbines described in Section 11.6, it is likely that marine mammals will be able to detect the turbines at various ranges, out to approximately 14km in some cases. Marine mammals are thus likely to be able to recognise the presence of the stationary noise source (the turbine) and will have time on any approach to this noise source to ready an avoidance response. Similarly, the noise propagation modelling suggests that there may be strong behavioural reactions by marine mammals around the turbines themselves which may lead to the marine mammals swimming away or around the turbines themselves, further limiting the likelihood of encounter.

11.225 Where marine mammals do not take avoidance measures at longer ranges, they are likely to come close to the turbine devices. In terms of reactions on approaching the blades, marine mammals ordinarily encounter obstacles in the water column and are clearly adept at dodging or swerving those obstacles, whether they are stationary such as the seabed or moving like predators. In daytime and clear waters, underwater structures may be visible at ranges of tens of meters underwater, and hence give sufficient warning for visual species to exhibit avoidance and evasion if necessary (Wilson *et al*., 2007). Note also that collision risk is expected to be greater for turbines deployed in regions of moderate to high turbidity, or if the turbines increase turbidity, because of reduced visibility (Scottish Executive, 2007), but it is known that the water column in the Project area does not hold a high sediment content and it is not likely that the turbines will resuspend any sediment themselves (see Section 9).

Examples of avoidance and evasion

11.226 Some understanding of how marine mammals react around these devices may be derived from existing tidal developments. For example, the Environmental Monitoring Programme (EMP) for the SeaGen tidal device in Strangford Lough has involved the assessment of all seal carcasses found in the lough and in post mortem none have shown signs of interaction with the SeaGen turbine, suggesting an absence of recurring fatal encounters between seals and the tidal turbine (Royal Haskoning, 2011).

11.227 Data from telemetry and acoustic studies in Strangford Lough suggest that there may be a degree of local avoidance by marine mammals of operating turbines, though no reduction in overall seal or harbour

porpoise transit rates through the narrows in which the turbine is located (Royal Haskoning, 2011). For example, there was evidence of a redistribution of harbour seals during turbine operation over approximately 250m around the turbine. Although Royal Haskoning (2011) suggest that this is probably of little biological significance, it indicates that harbour seals may well be detecting the presence of the turbine and responding to it to ensure no collision. Royal Haskoning (2011) state that this pattern of avoidance was similar regardless of whether the turbine was operating or not operating, suggesting that it was not a direct result of noise produced by the operating turbine, nor necessarily related to moving turbine rotors, and instead may have been due to the presence of the structure, or, importantly from a collision perspective, a learned "habit" of avoidance.

11.228 Interestingly, monitoring of the SeaGen device showed that seals transited at a relatively higher rate during periods of slack tide. As Royal Haskoning (2011) note in the EMP, this would clearly have the effect of reducing collision risk if seals were preferentially transiting during periods when the turbine was not operating.

11.229 As part of the deployment of a single TGL tidal device at the Falls of Warness EMEC test site in Orkney, TGL placed strain gauges in the blades of the turbine to monitor impact between objects in the water column and the device, with the main aim being to determine whether marine mammals had made contact with the device (TGL, 2011). The monitoring and extensive processing and post-processing analysis of data collected during a nine day monitoring period across a range of tidal states showed no evidence of any marine mammal impact on the blades of the device (TGL, 2011). Concurrent with the analysis, there were no reported sightings of injured or dead marine mammals in the locality of the turbine test site (TGL, 2011).

Multiple turbines

11.230 In addition to the current uncertainty on marine mammal behaviour around these types of renewable devices, it is also not currently understood how the reaction of a marine mammal to one turbine affects the encounter rate for other/multiple turbines. When the animals are at long range, multiple devices will provide a larger target and more cues for animals to avoid but they also act as a larger combined area that will need to be avoided (Gordon *et al.*, 2011). As the distance at which an animal may respond gets larger than the immediate vicinity of a turbine, avoidance behaviour will become possible and the number of turbines an animal might encounter when transiting is likely to fall. For example, once the range of response exceeds half the distance between two adjacent turbines then an animal will have the possibility of skirting around the outside of an array without actually entering it. This would be analogous to a person approaching a forest in fog. If there is enough visibility to see two trees at once then it's possible to work around the forest without entering it. If avoidance operates for marine vertebrates at such scales then encounter rates are likely to scale more to the number of turbines at the perimeter approached, rather than the entire array.

11.231 If animals do not avoid turbines at long range and turbine separation distance is greater than the animals are able to detect, at close range multiple devices could produce a more complex set of cues for approaching animals and increase the collision risk (Gordon *et al*., 2011). The tactics taken to minimise contact with one device could lead to greater likelihood of contact between the animal and another device, or could instead guide the animal away from the array (Gordon *et al*., 2011). However, the noise modelling suggests that animals will be able to detect the turbines at much greater than the turbine separation distance and multiple devices therefore seem most likely to produce greater cues at long range, raising the prospect of bringing about a reduction in the number of animals coming into close proximity to the turbines.

Implication of an encounter

11.232 In spite of these uncertainties, what is clear from the application of a range of possible avoidance rates is that some marine mammals are likely to encounter the turbine blades. What is unclear is the extent to which an encounter translates into injury or death. Wilson *et al*. (2007) comment that the effect may range from minor injuries such as abrasions to temporary or permanent debilitation (internal injuries, surface wounds, damage to delicate organs such as eyes) to more significant injuries (major cuts, amputations or internal trauma). In terms of minor collisions, the skin of a seal is considerably more resistant to abrasion than that of cetaceans. Depending on severity and bodily location these injuries may result in recoverable injury, long-term debilitation, delayed or instant mortality (Wilson *et al*., 2007). Injury is likely to be much more common than instant mortality since marine mammals are relatively robust to potential strikes as a result of the thick layer of blubber that protects defend the vital organs. However evidence from ship strikes suggests that for impacts with large objects, a blubber layer is insufficient to provide adequate protection (Laist *et al*., 2001).

Worst case assumptions

11.233 In summary, it is likely that the encounter rates predicted are likely to be an overestimate of the real encounter rate since:

- The worst case Project parameters have been used as inputs to the model;
- Density estimates for some of the species are likely to be overestimates;
- Monitoring evidence for other devices suggests a high degree of avoidance of tidal devices;
- Noise modelling shows the devices are likely to be audible over a number of kilometres, increasing the likelihood of early detection by mammals;
- Linear scaling up from one turbine to multiple turbines is likely to give an overestimate of encounter rates; and
- The differing nature of the types of movement through the water column by marine mammals (e.g. feeding dives involve a lot of time at the seabed whilst travelling dives involve less time) means that how the area is used will affect, to an extent, the encounter rate. For example for seals since feeding dives involve more time at the seabed, encounter rate is reduced as the blades are positioned further up in the water column. In contrast to the assessment of exclusion of seals from an area where the impact is greater in areas used for feeding, the impact of the turbines with respect to collision risk will be less in areas where feeding dives are more common than travelling dives. For grey seals, this species was observed feeding in the area and the true average possible encounter rate is likely to be somewhere between the encounter rates for the feeding and travelling dives, with each trip having a likelihood of encounter that depends on the purpose of that trip, or, on an even finer scale, of that dive.

11.234 In order to help the interpretation of the encounter modelling results and understand how best to apply the Scottish Government Survey, Deploy and Monitor Policy with respect to the marine mammal collision impacts, impact assessment results have been presented for the for years one, two and three.

Cetaceans

11.235 Considering the above, it is likely that avoidance rates will be at the upper end of the scale described in Table 11.17. For harbour porpoise, this means that less than 0.10% of the regional population would encounter the turbines annually and a smaller portion yet actually seriously injured or killed by the collision. For minke whales, less than around 0.20% would encounter the turbines and fewer still actually be injured or killed. The population level effects for these species are likely therefore to be inconsequential.

Pinnipeds

11.236 For grey seals, the numbers possibly encountering the device at the higher avoidance rates are sufficiently low in all cases that the PBR (959 grey seals; Scottish Government, 2012) will not be reached and population effects are not expected, especially when it is considered that the encounter rate, even with the avoidance factored in, does not represent serious injury or fatality in all cases. Note for grey seals that all Scottish regional grey seal populations have shown prolonged growth and some have now stabilised, and the seals are highly mobile between populations, such that the importance of the sub populations themselves is likely reduced (Scottish Government, 2011).

11.237 For harbour seals, the number that could possibly encounter the devices is approximately one quarter of that predicted for grey seals. The Orkney and North Scotland harbour seal population is much smaller than the grey seal population and these numbers are consequently closer to the PBR (18 animals;

Scottish Government, 2012). However, for higher avoidance rates (74%, 87% and 97% for ten turbines, 20 turbines and 86 turbines respectively), the number of animals that might be impacted is still below the PBR.

Impact rankings

11.238 For harbour porpoise, minke whale and grey seal, the number possibly encountering the turbines is relatively low, but the uncertainty regarding the extent of the impact is such that the ease with which assessment rankings can be assigned is less than for other, better understood impacts. To ensure that the possible impact is appropriately captured in light of the lack of available data, and in line with the precautionary approach, it is considered that the rankings should be set artificially high. To that end, a lower value of 90% will be assumed for avoidance, even though the available evidence described herein suggests it will be higher. For harbour seals, the numbers potentially affected are sufficiently close to the PBR to warrant an increased ranking relative to the other species groups. As such, they are presented in the impact table below as a separate entry.

11.239 The marine mammal species that may be found at the site meet many of the criteria for medium sensitivity of receptor (e.g. some species are listed on Annex II of the EU Habitats Directive or are listed as EPS) and the sensitivity of receptor is therefore ranked as medium. However, as the percentage of the regional population that might be affected is so small for harbour porpoise, minke whale and grey seal, the magnitude of impact is considered to be minor. For grey seals, it is also seen that the PBR will not be reached for anything other than very low avoidance. For the harbour seal, the majority, or even large minority, of the population is similarly not expected to be affected. However, the PBR level (at which population level effects may start to occur) may be breached if avoidance was to fall below 97% (and all encounters resulted in death) for 86 turbines and therefore a magnitude of major has been assigned (see Table 11.6 for magnitude definitions).

Impact significance

Scenario	Sensitivity of harbour porpoise, minke whale and grey seal	Magnitude of impact	Consequence	Significance
10 Turbines	Medium	Minor	Minor	Not Significant
20 Turbines	Medium	Minor	Minor	Not Significant
86 Turbines	Medium	Minor	Minor	Not Significant

Scenario	Sensitivity of harbour seal	Magnitude of impact	Consequence	Significance
10 turbines	Medium	Minor	Minor	Not Significant
20 Turbines	Medium	Minor	Minor	Not Significant
86 Turbines	Medium	Major	Major	Significant

MITIGATION IN RELATION TO IMPACT 11.10

- Based on extreme worst case modelling, the results presented above indicate that significant impacts are not expected on any species other than harbour seal. And that even then, significant impacts will be potentially linked to the larger array rather than intimal smaller array deployment. MeyGen therefore propose in line with the Scottish Government Survey, Deploy and Monitor Policy that the monitoring of the deployments in years one and two will allow for a better definition of avoidance rates and to better understand the possible impact of the full 86 turbine array. It will also inform the potential requirement for future mitigation and ensure no significant impacts on marine mammals.

Residual impact

Sensitivity of harbour seal	Magnitude of impact for 86 turbines	Consequence for 86 turbines	Significance for 86 turbines
Medium	Minor	Minor	Not Significant

11.7.5 Impact 11.11: Physical barrier to movement

11.240 There exists the potential for tidal arrays to form a barrier to the usual transit patterns of marine mammals through an area to waters far beyond or to access feeding/breeding grounds, either because of a physical barrier (which will stop animals passing by) or perceptions of devices or maintenance activities (if there is some innate response by the mammals to move away from vessels or structures). This is particularly relevant in a constrained area such as the Inner Sound.

11.241 Where marine mammals perceive an area as unavailable (for whatever reason) and do not then make use of that area, the animals can be considered as having been excluded from marine foraging/breeding habitats or, in the case of seals, terrestrial breeding/moulting habitats. Whilst it is considered likely that alternative foraging and breeding areas will generally be available to marine mammal species, there is a potential for devices to limit access to key areas (such as feeding hotspots), either because the devices themselves are located in such areas or because they present a perceived barrier which prevents access to such hotspots beyond. There are no marine mammals known to use the Inner Sound during specific migrations, and animals engaged in local movements as part of foraging, breeding and other life tasks will be the most likely receptors of any impact. Where species may be interchanging between populations over a larger scale (for example, bottlenose dolphins may move between the Moray Firth population and the Scottish west coast population; Robinson *et al*., 2009) then it is highly likely that they would use the wider Pentland Firth during these movements in addition to Inner Sound (if they do in fact use Inner Sound at all).

11.242 The turbines may present a barrier via two mechanisms; the physical barrier that the turbines themselves represent and the noise barrier that the any acoustic emissions might erect. The noise barrier has been described in Section 11.7.1. As the noise emissions extend out from the array, the possible barrier erected by the noise emissions is inherently larger than that possibly presented by the physical presence of the turbines (although it by no means constitutes a barrier across the whole of the Inner Sound). However, the physical barrier presented by the turbines can be considered the minimum barrier that the tidal array will present, but it may also represent the actual extent of the barrier if the noise emissions do not actually represent an increased barrier size (see Section 11.7.1 for discussion).

11.243 The extent to which this physical barrier will impact on marine mammals in the area will depend to a degree on the footprint of the project relative to remaining sea space in the Inner Sound (i.e. can animals pass round either side of the turbine or array noise) but also to the marine mammals' use of the area. Where the noise barrier assumes that the entire depth of the water column is unavailable in the areas where noise is above a certain level, the physical barrier extends only to the dimensions of the turbine blades as marine mammals could pass above, below or round those blades.

11.244 In terms of the physical barrier, each turbine presents an obstacle in the vertical plane, in that the marine mammals will be unable (or unwilling) to pass through the swept area of the turbine blade. As a worst case assumption, the turbine blades will have a radius of 20m which represents an area of approximately 314m^2 per turbine. The widest row of turbines will comprise 11 turbines and provide the greatest 'barrier area' of any of the rows of turbines. This row will present a swept area of approximately 3,454m^2 and it is this area that marine mammals are assumed to be unable to pass through. In the context of the vertical area available across the Inner Sound, the turbines present a barrier of approximately 8% of the area. Compared to that across the Pentland Firth as a whole, the turbines present a barrier of less than 1%. It is reasonable therefore to expect that the physical barrier will not introduce an obstacle to movement; all species and any individual marine mammal entering any part of the Inner Sound or the Pentland Firth can still reach any other part of the Inner Sound or Pentland Firth without coming into contact with the turbines. Marine mammals approaching the turbines will be able to move around, above or below the turbines. Although the turbines are sited across some of the deepest channel, no exclusively deep diving marine mammals are known to use the area. Indeed, marine mammals must regularly surface to breath and are consequently capable of passing over the top of the turbines. This is something that the marine mammals

may not even need to do, however, if they instead use the waters to the north and south of the devices. All turbines will be located in water that is deep enough to provide a minimum clearance from the blade tip to the sea surface of 8m.

11.245 As detailed in Section 11.7.1, evidence from the SeaGen tidal turbine in the narrows of Strangford Lough, Northern Ireland, suggests that although it is likely the case that animals will avoid the area of the turbine itself (whether due to visual or auditory cues, or some other mechanism), the results indicate that there is no barrier effect as a result of SeaGen presence or operation for seals (Royal Haskoning, 2010). Similarly for harbour porpoise, although there were fewer detections of harbour porpoise during operation, there appeared to be no difference in harbour porpoise detections north or south of the turbine, indicating that for this species the SeaGen device does not present a barrier to movement for this species either (Royal Haskoning, 2010). Although the specifics of the MeyGen project described herein differ from the SeaGen project, the results of the SeaGen monitoring programme seem to support the conclusion drawn above for the Project that the introduction of tidal turbines does not necessarily represent a barrier to movement between foraging, haulout or other important sites.

11.246 The marine mammal species that may be found at the site meet many of the criteria for medium sensitivity of receptor (e.g. some species are listed on Annex II of the EU Habitats Directive or are listed as EPS) and the sensitivity of receptor is therefore ranked as medium. However, as turbines are likely to represent, at a maximum, only around 8% of the Inner Sound and as movement through the Inner Sound will remain otherwise unrestricted, the magnitude of impact is considered to be negligible.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Medium	Negligible	Negligible	Not significant

MITIGATION IN RELATION TO IMPACT 11.11
▪ No specific mitigation measures are proposed as no significant impact predicted. Operational monitoring will be implemented in order to confirm the impact predications made here (see Section 11.12).

11.7.6 Impact 11.12: Indirect effects via prey species

11.247 As described in Section 11.6.4, it is possible that mammals may be affected if those prey species are negatively impacted by any of the operation or maintenance activities. Since the Fish Ecology (Section 13) and Benthic Ecology (Section 10) assessments concluded that installation related impacts on each of these potential prey species are likely to be minor or negligible, subsequent impacts on marine mammals that prey on these species should be of a similar nature.

11.248 It is possible, however, that the turbine support structures may provide new habitat for fish and shellfish species (the aggregation of fish around marine structures and man-made objects placed in the sea is well-documented e.g. Inger *et al.* 2009) and foraging success or efficiency of marine mammals in the area could increase. Although animals may not forage amongst the turbines, the effect could be to increase the prey availability around the turbines, which would be likely to remain accessible. This positive benefit is difficult to quantify, however, and it is possible that the deterrent effect of the operating noise emissions may limit marine mammal access to the waters around the turbines, limiting any benefit.

11.249 The marine mammal species that may be found at the site meet many of the criteria for medium sensitivity of receptor (e.g. some species are listed on Annex II of the EU Habitats Directive or are listed as EPS) and the sensitivity of receptor is therefore ranked as medium. However, as the species on which marine mammals are likely to prey will be unaffected to any significant extent by the Project, the magnitude of impact is considered to be negligible.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Medium	Negligible	Negligible	Not significant

MITIGATION IN RELATION TO IMPACT 11.12
▪ No mitigation measures are proposed as no significant impact predicted.

11.7.7 Impact 11.13: Accidental spillage from vessels

11.250 The vessels to be used during operations and maintenance will be the same size or smaller than those during construction and installation and will therefore have similar inventories of oil. The likelihood of spillage, mitigation measures and residual impacts are the same as those described for vessel spillage during construction and installation.

11.8 Impacts during Decommissioning

11.251 The tidal turbines will be removed from the TSS to a recovery vessel and returned to shore. The cables will be recovered to a vessel, the Horizontal Directional Drilling (HDD) bores filled at the breakthrough location and the piles cut at the seabed.

11.252 Decommissioning activities are assumed to generate noise levels similar to those generated during pile drilling. Decommissioning noise at one site at a time is therefore assumed to introduce no additional underwater noise to the environment over and above the noise generated from turbines in operational mode and impacts are likely to be equal or less to those described previously.

11.253 The likelihood and magnitude of impact of ship strike, increased turbidity, effects via prey species, barrier effect or collision risk will also be the same or less than during the installation and operation and maintenance activities and do not warrant additional assessment.

11.9 Potential Variances in Environmental Impacts

11.254 This impact assessment has assessed the maximum potential impacts associated with the project options with regards to impact on marine mammals. Relative to the application of the Rochdale Envelope approach in the consenting of other offshore renewables developments (e.g. offshore wind farms) the MeyGen consenting envelope does not involve large scale variability in key design parameters or impact footprints with regards to potential impacts on marine mammals.

11.255 An alternative project option that could potentially be followed through but which has not been assessed is the siting of turbines using TSS on the seafloor or installation via monopile instead of pin pile. Use of gravity based structures would result in a reduced noise output from the installation activities as drilling would not be required and the possible impact would be limited to the noise emissions from the installation vessels.

11.256 The turbine collision impact assessment has been based on the maximum number of turbines that could be installed by the end of each installation year (i.e. 10 in year one, 20 in year two and 86 in year three). Should a lesser number of turbines be installed, then the potential number of encounters and therefore potential marine mammal deaths, would be less than predicted.

11.10 Cumulative Impacts

11.10.1 Introduction

11.257 MeyGen has in consultation with Marine Scotland and Highland Council identified a list of other projects (MeyGen, 2011) which together with the Project may result in potential cumulative impacts. The list of

these projects including details of their status at the time of the EIA and a map showing their location is provided in Section 8; Table 8.3 and Figure 8.1 respectively.

11.258 Having considered the information presently available in the public domain on the projects for which there is a potential for cumulative impacts, Table 11.18 below indicates those with the potential to result in cumulative impacts from a marine mammal perspective. The consideration of which projects could result in potential cumulative impacts is based on the results of the project specific impact assessment together with the expert judgement of the specialist consultant.

Project title	Potential for cumulative impact	Project title	Potential for cumulative impact	Project title	Potential for cumulative impact
MeyGen Limited, MeyGen Tidal Energy Project, Phase 2	✓	SHETL, HVDC cable (onshore to an existing substation near Keith in Moray)	×	OPL, Ocean Power Technologies (OPT) wave power ocean trial	✓
ScottishPower Renewables UK Limited, Ness of Duncansby Tidal Energy Project	✓	Brough Head Wave Farm Limited, Brough Head Wave Energy Project	✓	MORL, Moray Offshore Renewables Ltd (MORL) offshore windfarm	✓
Pelamis Wave Power, Farr Point Wave Energy Project	✓	SSE Renewables Developments (UK) Limited, Costa Head Wave Energy Project	✓	SSE and Talisman, Beatrice offshore Windfarm Demonstrator Project	✓
Sea Generation (Brough Ness) Limited, Brough Ness Tidal Energy Project	✓	EON Climate & Renewables UK Developments Limited, West Orkney North Wave Energy Project	✓	BOWL, Beatrice Offshore Windfarm Ltd (BOWL) offshore windfarm	✓
Cantick Head Tidal Development Limited, Cantick Head Tidal Energy Project	✓	EON Climate & Renewables UK Developments Limited, West Orkney South Wave Energy Project	✓	Northern Isles Salmon, Chalmers Hope salmon cage site	✓
SSE, Caithness HVDC Connection - Converter station	×	ScottishPower Renewables UK Limited, Marwick Head Wave Energy Project	✓	Northern Isles Salmon, Pegal Bay salmon cage site	✓
SSE, Caithness HVDC Connection - Cable	×	SSE Renewables Developments (UK) Limited, Westray South Tidal Energy Project	✓	Northern Isles Salmon, Lyrawa salmon cage site	✓
RWE npower renewables, Stroupster Windfarm	×	EMEC, Wave Energy test site (Billia Croo, Orkney)	✓	Scottish Sea Farms, Bring Head salmon cage site	✓
SSE, Gills Bay 132 kV / 33 k V Substation Phase 1: substation and overhead cables (AC)	×	EMEC, Tidal energy test site (Fall of Warness, Orkney)	✓	Northern Isles Salmon, Cava South salmon cage site	✓
SSE, Gills Bay 132 kV / 33 k V Substation Phase 2: HVDC converter station and new DC buried cable	×	EMEC, Intermediate wave energy test site (St Mary's Bay, Orkney)	✓	Scottish Sea Farms, Toyness salmon cage site	✓
SHETL, HVDC cable (offshore Moray Firth)	×	EMEC, Intermediate tidal energy test site (Head of Holland, Orkney)	✓	Northern Isles Salmon, West Fara salmon cage site	✓

Table 11.18: Summary of potential cumulative impacts

11.259 The following sections summarise the nature of the potential cumulative impacts for each potential project phase:

- Construction and installation;
- Operations and maintenance; and
- Decommissioning.

11.10.2 Potential Cumulative Impacts during Construction and Installation

11.260 The nature of the possible cumulative impact will depend on the nature of the development; for example, there will be no cumulative operational effects with cable projects. However, the potential for cumulative impact exists in the installation phase with all other project types. The scope for such cumulative impact will, however, be limited to projects for which the installation schedule is similar to that of the MeyGen project.

11.261 The MeyGen Tidal Energy Project Phase 2 will introduce a further 312MW of tidal turbines into the Inner Sound. The exact number, location and layout within the Agreement for Lease area is not defined and will incorporate lessons learned from and technology advancements beyond Phase 1 of the Project. These factors will influence the potential for, nature of and significance of any cumulative impacts.

11.262 The impact ranges from installation vessels for other projects are likely to be of a similarly small scale as predicted for the Project and therefore the scope for cumulative impact is minimal since each project will be excluding very small areas from use at worst. In terms of installation of the devices themselves, piling for numerous large diameter wind turbines is likely to dwarf the relatively small behavioural impact ranges from wave and tidal devices. The main responsibility for reducing impact over these large ranges lies with the wind developers, which can be effected through the relevant EIA processes. Due to the location of the wind lease areas (much to the south and shielded by land) then it is not anticipated that areas of impact should be coincident and no in combination effects are likely. However, the cumulative impact of each project excluding small areas and the wind projects excluding larger areas might make a large proportion of a habitat unavailable for a particular marine mammal species use. As described above, however, the home ranges of the cetaceans using the Orkney and Pentland Firth Waters are part of much wider areas and as a result it is unlikely that cumulative impacts of temporary inability to enter an area (which is the worst case) will have an impact magnitude of greater than minor. No key breeding sites have been identified for cetaceans in this area.

11.263 Installation and maintenance vessels will be slow moving for all these developments and the risk of ship strike is much lower than for other vessel traffic. No cumulative effects are considered likely.

11.264 The possibility for cumulative impact on seals exists for the use of ducted propellers, however, as the high energy environment makes use of such vessels likely. Even though individual projects are unlikely to impact on many, or any, seals, the low PBR for the harbour seal especially means the prospect is raised. The possibility of cumulative impact is raised when the numbers that may be affected through interaction with the turbine blades are added to those possibly affected by interaction with ducted propellers. As it is an emerging issue and mitigation measures are not fully developed at this time, it is not possible to state there will be no cumulative impact. MeyGen commit to deploying relevant mitigation and monitoring measures should they use ducted propellers to limit the potential for impact. As such, the impact is expected to be minimal and cumulative impact with other developments considered unlikely.

11.265 Note that aquaculture sites and activities in Scapa Flow were identified as of possible concern for the Project during the EIA scoping phase but possible impact mechanisms do not overlap with those described in this chapter. However, aquaculture operators may apply to Marine Scotland for a licence to shoot seals in order to protect the health, welfare and status of their farmed fish stocks. As such, when placing potential impacts on seals in a wider regional context, it will be useful to consider the PBR for the Orkney & North Coast Seal Management Area. The number that may be removed for grey seals is high (959) and the combined number at risk from the Project and aquaculture will be highly unlikely to ever approach this value. For harbour seals, the PBR for 2012 is very low (18; Scottish Government, 2012) and it is unlikely that aquaculture interests would receive permission to shoot multiple animals. Indeed, permission has been given for removal of only seven animals (correct 1st February, 2012; Scottish Government, 2012) and the cumulative impact with the small number that could be licensed for shooting is therefore extremely unlikely to have a population effect.

11.10.3 Potential Cumulative Impacts during Operations and Maintenance

11.266 Whilst installation noise emissions will be temporary for the relatively short installation periods, operational noise is a continuous emission throughout the operational life cycle. In this respect the emissions from wave and wind projects will be of an entirely different nature to tidal and cumulative impacts are unlikely. There are only five other tidal projects in the whole area, plus MeyGen Phase 2, and the potential for cumulative impact is thus further reduced. Considering the operational impact ranges and the nature of those impacts, pinnipeds and odontocetes (including harbour porpoise, killer whales and Risso's dolphins) would be unlikely to experience any large areas of habitat exclusion or any impacts on larger scale movements from area to area. Although the possible strong behavioural reaction ranges are likely to extend over some hundreds of metres for mysticetes and although there are two further tidal sites on the north coast of the Pentland firth, the fact that the Phase 1 (and Phase 2) Project area are relatively enclosed within Inner Sound means that these impact ranges are very unlikely to overlap and there should not be any cumulative noise barrier across the Pentland Firth. The extended ranges of possible behavioural impact make cumulative impacts on mysticetes theoretically more likely than other marine mammals as the ranges are larger. However, mysticete density is very low compared to other species and the number that might be excluded from some areas will be very low.

11.267 It is possible that wind and wave devices will present a perceived physical barrier, much like described for the turbine in this Project. This could give rise to cumulative effects if large scale movements of animals are affected or if the devices block access to important feeding or breeding grounds. This is unlikely to be the case, however, as the devices are expected to represent a very small percentage of the available water column and marine mammals will be required to make only small deviations around devices to continue to access whatever it is they were trying to gain access to.

11.268 The turbine collision impact assessment highlights that there may be a risk to marine mammal populations from the presence and operation of the turbines. The percentage of the regional population of the cetacean species that might come into contact with the Project turbines is considered to be extremely low. As the effect is likely to be similarly low from the MeyGen Phase 2 and Ness of Duncansby and Cantick Head sites, the cumulative impact is likely to be low also. It is possible that different cetacean species use the three sites differently; where a species used one site and not others then that species would not be susceptible to any sort of cumulative impact. It is therefore not possible for a definitive assessment on potential cumulative impacts until site specific cetacean data for other Project locations is publically available.

11.269 For harbour seals, the local density of animals is very low and the number predicted to potentially encounter the devices also very low. As a result, the number that may be affected by the Project in terms of the local population is low. Cumulative effects with other developments therefore seem unlikely. However, the PBR for this species is very low and if a similar collision risk was present from the other proposed tidal projects, the cumulative impact may be sufficient to result in the PBR being reached, which could cause population level effects.

11.270 The distribution of seal haul outs in the Pentland Firth shows that the Inner Sound area hosts a relatively greater number of haul out sites than the waters surrounding the other two tidal lease areas (Ness of Duncansby and Cantick Head) in the Pentland Firth (SMRU Ltd, 2011, Scottish Government, 2011). As such, any cumulative impact with these other two sites would, in all likelihood, not be a linear scaling up of the possible worst case impact described from the Project herein. The possible cumulative impact from the MeyGen Phase 2 development may also not be a linear increase from that described for the Project herein; increasing the number of turbines may increase the number of animals likely to come in contact when the impact from one turbine is scaled up, but increasing the number of turbines will increase the auditory and visual cues to their presence, which may decrease the risk of collisions per turbine. Once monitoring results are available in order to better define avoidance rates this will allow for determination of potential impacts from larger and multiple arrays.

11.271 MeyGen commit to developing relevant mitigation and monitoring measures in consultation with Marine Scotland and SNH to limit the potential for impact. As such, it is anticipated that it will be possible to restrict the impact on the marine mammals in the Inner Sound and consequently limit the possibility for cumulative impact with other developments.

11.10.4 Potential Cumulative Impacts during Decommissioning

11.272 The potential for cumulative impacts with other projects during the decommissioning phase of the Project is unclear as such activities are not currently defined (they will be developed following best practice at the time) and information on other projects is similarly unavailable. Decommissioning activities for the Project are likely to generate noise levels similar to those generated during pile drilling and cumulative impacts related to decommissioning noise are unlikely to be greater than for installation activities.

11.273 Although it is possible that a number of the impacts that may occur during decommissioning (e.g. noise emissions, seabed impact) could act cumulatively with other developments, there is limited scope for much of this since it is highly unlikely that the other developments would be decommissioned at the same time as this development, or that of the MeyGen Phase 2 development (which would likely be decommissioned at the same time as the proposed development).

11.10.5 Mitigation Requirements for Potential Cumulative Impacts

11.274 No mitigation is required over and above the Project specific mitigation. It should however be noted that there is still some uncertainty over the potential impacts on marine mammals from potential collision with the tidal turbines. Should monitoring of the early years of deployment indicate mitigation is required to avoid significant cumulative impacts, MeyGen will develop and adopt mitigation as appropriate.

11.11 Habitat Regulations Appraisal

11.275 For projects which could affect a Natura site, a competent authority (in this case Marine Scotland for offshore and The Highland Council for onshore) is required to determine whether the Project will have a likely significant effect on the qualifying interests of any Special Protection Areas (SPAs) and any Special Areas of Conservation (SACs). Depending on the outcome of this determination, the competent authority will undertake an Appropriate Assessment of the implications of the Project for the Natura site's conservation objectives. The responsibility for provision of information with which to inform the Appropriate Assessment rests with the applicant.

11.276 Due to the distances over which marine mammal species for which SACs are designated can travel, there has been a need to investigate the potential Likely Significant Effects on a number of SAC sites designated for their marine mammal interests. This assessment is presented in a separate HRA report (see HRA document on the supporting studies CD, MeyGen, 2012).

11.12 Proposed Monitoring

11.277 The majority of potential impacts on marine mammals have been assessed as being negligible or minor. There is however still some uncertainty around the potential for impacts from collision with the turbines and MeyGen recognises the need for operational monitoring in order to better clarify these uncertainties.

11.278 Where impacts cannot be fully quantified (e.g. turbine collision risk). MeyGen is committed to developing a marine mammal monitoring program. This program will be based on the 'Survey, Deploy and Monitor' strategy in accordance with Scottish Government policy (currently available in draft).

11.279 MeyGen has recognised that being the first application for a commercial scale tidal stream project in Scotland and the first from The Crown Estate's Pentland Firth and Orkney Waters leasing round, has meant that there is potential for the Project to form part of an industry wide strategic monitoring program that will benefit future projects as well.

11.280 Where strategic monitoring is appropriate, MeyGen would look to a collaborative effort between the Project, wider industry, regulators and stakeholders to take this forward in the most efficient way for the interest of the Project and future projects elsewhere in Scotland and the UK.

11.281 As part of this EIA and the MeyGen commitment to post-installation monitoring, the draft SNH survey and monitoring guidance (MacLeod *et al*. 2011, Sparling *et al*. 2011) has been reviewed. Although this guidance does not, and cannot, give specific details of what marine mammal monitoring should take place, based on the general approaches described and on current knowledge of the site (obtained from

the extensive baseline surveys), it is likely that the monitoring programme could include some or all of the following:

- Disturbance and displacement;
    - Targeted observations of all marine mammals to determine how area use or behaviour may have changed over time;
    - Acoustic monitoring of harbour porpoise (and incidentally other echo-locating species) using static loggers to assist with determining area use;
    - Collection of underwater noise measurements of the candidate prototype tidal turbines. The data collected will be used to validate the underwater noise modelling completed to inform the impact assessment;
- Collision risk;
    - MeyGen believes that understanding marine mammal behaviour around tidal turbines and the risk of collisions occurring is fundamental for the industry to progress. It is therefore proposed that this potential impact is considered as strategic research and therefore monitoring development in cooperation with regulators, stakeholders and other developers. This impact assessment has indicated seals as the species group of most concern. Monitoring could include:
    - Continuation of ongoing seal tagging programme in the Inner Sound;
    - Installation of one or more active monitoring systems on one or more tidal device to better understand the near-field response of marine mammals (and other marine species) to operational tidal devices; and
    - Shoreline monitoring for marine mammal carcases and subsequent necropsy to determine if interaction between marine mammals and turbines/ducted propellers is occurring.

11.282 MeyGen will work with the regulator (Marine Scotland) and its advisory bodies (e.g. SNH) to agree the details of appropriate monitoring and will ensure that the monitoring programme is aligned with industry best practice. Methods for assessing disturbance and displacement impacts (including underwater noise) and collision risk can potentially be linked with similar effort required for Section 12 Ornithology and Section 13 Fish Ecology.

11.283 Where monitoring indicates that specific mitigating measures may be reasonably required, MeyGen is committed to put these in place.

11.13 Summary and Conclusions

11.284 Boat-based and land-based surveys of the Inner Sound recorded four cetacean (harbour porpoise, minke whale, killer whale and Risso's dolphin) and two pinniped species (grey and harbour seal) over 22 monthly surveys. The harbour porpoise dominated cetacean observations, with the minke whale, killer whale and Risso's dolphins only sighted on a few occasions. Grey seals dominated pinniped observations, with relatively few harbour seals recorded. Marine mammal sightings were distributed throughout the survey area, although sightings of cetaceans were more numerous in the western portion of the survey area and pinniped sightings seemed to show some concentration towards the east of the survey area. A large number of seals were observed hauled out on Stroma and adjacent rock outcrops.

11.285 A number of potential impacts associated with the installation, operation, maintenance and decommissioning of the Project on marine mammals have been assessed. This assessment identified a number of key issues including noise emissions, ship strikes, increased turbidity, indirect effects via prey species, accidental events, physical barriers and collision risk.

11.286 The noise (source) level for drilling and vessel activities (both during installation and maintenance activities) is considerably below the level at which lethal injury to marine mammals might occur and it is therefore predicted that no marine animals will be killed as a result of underwater noise emissions. Noise (source) levels are also below levels at which hearing damage might occur. In the case of behavioural responses to the noise, the zones of possible impact from drilling and vessel operations are so small (up to 1m for drilling and around a maximum of 50m for vessels, depending on the species) and the local/regional density estimates so low that no animals are expected to be affected.

11.287 As with installation and maintenance activities, noise (source) levels for operational turbines are considerably below the levels at which lethal injury to species of marine mammal might occur. For operational turbines, strong avoidance might be expected up to 38m for seals, 98m for odontocetes and 588m for mysticetes. Combining these ranges with local density estimates suggests approximately one or fewer of any species could be expected to experience strong behavioural avoidance at any one time during turbine operation. Considering the regional population sizes of these species and the fact that the impact is not considered to be sufficient to interfere with vital life processes, these numbers are likely of little concern at a population level.

11.288 No marine mammals of any species should experience a change in hearing ability (permanently or temporarily) from the installation operations and no marine mammals should be exposed to temporary hearing changes from the operational period, thus no animals are expected to leave the region and no population level impacts are expected.

11.289 In addition to the possibility that noise emissions could cause behavioural impacts, the noise emissions from the turbines could present a 'noise barrier' to movement. For pinnipeds, this would only apply to around 38m out from the turbine array. For odontocetes, this could occur out to 98m from the turbine, which could present a noise around the tidal array in the centre of the Inner Sound. This would not stop animals travelling through the Inner Sound, however, as they could use the waters to the north or south of the array. For mysticetes (including the minke whale) this barrier of strong avoidance could effectively remove a slightly larger area from use, extending to approximately 588m around the tidal array. This species group is not expected to use the area with any regularity and the actual presence of the noise barrier is unlikely to affect regional area use for mysticetes in general.

11.290 The devices can also form a physical barrier, with each turbine presenting an obstacle in the vertical plane, through which marine mammals may be unable (or unwilling) to pass through. As a worst case, the widest row of turbines the turbines present a barrier of approximately 8% of the sea area available across the Inner Sound. Compared to that across the Pentland Firth as a whole, the turbines present a barrier of less than 1%. It is reasonable therefore to expect that the physical barrier will not introduce an obstacle to movement. Information from monitoring of marine mammals around the SeaGen tidal turbine in the narrows of Strangford Lough showed it is likely the case that seals and harbour porpoise animals will avoid the area of the turbine itself but that there is no barrier effect as a result of SeaGen presence or operation (Royal Haskoning, 2010).

11.291 Risk of collision between a moving turbine blade and a marine mammal is considered to be a key potential effect of turbine operation and it is considered that all species of marine mammals are at some risk of this collision impact, which could ultimately result in death or injury. Little is known about behavioural reactions around such devices but some understanding of how marine mammals react around these devices can be derived from existing tidal developments. For example, monitoring of the SeaGen tidal device in Strangford Lough has involved the assessment of all seal carcasses found in the lough and in post mortem none have shown signs of interaction with SeaGen. Data from seal telemetry and acoustic studies in Strangford Lough suggest that there may be a degree of local avoidance by marine mammals of operating turbines.

11.292 Taking account of possible avoidance rates, it is likely that less than 0.10% of the regional population of harbour porpoise would encounter the turbines annually and a smaller portion yet actually seriously injured or killed by the collision. For minke whales, less than 0.20% of the regional population would encounter the turbines and fewer still actually be injured or killed. The population level effects for these species are likely therefore to be inconsequential. For grey seals, the numbers of animals possibly encountering the device at the higher avoidance rates are sufficiently low in all cases that the PBR (959 grey seals) will not be reached and therefore regional population effects are not expected, especially when

it is considered that the encounter rate, even with the avoidance factored in, does not represent serious injury or fatality in all cases. For harbour seals, the number that could possibly encounter the devices is approximately one quarter that predicted for grey seals. However, the Orkney and North Scotland harbour seal population is much smaller than the grey seal population and these numbers are consequently closer to the PBR, although for higher avoidance rates still remain below it.

11.293 MeyGen will apply appropriate mitigation, as deemed necessary in consultation with Marine Scotland and SNH, including deployment of a satisfactory monitoring protocol. This monitoring will be instigated to cover the operation of the initial ten to 20 (maximum) turbines that will be installed in years one and two. The monitoring will allow for a better definition of the avoidance rates to better understand the possible impact of the full 86 turbine array and to inform the potential requirement for additional, future mitigation.

11.294 Vessels involved in the Project will be slow travelling when moving to the site and extremely slow or stationary when engaged in the activities at the turbine locations. As such, these vessels are much less likely to cause death or injury through collision than commercial shipping activity. A number of 'corkscrew' injuries have been reported in both grey and harbour seals and it is though that these may relate to interaction between the seal and specific types of ship propellers (e.g. propellers that have been shrouded with a nozzle, or a configuration of propellers placed in groups that can be rotated in any horizontal direction). These systems are common to a wide range of ships including tugs, self propelled barges and various types of offshore support vessels and may be used on the installation vessels in this project. It is understood that investigation is ongoing on the potential link between these injuries ducted propellers and that mitigation measures relevant to minimising the risk of seal spiral injuries and fatalities are currently being developed at an industry and regulator level. MeyGen will apply appropriate mitigation, as deemed necessary in consultation with Marine Scotland and SNH, should vessels with ducted propellers be used, in order to avoid any significant impact.

11.295 The benthic impact assessment undertaken as part of this EIA (Section 10) has determined that any increase in turbidity or suspended sediment levels is expected to be temporally and spatially restricted, largely due to the small volumes released and the high energy environment of the Inner Sound. Negative effects on marine mammals (through, for example, limiting ability to search for prey) are therefore not expected.

11.296 It is possible that mammals may be affected if fish/shellfish prey species are negatively impacted by any aspect of the Project. Both the fish and benthic ecology assessments concluded, however, that impacts on potential prey species are likely to be minor or negligible and marine mammals that prey on these species should therefore be unaffected.

11.297 It is possible that an accidental loss of diesel from vessels involved in the Project could impact negatively on marine mammal species through toxicological effects or through smothering by oil. However, marine mammals are highly mobile and are able to detect these pollutants and as a result are expected to avoid areas where pollution has occurred. Even where diesel may accumulates on seal haulout sites, sensitivity is limited by species and time of year (grey seal pups may be most at risk but are born from only the end of September until mid December). Given the low likelihood of loss of diesel and the ability of marine mammals to move away from affected areas in the short term, accidental pollution as a result of the Project is considered to be non-significant.

11.298 Any impacts that decommissioning operations may have on marine mammals will occur at a similar or lesser magnitude than the impacts described for those installation and operation phases. In conjunction with an agreed decommissioning plan, the decommissioning of the turbines is not expected to impact significantly on marine mammals.

11.299 The impact assessment herein shows that PBR for grey seals is unlikely to be reached and this species is unlikely to be affected by the Project at a population level. The assessment shows, however, that the risk of collision may be such that the low PBR value for harbour seals could be exceeded and negative effects may be felt at the population level. However, the turbines will be installed in a staged 3 year programme, increasing from ten turbines to 20 turbines to a maximum of 86 turbines; during this time MeyGen will undertake a monitoring programme which will better define the avoidance rates for species using the area and inform the potential requirement for additional, future mitigation.

11.300 The scale of the individual effects of the installation, operation and decommissioning of the devices are not expected to combine with those from other projects in the wider area to produce significant negative cumulative impacts.

11.301 MeyGen has committed to undertaking monitoring of marine mammals in the vicinity of the tidal array and within Inner Sound to determine that the impact is as assessed above. This plan will be developed with the relevant authorities and will consider all available guidance and best practice.

11.302 Overall through the implementation of proposed mitigation strategies and commitments the impact of the proposed Project on marine mammal ecology is considered to be not significant.

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12 ORNITHOLOGY

12.1 The table below provides a list of all the supporting studies which relate to the Ornithology impact assessment. All supporting studies are provided on the accompanying CD.

Details of study	Location on supporting studies CD
Ornithological Technical Annex for Phase 1 of the MeyGen Tidal Energy Project (RPS 2011b)	OFFSHORE\Marine Wildlife\Ornithology
Benthic survey for Phase 1 of the MeyGen tidal stream energy project, Inner Sound, Pentland Firth (ASML, 2011)	OFFSHORE\Seabed interactions

12.1 Introduction

12.2 This section assesses the effects of the proposed Project on the ornithological interests of the site and surrounding area. The assessment was undertaken by RPS.

12.3 Scottish coastal waters support a wide diversity of seabirds, and the Pentland Firth and Orkney region is an area of international importance for seabird populations. The ornithological importance of the areas surrounding the Pentland Firth Inner Sound is not restricted to seabirds; the largest expanse of peatland in the UK is located in Caithness and Sutherland and encompasses much of the land immediately to the south and west of the Inner Sound. This area is important for breeding waders, raptors and divers.

12.4 This section provides a baseline description of the bird populations in the Inner Sound of the Pentland Firth and puts them into context of Scottish, UK, European and World-wide conservation.

12.2 Assessment Parameters

12.2.1 Rochdale Envelope

12.5 In line with the Rochdale Envelope approach, this assessment considers the maximum ('worst case') project parameters. Identification of the worst case scenario for each receptor (i.e. Environmental Impact Assessment (EIA) topic) ensures that impacts of greater adverse significance would not arise should any other development scenario be taken forward in the final scheme design. Table 12.1 describes the detail of the project parameters that have been used in this assessment and explains why these are considered to be worst case. The potential impacts from alternative Project parameters have been considered in Section 12.9.

Project parameter relevant to the assessment		'Maximum' Project parameter for impact assessment	Explanation of maximum Project parameter
Turbine	Number	86 turbines	The diving bird encounter model is based on a maximum volume of water swept by the turbine blades. This volume is based on number of turbines, rotor diameter and blade thickness. The maximum swept volume for the 86MW project is based on 86, 1MW turbines with 20m diameter rotors and blade thickness of 0.5m. The maximum swept volume of water is $(\pi(10^2))*86*0.5m$ = 13,509m^3 (157m^3 per turbine).
	Layout	N/A	Turbine spacing does not influence the bird impact assessment or diving bird encounter model.
	Rotor diameter	20m	The diving bird encounter model is based on a maximum volume of water swept by the turbine blades. This volume is based on number of turbines, rotor diameter and blade thickness. The maximum swept volume for the 86MW project is based on 86, 1MW turbines with 20m diameter rotors and blade thickness of 0.5m.
	Blade thickness	0.5m	The diving bird encounter model is based on a maximum volume of water swept by the turbine blades. This volume is based on number of turbines, rotor diameter and blade thickness. The maximum swept volume for the 86MW project is based on 86, 1MW turbines with 20m diameter rotors and blade thickness of 0.5m. The maximum blade thickness is 0.5m. The blade thickness decreases down the length of the blade however for the purposes of the assessment the maximum width is used.
	Minimum clearance between sea surface and turbine blade tip	8m	The minimum clearance between the turbine blade tip and the sea surface is 8m. The minimum clearance is used to calculate the percentage of turbine deployment area/water volume taken up by turbines rotors.
	Clearance from blade tip to seabed	4.5m	The minimum clearance between the turbine blade tip and the seabed is 4.5m. The minimum clearance is used to calculate the percentage of turbine deployment area/water volume taken up by turbines rotors.
	Number of blades per rotor	N/A	This Project parameter does not influence the bird impact assessment. The number of turbine blades is not an input parameter to the bird encounter model.
	Rotation speed	N/A	This Project parameter does not influence the bird impact assessment. The turbine rotational speed is not an input parameter to the bird encounter model.
	Operational noise	36 x 2.4MW turbines	The 2.4 MW turbine produces the highest noise and an array of 36 turbines of 2.4MW produces higher noise emissions than an array of 86 turbines of 1MW.
	Decommissioning	All turbines removed at decommissioning	All turbines will be removed at decommissioning.
	Oil fluid inventory	1,500 litres	The tidal turbines will contain an inventory of fluids including oil, hydraulic fluid and coolant. Turbine inventories will be between 645 and 1,500 litres.
Turbine support structure	Maximum drill cuttings released into marine environment	86 monopile Turbine Support Structure (TSS)	The drilled monopile TSS will result in the maximum release of drill cuttings to the marine environment. Assuming the maximum number of 86 TSSs, the maximum amount of drill cuttings that can be generated from turbine support installations is 17,200m^3 (total for 86 TSSs).
	Installation noise	Pin-pile TSS	Pin pile drilling produces higher noise output than monopole drilling based on available data. Pin pile source levels are 178 dB re 1 µPa at 1 m.
	Maximum amount of compressor lubricant released into the marine environment	86 monopile TSS	Monopile drilling operations will take approximately 4 hours per pile. A compressor is used to pump air into the drilled holes to lift cuttings clear. The lubricant will be discharged to sea along with the cuttings at a maximum rate of 5 litres per hour, i.e. 20m^3 per monopile and 1,720m^3 for all 86 installed over 3 years.

Project parameter relevant to the assessment		'Maximum' Project parameter for impact assessment	Explanation of maximum Project parameter
Cable landfall	Maximum drill cuttings released to marine) environment	29 Horizontal Directional Drill (HDD) bores, drilled from either Ness of Quoys or Ness of Huna	The majority of drill cuttings generated from the drilling of the HDD bores will be returned to shore and not discharged to sea; however it is estimated that the contents of the last 10m of each bore could be discharged to sea and the seabed breakthrough. The greatest potential volume of cuttings discharged to sea at breakthrough will result from last 10m of 29 boreholes of 0.6m diameter 82m^2.
Vessels	Installation vessel physical presence	1 Dynamic Positioning (DP) vessel for the duration of the installation for year 1 and 2 2 DP vessels for year 3 installation	Installation activities will be carried out by a single DP vessel during year 1 and 2, all installation activities to be undertaken using a single DP vessel. If other smaller vessels used to undertake some of the work of the DP vessel, no concurrent multiple vessel activities will take place, i.e. no more than one vessel on site at any one time. Year 3 installation will require a maximum 2 DP vessels for TSS installation. These two vessels may be present on site at the same time during year 3.
	Installation vessel noise	Tug vessel noise	Noise data for DP vessels are currently unavailable. Of the vessel noise data available tugs represent the noisiest vessels and are used to represent the highest possible noise source during installation operations. Tug source levels are 172 dB re 1 µPa at 1 m.
	Maintenance vessel physical presence	1 DP vessel present every 2.8 days	Based on a maximum 86 turbine array, 1 DP vessel will be present a maximum of 130 times (i.e. single slack tide operation) per year i.e. the DP vessel present on site every 2.8 days.
	Maintenance vessel noise	Tug vessel noise	Noise data for DP vessels are currently unavailable. Of the vessel noise data available tugs represent the noisiest vessels and are used to represent the highest possible noise source during maintenance operations. Tug source levels are 172 dB re 1 µPa at 1 m.
Onshore Project components	Maximum onshore footprint	Power Conversion Centre (PCC) construction and HDD activities at Ness of Quoys or Ness of Huna; all potential cable corridors between PCC locations and SHETL substation proposed at Phillips Mains (see Figure 2.1) – maximum potential project footprints (at EIA commencement)	Onshore construction activities have the potential to impact onshore bird nesting/resting habitats and foraging areas. Impacts from all potential onshore infrastructure footprints have been considered in the bird impact assessment.

Table 12.1: Rochdale Envelope parameters for the ornithology assessment

12.2.2 Area of assessment

12.6 The focus of the impact assessment is potential impacts on birds using the Project area and adjacent waters. The variation in the area over which impacts occur and the area over which an impact may occur can vary significantly between species based on their ecology and range over which their populations can be found. Therefore, potential impacts have also been set in the context of a wider study area over which birds encountered in the Project area are thought to range.

12.3 Legislative Framework and Regulatory Context

12.3.1 EIA guidance

12.7 The Scottish Government has developed guidance for wave and tidal developers seeking consent for projects in Scottish waters (including the Renewable Energy Zone (REZ) out to 200nm). These guidelines give an overview of the potential impacts of the marine energy developments on birds, listing the following potential effects on birds as ones which should be considered:

- Collision risk;
- Entrapment risk;
- Disturbance as a result of noise;
- Pollution from routine and accidental discharges;
- Disturbance of breeding birds;
- Displacement of birds from foraging areas;
- Disturbance displacement to moulting and rafting/loafing birds; and
- Creation of resting or breeding habitat.

12.8 In addition to the above guidance, the Institute of Ecology and Environmental Management (IEEM) have developed guidance for ecological impact assessment in Britain and Ireland for the marine and coastal environment. Within the IEEM guidance, predicting and characterising impacts on species (e.g. extent, duration, magnitude and confidence in predictions) within various geographical contexts (e.g. national or regional populations) or designated sites is carried out on the basis of species distribution and status, and this procedure is followed here.

12.3.2 Legislation

12.9 In addition to the EIA Regulations, key legislation for ornithological interest includes:

- The Council Directive on the Conservation of Wild Birds 2009/147/EC (EU Birds Directive);
- Nature conservation (Scotland) Act 2004;
- Wildlife and Countryside Act 1981 (as amended); and
- Conservation (Natural Habitats, etc.) Regulations 1994 (as amended)

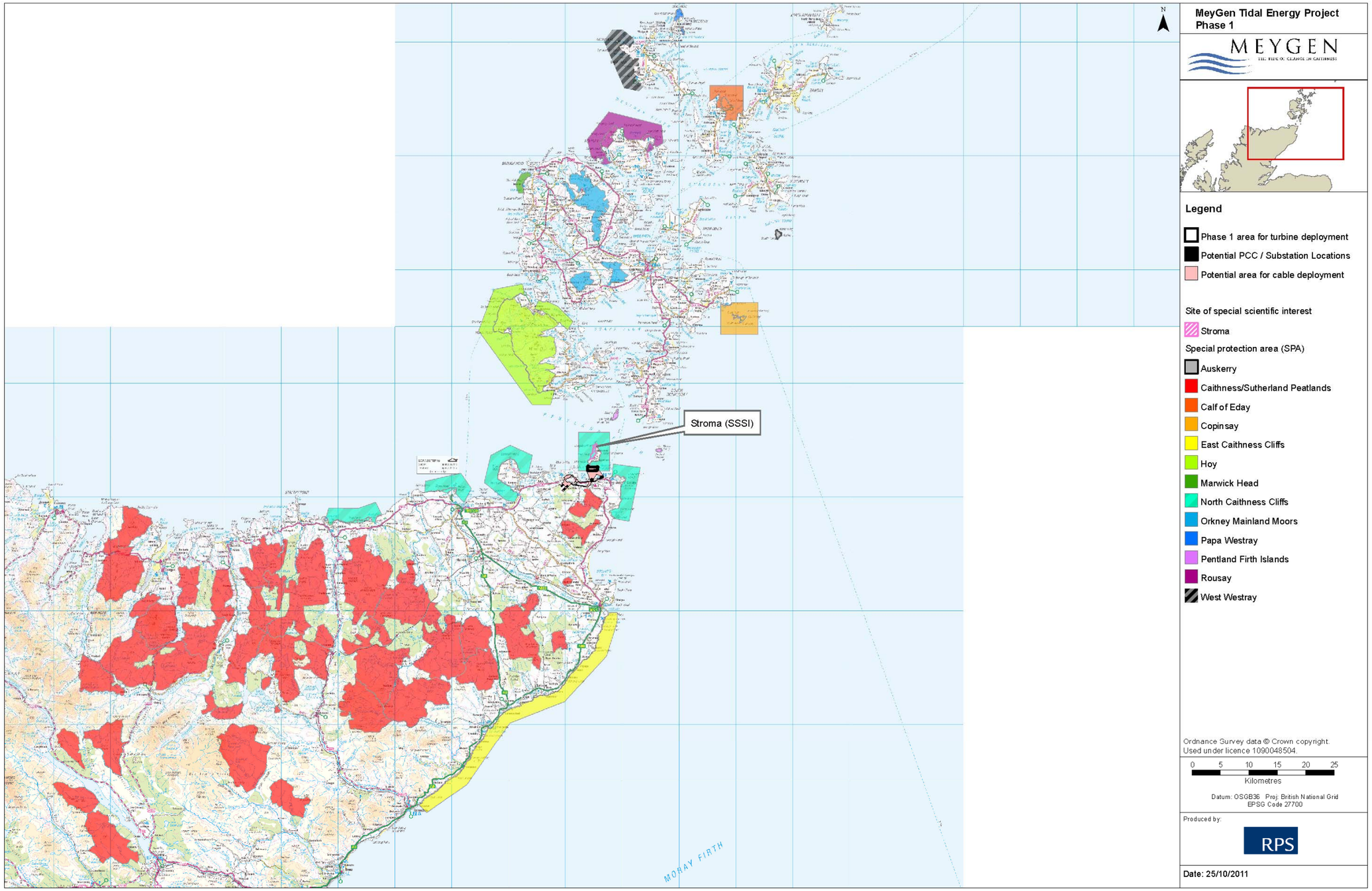

Figure 12.1: Special Protection Areas with species which may be connected with the MeyGen Tidal Energy Project site

EU Birds Directive

12.10 The EU Birds Directive 79/409/EEC (as amended) aims to provide a comprehensive scheme of protection for all wild bird species naturally occurring in the Union. To meet the requirements outlined in Article 4 of the Birds Directive, particular emphasis is given to the protection of habitat for endangered as well as migratory species (i.e. as listed under Annex I) via the establishment of a coherent network of Special Protection Areas (SPAs) comprising all of the most suitable territories for these species. Several of the bird species listed on Annex I of the Birds Directive occur within the Pentland Firth and the project area itself lies within the North Caithness Cliffs SPA (Figure 12.1).

12.11 In addition to the North Caithness Cliffs SPA, a further 26 SPAs on mainland Britain or offshore islands have the potential to interact with the Project site. Several of these SPAs may be relevant to the Project because they qualify on the basis of their breeding seabird populations, with some seabird species foraging widely over extensive areas, potentially including the Project site.

12.12 Although none of these additional 26 SPAs overlap with the Project area, and all except 3 are more than 10km distant, at least 20 of these can be considered as relevant because the proposed site falls within the mean maximum foraging ranges of some of the named qualifying seabird and diver species. The tables include both species which are listed as qualifying features and also those named as part of the breeding seabird assemblages for each SPA. In addition, for terrestrial bird species (including wildfowl), those SPAs in closest proximity to the Project site (notably Caithness & Sutherlands Peatlands and Caithness Lochs) are likely to be relevant because these lie within potential foraging distances of SPA species, whilst others which are further afield are unlikely to be of relevance because they lie beyond the likely foraging ranges of their qualifying SPA species.

12.13 Further details of the distance between each SPA and the Project area and the species for which each has been designated are provided in the Baseline Description (Section 12.5).

Wildlife and Countryside Act

12.14 Under the Nature Conservation (Scotland) Act 2004, and the Wildlife and Countryside Act (1981), Sites of Special Scientific Interest (SSSIs) in Scotland are designated by Scottish Natural Heritage (SNH), where the land is considered to be of special interest by reason of any of its natural features, such that they form a network of the best examples of natural features throughout Scotland, and support a wider network across Great Britain and the EU. Under the Nature Conservation (Scotland) Act 2004, SSSIs in Scotland are subject to notifications regarding operations requiring consent and have agreed management statements between SNH and the land owners or occupiers.

12.15 The western side of the island of Stroma is designated as a SSSI for its nationally important colonies of breeding seabirds, in particular of common guillemot, Arctic tern (*Sterna paradisaea*) and Sandwich tern (*Sterna sandvicensis*). This SSSI lies wholly within the North Caithness Cliffs SPA, however it is mentioned here because black guillemot (*Cepphus grylle*) is named as a component of the cliff nesting seabird colony. This species does not qualify for SPA status as it is classed as non-migratory.

12.4 Assessment Methodology

12.4.1 Scoping and consultation

12.16 Since the commencement of the Project, consultation on ornithology issues has been ongoing. Table 12.2 summarises all consultation relevant to ornithology. In addition, relevant comments from the EIA Scoping Opinion are summarised in Table 12.3, together with responses to the comments and reference to the Environmental Statement (ES) sections relevant to the specific comment.

Date	Stakeholder	Consultation	Topic/specific issue
11th August 2009	SNH	Meeting	Site visit and meeting to discuss bird and marine mammal survey methodology.
24th September 2009	SNH	Submission of document	Survey methodology.
17th November 2009	SNH	Submission of document	Revised survey methodology.
24th December 2009	SNH	Receipt of consultation	Confirmation on survey methodology changes.
7th April 2011	Marine Scotland and SNH	Pre-Scoping meeting	EIA surveys and studies required and the data. needs for each EIA study.
27th May 2011	Marine Scotland, statutory consultees and non statutory consultees	Submission of EIA Scoping Report	Request for EIA Scoping Opinion from Marine Scotland and statutory consultees and request for comment from non statutory consultees.
6th May 2011	Marine Scotland and SNH	Submission of document for comment	Submission of interim survey report summarising the results from first 18 months of survey.
6th June 2011	Marine Scotland and SNH	Meeting	Presentation of survey results from first 18 months of survey and discussion on EIA and cumulative impact assessment scope and HRA scope.
30th June – 2nd July 2011	Local stakeholders	Public Event - EIA Scoping	Public event to collate information/opinions on proposed EIA scope.
8th August 2011	Marine Scotland and SNH	Submission of document for comment	Submission of HRA Screening Report.
30th September 2011	Marine Scotland and SNH	Letter	Response to HRA Screening Report.
31st September 2011	Marine Scotland, The Highland Council, statutory consultees and non statutory consultees	Receipt of EIA Scoping Opinion	Receipt of response to EIA Scoping Report and other comments from non statutory consultees.
3rd October 2011	Marine Scotland	Project update meeting	Report on EIA progress including presentation of survey results.
2nd November 2011	Marine Scotland and SNH	Meeting	Discussion of assessment methodology; preliminary assessment results and HRA requirements.
6th – 7th December 2011	Local stakeholders	Public Event – pre application consultation	Public event to communicate the findings of the EIA to local stakeholders.
2nd March 2012	Marine Scotland and SNH	Meeting	Final meeting to close out HRA approach to the Project.

Table 12.2: Consultation undertaken in relation to ornithology

Name of organisation	Key concerns	Response	ES section within which the specific issue is addressed
SNH	Since the seabird and marine mammal surveys began in 2009 the lease area has changed. It is apparent that the surveys no longer cover the whole of the lease area. Given that most of the proposed lease area is within the North Caithness Cliffs SPA this is an important data gap. We strongly recommend that a strategy for surveying this area is adopted and discussed with SNH soon.	The current impact assessment is concerned only with Phase I of the Project. This comprises a smaller section in the centre of the Agreement for Lease area. SNH have confirmed that the survey data are satisfactory for this assessment (email communication, 20/10/2011).	Section 12.4.2 Field Survey
SNH	Regarding identification of SPAs, please refer to advice provided in our response to the EIA Scoping Report and HRA screening report (31/08/2011). We	Mean maximum foraging ranges[1] have been used to identify seabird colonies and SPAs for inclusion in the assessment. [NB: feedback on the initial	Impact Assessment Sections: 12.6, 12.7, 12.8 and

Name of organisation	Key concerns	Response	ES section within which the specific issue is addressed
	recommend using the meta-data on seabird foraging ranges available from the BirdLife International database to determine which qualifying species from which sites are included. For some seabird species, the meta-data is such that it allows the use of cumulative frequency plots to determine the foraging range at which 95% of the population will be included. If these data are not available, or of poor quality, then we recommend using the mean of the species maximum foraging range. Foraging ranges of each qualifying species should be plotted from the SPA to the lease area to determine which foraging ranges overlap with the lease area and, therefore, which qualifying species (and which SPAs) should be included at this stage of the HRA. Although this will initially produce a long list of SPAs, this will be refined through an iterative process as the results of survey work are presented by MeyGen, and as species sensitivity to potential impacts from the proposal are defined. Considering MeyGen Ltd has undertaken a large amount of survey work, they should be able to refine the SPA list by scoping out the qualifying species of sites which are not present in the survey results. It would be useful if this information/list, together with the justification for scoping in or out, could be presented at the forthcoming HRA meeting.	Habitats Regulations Appraisal (HRA) screening from MS and SNH drew attention to the fact that the mean maximum foraging range should be used as a guide rather than an absolute limit, and that SPAs located just beyond a species' mean maximum foraging range should also be considered for inclusion.]	12.11
Marine Scotland	From the EIA Scoping Report it is not clear what will be done with the bird survey data that has been collected since October 2009. Marine Scotland queries how the developer will utilise the image library from the aerial bird surveys currently being undertaken in the area by the Scottish Government and The Crown Estate? What analysis will be undertaken either of the data gathered by the applicant or the data collected by the Scottish Government and The Crown Estate? Are there any plans for design based analysis or will a more advanced form of analysis such as density surface modelling be used?	The final results of these surveys were made available too late for them to be incorporated into this assessment. Furthermore, consideration of preliminary versions of the report suggested that the spatial resolution of these surveys was unlikely to provide sufficient detail for the purposes of this assessment.	N/A
Marine Scotland	Information on how the survey results will be presented and how uncertainty will be estimated in the estimates of populations and distributions would be welcome as well as any information the developer may have with regards collecting the data required for the Appropriate Assessment.	These aspects will be considered within the Ornithology ES section and the Habitats Regulations Appraisal (HRA).	Section 12.5 Baseline Description; Ornithological Technical Annex (RPS, 2011b); HRA Report (MeyGen, 2011)
Royal Society for the Protection of Birds (RSPB)	Whilst adverse effects on birds arising through collision or other mechanisms identified on p.55 seem unlikely to be significant, there is great uncertainty about this as we lack the detailed knowledge to be gained from experience of the installation of such devices elsewhere, particularly in a high-energy, bird-rich site. It is known that guillemots and other diving seabirds do reach such depths and so could be affected. Consideration should also be given to the likelihood of pollution, from the devices themselves or from associated vessels as this could directly impact on birds or give rise to secondary effects through their foodstuffs.	These aspects will be captured within the Ornithology ES section Potential pollution events and their implications are considered in the ES.	Impact Assessment Sections: 12.6.2, 12.6.3, 12.7.2, 12.7.3, 12.7.5
RSPB	In addition to the North Caithness Cliffs SPA, other Natura sites which may be affected by the proposed development should also be considered in the EIA. The qualifying interest of the nearby Pentland Firth Islands – breeding Arctic terns – might be thought unlikely to be affected as these birds are shallow divers. A small area of sandbank has been identified within the lease area however, which may support sandeels, their principle food, so a systematic appraisal of the possibility of impact must be completed. We note, too, that spawning and nursery grounds for sprats occur within the study area: this is another important food for seabirds and the possibility of secondary impacts must be considered. The continuing run of poor seabird breeding seasons and consequent population declines give further reason for adopting a precautionary approach as any adverse impacts, however small, arising from new development would be additional.	An HRA Screening process has been undertaken and consultations undertaken with Marine Scotland and SNH on the HRA process and its application to the Project. This has informed the SPA sites and Project impacts that need to be considered from an HRA perspective.	Impact Assessment Sections: 12.7.6, 12.11; HRA Report (MeyGen, 2011)

Note:

1: The mean maximum foraging range for a species is defined as the mean of the maximum foraging distances from the range of studies and data sources held for that species by BirdLife International – http://seabird.wikispaces.com

Table 12.3: Scoping comments relevant to ornithology

Desk based study

12.17 Information regarding species specific seabird ecology was obtained from a wide range of sources and is cited within the text as appropriate. The main sources of seabird population estimates were the most recent national seabird census (commonly referred to as Seabird 2000, Mitchell *et al.,* 2004) and for updated data the Seabird Monitoring Programme online database (http://jncc.defra.gov.uk/page-4460), maintained by the Joint Nature Conservation Committee (JNCC).

12.18 The bird descriptions and impact assessment for the onshore aspects of the Project are entirely desk based, utilising Phase 1 habitat assessments, descriptions of the bird interests in the region and the JNCC SPA citations.

12.4.2 Field survey

12.19 Two independent field surveys were undertaken to obtain baseline bird information (but also incorporating marine mammals and basking sharks); boat based observations and land based observations. Both were conducted over a period of two years, between October 2009 and September 2011. At the outset of the survey programme there was no specific guidance on surveying for tidal turbine developments. Consequently, SNH were consulted during the initial development of the survey methods, and further consulted about refinements promoted after the preliminary surveys had been undertaken. Further details are provided in the relevant sections.

Boat based survey

12.20 Boat surveys were conducted across the entire Agreement for Lease (AfL) area as defined in October 2009 (covering 3.25km^2) and a surrounding 1km buffer (hereafter the boat based survey area). Water depths within the boat based study area vary between 31 and 47m below lowest astronomical tide, whilst tidal currents within some parts of the area can reach 5.0m/s during spring flood tides, although 2.0 – 3.5m/s is more typical. The buffer area was included because of the lack of a control site. In consultation with SNH it was decided that identification of an appropriate control site was not feasible due to the fact that the combination of physical and tidal features in the Inner Sound were unlikely to be well represented by any nearby areas of sea.

12.21 Boat surveys were conducted at monthly intervals between October 2009 and September 2011, except in October 2010 and December 2010, when surveys were not undertaken due to extended periods of unsuitable weather. Thus, a total of 22 boat surveys were undertaken (SNH advised that there was no requirement to provide additional surveys for those ones missed).

12.22 Boat surveys were conducted using modified European Seabird at Sea (ESAS) methods, and based on those developed for surveying proposed offshore wind farm developments (Tasker *et al.,* 1984; Camphuysen *et al.,* 2004; Maclean *et al*., 2009). The standard methods are appropriate to larger offshore survey areas, such as offshore wind farm developments, but were modified to account for the smaller scale of the study area.

12.23 Thus, a line-transect method was used but with the width of the surveyed area reduced from 300m to 200m on either side of the survey vessel, to minimise the chances of double counting individuals, which are increased on this site due to the shorter transect lengths involved (Figure 12.2). It was initially proposed to survey against the direction of flow to further reduce this risk; however the high flow speed meant that this was not possible. Nevertheless, because the transect traverses the main direction of flow approximately perpendicularly, the risk of double counting is considered to be low. Birds were recorded both on the sea surface and in flight, however given the nature of the proposed development, the baseline description section (Section 12.5) and impact assessment sections (Section 12.6, to Section 12.9) are based just on birds recorded on the water.

12.24 The initial survey route, used for the first two boat surveys, consisted of a 15km long step-shape with 90° turns, with primary transects running north – south and linking ones east – west. This route was difficult for the survey vessel to maintain due to the strong tidal flow. Therefore a revised route was trialled during the third survey, consisting of a 13km long saw-tooth profile. The proposed change was discussed with SNH prior to its trial and its use agreed. The new route was found to be more achievable and was used for the remainder of the surveys).

12.25 The survey area was based on the full extent of the Agreement for Lease (AfL) area as defined in October 2009. This AfL area was slightly modified towards the end of the two year survey period (see Section 4). While the boat survey route still sampled all of the AfL area, SNH raised concerns about the extent of coverage at the north west end of the site (Table 12.3). However, with regards to the Phase I area alone, these concerns were withdrawn. Therefore the survey data remains suitable for the Phase I site characterisation and impact assessment purposes.

12.26 The density of species recorded on the sea surface was estimated using Distance analysis (Thomas *et al*., 2010). Due to the comparatively small scale of the site, it was not possible to estimate densities just using observations made within the Project site. Hence, the densities reported here are those estimated for the entire boat survey area. Estimated monthly abundances for each species within the Project area were derived as the product of the area and the density.

12.27 An additional component of the boat surveys, not included in the standard ESAS methods, was the collection of data on dive duration for diving seabirds. This was undertaken from four locations ('stationary points') within the Inner Sound (Figure 12.2).

12.28 Surveys were planned to coincide with a range of tidal conditions, although constraints due to poor weather sometimes restricted the range of tides across which data were collected. The number of survey runs completed per day varied between summer and winter due to differences in day length, but no more than three of the four transects and two of the four sets of stationary point observations were obtained on any single day. The short day length during winter also precluded surveying across the complete tidal range over consecutive days, so that wherever possible surveys in consecutive months were undertaken during different states of tide. In addition, surveys alternated monthly between neap and intermediate tides, but surveys could not be completed during spring tide conditions because the strong tidal flow prevented stationary point observations being made. These conditions were however covered by land based surveys.

12.29 Further details on the methods employed are provided in the accompanying Ornithological Technical Annex (RPS, 2011b).

Land based survey

12.30 The proximity of the AfL area to land means that land-based vantage point (VP) surveys can provide a valuable complement to the boat surveys. Land based observations can be undertaken across a wider spread of time than is practical with boat-based surveys, thereby filling in potential gaps in the boat survey programme. Therefore, they are useful in providing more detailed information on seasonal, and other temporal, variation in abundance of bird species and in helping to assess the reliability of seasonal trends determined from the boat surveys.

12.31 As with the boat surveys, the methods for land-based-based VP surveys were developed in discussion with SNH. Methods were adapted from the VP surveys used for onshore wind farm developments (SNH, 2005), but with the focus on recording birds on the sea, although birds in flight were also recorded. Three locations were selected for VP surveys, which offered a range of viewpoints across the study area (Figure 12.2). Although the island of Stroma would have offered potentially suitable locations for VP surveys, all three locations had to be on the mainland because of the health and safety concerns associated with locating personnel onto a small uninhabited island.

12.32 VP surveys were undertaken from October 2009 to September 2011, with a total of 198 visits across all VPs made during this period. The target level of survey intensity was to achieve a minimum of six hours of observation at each of the three VPs in each month. This was typically spread across two, three hour periods, separated at each individual VP by at least seven days (although sometimes sessions were split into shorter periods). This ensured a wide spread of observations throughout each month. Some surveys were conducted from different VPs on the same day, but only sequentially, not concurrently.

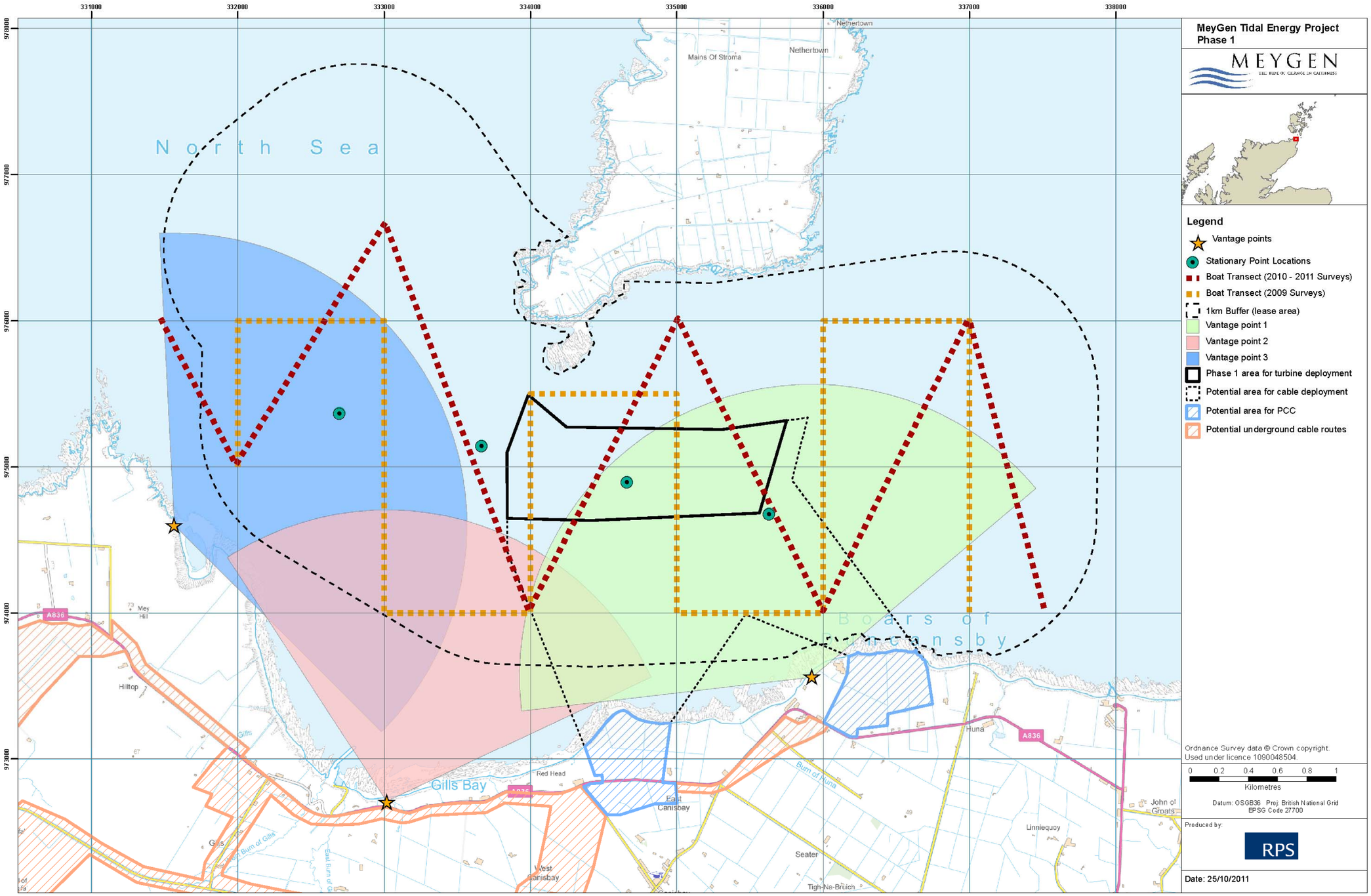

Figure 12.2: Boat survey route, static point locations and land based vantage point viewsheds for the MeyGen Tidal Energy Project. The orange line indicates the boat route originally used (2 surveys) which was then modified to the red route for all remaining ones

12.33 During each survey the viewshed (i.e. the visible area within which bird observations were recorded) was scanned systematically by a single observer and bird locations were recorded using a grid system. Each half-hour of a survey period was divided between different activities. Approximately 20 to 25 minutes were devoted to recording the positions of all birds observed on the water, recording species, number, grid cell and precise time of day. A further 5 to 10 minutes were spent recording snapshots of birds in flight. The latter activity was undertaken during two periods of approximately five minutes, and involved recording the species, number, distance from the observer (in 500m bands), flight height (as <2m, 2 to 10m or >10m) and precise time for any birds passing a fixed bearing.

12.34 Vantage point surveys were timed to provide information on patterns of bird behaviour through the tidal cycle and different seasonal periods. Of the six hours of observations undertaken at each VP per month, half were timed to occur around low tide, and half around high tide. Surveys were also spread between neap, intermediate and spring tides, with the aim of covering the full range of tide states within each season.

12.35 The counts from the land based surveys could not be used to generate bird density estimates in the same way as for those from boat surveys. This was because the decrease in detection rate with distance from the observer was confounded with likely changes in actual bird density with increasing distance from the shore. Thus, land based counts were expressed in terms of birds recorded per hour to provide an index of bird activity.

12.4.3 Impact assessment methods

12.36 Determination of potential impacts on seabird populations was achieved using a range of methods, some of which have been developed specifically with regard to diving seabirds and tidal turbines. Brief details are provided below, with more comprehensive descriptions provided in the Ornithological Technical Annex (RPS, 2011b, a copy of which is provided in the supporting studies CD).

12.37 The potential impacts considered in this assessment are:

- Disturbance and displacement of birds during the construction phase due to vessel presence and offshore construction activities;
- Accidental spillages of pollutants from construction and maintenance vessels;
- Disturbance and displacement during the operational phase due to maintenance activities (e.g. vessel traffic) and the presence of the turbines themselves;
- Increased annual mortality rates for diving species resulting from collisions with operating turbines
- Accidental spillages of pollutants from the turbines;
- Disturbance and displacement of birds during the decommissioning phase (expected to be similar in nature but smaller in magnitude to those during construction); and
- Cumulative impacts in combination with other projects in the region.

Displacement assessment methods

12.38 The potential extent, to which species will be displaced from the Project site due to various sources of disturbance, and the consequent impacts on their populations, is very difficult to predict. Some attempts have been made to estimate this for offshore wind farms (e.g. Horns Rev and Nysted, Denmark, Petersen *et al*., 2006; Southern Kalmar Sound, Sweden, Pettersen, 2005; Egmond aan Zee, the Netherlands, Lindeboom *et al*., 2011). However, the comparative infancy of tidal turbine installations, and the differences between such developments and offshore wind farms with regards to disturbance, means there is little in the way of equivalent methods for these technologies.

12.39 To explore the potential impacts of displacement on seabirds foraging in the vicinity of the turbines, population models were developed for each species considered to be at risk. The impact of displacement on the population of each of these species was modelled as a reduction in breeding success for the proposed lifetime of the Project. This was based on the assumption that each displaced bird will fail to breed. As the tidal turbines themselves could plausibly directly affect only individuals utilising the water column directly above the turbines, the number of individuals at risk of being displaced was estimated for the turbine deployment area (1.1km^2) using the peak breeding season density recorded during the boat surveys. Displacement impacts were considered between 0 and 100% of the birds estimated to be affected, although the worst case (complete displacement) forms the basis of the assessment.

Collision risk assessment methods

12.40 Wind turbine collision risk methods (e.g. Band, 2011) are well established and form a central component of wind farm impact assessments. The potential to adapt wind turbine methods was considered as a starting point for development of the tidal turbine collision model. Wind turbine collision risk modelling uses estimates of the density of birds flying at rotor height collected during site surveys, in combination with species specific variables (e.g. body length, wingspan, flight speed) and wind farm specific variables (e.g. number and dimensions of turbines) to estimate the number of possible transits through the turbine rotors during a given period of time. The probability that a single transit will result in a collision is calculated, and the product of the number of transits and the probability of collision provides an estimate of the number of collisions which would occur during the given period of time. However, this estimate does not include any allowance for avoiding action by birds. Therefore this value is adjusted to take account of avoidance (current research indicates that avoidance rates of ≥ 98% are appropriate).

12.41 The biggest challenges in developing a tidal turbine collision risk model based on this approach are the lack of data regarding the way birds move through the underwater environment (which would determine the number of potential transits and probability of a collision) and the range over which they may be able to perceive moving rotors (which would determine the levels of avoidance rate to use).

12.42 This is a reflection of the difficulty in studying natural seabird diving behaviour in the wild. The way in which diving birds move through their environment is little known, and thus it is not considered possible to estimate the number of rotor transits which may occur during a given period of time. For example, in the wind farm approach, flying birds are modelled on the basis that they pass horizontally through the plane of the rotor blade in a straight line. Diving birds hunting highly mobile prey (e.g. fish) are likely to move rapidly in three dimensions. It is therefore conceivable that whilst pursing prey a bird could pass through the swept volume of a tidal rotor in any direction (e.g. horizontally or vertically), and could potentially pass in and out of the rotor swept volume more than once. The collection of detailed data on how birds move around underwater with which to begin to estimate the rates of rotor transit for a tidal collision model will only become possible through the study of birds in relation to installed devices.

12.43 However, there is a requirement to attempt to make such assessments in advance in order that potential impacts can be assessed as far as possible. To estimate the potential impacts of mortality due to collisions with tidal turbines, a combination of population modelling and exposure time modelling has been developed (RPS, 2011c). SNH commissioned this work from RPS during 2010, as part of ongoing research to improve understanding of the potential environmental impacts of marine renewable energy. The work was overseen by SNH and the Marine Environment Spatial Planning Group (MESPG). MESPG is led by Marine Scotland and includes representatives from Highlands and Islands Enterprise, The Crown Estate, SNH, the JNCC and the renewables industry. During the development of the modelling approach, regular consultations were conducted with nominated officers at SNH, and the finished methodology was presented to MESPG in 2010 before the final report was delivered to SNH in early 2011. A workshop to peer review this modelling approach has recently been undertaken by SNH. While this workshop may lead to further refinements of the methods, the timetable for this process will extend beyond that available for the current application. Therefore, in the absence of alternative guidance (currently it is the only fully developed tidal turbine bird collision modelling approach), the approach developed by RPS and presented to SNH has been adopted here.

12.44 The method developed for assessing potential collisions, generates an estimate of the length of time (during a given period, e.g. one month) that individual birds of each species are predicted to spend within the total rotor swept volume of the proposed development (i.e. the rotor swept volume for all turbines combined). The number of individuals which would be predicted to be killed by collisions can be considered as the product of the collision rate (per unit of time), the population size and the estimated individual exposure time. As discussed, estimating a collision rate directly is not currently possible. However, re-arranging the variables above (exposure time, population size, number killed and collision rate) allows the calculation of the collision rate which would result in a particular number of deaths. Thus, by using the exposure time, population size and the predicted number of individuals which can be removed from the population before the growth rate becomes negative, a minimum collision rate which will lead to an impact on the population can be estimated.

12.45 Although it is not currently possible to state a threshold acceptability for collision rates with tidal turbines, what this approach does enable is the identification of collisions rates which, given a particular population size, are considered to be likely or unlikely to occur, thereby providing evidence as to whether impacts are significant or insignificant.

12.46 A brief summary of the method is provided below, with more details given in the Ornithological Technical Annex (RPS, 2011b). The modelling is based on the following stages:

- Development of a population model, from which thresholds of sustainable additional mortality can be estimated;
- Estimation of the time which individuals of a species spend within the volume of water occupied by the turbine rotors during a defined period (e.g. month, year), and
- Calculation of the collision rate which would be required, given the exposure time, to generate a level of mortality which would trigger a population decline.

12.47 The exposure time model makes the simplifying assumption that the rate of collisions is sufficiently small that it can be assumed to equal the probability of collision. It also assumes that the additional mortality accruing from the turbines is sufficiently small that its affect on the number of animals available in subsequent time periods can be ignored. Both of these assumptions will cause the number of collisions to be slightly over-estimated, thus rendering the approach precautionary. Whilst extending the model to incorporate changes in colony size throughout the year would be possible, this would require an estimate of monthly mortality (both natural and that due to collisions) to be included. Such estimates are not available.

12.48 Indeed, it is worth stressing that the model does not generate estimates of predicted collision mortality, but rather provides an approximate scale of risk for a given species associated with a range of mortality levels. In its present form there is no feedback between the two model components (exposure time and population model) since, as discussed earlier, there is currently no means to estimate tidal turbine mortality rates to feed into the population model. Thus, the population at risk is updated within the population model on an annual basis, irrespective of the variability in monthly rates of exposure time, and the likely variability in timing of collisions this implies.

12.49 The population models for each species have been developed using demographic data collected from published studies. The size of the initial population to use in the model was derived by combining estimates from breeding populations considered to be within range of the site. Published estimates for the mean maximum foraging ranges (e.g. Langston, 2010; BirdLife International, 2011) were used to determine which sites to include in these estimates.

Accidental pollution assessment methods

12.50 The potential impacts of accidental spillages of oil and other pollutants from the vessels involved in the construction and maintenance of the proposed development and the turbines themselves are assessed based on the likelihood of such events occurring and the potential consequences for seabirds in the Inner Sound. Section 24 of this ES provides the Accidental Events Impact Assessment, and the results presented in this section are used here in conjunction with published species specific values of seabird vulnerability to surface pollutants (Williams *et al*., 1995) to generate predicted impacts.

12.4.4 Significance criteria

12.51 The EIA process and methodology are described in detail in Section 8. Each assessment section is, however, required to develop its own criteria for the 'sensitivity of receptor' and 'magnitude of impact' aspects since the definition of these will vary between different topics. For ornithology, the significance criteria used in this section is based on the methodology described in Section 8 but the sensitivity of the receptor and magnitude of impact are defined in Table 12.4 and Table 12.5 respectively.

12.52 The consequences of impacts are then considered by reference to the relevant criteria in the EIA Regulations. The significance of impacts in relation to the EIA Regulations are defined in Section 8, Table 8.2.

Sensitivity of receptor	Definition
Very High	▪ Bird species that forms part of a cited interest of an SPA or Ramsar site that may potentially interact with the Project at some stage of their life cycle. ▪ A bird species for which a significant proportion (more than 1%) of the international population is found within the Project site. ▪ In the context of a particular impact, species which are considered very likely to be negatively affected by that impact.
High	▪ Bird species that forms part of a cited interest of an SSSI that may potentially interact with the Project at some stage of their life cycle. ▪ A bird species for which a significant proportion (>1%) of the national population is found within the site. ▪ In the context of a particular impact, species which are considered likely to be negatively affected by that impact.
Medium	▪ Bird species that are listed on Annex I of the EU Birds Directive or on Schedule 1 of the Wildlife and Countryside Act 1981, requiring increased legal protection from disturbance during the breeding season. ▪ A species listed on the Birds of Conservation Concern (BOCC) Red list. ▪ Birds that are the subject of a specific action plan within the UK Biodiversity Action Plan. ▪ A bird species for which a significant proportion (more than 1%) of the regional population is found within the site, or at the extremity of a distributional range. ▪ In the context of a particular impact, species which may be negatively affected by that impact.
Low	▪ Any other species of conservation interest (e.g. Amber-listed species on the Birds of Conservation Concern not covered above). ▪ In the context of a particular impact, species which are considered unlikely to be negatively affected by that impact.
Negligible	▪ All other species of low Conservation Concern (e.g. Green-listed species). ▪ In the context of a particular impact, species which will not be negatively affected by that impact.

Table 12.4: Definitions for sensitivity of receptor

Magnitude of impact	Definition
Severe	▪ Would cause the loss of a major proportion (>80% population loss) or whole feature / population, or cause sufficient damage to a feature to immediately affect its viability. ▪ Irreversible. ▪ Impact highly likely to occur

Major	▪ Major effects on the feature / population, for example more than 20% population loss. ▪ Irreversibly alter the nature of the feature in the short-to-long term and affect its long-term viability. ▪ Impact likely to occur.
Moderate	▪ Effect leading to between 5-20% population loss. ▪ Effects that are detectable in short and long-term, but which should not alter the long-term viability of the feature/ population. ▪ Impact will possibly occur.
Minor	▪ Effects leading to 1-5% population loss. ▪ Either of sufficiently small-scale or of short duration to cause no long-term harm to the feature / population. ▪ Impact unlikely to occur.
Negligible	▪ A potential impact that is not expected to affect the feature / population in any way; therefore no effects are predicted (<1% population loss). ▪ Impact extremely unlikely to occur.
Positive	▪ An enhancement of an ecosystem or population parameter.

Table 12.5: Definitions for magnitude of impact

12.4.5 Data gaps and uncertainties

Seabird density estimation

12.53 The small spatial scale of the Project means that seabird density estimates cannot be robustly calculated for the Project area itself. This is a reflection of the limitations of analysis methods for seabird surveys, which generate variances around mean values using between transect line variation. With such a small site, it is not possible to accommodate sufficient transects to permit robust estimation. Thus the seabird densities provided in this assessment and used to estimate potential impacts have been calculated at the level of the entire survey area.

Connectivity between seabird breeding colonies and foraging locations

12.54 The origin of seabirds observed within the surveyed area cannot be determined from the boat and land surveys. The only reliable means to establish linkages between a proposed development site and breeding colonies is through the use of geo-location tags fitted to individual seabirds. An attempt was made during the 2011 breeding season to fit tags to black guillemots breeding on the island of Stroma (this was conducted by researchers at the Environmental Research Institute, Thurso). Unfortunately this pilot project failed to provide any useable data, and therefore linkages between the site and breeding colonies has been based on knowledge of foraging ranges (an approach agreed with Marine Scotland SNH).

Seabird diving behaviour and underwater swimming ability

12.55 As discussed in the collision methodology section, the behaviour and movement of seabirds whilst diving is little understood generally due to the difficulty of conducting studies of diving in the wild. These data are considered to be critical for the prediction of mortality rates. The absence of these data has led to the adoption of an alternative approach to collision assessment, whereby the minimum collision rate required to cause a threshold of population impact is derived. Given the current lack of knowledge on diving bird abilities this is considered to be the most appropriate method to adopt.

Terrestrial bird assessment

12.56 The baseline description and impact assessment for the onshore developments presented here is based on published information. Once the specific sites have been identified, targeted bird surveys will be conducted, to determine the distribution, habitat use and status of birds within the Project footprint and the surrounding area.

12.5 Baseline Description

12.57 Located between the northeast tip of the Scottish mainland and the Orkney archipelago, the Pentland Firth Inner Sound is within an area of international importance for seabird populations. This is evident from the wide array of SPAs that are located in this area and which hold large breeding populations of a wide range of seabird species.

12.58 Several SPAs may be considered relevant to the Project area (Table 12.6, Table 12.7). The Project area itself lies within the North Caithness Cliffs SPA, which was designated in 1996 and comprises five separate sections of maritime cliff (nr. Melvich, Scrabster, Dunnet Head, Stroma and Duncansby Head). In 2009 the boundary was amended to include seaward extensions of 2km to each sub-component of the SPA, in recognition that these areas of sea adjacent to the breeding colonies are important for essential activities such as preening, bathing, and displaying (SNH, 2008).

12.59 Additionally, there are at least a further 20 SPAs where potential impacts on qualifying seabird and diver species need to be considered because the Project area lies within the mean maximum foraging range of at least some of these species.

12.60 The species that are listed as qualifying features for each of these SPAs, along with those named as part of the breeding seabird assemblage for the SPA, are given in Table 12.6 and Table 12.7 along with their population estimates for the SPAs (as taken from the citation or more recent re-assessments where available). These tables show that there are a total of 18 species of seabird and diver listed as qualifying features or as part of the breeding seabird assemblage of those SPAs, with some of these species having substantial populations on individual SPAs, as well as across this suite of SPAs. Gannets have a very large foraging range (mean maximum range: 308km), thus in recognition of this fact additional SPAs located beyond Orkney have been included for this species. These are listed in Table 12.7. In addition, black guillemot are also named as a component of the cliff nesting seabird colony on the Stroma SSSI (which lies wholly within the North Caithness Cliffs SPA).

12.61 The ornithological importance of the areas surrounding the Pentland Firth Inner Sound is not restricted to seabirds. Thus, the largest expanse of peatland in the UK occurs in Caithness and Sutherland and encompasses much of the land immediately to the south and west of the Inner Sound. These peatlands are designated for a wide range of bird species, including golden eagle, hen harrier, short-eared owl, golden plover, dunlin, greenshank and red-throated diver.

12.62 Species associated with the North Caithness Cliffs SPA and/or some of the other SPAs listed in Table 12.6 and Table 12.7 for which significant impacts are identified will be subject to a Habitat Regulations Assessment (Section 12.11).

SPA name	Qualifying interests		Minimum distance from the Project (km)
	Name (season)	Number (pairs or individuals, year of citation)	
North Caithness Cliffs	Northern fulmar (breeding)	14,700 prs. (1985-1988)	0
	Peregrine falcon (breeding)	6 prs. (mid-1990s)	
	Kittiwake (breeding)	13,100 prs. (1985-1988)	
	Common guillemot (breeding)	38,300 ind. (1985-1988)	
	Razorbill (breeding)	4,000 ind. (1985-1988)	
	Atlantic puffin (breeding)	1,750 prs. (1985-1988)	
Caithness and Sutherland Peatlands	Black-throated diver (breeding)	26 prs (1986-96)	0.25
	Golden eagle (breeding)	5 prs (1986-96)	

SPA name	Qualifying interests		Minimum distance from the Project (km)
	Name (season)	Number (pairs or individuals, year of citation)	
	Golden plover (breeding)	1,064 prs (mid-1990s)	
	Hen harrier (breeding)	14 prs (1993-97)	
	Merlin (breeding)	54 prs (mid-1990s)	
	Red-throated diver (breeding)	89 prs (1993-94)	
	Short-eared owl (breeding)	30 prs (mid-1990s)	
	Wood sandpiper (breeding)	5 prs (1994-95)	
	Dunlin (breeding)	1,860 prs (1994)	
	Common Scoter (breeding)	27 prs (1996)	
	Greenshank (breeding)	256 prs (1994 - 1995)	
	Wigeon (breeding)	43 prs (1994)	
Caithness Lochs	Greenland white-fronted goose (wintering)	440 ind. (1993/94-1997/98)	2.3
	Greylag goose (Wintering)	7,190 ind. (1993/94-1997/98)	
	Whooper swan (Wintering)	240 ind. (1993/94-1997/98)	
Pentland Firth Islands	Arctic tern (breeding)	1,200 prs. (1992-1995)	8.9
Hoy	Peregrine (breeding)	6 prs. (mid-1990s)	11.2
	Northern fulmar (breeding)	35,000 prs. (1985-1988)	
	Great skua (breeding)	1,900 prs. (NA)	
	Kittiwake (breeding)	3,000 prs (1985-1988)	
	Great black-backed gull (breeding)	570prs. (1985-1988)	
	Arctic skua (breeding)	59 prs. (1985-1988)	
	Atlantic puffin (breeding)	3,500 prs. (NA)	
	Common guillemot (breeding)	13,400 prs (1985-1988)	
	Red-throated diver (breeding)	58 territories (1994)	
Switha	Barnacle goose (wintering)	1,120 ind. (1993-1997)	14.2
East Caithness Cliffs	Northern fulmar (breeding)	15,000 prs. (1985-1988)	22.3
	Great cormorant (breeding)	230 prs. (1985-1988)	
	European shag (breeding)	2,300 prs. (1985-1988)	
	Peregrine falcon (breeding)	6 prs. (1985-1988)	
	Herring gull (breeding)	9,400 prs. (1985-1988)	
	Great black-backed gull (breeding)	800 prs. (1985-1988)	
	Kittiwake (breeding)	32,500 prs. (1985-1988)	
	Common guillemot (breeding)	106,700 ind. (1985-1988)	
	Razorbill (breeding)	15,800 ind. (1985-1988)	
	Atlantic puffin (breeding)	1,750 prs. (1985-1988)	

SPA name	Qualifying interests		Minimum distance from the Project (km)
	Name (season)	Number (pairs or individuals, year of citation)	
	Northern fulmar (breeding)	15,000 prs. (1985-1988)	
Orkney Mainland Moors	Hen harrier (breeding and wintering)	28 females (breeding) 13 ind. (wintering) (1994-98)	29.6
	Red-throated divers (breeding)	18 prs. (NA)	
	Short-eared owl (breeding)	19 prs. (1993-95)	
Copinsay	Northern fulmar (breeding)	1,615 prs. (1985-1988)	31.0
	Kittiwake (breeding)	9,550 prs. (1985-1988)	
	Great black-backed gull (breeding)	490 prs. (1985-1988)	
	Common guillemot (breeding)	29,450 ind (1985-1988)	
Marwick Head	Kittiwake (breeding)	7,700 prs (1991)	48.5
	Common guillemot (breeding)	37,700 ind. (1991)	
Auskerry	European storm petrel (breeding)	3,600 prs. (1995)	51.1
	Arctic tern (breeding)	780 prs. (1992-95)	
Rousay	Northern fulmar (breeding)	1,240 prs. (1986 & 1997)	53
	Kittiwake (breeding)	4,900 prs. (1986 & 1997)	
	Arctic skua (breeding)	130 prs. (1992)	
	Arctic tern (breeding)	790 prs. (1991-1995)	
	Common guillemot (breeding)	10,600 ind. (1986 & 1997)	
North Sutherland Coastal Islands	Barnacle goose (wintering)	631 ind. (1992/93-1996/97)	65.0
Calf of Eday	Northern fulmar (breeding)	1,955 prs. (1985-1988).	65.3
	Kittiwake (breeding)	1,717 prs. (1985-1988).	
	Great black-backed gull (breeding)	938 prs. (1985-1988).	
	Common guillemot (breeding)	12,645 ind. (1985-1988).	
	Great cormorant (breeding)	223 prs. (1985-1988).	
West Westray	Northern fulmar (breeding)	1,400 prs. (1985-1988)	65.7
	Arctic skua (breeding)	78 prs. (1985-1988)	
	Arctic tern (breeding)	1,140 prs (1985-1988)	
	Kittiwake (breeding)	23,900 prs. (1985-1988)	
	Common guillemot (breeding)	42,150 ind. (1985-1988)	
	Razorbill (breeding)	1,946 ind. (1985-1988)	
East Sanday Coast	Turnstone (wintering)	1,400 ind. (1991-1994)	71.5
	Purple sandpiper (wintering)	840 ind. (NA)	
Papa Westray	Arctic tern (breeding)	1,950 prs. (1997)	77.4
Sule Skerry and Sule Stack	European storm petrel (breeding)	500 prs (1985-1988)	82.2
	Leach's storm petrel (breeding)	5 prs (1985-1988)	
	Common guillemot (breeding)	6,298 ind. (1985-1988)	
	European shag (breeding)	874 prs (1985-1988)	
	Atlantic puffin (breeding)	46,900 prs (1985-1988)	
	Gannet (breeding)	4,675 prs (2004)	
Strath Carnaig and	Hen harrier (breeding)	12 prs (2002-04)	88.2

SPA name	Qualifying interests		Minimum distance from the Project (km)
	Name (season)	Number (pairs or individuals, year of citation)	
Strath Fleet Moors			
Dornoch Firth and Loch Fleet	Bar-tailed godwit (Wintering)	1,300 ind. (1992-1996)	88.9
	Greylag goose (Wintering)	2,079 ind. (1992-1996)	
	Osprey (breeding)	20 prs. (early 1990s)	
	Wigeon (wintering)	15,022 ind. (1992-1996)	
Foinaven	Golden eagle (breeding)	6 active territories (2003)	89.1
Cape Wrath	Kittiwake (breeding)	9,700 prs. (1985-1988)	91.1
	Common guillemot (breeding)	13,700 ind. (1985-1988)	
	Razorbill (breeding)	1,800 ind. (1985-1988)	
	Atlantic puffin (breeding)	5,900 prs. (1985-1988)	
	Northern fulmar (breeding)	2,300 prs. (1985-1988)	

Table 12.6: Special Protection Areas (SPAs) and their qualifying interests within foraging range of the MeyGen Tidal Energy Project site

SPA name	Number of breeding pairs (year of count)	Distance from the Project (km)
Fair Isle	1,875 (2004)	129
North Rona & Sula Sgeir	9,225 (2004)	157
Noss	8,652 (2003)	202
Forth Islands	48,065 (2004)	271
Hermaness, Saxa Vord and Valla Field	15,633 (2003)	274

Table 12.7: UK SPAs designated for breeding gannet within mean maximum foraging range (308km)

12.5.1 Seabird populations in the Project area

12.63 Data recorded during the boat based surveys were used to generate estimates of bird densities within the survey area for each survey using observations of birds on the water, while data for birds observed on the sea surface obtained from the land based surveys were used to provide further information on seasonal and annual variation in relative abundance.

12.64 During the 22 boat surveys, a total of 13,248 individuals comprising 19 species were recorded on the sea within the transect area. During land-based surveys a total of 21,568 individuals were recorded during distribution scans, comprising 24 species and 2 species groups (Table 12.8).

Species (sensitivity based on conservation status indicated by colour: see Table 12.4 for explanations)	Species listed as SPA feature or component of SSSI feature (if not SPA feature)	Land based surveys		Boat based surveys (birds on sea)		
		Sum of maximum single survey counts (i.e. sum of survey counts)[1]	Maximum single survey count (i.e. peak day count)[2]	Total number of individuals recorded[3]	Peak density (birds/km^2)[4]	Peak abundance in the turbine deployment area (1.1km^2)[5]
Northern fulmar (*Fulmarus glacialis*)	SPA	1,935	300	2,156	13.12	16
Northern gannet (*Morus bassanus*)	SPA	1,162	500	162	0.99	1
Great cormorant (*Phalacrocorax carbo*)	SPA	38	3	1	-	-
European shag (*Phalacrocorax aristotelis*)	SPA	10,953	1,300	4,744	17.96	21
Common gull (*Larus canus*)	-	200	60	259	12.84	15
Great skua (*Stercorarius skua*)	SPA	1	1	39	0.47	<1
Arctic skua (*Stercorarius parasiticus*)	SPA	2	2	-	-	-
Black legged kittiwake (*Rissa tridactyla*)	SPA	333	110	14	0.12	<1
Herring gull (*Larus argentatus*)	SPA	-	-	61	0.75	<1
Iceland gull (*Larus glaucoides*)	-	1	1	-	-	-
Great black-backed gull (*Larus marinus*)	SPA	-	-	208	2.05	2
Unidentified gull	-	2,370	1,520	-	-	-
Arctic tern (*Sterna paradisaea*)	SPA	95	80	-	-	-
Common guillemot (*Uria aalge*)	SPA	56	12	815	23.92	27
Razorbill (*Alca torda*)	SPA	248	34	332	7.95	9
Atlantic puffin (*Fratercula arctica*)	SPA	138	30	690	12.48	14
Black guillemot (*Cepphus grylle*)	SSSI	482	55	2,504	15.87	18
Unidentified auk	-	1,150	400	-	-	-
Great northern diver (*Gavia immer*)	-	2	1	3	-	-
Red-throated diver (*Gavia stellata*)	SPA	109	14	27	0.3	<1
Red-breasted merganser (*Mergus serrator*)	-	31	6	-	-	-
Common eider (*Somateria mollissima*)	-	1,961	99	1,045	7.76	9
Wigeon (*Anas penelope*)	SPA	24	10	50	1.56	2
Greylag goose (*Anser anser*)	SPA	260	150	124	-	-
Grey plover (*Pluvialis*	-	-	-	14	-	-

Species (sensitivity based on conservation status indicated by colour: see Table 12.4 for explanations)	Species listed as SPA feature or component of SSSI feature (if not SPA feature)	Land based surveys		Boat based surveys (birds on sea)		
		Sum of maximum single survey counts (i.e. sum of survey counts)[1]	Maximum single survey count (i.e. peak day count)[2]	Total number of individuals recorded[3]	Peak density (birds/km^2)[4]	Peak abundance in the turbine deployment area (1.1km^2)[5]
squatarola)						
Common scoter (*Melanitta nigra*)	SPA	1	1	-	-	-
Gadwall (*Anas strepera*)	-	6	2	-	-	-
Goldeneye (*Bucephala clangula*)	-	5	3	-	-	-
Long-tailed duck (*Clangula hyemalis*)	-	6	3	-	-	-
Pintail (*Anas acuta*)	-	1	1	-	-	-

Notes:
[1] The sum (across all surveys) of the peak count made during each 3 hour duration survey.
[2] The peak count recorded during the two years of surveys (i.e. the highest number observed within the survey area during any single 3 hour duration survey).
[3] Represents the total of number of bird observations recorded on the water during all boat surveys.
[4] Estimated by applying Distance analysis to the birds observed on the water recorded during each survey. The value reported here is the highest density recorded across all boat surveys.
[5] Represents the peak abundance of birds on the water within the turbine deployment area during a single survey. This was derived as the product of the peak density multiplied by the Phase 1 area.

Table 12.8: Total number of birds recorded on the sea during land and boat based surveys between October 2009 and September 2011. Boat based density and abundance estimates calculated using Distance analysis of birds observed on sea surface in transects. For those species considered in this assessment, names are colour coded according to their defined sensitivity (see Table 12.4)

12.65 Among the 29 species recorded in total, several form part of the SPA citations in Table 12.6 and Table 12.7, either qualifying under (i) Article 4.1 of the Directive (2009/147/EC) by supporting populations of European importance listed on Annex I of the Directive; (ii) Article 4.2 of the Directive (2009/147/EC) by supporting populations of European importance of migratory species; or (iii) forming part of a seabird assemblage of international importance under Article 4.2.

12.66 Species sensitivity was evaluated by considering a range of criteria concerning the importance of both the numbers of birds on the site and/or the overall conservation status of the species, and whether the species is protected under certain legislation, or is a cited interest feature of a designated site of national or international importance. The sensitivity categories of the ornithological receptors are defined in Table 12.4. Thus, density and peak population data from the boat surveys were used, but at this stage ecological and behavioural characteristics that might affect the species' response to the Project and its construction and decommissioning were not evaluated.

12.67 Target species for assessment were chosen from the list of species listed within local SPAs and non-SPA seabird colonies by evaluating boat and land-based survey data and determining species occurrence in the study area. Individuals were assumed to originate from seabird colonies in the region, defined as those within the mean maximum foraging range of the Project site. This list primarily focussed on species which forage at sea at depths which could put them at risk of direct impact (either through displacement or collision). However, additional species which do not dive to such depths were included to reflect the potential for indirect impacts mediated through effects on prey species. Some species which were not recorded in large numbers were also included, for example, in acknowledgement of their wider conservation status.

12.68 The species selected which were observed during the boat surveys are listed in Table 12.9. Peak populations which exceed 1% of the national threshold are classified as nationally important populations; peak populations which exceed 1% of the regional population threshold are classified as regionally significant. Two additional species, only seen during the land based surveys (cormorant and Arctic tern) were also considered at potential risk and included in the baseline descriptions and impact assessment.

12.69 Although wigeon, common scoter and greylag goose are technically of very high sensitivity (Table 12.8), due to them being SPA qualifying species within potential foraging range of the development site, these species are not considered further for detailed assessment. Wigeon and common scoter are qualifying species of the Caithness and Sutherland SPA during the breeding season, however no observations of either species were made within this period. The infrequency of records and relatively small numbers of each species in the winter periods, compared to overall migratory numbers are insignificant, and so no effects are predicted. For greylag goose (qualifying for the Caithness Lochs SPA over winter), although occasional records were made during boat and land surveys of birds loafing on the sea, the species will not utilise the offshore Project area for foraging, and so no effects are predicted. All three species are however considered in relation to the potential terrestrial effects of the development on bird species.

Species (sensitivity based on conservation status indicated by colour: see Table 12.4 for explanations)	Estimated Peak Population in turbine deployment area		Number of individuals required to meet GB 1% Threshold[1]	Nationally Important Population as determined by 1 % threshold ?	Mean maximum foraging range (km)[2]	Regional Population (number of breeding birds within mean maximum foraging range[3])	Regionally Important Population?
	Winter (Oct-Apr)	Summer (May-Sep)					
Northern fulmar	15	7	9,975	No	311	396,698	No
Gannet	1	1	4,371	No	308	44,718	No
Cormorant	NA	NA	350	No	32	0	No
European Shag	21	16	5,200	No	16	628	Yes
Great skua	<1	<1	193	No	42	4,816	No
Arctic skua	NA	NA	43	No	40	1,582	NA
Common gull	15	<1	4,293 (winter) 963 (summer)	No	50	8,572	No
Herring gull	<1	<1	2,772 (winter) 4,500 (summer)	No	54	10,686	No
Great black-backed Gull	2	<1	342 (winter) 400 (summer)	No	40	5,460	No
Black legged Kittiwake	<1	<1	7,337	No	66	262,740	No
Arctic tern	NA	NA	530	No	12	1,508	NA
Common guillemot	3	27	13,224	No	61	278,874	No
Razorbill	4	9	1,645	No	31	6,971	No
Black guillemot	18	16	381	No	12	431	Yes
Atlantic puffin	14	12	11,614	No	62	4,088	No

Species (sensitivity based on conservation status indicated by colour: see Table 12.4 for explanations)	Estimated Peak Population in turbine deployment area		Number of individuals required to meet GB 1% Threshold[1]	Nationally Important Population as determined by 1 % threshold ?	Mean maximum foraging range (km)[2]	Regional Population (number of breeding birds within mean maximum foraging range[3])	Regionally Important Population?
	Winter (Oct-Apr)	Summer (May-Sep)					
Red-throated diver	<1	0	41	No	12	479	No
Eider	9	4	550 (winter) 624 (summer)	No	38	Unknown	Unknown

Notes:
[1] As determined using GB population estimates given by Baker et al. (2006) or Holt et al. (2011).
[2] Defined as the mean of the maximum foraging distances from the range of studies and data sources held by BirdLife International – http://seabird.wikispaces.com.
3 As determined using data from Mitchell et al. (2004) and the JNCC Seabird Monitoring Programme (http://jncc.defra.gov.uk).

Table 12.9: Estimated peak abundance of target species in the turbine deployment area, recorded during boat surveys compared to regional and national abundance thresholds

12.70 The monthly density for each of the target species derived using Distance analysis of birds observed on the sea surface during the boat surveys, averaged over the two years of surveys is presented in Table 12.10. This overview highlights the patterns of site use among the target species, with auks present at densities in the breeding season (although black guillemot are present in higher numbers through most of the year), the gulls, eiders and red-throated divers present in higher densities in winter (albeit at much lower overall levels), gannets present in very low densities in most months and shag present in higher densities throughout most of the year.

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Northern fulmar	2.69	11.32	8.29	3.33	3.20	4.08	5.11	1.42	1.06	-	0.64	1.73
Northern gannet	0.28	-	0.15	0.79	0.09	0.40	0.13	0.02	0.25	0.81	0.10	-
European shag	9.27	12.59	14.43	8.18	7.70	7.16	9.05	10.08	8.68	3.56	12.36	2.18
Great skua	-	-	-	0.10	0.11	0.29	0.09	0.09	0.10	-	-	-
Common gull	0.06	6.44	0.07	0.04	-	0.04	-	0.05	-	-	0.13	-
Herring gull	0.37	0.43	0.46	-	-	-	-	0.04	-	-	0.32	0.06
Great black-backed gull	1.17	0.98	0.62	0.09	-	0.01	0.07	0.03	0.02	0.15	0.15	0.04
Black-legged kittiwake	0.02	0.07	0.06	0.04	-	0.02	0.02	-	0.02	-	0.02	0.05
Common guillemot	-	1.38	1.71	1.92	4.31	5.79	12.33	0.09	0.61	0.50	0.53	0.08
Razorbill	-	-	1.53	1.79	3.38	0.89	4.02	-	0.05	0.39	0.09	-
Black guillemot	6.76	11.62	13.78	13.17	11.33	7.32	7.54	6.16	1.52	0.17	4.04	4.95
Atlantic puffin	-	-	0.03	6.70	3.42	8.70	2.66	0.07	-	-	0.08	-
Red-throated diver	0.06	0.08	0.21	0.04	-	-	-	-	-	-	0.02	-
Eider	2.28	5.68	4.64	0.37	0.05	0.02	1.65	-	-	0.19	2.08	1.68

Key to shading:	
	< 2.0 birds/km2
	2.01 – 6.0 birds/km2
	6.01 – 10.0 birds/km2
	>10.01 birds/km2

Table 12.10: Average monthly density of birds observed on the sea surface during boat surveys of the Project site

12.71 For each of the target species selected for inclusion in the impact assessment, population densities for the boat based survey area are presented below, together with data on the seasonal, annual and spatial distribution across this area. Land-based survey data are also presented to augment the boat data in providing information on seasonal and annual variation in species occurrence and abundance. While the seasonal trends for the boat data present the estimates for each survey, to aid clarity, the land based observations have been combined into a single monthly estimate across all years. The designated sites (SPAs and SSSIs) within foraging range for which each species is a qualifying feature are also indicated. The exact connection between the SPA populations of these species on designated sites and those using the Project area are examined in more detail in the HRA.

Northern fulmar

12.72 Northern fulmars (hereafter fulmar) are one of the most common seabirds all year round in northern Britain. Adults show no pronounced pattern of migration, but rather disperse from the colonies at the end of the breeding season and return to nest the following year (Mitchell *et al*., 2004). The highest numbers of fulmar in the north and west of Scotland, including Shetland, occurs between March and April and continues into July with high numbers of birds around nest sites at this time. Between August and November the distribution of fulmars extends southwards as birds disperse from their breeding colonies. In the months between December and February, the highest densities of fulmar remain in the vicinity of Shetland, Orkney and the Moray Firth (Stone *et al*., 1995). Fulmars feed at sea on a wide range of marine foods, notably zooplankton, small fish and offal from fisheries, with the importance of different food sources varying geographically and temporally, both within and between years (Mitchell *et al.* 2004). Most feeding is by surface-seizing whilst floating or swimming, and rarely by pursuit plunging during which they may reach depths of over 4m (Cramp & Simmons, 2004).

12.73 The European population of fulmar is between 2.8 and 4.4 million pairs, and is considered stable (Burfield & van Bommel, 2004). Great Britain supports over 500,000 pairs, or between 11% and 18% of the European total population, most of which breed in Scotland. Although the overall population is stable and

appears to be undergoing continued range expansion, fulmar are recognised as a species of conservation concern in Britain as over 50% of the breeding population occurs within ten breeding sites (Eaton *et al*., 2009). Mitchell *et al*. (2004) recorded an overall increase of 4% in numbers across Caithness and Orkney since the late 1980s, but with some geographical variations in this trend, and with the increase driven largely by changes on Orkney.

12.74 Mitchell *et al*. (2004) recorded a total of 120,803 Apparently Occupied Sites (AOS) in Orkney, Caithness and the East Sutherland coast, whilst a further 23,200 were recorded on the northwest Sutherland coast (some of which will be in the vicinity of the MeyGen site) during the Seabird 2000 survey programme, compared to a total of 485,852 AOS in the whole of Scotland (of which 279,390 were in Shetland and Orkney). The Seabird Monitoring Programme database yields an estimate of 60,700 pairs in Orkney counted during the Seabird 2000 census (Mitchell *et al*., 2004).

12.75 The peak density of birds recorded on the survey area was 13.12per km^2. Boat surveys recorded fulmar activity on the survey area year round with only October 2009 and November 2010 surveys failing to record any birds. Numbers were highest between March and August when adults were attending nests, but with a marked pre-breeding peak, when birds have recently returned to their nesting sites. In terms of the distribution within the survey area, birds occurred throughout the site in most seasons, but with the greatest concentrations occurring in the western and northern parts of the area (Figure 12.3). Fulmar are qualifying interests of the following SPAs in the North of Scotland and Orkney region: North Caithness Cliffs, Hoy, East Caithness Cliffs, Copinsay, Rousay. Calf of Eday, West Westray and Cape Wrath (other SPAs may need to be considered in the HRA).

Northern gannet

12.76 Great Britain is home to over half of the world breeding population of northern gannet (hereafter gannet), which is estimated to be about 390,000 pairs (Mitchell *et al*., 2004). Gannets return to their breeding colonies from early January, tending to be a month or so later in the most northern British colonies; many British breeders having spent the autumn and early winter months in waters around southern Europe and north Africa. Colony attendance is variable until April when the first eggs are laid (Cramp & Simmons, 2004). Gannets are an opportunistic, generalist, predator that feed on a wide variety of prey, mostly surface schooling fish and squid, but also discards from trawlers (BirdLife International, 2011). They appear to focus foraging activities on bathymetric features probably associated with high primary productivity (e.g. deep-water depressions and sandbanks) and, when foraging, employ both short dives of a few metres only and longer dives (up to 30 seconds), taking them to depths of 20m or more (BirdLife International, 2011; Mitchell *et al*., 2004). Dive behaviour studies undertaken during the present surveys recorded an average dive duration of approximately seven seconds for gannet, but this was derived from only six observations.

12.77 Gannet is of conservation concern within the UK, being Amber listed (i.e. of moderate concern) in the UK's Birds of Conservation Concern (BoCC) (Eaton *et al*. 2009). This is on the basis of the international importance of the British population, which represents over 20% of the European breeding population. Furthermore, over half of the British gannet breeding population occurs at less than ten sites. The Scottish gannet population accounts for 70% of the GB population (Mavor *et al*., 2006).

12.78 Site Condition Monitoring of gannet colonies in north east Scotland has revealed significant increases in the breeding population, with an annual rate of increase of 8 % between 2001 and 2004 (Murray *et al*., 2006).

12.79 At a distance of 82km, Sule Stack is the closest breeding colony to the Project site. Numbers here were estimated as 5,137 apparently occupied nests (AONs) in 1998-2000 (Mitchell *et al*. 2004). Numbers at this colony have fluctuated in the last few decades, with a decline of 17% between the mid 1990s and mid 1980s, followed by a 5% increase from the mid 1990s to 1998-2000 (Mitchell *et al*., 2004).

12.80 The peak density of birds recorded on the survey area was 0.99 birds per km^2 (April 2010). Numbers estimated across the survey area were variable both throughout the year and across the two years of study. There were no readily discernible patterns in the distribution of gannet records across the survey area (Figure 12.4). Gannet are qualifying interests of the following SPAs in the North of Scotland region: Orkney and Shetland region: Forth Islands, Sule Skerry and Sule Stack, Fair Isle, North Rona and Sula Sgeir, Noss and Hermaness, Saxa Vord and Valla Field.

Great cormorant

12.81 The great cormorant (hereafter cormorant) is a species that occupies both marine and freshwater habitats. In the marine environment it is generally associated with sheltered coastal areas in estuaries, coastal bays and similar habitats, and generally avoids deep water and areas that are far offshore (BirdLife International, 2011). At sea, the species feeds primarily upon bottom-living fish over bare or vegetated substrates (e.g. flatfish, blennies and gadoids), but will also take schooling fish (e.g. sandeels).

12.82 The cormorant is listed as a species of low conservation concern in Europe, with an estimated 55,000 pairs, of which the UK number is an estimated 6,824 pairs (Mitchell *et al*., 2004), representing 12%. Just over half of these breed in Scotland, with Orkney (412 AON) and Caithness (107 AON) accounting for 14% of this total.

12.83 No cormorant were observed during the boat surveys of the Inner Sound, however they were observed on the sea on 30 occasions from the land based surveys, of which only five were between April and August (inclusive, taken as the breeding season, Snow and Perrins, 1998). It thus appears that the Inner Sound is not an important site for this species during the breeding season. Most observations were of individual birds (83% of records) with the largest flock observed comprising four birds. It is not possible to estimate a density for this species from the land observations because Distance analysis could not be applied to land-based data (due to the confounding effects of variations in bird density with distance from the shore and with distance from the observer). The only SPAs for which cormorant are a qualifying interest in the North of Scotland and Orkney region are East Caithness Cliffs and Calf of Eday (other SPAs may need to be considered in the HRA).

European shag

12.84 The European shag (hereafter shag) is a largely sedentary species that shows a strong preference for rocky coasts and islands with adjacent deep water. Primarily an inshore species, shags tend to forage over sandy and rocky seabeds, showing preferences for sheltered fishing grounds, such as bays and channels, although generally avoiding estuaries and shallow inlets (BirdLife International, 2011). Shags feed almost exclusively on fish, taking a wide range of benthic, demersal and pelagic species, but with sandeels predominating in most dietary studies at British colonies (BirdLife International, 2011). Other prey that are commonly taken include gadoids, gobies, flatfish and sea scorpions. Foraging often involves deep dives, and studies show a wide range of dive depths (e.g. 4m to 61 m at Sumburgh Head, Shetland), with mean dive depths of approximately 20m to 30m. Dive depths may also vary significantly between years at the same site (BirdLife International, 2011). Dive durations recorded during the present surveys differed between the breeding (May to July) and non-breeding periods, averaging 47 seconds and 96 seconds, respectively.

12.85 The shag is listed as a species of low conservation concern in Europe, with between 75,000 and 81,000 breeding pairs. The estimated number of pairs in the UK is 27,477 breeding pairs (Baker *et al*., 2006), comprising 38.3% of the bio-geographic population and 34.1% of the global population (Mitchell *et al*., 2004). This species is of moderate conservation concern (Amber-listed) in the UK due to its localised populations and recent breeding population decline.

12.86 Eighty percent of the breeding European shag population in Britain nests in Scotland. Of these birds, 3,008 AONs are estimated to occur in Orkney and Caithness. There are a further 880 AONs on the northwest Sutherland coast, some of which may occur within the vicinity of the Project site (Mitchell *et al*. 2004). Breeding birds in these areas are often resident year round, generally remaining close to colonies and foraging close to shore.

12.87 In keeping with the national trend, numbers of European shag have declined in both Orkney and Caithness over the last few decades, with declines of 26% and 57%, respectively, recorded in these areas between the mid 1980s and 1998-2000 (Mitchell *et al*., 2004).

12.88 The peak density of birds recorded on the survey area was 17.96 per km^2, with relatively high numbers of birds present on the survey area year-round. The lower abundance of birds recorded during the summer period coincides with birds attending nests and chicks at colonies. Birds were relatively evenly distributed across the survey area during the pre-breeding (February to April) and winter (November to January) periods, but showed a distinct concentration in the northern half of the area (and particularly in the areas immediately south of Stroma) during the breeding (May to July) and post-breeding (August to October) periods (Figure 12.5). The only SPAs for which shag are a qualifying interest in the North of Scotland and Orkney region are East Caithness Cliffs and Sule Skerry and Sule Stack (other SPAs may need to be considered in the HRA).

Common gull

12.89 The common gull is a widespread breeder across Europe and is equally adapted to breeding on exposed marine coasts as it is to inland sites, which may be close to or far from water (Cramp & Simmons, 2004). Seacoast breeding sites include small inshore rocky stacks, islands, cliff ledges and shingle banks, whilst the main prey taken by birds occupying marine environments are likely to comprise invertebrates (e.g. bivalves and crustaceans) and fish, with the latter being taken by direct predation, kleptoparasitism and scavenging. Predation of fish is largely by surface-seizing of prey, and plunge-diving is rare (Cramp & Simmons, 2004).

12.90 The European population is estimated to be in excess of 590,000 pairs (Burfield & van Bommel, 2004). There have been recent declines in numbers across much of north-west Europe and the population is classed as depleted, so that it has an unfavourable conservation status within Europe (Burfield & van Bommel, 2004). Within the UK, the species has increased in recent decades but is classed as of moderate conservation concern (Amber-listed) on the basis of it's unfavourable European conservation status, as well as the international importance of the UK wintering population is (Eaton *et al*., 2009).

12.91 Mitchell *et al*. (2004) estimated that there were 11,733 AONs in Orkney, Caithness and the East Sutherland coast, with the vast majority of these (11,141) being in Orkney. This represents almost 25% of the British breeding population. An estimated 453 AONs were recorded on the North Caithness coast. Numbers in Orkney and Caithness have increased over recent decades, with increases of 37% in Orkney and of 208% in Caithness between the mid 1980s and 1998 to 2000 (Mitchell *et al*., 2004).

12.92 Common gull were mostly recorded in low numbers during the winter, with a marked peak in February 2010 giving a density of 12.8 per km^2. This equated to a peak abundance of 176 individuals within the survey area. In no other month was the abundance greater than three individuals. The distribution of sightings across the Inner Sound indicates the presence of a few large flocks, as would be expected for wintering gulls (Figure 12.6). Common gull are not a qualifying feature for any of the SPAs or SSSIs in the North of Scotland and Orkney region.

Great skua

12.93 The British population of great skuas represents 61% of the northern hemisphere population of this species (with the northern hemisphere population representing the world population of the nominate subspecies of this polytypic species). The entire British population breeds in the far north of Scotland, and primarily in Shetland (Forrester *et al*., 2007). The species is migratory, typically wintering off Iberia and northwest Africa, with birds leaving their breeding areas in late summer and returning in March to April (BirdLife International, 2011). A wide range of prey is taken by great skuas, notably fish, discards from trawlers and other seabirds, and there may be considerable annual, seasonal and geographic variation in diet, whilst particular individuals may also specialise on particular prey-types. The main fish species in the diet include sandeels, whiting, haddock and herring, and these are taken by splash diving, surface seizing or kleptoparasitising other seabirds. During the breeding season, some birds may forage far offshore (possibly 50km to 100km from their breeding site), although others remain much closer to their breeding areas, whilst foraging is concentrated in offshore and pelagic zone outside the breeding season (BirdLife International, 2011).

12.94 Great skuas are of moderate conservation concern (Amber-listed) within the UK, on the basis of both the international importance of the population (exceeding 20% of the European population) and on its localised occurrence (at 10 or fewer sites). Mitchell *et al*. (2004) estimate there to be 9,600 apparently occupied territories (AOTs) in Britain; this count, however, was taken before the sandeel fishery collapse and is a peak number (Furness, 2007). Of these, 2,207 occurred on Orkney and five in Caithness. Numbers on Orkney have increased dramatically since the early 1970s (by 2,410%), but with most of that increase having occurred by the mid 1980s, since when there has been a 10% increase (Mitchell *et al*., 2004).

12.95 Great skuas are a summer visitor to Britain and spend their winters at sea, typically off Iberia (BirdLife International, 2011). Boat survey data reflect this, with birds recorded on the survey area between the months of April and September only, and a peak from June to August. A peak density of just 0.48 birds per km^2 was recorded on the survey area in 2011, when overall numbers were higher than in 2010. No discernible distributional patterns are apparent across the survey area, which is unsurprising given the scarcity of records overall (Figure 12.7). The only SPA for which great skua are a qualifying interest in the North of Scotland and Orkney region is Hoy (other SPAs may need to be considered in the HRA).

Arctic skua

12.96 The Arctic skua is a long-distance migrant, with small numbers wintering in the Northern Hemisphere. Individuals typically leave the breeding area in August, and returns in April-May (seabird.wikispaces.com).

12.97 In the breeding season, this species breeds in moorland or grassland. Individuals typically obtain food through kleptoparasitism on other seabird species, but can also take wader chicks, bird's eggs, insects and berries (BirdLife International, 2011). Birds generally do not have a specific foraging habitat; rather their foraging areas are determined by the opportunities for kleptoparastism, so the birds are commonly found around colonies of host species. Consequently, it is likely they obtain most of their prey without venturing far out to sea.

12.98 Arctic skua is listed as a species of low conservation concern in Europe, with an estimated 20,000-40,000 pairs, of which the UK number is an estimated 2,136 pairs (Mitchell et al., 2004), representing upwards of 5%. All of these breed in Scotland, with Shetland (1,120 AOT) and Orkney (720 AOT) accounting for 86% of this total. Caithness holds around 3% (71 AOT).

12.99 No cormorant were observed on sea during the boat surveys of the Inner Sound, however they were observed in flight on eight occasions between May and August 2010, with a single individual in June 2011. Only one bird was observed on land-based surveys, in May 2010. It thus appears that the Inner Sound is not an important site for this species during the breeding season. As would be expected, nearly all observations were of individual birds with two birds recorded simultaneously on one occasion. It was not possible to estimate an accurate density for this species from the boat or land observations as there were insufficient counts for Distance analysis. The only SPA within foraging range for which Arctic skua is Hoy.

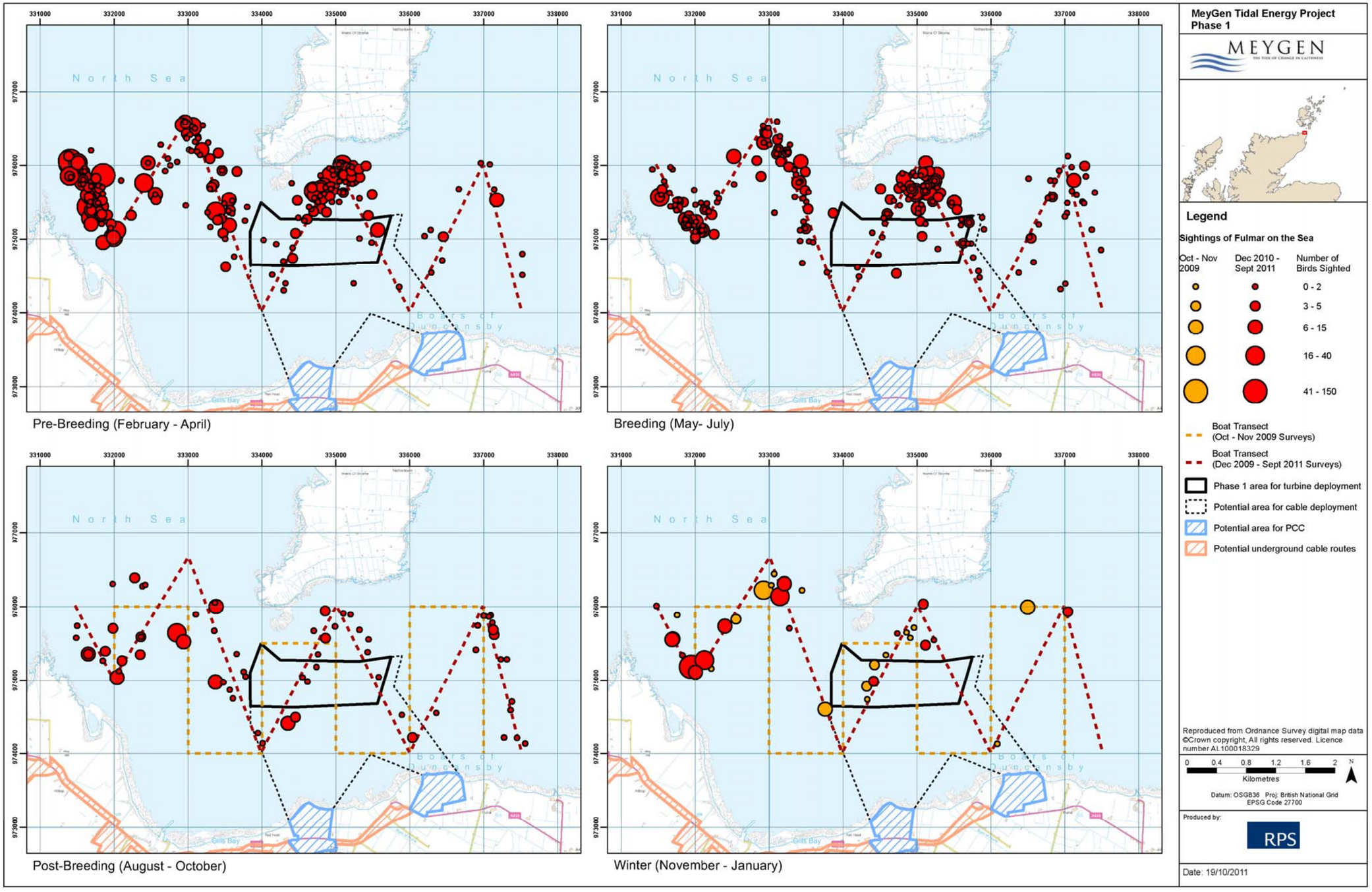

Figure 12.3: Boat based observations of northern fulmar recorded between October 2009 and September 2011

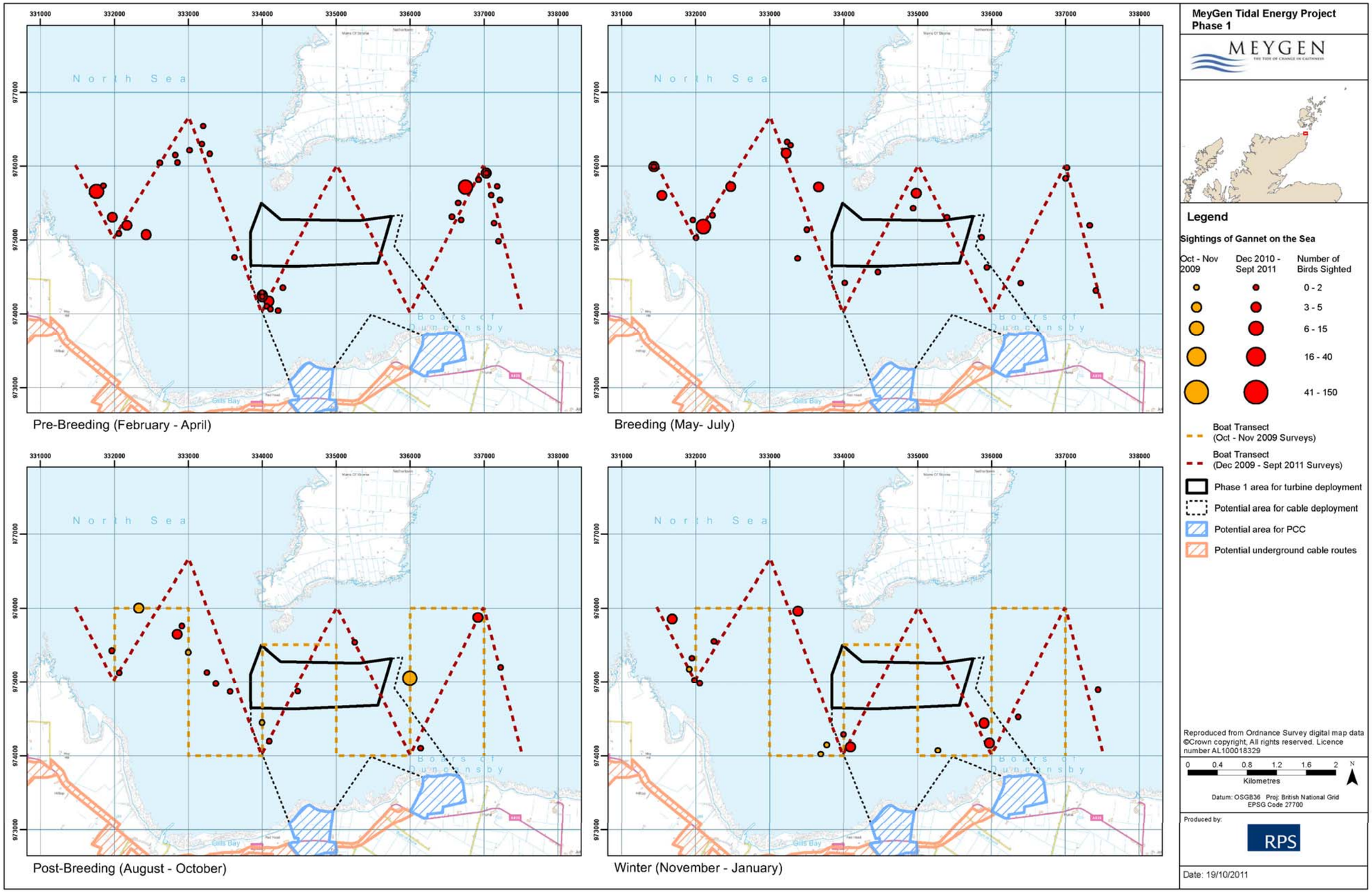

Figure 12.4: Boat based observations of northern gannet recorded between October 2009 and September 2011

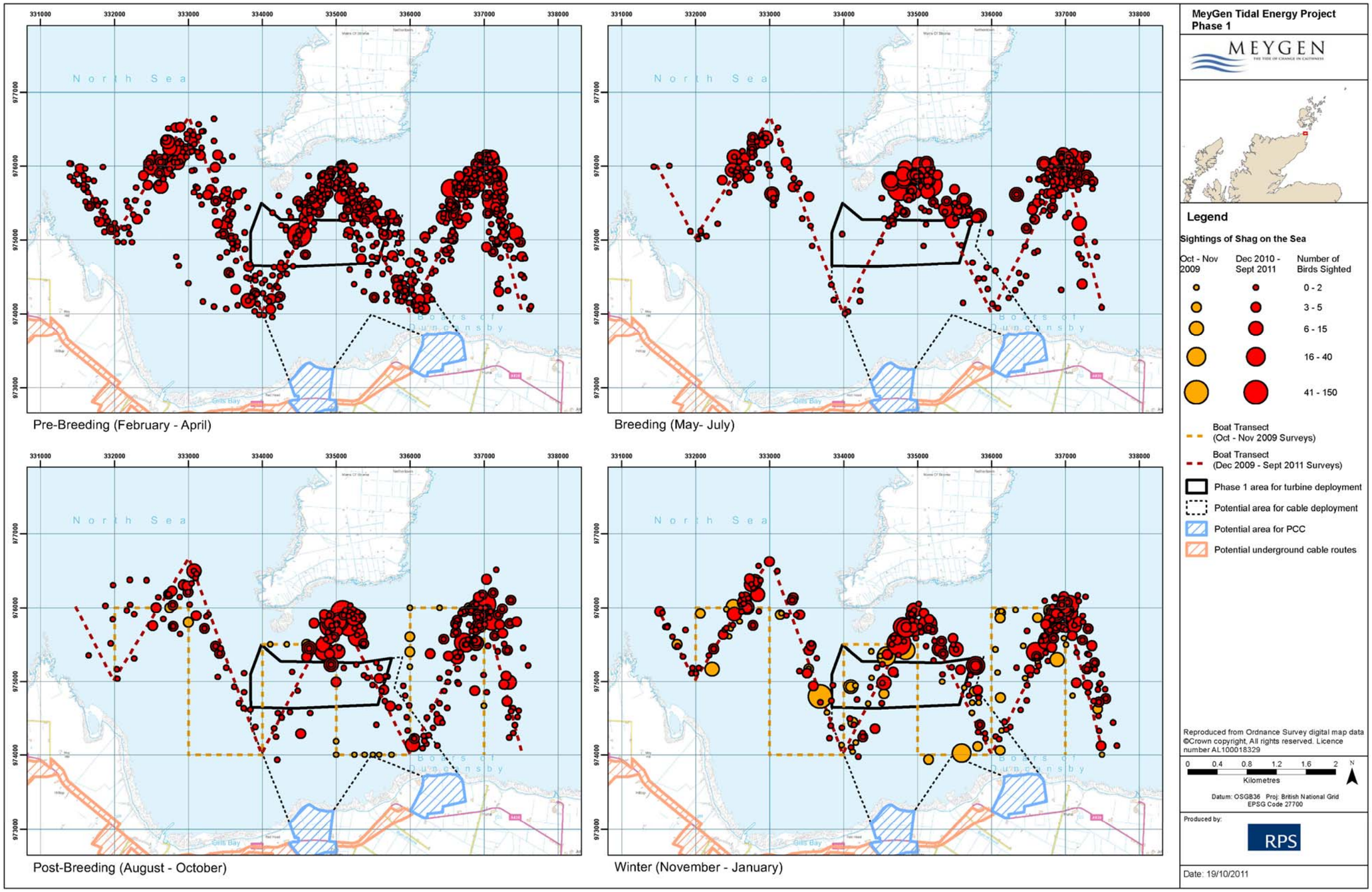

Figure 12.5: Boat based observations of shag recorded between October 2009 and September 2011

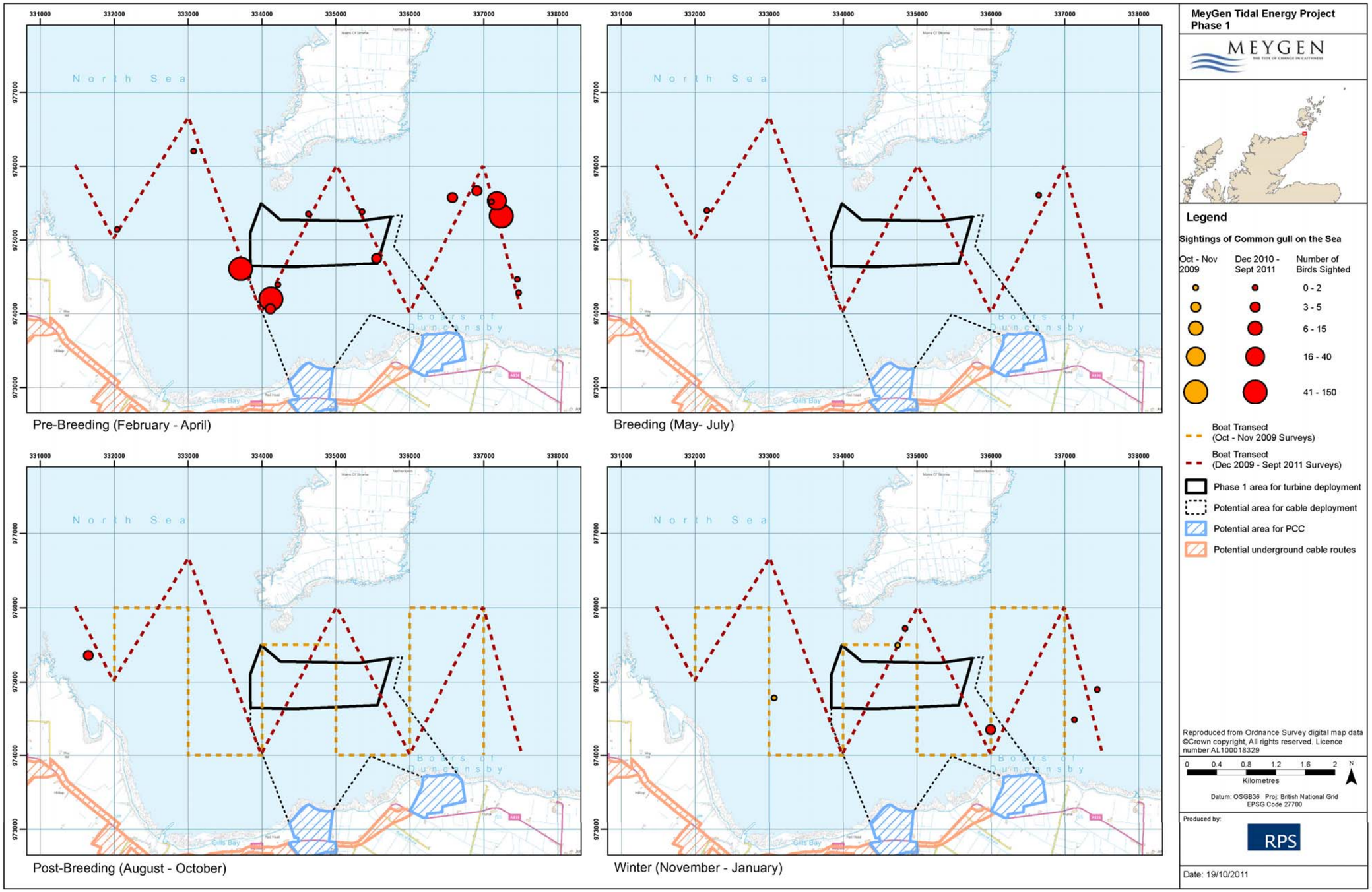

Figure 12.6: Boat based observations of common gull recorded between October 2009 and September 2011

Black-legged kittiwake

12.100 The European population of black-legged kittiwake (hereafter, kittiwake) of 2.1 to 3 million pairs has fluctuated over time and within different countries but has been provisionally evaluated as secure (Burfield & van Bommel, 2004). Kittiwakes are the most numerous breeding gull in Britain and Ireland with 415,995 pairs (Mitchell *et al*., 2004).

12.101 Kittiwakes are migratory, dispersing after the breeding season from coastal areas to the open ocean and returning to their breeding areas from January (BirdLife International, 2011). Breeding begins from mid-May to mid-June, with colonies located on high, steep, coastal cliffs with narrow ledges. The main foods of kittiwakes are marine invertebrates (e.g. squid and shrimps) and fish, with discards from trawlers also being taken. During the breeding season, small (15cm to 20cm) pelagic shoaling fish, such as sandeels, sprats and young herring, are of most importance. Prey are taken mainly from within a few metres of the sea surface, with surfaces-seizing and splash diving being the main foraging techniques employed. Thus, dive depths of >1m are considered unlikely (BirdLife International, 2011).

12.102 An estimated 131,000 birds breed in the North Caithness Cliffs SPA, with a further 40,410 breeding pairs recorded in the East Caithness Cliffs SPA, which between them account for nearly 10% of the kittiwake population in Great Britain and Ireland.

12.103 These high numbers are reflected in the distribution of kittiwakes between June and July, when the highest densities are found around the large breeding colonies in Orkney and the north and north east of Scotland (Stone *et al*., 1995). Outside the breeding season, the species is essentially pelagic as they disperse widely across the North Sea, although high densities remain in the Moray Firth between August and October (Stone *et al*., 1995). During the winter, it is likely that populations from many breeding localities mix together in the North Sea (Mitchell *et al*., 2004).

12.104 In recent years breeding colonies in the north east have experienced large declines in reproductive success. However, these declines have been least in those colonies in regions which do not border the North Sea (Mavor *et al*. 2004).

12.105 Kittiwakes have been recorded during boat surveys at low densities throughout most of the year. Peak sightings of birds in flight occurred between April and July, although the peak number of birds on the water was recorded in March (0.12 per km^2), equating to an estimated peak abundance of two individuals. There was no apparent pattern in the distribution of sightings across the study area (Figure 12.8). Kittiwake are qualifying interests of the following SPAs in the North of Scotland and Orkney region: North Caithness Cliffs, East Caithness Cliffs, Cape Wrath, Calf of Eday, Copinsay, Hoy, Marwick Head, Rousay and West Westray (other SPAs may need to be considered in the HRA).

Herring gull

12.106 Herring gulls are largely resident around the British coasts, showing limited short-distance movements between the breeding and wintering seasons. Rocky coastlines with cliffs, islets and offshore islands provide the preferred breeding habitats, although a range of other habitats (including buildings in urban areas) are used (Mitchell *et al*., 2004). As a predator, scavenger and kleptoparasite, the herring gull is an opportunistic feeder, taking a wide range of foods that may be obtained from terrestrial as well as marine habitats (e.g. earthworms, molluscs, crabs, fish, birds, waste from the fishing industry and landfill sites). When foraging at sea, food is obtained by a range of means, including surface-plunging, surface-seizing and shallow surface-diving (Cramp & Simmons, 2004).

12.107 Herring gulls are a species of low conservation concern in Europe, with a total population of between 660,000 and 900,000 breeding pairs. It is however a Red-listed species of conservation concern (i.e. of high concern) in the UK due to long-term declines in breeding and non-breeding populations. The UK population is approximately 139,200 pairs, or 12.1% of the global population (18% of bio-geographic population). Despite the increases in urban nesting, the total herring gull population is now at its lowest level since monitoring began in 1969/70. The Scottish breeding population was estimated at 71,659 breeding pairs in 2000 (Mitchell *et al*., 2004). However, the species is a Red-listed species of conservation concern in the UK due to long term declines in breeding and non-breeding populations. Despite the increases in urban-nesters, the total herring gull population is now at its lowest level since monitoring began in 1969/70.

12.108 The number of breeding pairs estimated within the mean maximum foraging range of the Project is 3,519 (JNCC Seabird Monitoring Programme database). Herring gulls were observed over winter in low numbers in the boat survey study area, with a peak density in February 2010 of 0.75 per km^2, equating to an abundance of 10 individuals in the boat survey area. No obvious spatial patterns were evident in the distribution of sightings (Figure 12.9). The only SPA in the North of Scotland and Orkney region for which herring gull are a qualifying species is East Caithness Cliffs (other SPAs may need to be considered in the HRA)

Great black-backed gull

12.109 An estimated 95,546 pairs of great black-backed gulls live along the edge of the Atlantic (Hagemeijer and Blair, 1997), with about 18,000 of those pairs residing in Britain (Mitchell *et al*., 2004). Of the British population, 85% breed in Scotland, with the majority of these populations occurring on Orkney, Shetland and the west coast (Lloyd *et al*., 1991), where there are extensive areas of the preferred breeding habitat of well-vegetated rocky coastline with stacks and cliffs. The species is resident within Britain & Ireland, and birds generally winter south of their breeding areas, with Scottish breeders making longer movements than those from more southerly locations (Cramp & Simmons, 2004). As for other large gull species, great black backed gulls are omnivorous, and rely to a large extent on both predation and scavenging for food. As such they take a wide range of foods, which often include substantial quantities of mammalian and avian prey, whilst they are also the most marine of the large gulls that breed in Britain and exploit discards from trawlers to a considerable extent (Mitchell *et al*., 2004).

12.110 An estimated 529 pairs breed within mean maximum foraging range of the Project (JNCC Seabird Monitoring Programme database), mostly in Orkney. The British breeding population does not migrate, but remains resident year round (Stone *et al*., 1995). Population declines of up to 30% have been recorded in the north of Scotland between 2003 and 2004, and complete colony failure occurred in several monitored locations in 1997 and 2003 (Mavor *et al*., 2004).

12.111 The peak density of foraging birds observed on the boat based study area was 2.05 per km^2 with an estimated peak winter abundance (January 2011) of 28 individuals in the boat survey area. Very few individuals of this species were seen during the breeding season (Figure 12.10). Great black-backed gull are qualifying interests of the following SPAs in the North of Scotland and Orkney region: East Caithness Cliffs, Calf of Eday, Copinsay and Hoy (other SPAs may need to be considered in the HRA).

Arctic tern

12.112 About 480,000 to 850,000 pairs of Arctic terns breed in Europe, with about 53,000 of these pairs nesting in Britain. The British breeding population constitutes 4.7% of the biogeographic population and 3.1% of the global population (Mitchell *et al.,* 2004). Of the British population, 47,306 pairs nested in Scotland, predominantly in Shetland and Orkney (Mitchell *et al.,* 2004). Arctic terns are notable long-distance migrants, returning to their British breeding grounds in May each year, where they nest on a range of habitats, such as wind-clipped heaths, shingle beaches and spits, rocky ground and small islands. Birds have a strongly inshore distribution during the breeding season, usually foraging within approximately 3km of their breeding colonies, although they may occasionally make much longer foraging trips (e.g. up to 50km away; BirdLife International, 2011). During migration they generally occur in the marine environment and often far offshore. Small fish, crustaceans and zooplankton comprise the bulk of the diet. Sandeels are particularly important during the breeding season in Britain, with saithe, herring and sprat amongst the other fish species recorded in the diet of British breeding birds (BirdLife International, 2011). Foraging is mainly by plunge-diving and surface-dipping, with dives unlikely to be deeper than 0.5m, although little information is available on diving depths (BirdLife International, 2011).

12.113 Although Arctic tern are not of concern in Europe or worldwide, they are of moderate conservation concern (i.e. Amber listed) in the UK due to recent population declines.

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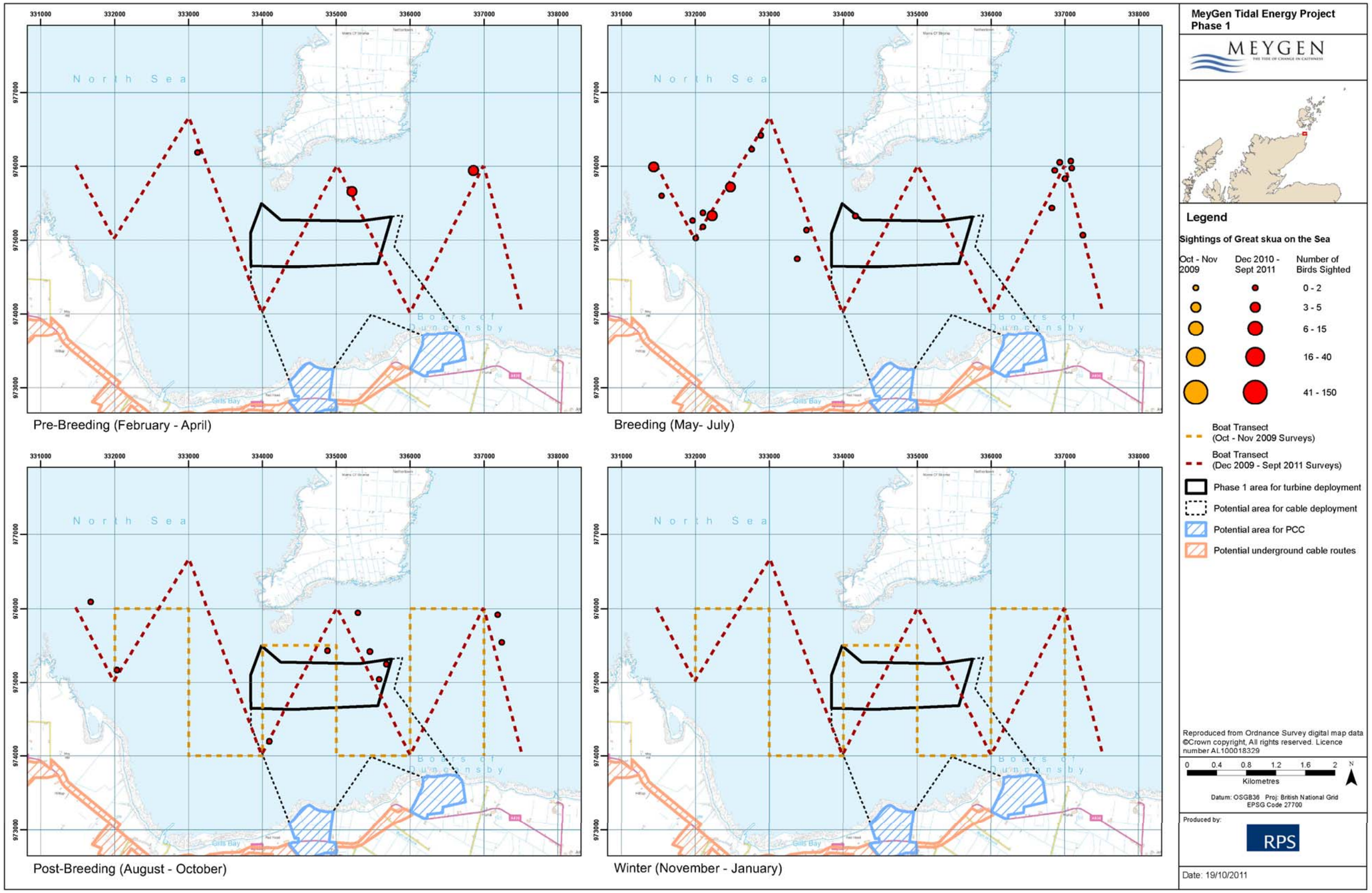

Figure 12.7: Boat based observations of great skua recorded between October 2009 and September 2011

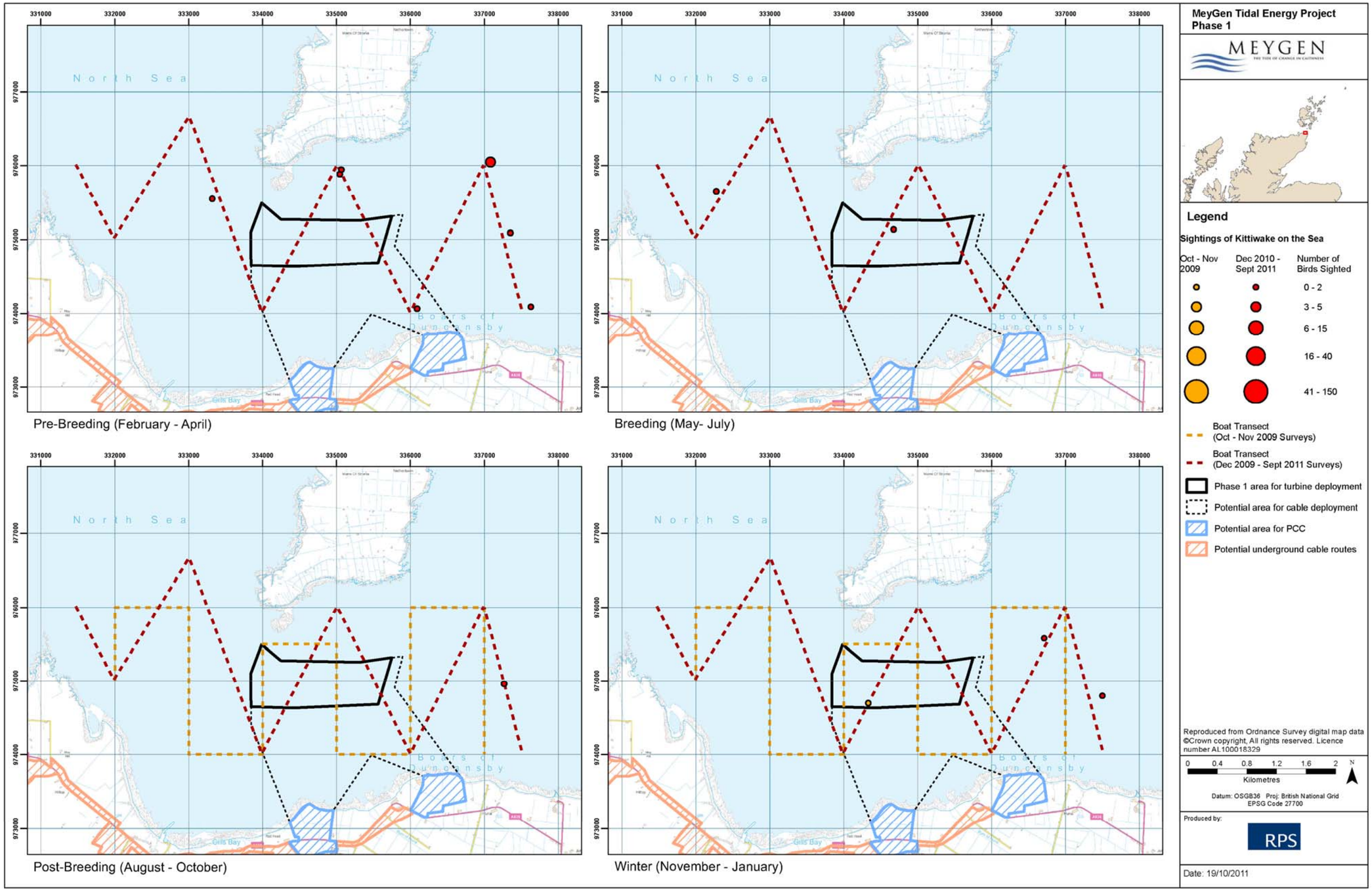

Figure 12.8: Boat based observations of black legged kittiwake recorded between October 2009 and September 2011

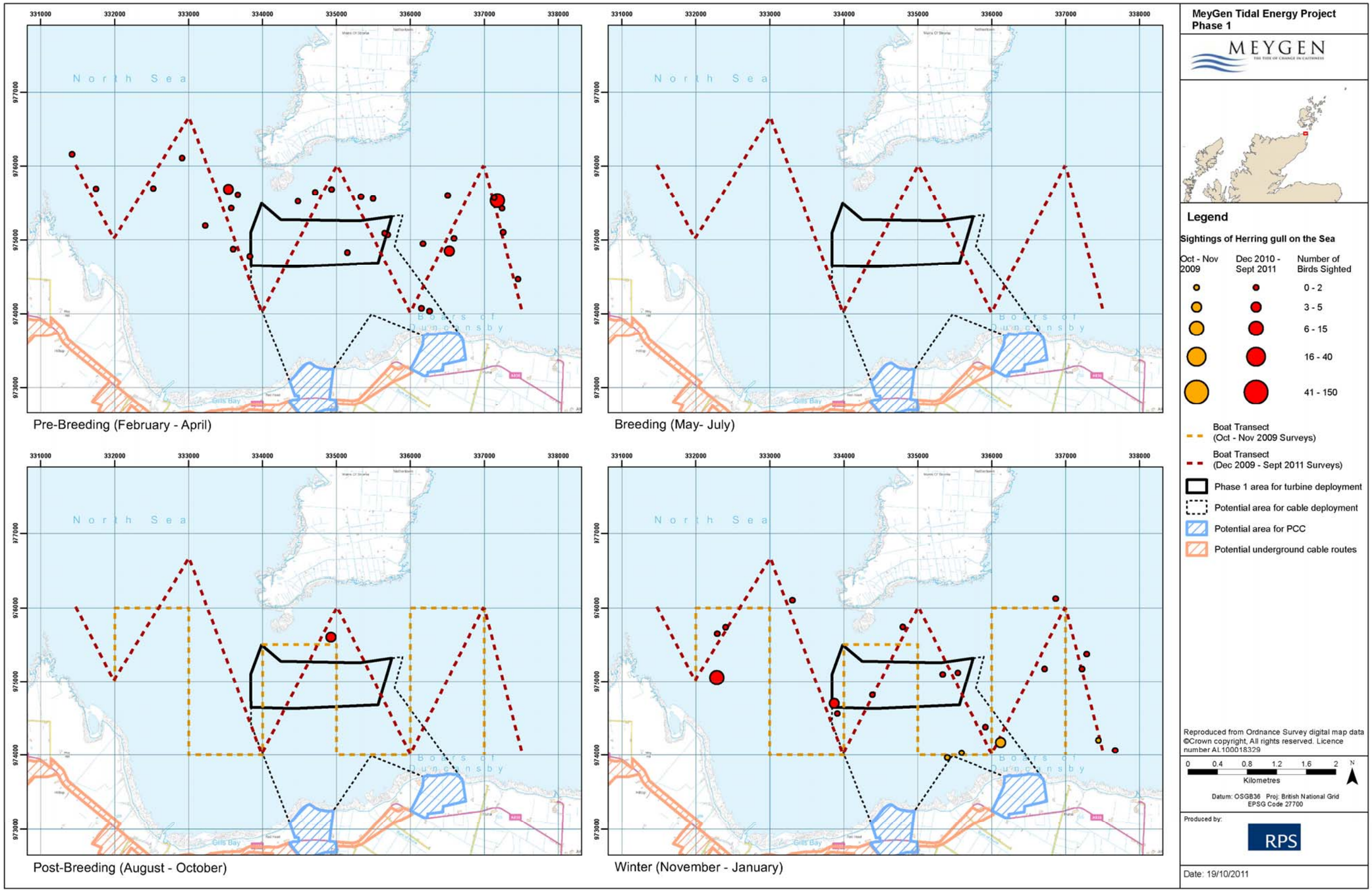

Figure 12.9: Boat based observations of herring gull recorded between October 2009 and September 2011

12.114 No Arctic tern were seen during the boat surveys, however they were observed on six occasions during May, June and July 2010 during the land based surveys. Flock sizes varied from 1 to 80, but it is not possible to estimate a density for this species from the land observations. It thus appears that the Inner Sound is used by this species at a low level during the breeding season. Arctic tern are the qualifying interests of the following SPAs in the North of Scotland and Orkney region: Pentland Firth Islands, Auskerry, Papa Westray, Rousay and West Westray (other SPAs may need to be considered in the HRA).

Common guillemot

12.115 Common guillemots return to their British breeding colonies in March or April each year, with many of the adults having wintered offshore usually within a few hundred kilometres of the colony. British breeding colonies are mainly on steep cliff faces, with most foraging during the breeding season occurring within 10km to 20km of the colony, although foraging distances of over 100km have been recorded (BirdLife International, 2011). Schooling pelagic fish (mostly sandeel, herring, sprat, capelin and gadoids) are the principal food of common guillemots, with crustaceans also important in some instances. Prey are caught by pursuit diving, with birds generally diving from the surface, typically to depths of less than 50m, but up to 200m on occasions (BirdLife International, 2011). Dive durations recorded during the present surveys averaged 35 seconds.

12.116 Common guillemot is considered to be a species of low conservation concern worldwide. Between 2 and 2.7 million pairs breed in Europe, with 1.3 million individuals in Britain, 1.1 million of which breed in Scotland. However, the species is of moderate conservation concern in the UK, as British common guillemots account for a third of the bio-geographic population (Mitchell *et al*., 2004).

12.117 An estimated 278,874 individuals breed within the mean maximum foraging range of the Project (JNCC Seabird Monitoring Programme database), of which 38,000 individuals breed within the North Caithness Cliffs SPA.

12.118 Data from boat surveys yielded a peak density estimate of 23.9 per km^2 which equated to an estimated peak abundance on the sea within the survey area of 328 birds. Peak numbers were observed between May and July inclusive with birds seen throughout the boat-based study area (Figure 12.11). Common guillemot are qualifying interests of the following SPAs in the North of Scotland and Orkney region: North Caithness Cliffs, East Caithness Cliffs, Cape Wrath, Sule Skerry and Sule Stack, Calf of Eday, Copinsay, Hoy, Marwick Head, Rousay and West Westray (other SPAs may need to be considered in the HRA).

Razorbill

12.119 Razorbills return to their British breeding colonies in April and May, with birds having wintered along the Atlantic coast of Europe, from southwest Norway to Iberia, and North Africa and into the western Mediterranean (Mitchell *et al*., 2004). British breeding colonies are mainly on rocky sea cliffs, with most foraging during the breeding season occurring within 15km of the colony, although foraging distances may be over 50km on occasions (BirdLife International, 2011). Razorbills generally forage in relatively shallow waters (<100m) which offer predictable feeding conditions, often over sandy seabeds and at upwellings or tidal fronts. As with common guillemots, they feed mainly upon schooling fish, with sandeel most important to British breeders, whilst herring, sprats and rockling (*Gaidropsarus* spp.) may also be important (BirdLife International, 2011). Fish are caught by pursuit diving from the surface, typically to depths of 5m to 30m, but possibly deeper than 100m on occasions (Bird Life International, 2011). Dive durations recorded during the present surveys differed between the breeding (May to July) and non-breeding periods, averaging 19 seconds and 40 seconds, respectively.

12.120 The European razorbill population is estimated to be between 430,000 and 760,000 breeding pairs, of which 23% (164,000) breed in Britain and approximately 139,186 of these birds breed in Scotland (Mitchell *et al*., 2004).

12.121 An estimated 6,971 individuals breed within the mean maximum foraging range of the Project (JNCC Seabird Monitoring Programme database). Densities calculated from boat survey data gave a peak of 7.95 per km^2, which equates to an estimated peak abundance of 109 birds in the boat survey area. While razorbills were recorded all year round, numbers peaked between April and July inclusive, indicative of the presence of breeding birds. There was no apparent pattern in the spatial distribution of observed birds (Figure 12.12). Razorbill are qualifying interests of the following SPAs in the North of Scotland and Orkney region: North Caithness Cliffs, East Caithness Cliffs, Cape Wrath and West Westray (other SPAs may need to be considered in the HRA).

Atlantic puffin

12.122 Atlantic puffins (hereafter puffins) are usually present at their British breeding colonies between April and early August, although birds in east coast colonies may begin arriving as early as late February (Mitchell *et al.,* 2004). Birds largely winter offshore, and often beyond the continental shelf into the pelagic zones. British breeding colonies generally occur on the grassy slopes above sea cliffs or on offshore islands, where nesting burrows can be dug, or else among boulder screes and at low densities in crevices on sheer cliffs (BirdLife International, 2011; Mitchell *et al*., 2004). Small to mid-sized schooling fish are the main food, with a wide range of species taken, whilst crustaceans, polychaetes and squid may be important in spring. Typical prey in Britain includes sandeel, sprat, capelin, whiting, haddock and herring, with sandeel generally preferred where they are available (BirdLife International, 2011). During the breeding season puffins appear to forage mainly in relatively shallow waters, and tidal fronts may provide important foraging areas. Little information is available on foraging ranges from breeding colonies but puffins appear to conduct most foraging within 10km, although foraging at much greater distances (>40km) may occur (BirdLife International, 2011). In common with other auks, puffins hunt by pursuit diving, typically to depths of <30m, but deeper than 60m on some occasions (BirdLife International, 2011). Dive durations recorded during the present surveys averaged 40 seconds.

12.123 The European population of puffin is thought to be between 5.7 and 7.3 million pairs, of which about 580,700 pairs nest in Britain, comprising 9.6% of the global population (Mitchell *et al*., 2004).

12.124 In Scotland an estimated 493,042 pairs breed, with an estimated 4,088 pairs breeding within the mean maximum foraging range of the Project (JNCC Seabird Monitoring Programme database). The Atlantic puffin is listed as a species of moderate conservation concern in the UK, due to localised populations and population declines in Europe.

12.125 The peak period for puffins recorded during the boat surveys was between April and July, with a peak density of 12.5 per km^2 recorded in April 2010. This equated to a peak abundance in the boat survey area of 171 birds. Birds were recorded throughout the boat survey area (Figure 12.13). Atlantic puffin are qualifying interests of the following SPAs in the North of Scotland and Orkney region: North Caithness Cliffs, East Caithness Cliffs, Cape Wrath, Sule Skerry and Sule Stack and Hoy (other SPAs may need to be considered in the HRA).

Black guillemot

12.126 In contrast to the other British auks, black guillemots show little dispersal from their British breeding sites in winter, tending to remain within 2km of the shore (Mitchell *et al*., 2004). Breeding sites are generally small rocky islands and low-lying stretches of rocky coast, where nests occur in crevices or under boulders. During the breeding season, birds feed mainly in shallow (<35m), inshore, waters usually <5km from breeding sites, and often over hard-bottomed areas or ledges. Overall, black guillemots take a wider range of prey than other Atlantic auks. Benthic fish (e.g. butterfish) are often the main prey, but species such as sandeel are also important, as are crustaceans, annelids and molluscs (BirdLife International, 2011). Much foraging by black guillemots probably occurs near the sea bottom, but at relatively shallow depths (e.g. 10 to 30m), with birds recorded at depths of up to 50m (BirdLife International, 2011). Dive durations recorded during the present surveys averaged 57 seconds.

12.127 Black guillemot is a widespread breeding species in coastal areas of northern Europe, which comprise 50% of the species' global breeding range (Burfield & van Bommel, 2004). The European breeding population is in excess of 130,000 pairs, but the species is considered to have an unfavourable conservation status on the basis of a moderate population decline during 1990 to 2000 (Burfield & van Bommel, 2004). Within the UK, where numbers appear to be relatively stable, the black guillemot is of moderate conservation concern (Amber-listed) due to its unfavourable conservation status in Europe (Eaton *et al*., 2009).

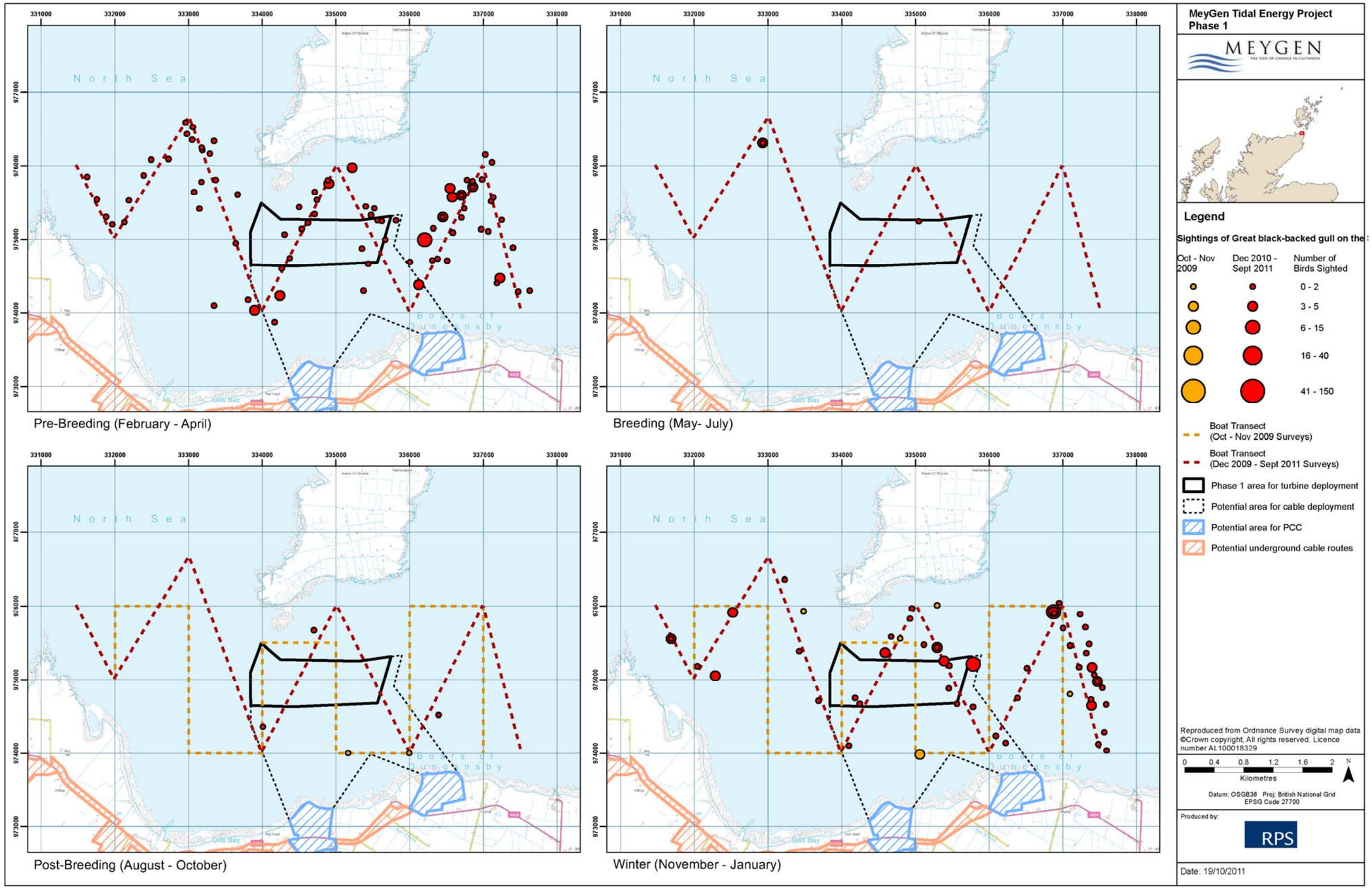

Figure 12.10: Boat based observations of great black-backed gull recorded between October 2009 and September 2011

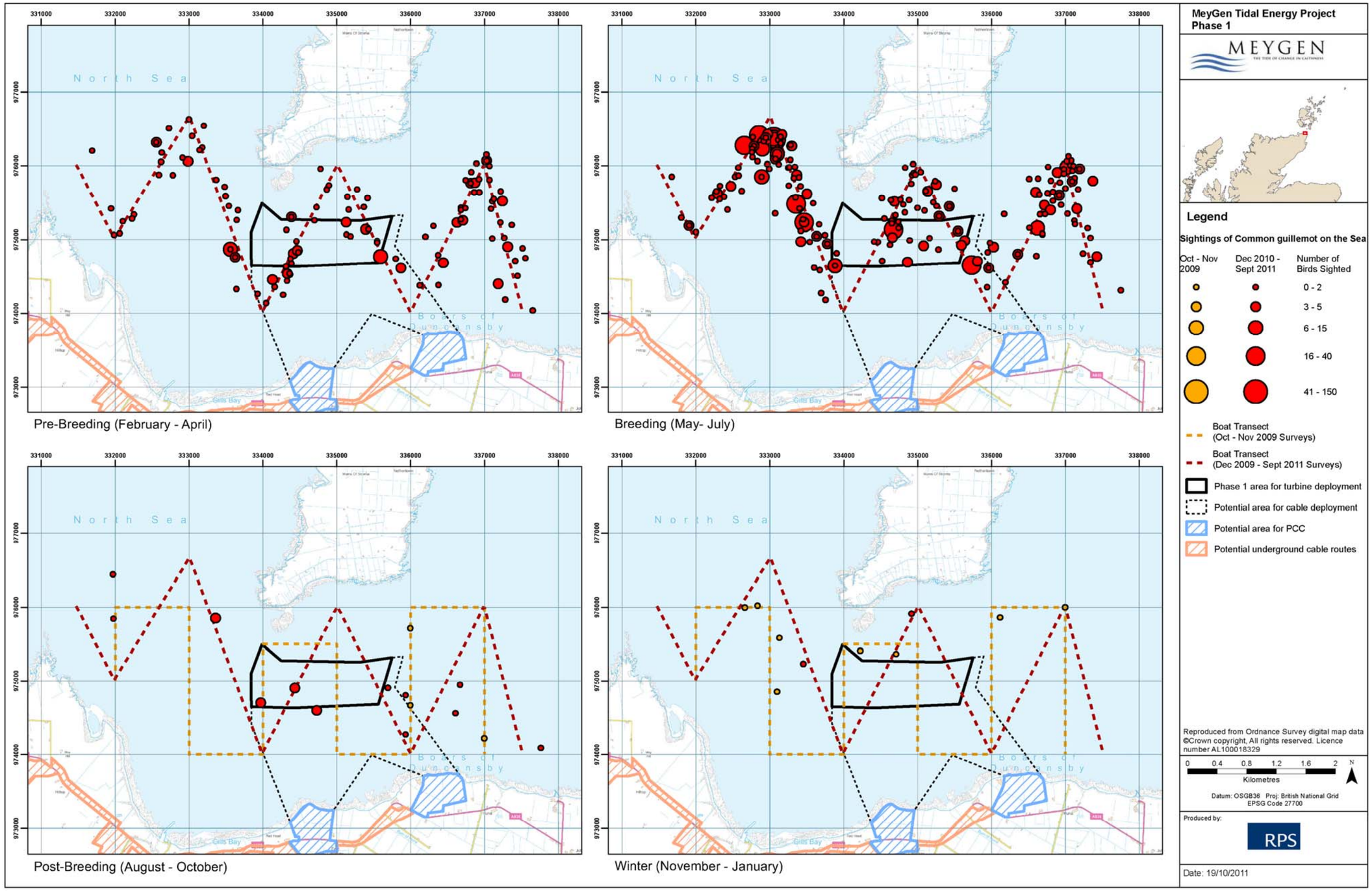

Figure 12.11: Boat based observations of common guillemot recorded between October 2009 and September 2011

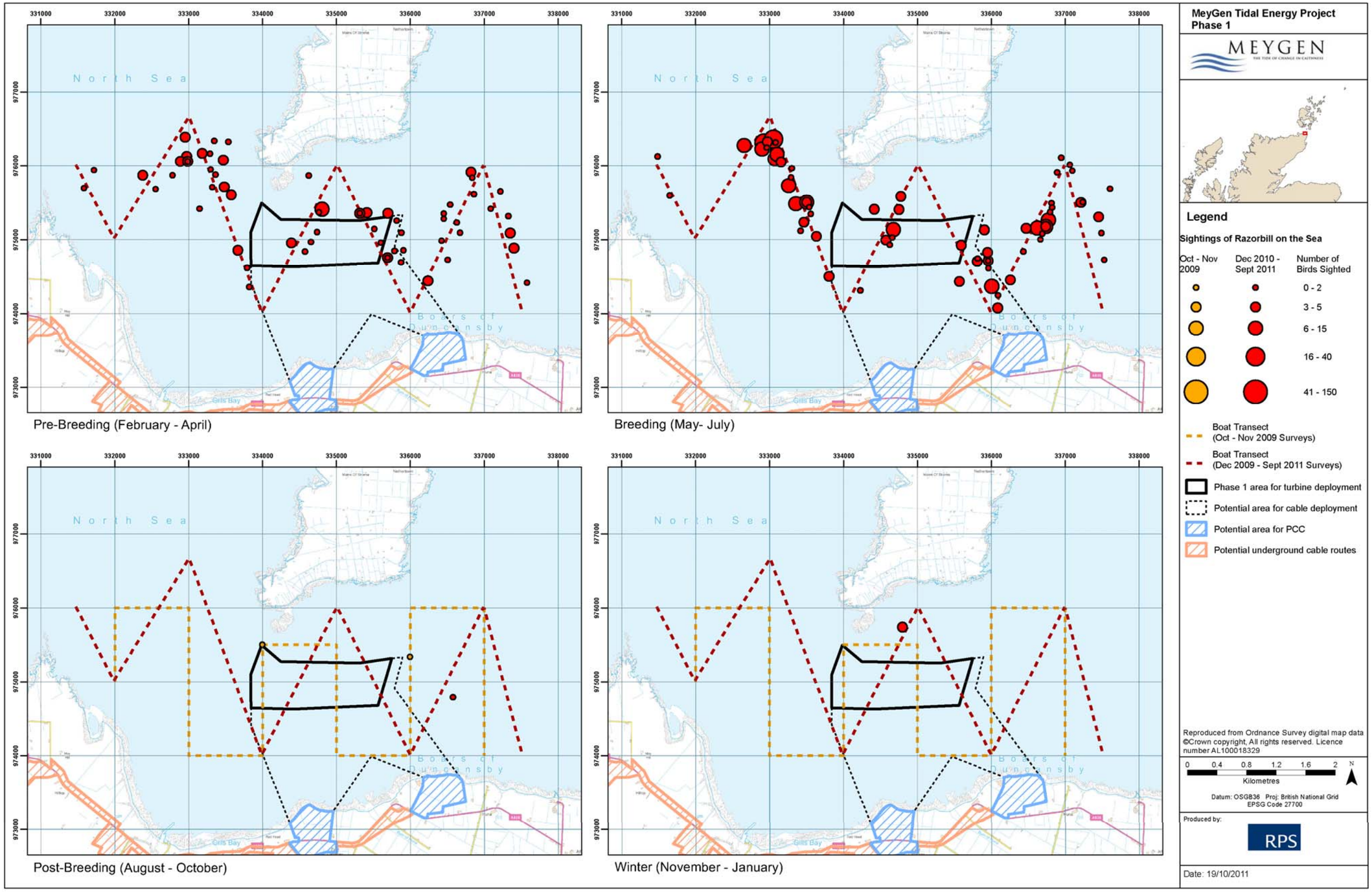

Figure 12.12: Boat based observations of razorbill recorded between October 2009 and September 2011

12.128 There were an estimated 7,067 pre-breeding individual black guillemots (the count unit used for this species) in Orkney and Caithness in 1998 to 2000 (Mitchell *et al*., 2004). Of the 1,247 pre-breeding individuals recorded in Caithness, 1,104 were associated with East Caithness and 143 with the North Caithness coast area (within which the MeyGen site lies). Numbers in Orkney and Caithness declined by 19% between the mid 1980s and 1998-2000 (Mitchell *et al*., 2004).

12.129 Black guillemot were recorded on every boat survey, although numbers were highest during the pre-breeding and breeding seasons, dropping to very low numbers in September and October. The peak density recorded in the boat surveys was 15.9 per km^2 recorded in March 2010. This equated to a peak abundance in the boat survey area of 217 birds. Birds were recorded throughout the boat survey area (Figure 12.14). This species is not a qualifying feature for any of the SPAs in the north of Scotland and Orkney region, but it is identified as a component of the cliff nesting seabird colony of the Stroma SSSI.

Red-throated diver

12.130 Red-throated divers are strongly migratory and dispersive, with British breeders returning to breeding areas from March onwards (Forrester & Andrews, 2007; BirdLife International, 2011). Birds generally nest on small lochs on inland heathland and blanket bog habitats, commuting to tidal estuaries and inshore marine areas (usually within 2km of the nest site) to feed (Forrester & Andrews, 2001; BirdLife International, 2011). Birds occur further offshore outside the breeding season. A wide range of fish species may be taken, including herring, sprat and sandeel, whilst marine worms, copepods and crustaceans have also been recorded in the diet. Prey are captured by pursuit diving from the surface, with most dives undertaken in shallow waters of <20m to 30m depth (BirdLife International, 2011).

12.131 The red-throated diver is a widespread breeder across much of northern Europe, where less than a quarter of the global population occur (Burfield & van Bommel, 2004). The species has an unfavourable conservation status in Europe due to large declines during the latter part of the 20th century, although numbers appear to have remained relatively stable since then. Within Britain the species is of moderate conservation concern (Amber-listed) on the basis of its unfavourable status in Europe (Eaton *et al*., 2009). The entire UK breeding population of 4,146 adult birds occurs within Scotland, where numbers increased by approximately 34% between 1994 and 2006 (Dillon *et al*., 2009).

12.132 Although no population figures are available for Caithness and Sutherland specifically, there are an estimated 189 adult birds present within the Caithness and Sutherland Peatlands SPA during the breeding season (Dillon *et al*., 2009). This will include the vast majority of birds occurring on the breeding grounds in Caithness and Sutherland, and within the vicinity of the Project area. A further 280 adult birds are present in Orkney during the breeding season (Dillon *et al*., 2009). Although numbers in Orkney were estimated to have undergone a small decline (3.2%) between 1994 and 2006, numbers in Caithness are likely to have increased during the same period (given that an overall increase of 14% was recorded in mainland Scotland).

12.133 Red-throated divers were recorded between November and April on the boat surveys, with a peak in late winter (March 2010) of 0.3 per km^2. This equated to a peak abundance in the boat survey area of four birds. It therefore does not appear that breeding birds use the survey area for foraging. Most observed birds were seen near to the coast, with very few recorded in the middle of the Inner Sound (Figure 12.15). Red-throated diver are a qualifying interest of the following SPAs in the North of Scotland and Orkney region: Caithness and Sutherland Peatlands, Hoy and Orkney Mainland Moors (other SPAs may need to be considered in the HRA).

Common eider

12.134 The common eider (hereafter eider) may use a wide range of foraging habitats (e.g. open shallow water overlying rocky substrates or kelp beds, and sheltered bays with sandy substrates), which are generally close (<1km) to the shore. Benthic invertebrates are the main food; most notably intertidal and subtidal molluscs (e.g. common mussels) but also crustaceans and echinoderms (BirdLife International, 2011). Their prey is obtained by surface diving and, in shallow water, by head-dipping and up-ending, and dive depths will generally be <10m, although they are capable of diving to depths of 42m to feed (BirdLife International, 2011).

12.135 Eiders breed in coastal areas of north-west and northern Europe, where more than 50% of the global population is found (Burfield & van Bommel, 2004). The large European population (estimated to be in excess of 840,000 pairs) is considered to have a secure status, and is therefore of low conservation concern. There are an estimated 31,200 breeding pairs of eider within the UK, where the species is of moderate conservation concern (Amber-listed) due to a decline of 25 - 50% in numbers over the past 25 years (Baker *et al*., 2006; Eaton *et al*., 2009).

12.136 An estimated 6,000 adult eider occur in Orkney, and a further 4,500 in Caithness and Sutherland, with birds in both areas considered to be largely sedentary so that numbers are similar throughout the year (Forrester *et al*., 2007). There are insufficient data to estimate the proportion of the Caithness and Sutherland population that occurs within the vicinity of the MeyGen site, whilst data on population trends specific to those areas are also lacking.

12.137 Eider were almost exclusively observed between November and March on the boat surveys, with a peak in late winter (February and March 2010) of 7.8 per km^2. This equated to a peak abundance in the boat survey area of 106 birds. There was no apparent pattern to the spatial distribution of birds observed (Figure 12.16). Eider are not a qualifying feature for any of the SPAs or SSSIs in the north of Scotland and Orkney region.

Onshore habitats and the associated bird community

12.138 The proposed onshore infrastructure comprises the temporary HDD site, PPC and underground cables to the grid connection. An onshore area approximately of 7km^2 was surveyed (extended phase 1 habitat survey) and assessed for this ES, although the eventual onshore infrastructure footprint will not cover this whole area and is expected to occupy no more than approximately 3.5km^2 of land. Actual buildings and associated infrastructure (e.g. car parking) may comprise no more than 0.5km^2 of land, with the remaining affected areas being underground cables.

12.139 The habitats affected by the proposed onshore developments are largely grassland and dry heath, with smaller areas of woodland, scrub and wet heath and bog, as determined by extended Phase 1 habitat surveys (Xodus, 2011). The proposed sites for the buildings (PCC) occur entirely on grassland habitats with the exception part of the Ness of Quoys PCC option. This covers an area of approximately 0.085km^2 of mixed wet heath, acid grassland and modified bog habitat (Xodus, 2011). These habitats may provide important breeding and foraging habitats for terrestrial bird species, and so the onshore element of the Project may affect bird populations associated with neighbouring SPAs. The Caithness and Sutherland Peatlands SPA and Caithness Lochs SPA are the most likely to be affected by any such impacts that may occur on terrestrial bird populations (Table 12.6).

12.140 In terms of the provision of foraging habitat for SPA qualifying species, the onshore Project site is unlikely to be of particular importance because it forms part of a much larger expanse of similar habitat, which extends along much of the north Caithness coast. Thus, there is no reason to suspect that such potential foraging habitat is limiting in this area. Golden plover may have traditional feeding fields that are used year after year, but again it is highly unlikely that this would represent a major issue on this site. Although the site is just 0.25km from the Caithness and Sutherland Peatlands SPA (and well within the distance that nesting golden plover may fly to access feeding fields, which occasionally may be up to approximately 10km, O'Connell *et al*., 1996), it is in such close proximity to the north-eastern fragment of the SPA only (Figure 12.1). The site is over 18km from the main extent of this SPA and so well beyond the likely distance that the vast majority of the nesting golden plover on this SPA will commute to feeding fields.

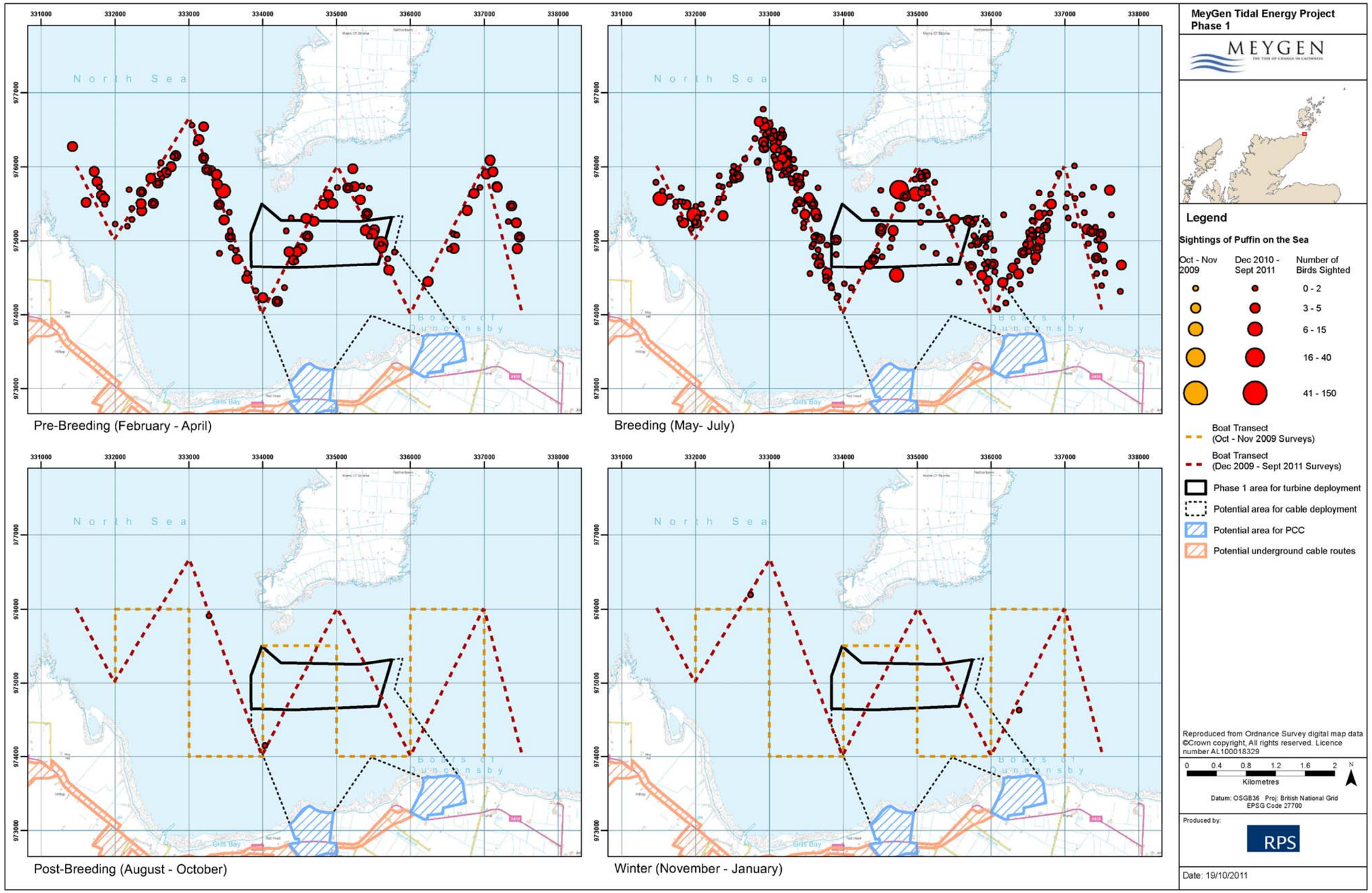

Figure 12.13: Boat based observations of Atlantic puffin recorded between October 2009 and September 2011

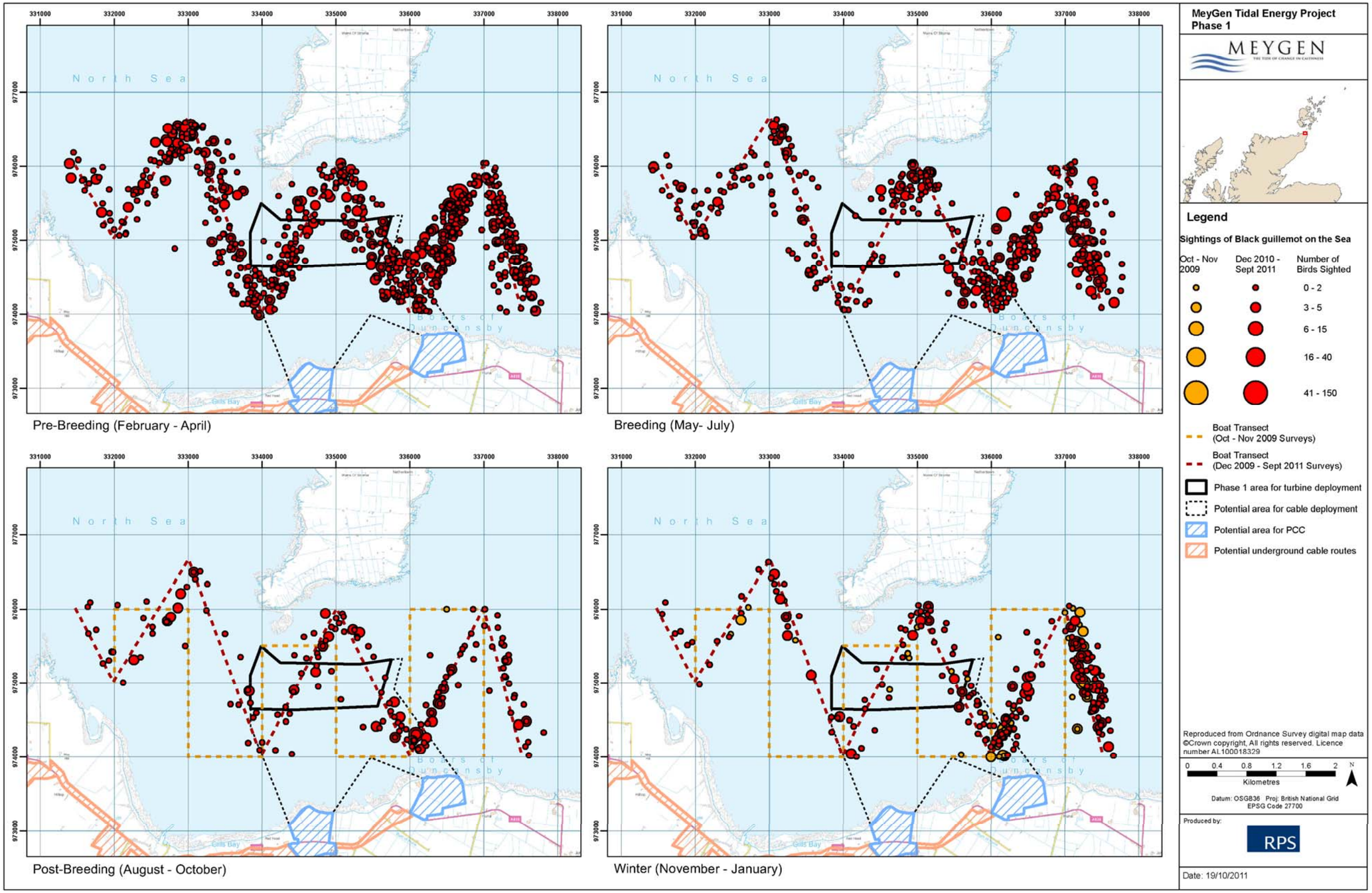

Figure 12.14: Boat based observations of black guillemot recorded between October 2009 and September 2011

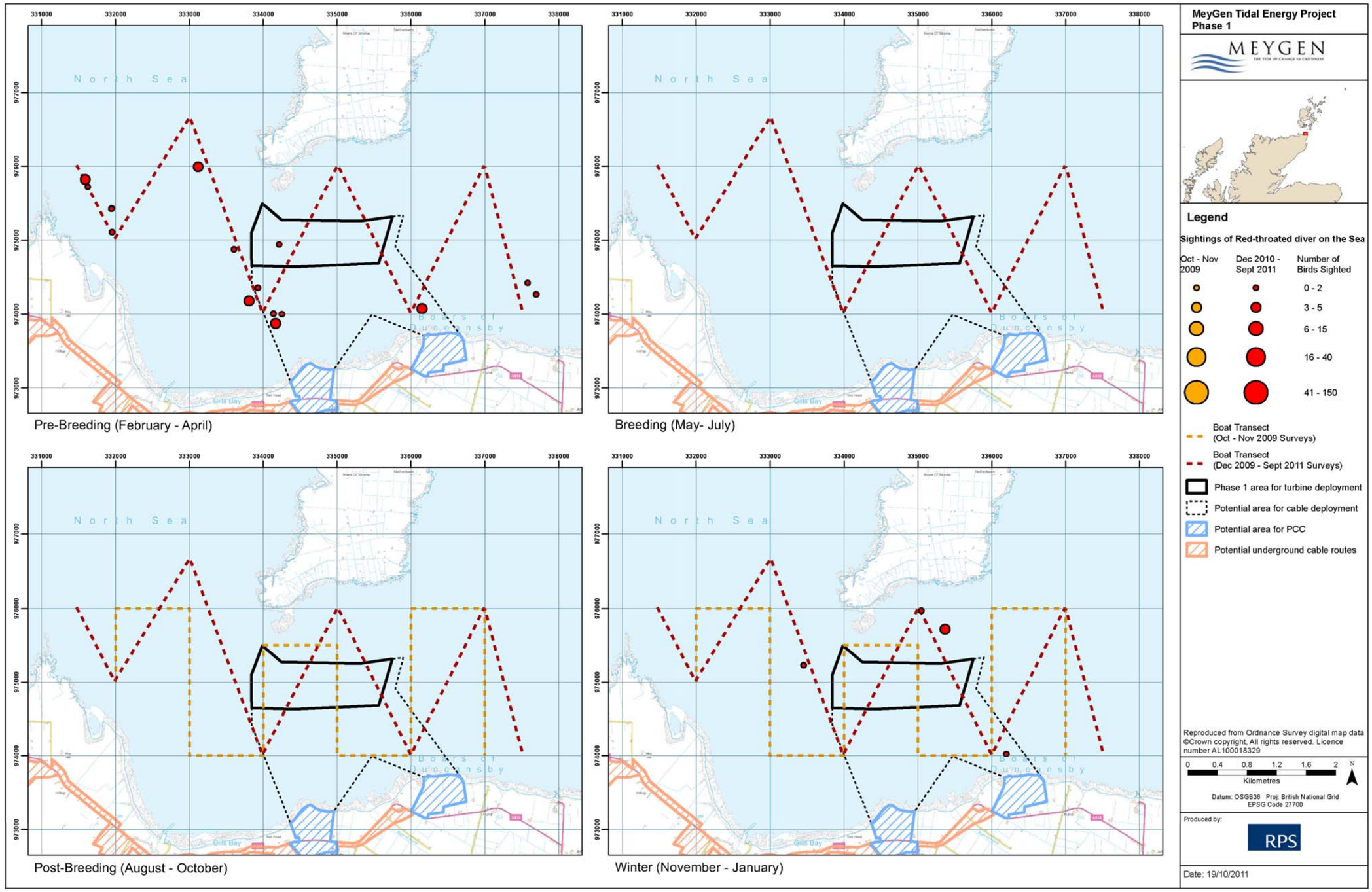

Figure 12.15: Boat based observations of red-throated diver recorded between October 2009 and September 2011

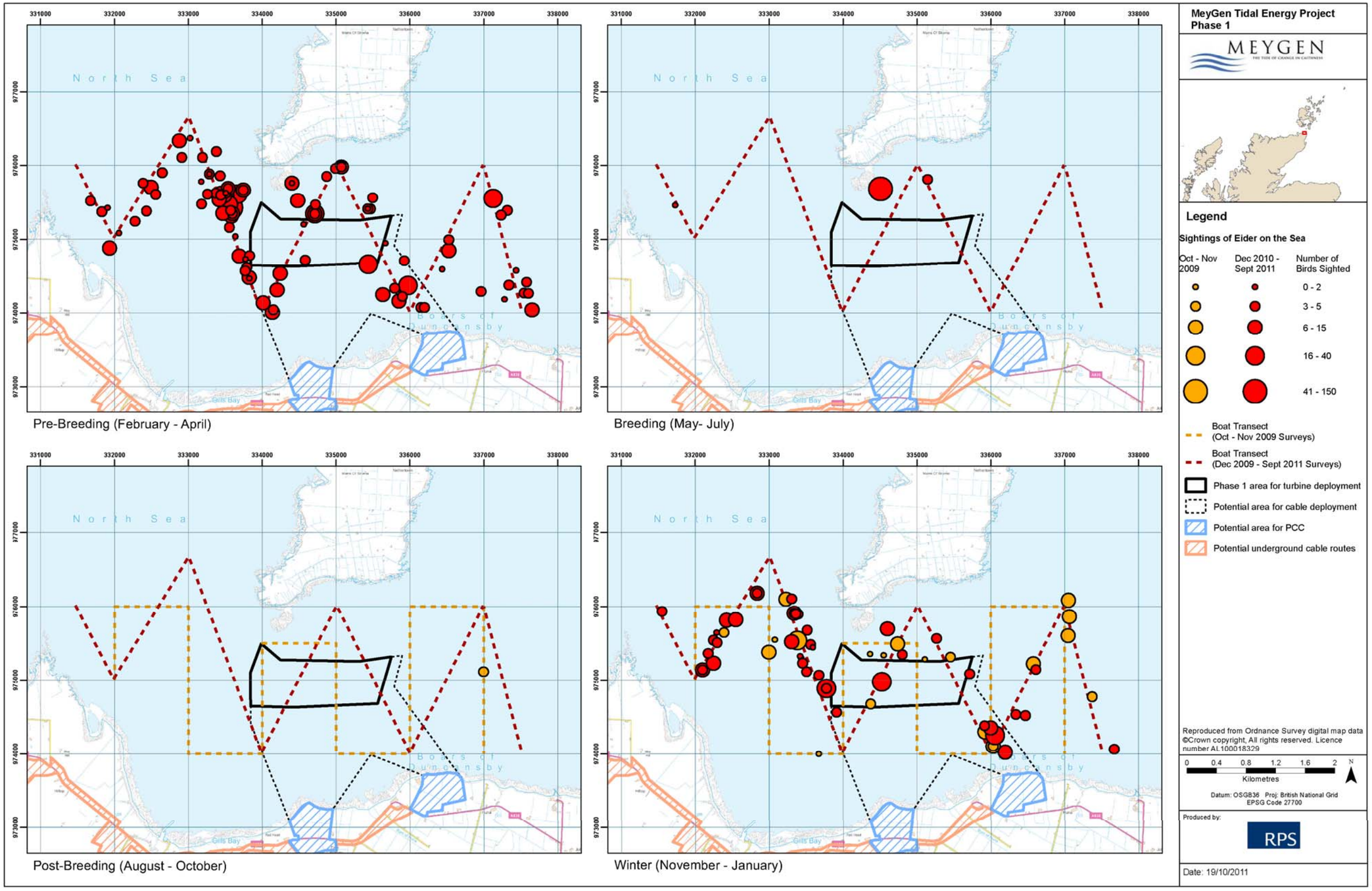

Figure 12.16: Boat based observations of eider recorded between October 2009 and September 2011

12.6 Impacts during Construction and Installation

12.141 Potential effects on birds associated with the construction phase of the Project include:

- Disturbance / displacement due to increased boat traffic;
- Disturbance / displacement due to offshore construction activities; and
- Indirect impacts of sub-structure installation on the local habitat conditions and prey stocks.

12.142 These impacts are considered in more detail below.

12.6.1 Impact 12.1: Disturbance / displacement due to increased boat traffic

12.143 Disturbance from increased boat traffic could affect seabirds and divers within the Project area in a number of ways. As a worst case scenario, such activity could cause complete avoidance of the Project area and its surrounds by certain species, so causing displacement from potentially important foraging and loafing areas. This could lead to birds being forced to forage in areas of lower prey availability, or increase competition for resources at other locations. Other, less severe, effects may involve frequent disturbance whilst foraging, or flushing of birds in response to the boat traffic. The consequences of such disturbance and displacement effects may include reduced foraging efficiency, greater energy expenditure and elevated stress levels. Although it is conceivable that such effects can potentially lead to population level impacts by reducing reproductive rates or increasing mortality rates, this is only likely to occur if the Project area provides important resources (e.g. abundant prey species), which are unavailable in other locations to which the species has access, and if the Project area is heavily used at critical times in the year (e.g. during the breeding season).

12.144 For each sensitive receptor species, the impact of disturbance from increased boat traffic was evaluated on the basis of:

- Knowledge of the sensitivity of each bird species based on their likely vulnerability to disturbance from boat traffic taken from several different sources, notably Ronconi & St. Clair (2002), Garthe and Hüppop (2004), King *et al*. (2009) and Furness & Wade (2012);
- The magnitude of disturbance that is expected to take place; and
- The likelihood of a temporal overlap of construction traffic and each species' presence in the Project area.

12.145 Table 12.11 provides assessment of the impact specific species sensitivity, magnitude, consequence and significance of boat traffic during construction and decommissioning. Assessment of consequence and significance for each species followed the methods set out in Section 8.

Impact significance

Species	Sensitivity to boat traffic (see notes)	Impact magnitude	Rationale	Consequence	Significance
Red-throated diver	High[1]	Negligible	Only present outside breeding season and in very low numbers.	Minor	Not Significant
Fulmar	Low[1]	Negligible	Attracted to boat traffic.	Negligible	Not Significant
Gannet	Low[1]	Negligible	Mostly ignore vessels, show occasional attraction.	Negligible	Not Significant
Cormorant	High[1]	Negligible	Mostly present outside breeding season and in low numbers.	Minor	Not Significant
Shag	Medium[1]	Minor	Any displacement expected to be limited to small area.	Minor	Not Significant
Eider	Medium[1]	Negligible	Mainly present outside breeding season.	Negligible	Not Significant
Great skua	Low[1]	Negligible	Not habitat limited.	Negligible	Not Significant
Arctic skua	Low[1]	Negligible	Not significantly disturbed by vessels; not habitat limited at local scale.	Negligible	Not Significant
Kittiwake	Low[1]	Negligible	Not habitat limited.	Negligible	Not Significant
Common gull	Low[2]	Negligible	Not habitat limited.	Negligible	Not Significant
Great black-backed gull	Low[1]	Negligible	Not habitat limited.	Negligible	Not Significant
Herring gull	Low[1]	Negligible	Not habitat limited.	Negligible	Not Significant
Arctic tern	Low[1]	Negligible	Not significantly disturbed by vessels; not habitat limited at local scale.	Negligible	Not Significant
Guillemot	Medium[1]	Minor	Not significantly disturbed by vessels; not habitat limited at local scale.	Minor	Not Significant
Razorbill	Medium[1]	Minor	Not significantly disturbed by vessels; not habitat limited at local scale.	Minor	Not Significant
Black guillemot	Medium[1,4]	Minor	Not significantly disturbed by vessels. Any displacement expected to be limited to small area.	Minor	Not Significant
Puffin	Low[1]	Minor	Not significantly disturbed by vessels; not habitat limited at local scale.	Minor	Not Significant

Notes:
1 – Garthe and Hüppop (2004)
2 – King et al. (2009)
3 – Ronconi & St. Clair (2002)
4 – Furness & Wade (2012)

Table 12.11: Details of species sensitivity and vulnerability to disturbance from boat traffic and predicted significance of impacts

12.146 Overall, the sensitivity of receptors to disturbance by boat traffic varies between low and high and the magnitude of the impact is assessed as negligible or minor for all species. This is based on a combination of the time of year when construction vessels are expected to be present (spring to autumn) and the time of year each species has been recorded on site (Table 12.10) and the short term and localised nature of the predicted impacts.

MITIGATION IN RELATION TO IMPACT 12.1
▪ No specific mitigation measures are proposed as no significant impact predicted. Operational monitoring will be implemented in order to confirm the impact predications made here (see Section 12.12).

12.6.2 Impact 12.2: Release of drill cuttings and fluid

12.147 Details of the predicted worst case release of drill cuttings and lubricating fluids (compressor lubricant) released during TSS piling and HDD drilling operations are provided in Section 10 (Impact 10.2). No significant impacts on benthic communities were identified. The volumes of discharge predicted to occur are considered to be sufficiently small and will be rapidly dispersed and are only temporary in nature that they will have no impact on any of the bird species present.

Sensitivity	Impact magnitude	Consequence	Significance
Very high	Negligible	Minor	Not Significant

MITIGATION IN RELATION TO IMPACT 12.2
▪ No specific mitigation measures are proposed as no significant impact predicted. Operational monitoring will be implemented in order to confirm the impact predications made here (see Section 12.12).

12.6.3 Impact 12.3: Accidental spillage from vessels

12.148 The discussion around this impact focuses on the potential impacts associated with the release of a large inventory of fuel oil from a vessel. This is considered to be the worst case potential accidental pollution impact. Other smaller inventories of polluting substances may potentially be released during the course of the Project. These impacts and their potential consequences are discussed further in accidental events (Section 24)

12.149 The total oil inventory for the large DP installation vessels is likely to be in the region of 6,000,000 to 8,000,000 litres of marine diesel stored in a number of separate tanks. The worse case spill from a single tank rupture is likely to be in the region of 600,000 litres of marine diesel released into the marine environment.

12.150 Oil spills can have a number of environmental impacts. Actual effects will vary depending on a wide range of factors including the volume and type of oil spilt and the sea and weather conditions at the time of the spill. Effects will also be dependant on the presence of environmental sensitivities in the path of the spill.

12.151 To determine the magnitude of impact and the associated significance, the vulnerability of each species to surface pollutants is combined with the impact magnitude estimated in the Accidental Events section (Section 24). For a total loss of inventory these are presented in Table 12.12 and for a partial loss in Table 12.13. In these assessments seasonality is taken into account in the determination of impact magnitude through consideration of the peak period of bird presence in the Inner Sound, since most vessel presence (and hence spillage risk) will occur during the spring to autumn period. The predicted magnitude includes consideration of the likelihood of accidental spillage, defined here for both a total and partial loss of inventory as extremely unlikely to occur.

Impact significance

Species	Sensitivity to surface pollutants[1] (see notes)	Impact magnitude	Rationale	Consequence	Significance
Red-throated diver	Very high	Negligible	Only present outside breeding season and in very low numbers.	Minor	Not Significant
Fulmar	Medium	Negligible	Peak density in winter.	Negligible	Not Significant
Gannet	High	Negligible	Present in very low numbers.	Minor	Not Significant
Cormorant	High	Negligible	Present in very low numbers.	Minor	Not Significant
European shag	Very high	Negligible	Present throughout year.	Minor	Not Significant
Eider	Medium	Negligible	Mainly present in winter.	Negligible	Not Significant
Great skua	Very high	Negligible	Mainly present in summer.	Minor	Not Significant
Arctic skua	Very high	Negligible	Mainly present in summer.	Minor	Not Significant
Kittiwake	Medium	Negligible	Present in very low numbers.	Negligible	Not Significant
Common gull	Medium	Negligible	Present in very low numbers, peaks in winter.	Negligible	Not Significant
Great black-backed gull	High	Negligible	Present in very low numbers, peaks in winter.	Minor	Not Significant
Herring gull	Medium	Negligible	Present in very low numbers, peaks in winter.	Negligible	Not Significant
Arctic tern	Medium	Negligible	Occasional presence during summer.	Negligible	Not Significant
Guillemot	High	Negligible	Numbers peak in summer.	Minor	Not Significant
Razorbill	High	Negligible	Numbers peak in summer.	Minor	Not Significant
Black guillemot	Very high	Negligible	Present throughout year.	Minor	Not Significant
Puffin	High	Negligible	Numbers peak in summer.	Minor	Not Significant

Notes:
[1] Vulnerability to surface pollutants was derived from the Oil Vulnerability Index of Williams et al. (1995).

Table 12.12: Details of species sensitivity and vulnerability to surface pollutants and the significance of any impacts, in relation to a total loss of inventory

Species	Sensitivity to surface pollutants[1] (see notes)	Impact magnitude	Rationale	Consequence	Significance
Red-throated diver	Very high	Negligible	Only present outside breeding season and in very low numbers.	Minor	Not Significant
Fulmar	Medium	Negligible	Peak density in winter.	Negligible	Not Significant
Gannet	High	Negligible	Present in very low numbers.	Minor	Not Significant
Cormorant	High	Negligible	Present in very low numbers.	Minor	Not Significant
European shag	Very high	Negligible	Present throughout year.	Minor	Not Significant
Eider	Medium	Negligible	Mainly present in winter.	Negligible	Not Significant
Great skua	Very high	Negligible	Mainly present in summer.	Minor	Not Significant
Arctic skua	Very high	Negligible	Mainly present in summer.	Minor	Not Significant
Kittiwake	Medium	Negligible	Present in very low numbers.	Negligible	Not Significant
Common gull	Medium	Negligible	Present in very low numbers, peaks in winter.	Negligible	Not Significant
Great black-backed gull	High	Negligible	Present in very low numbers, peaks in winter.	Minor	Not Significant
Herring gull	Medium	Negligible	Present in very low numbers, peaks in winter.	Negligible	Not Significant
Arctic tern	Medium	Negligible	Occasional presence during summer.	Negligible	Not Significant
Guillemot	High	Negligible	Numbers peak in summer.	Minor	Not Significant
Razorbill	High	Negligible	Numbers peak in summer.	Minor	Not Significant
Black guillemot	Very high	Negligible	Present throughout year.	Minor	Not Significant
Puffin	High	Negligible	Numbers peak in summer.	Minor	Not Significant

Notes:
[1]Vulnerability to surface pollutants was derived from the Oil Vulnerability Index of Williams et al. (1995).

Table 12.13: Details of species sensitivity and vulnerability to surface pollutants and the significance of any impacts, in relation to a partial inventory loss

MITIGATION IN RELATION TO IMPACT 12.3

- Although no significant impacts have been identified, due to the high/very high sensitivity of some species mitigation measures have been identified.
- All vessels associated with Project operations will comply with IMO/MCA codes for prevention of oil pollution and any vessels over 400 GT will have onboard SOPEP's.
- All vessels associated with Project operations will carry onboard oil and chemical spill mop up kits.
- Where possible vessels with a proven track record for operating in similar conditions will be employed.
- Vessel activities associated with installation, operation, routine maintenance and decommissioning will occur in suitable conditions to reduce the chance of an oil spill resulting from the influence of unfavourable weather conditions.

12.6.4 Impact 12.4: Disturbance / displacement due to underwater noise

Direct impacts on birds

12.152 Construction works may involve noisy and potentially disturbing activities such as drilling piles. This will be expected to disturb birds through above-sea noise, which could result in temporary displacement effects. However, a lack of specific information on the response of many species to noise, in particular the type, duration and severity of the impact and the potential to which birds may habituate, makes predictions very difficult. Factors to take into account include:

- The activity the birds are engaged in (e.g. foraging, loafing or moulting), which will determine the extent to which alternative locations are readily available;
- The duration of occupancy of the site and the time of year (construction activity is not anticipated to occur all year round); and
- The origin of the birds potentially affected.

12.153 Very little is known about how diving birds may respond directly to underwater noise. As species which have hearing adapted primarily for use in air, it is expected that hearing sensitivity underwater will generally be low, in comparison to that for marine mammals, for example.

12.154 It is anticipated that construction will occur during the spring, summer and autumn to take advantage of more benign weather conditions, thus for bird species recorded predominantly in the winter (red-throated diver, eider, gulls), direct impacts of negligible magnitude (Table 12.14).

12.155 For cormorant, common guillemot, razorbill and puffin, with large foraging ranges, and also for Arctic tern, the Project site is not considered to represent a foraging location of high importance. Thus for these medium sensitivity species direct impacts of construction activity will be of minor magnitude (Table 12.14).

12.156 For the medium sensitivity species, black guillemot and shag, predicted impacts of minor magnitude were assessed (Table 12.14).

12.157 In relation to direct impacts, gannet are considered unlikely to respond adversely to noise and other construction activity. Overall therefore, this low sensitivity species is considered likely to experience an impact of negligible magnitude (Table 12.14).

Indirect impacts via effects on prey species

12.158 There is also the potential that for some species the impact of construction activity (especially drilling) would occur indirectly through impacts upon the distribution of prey species. However, Kongsberg (2012) report that underwater drilling tends to be a low noise level operation, at least compared with other activities. In a relatively noisy environment such as the Inner Sound, it may be assumed that the drilling noise will propagate over only short distances before it falls below background noise levels. The modelling undertaken for the Inner Sound confirms this, with drilling noise falling to background noise levels at a range of 0.5km from the noise source. The source level for drilling activities is considerably below the level at which lethal injury to fish might occur and it is therefore unlikely that any marine animals will be killed by the underwater noise from pile drilling. For construction activities Kongsberg (2012) reported that no behavioural reactions are likely to manifest in hearing generalist fish. They are the most insensitive of generic species to the man-made noises that may be generated by the Project. Drilling noise is sufficiently low that hearing generalists and specialist fish would need to be less than 1m from the source of the drilling activity to elicit any behavioural response. When exposed to vessel noise, mild behavioural avoidance may occur out to a maximum distance of approximately 14m (Kongsberg, 2012). Hearing specialists would need to be less than 1m from the source of the drilling activity to elicit a strong behavioural response.

12.159 Construction activities are therefore not expected to cause fish to re-distribute more than a few metres away from the sources of disturbance. Such short range and temporary displacement of fish from the immediate area is predicted to be of little consequence to foraging birds. Furthermore, any effects on the distribution of fish are likely to be limited to the spring, summer and autumn periods.

12.160 Therefore, in an analogous way to the direct impacts of underwater noise, indirect impacts (via effects on prey) on bird species present mainly in the winter period of negligible magnitude are predicted (Table 12.14).

12.161 Again, analogous to direct impacts of underwater noise, and given that the Project area is not considered to represent a foraging location of high importance for cormorant, common guillemot, razorbill and puffin, with large foraging ranges, and also for Arctic tern, the indirect impacts (via effects on prey), are predicted to be of minor magnitude (Table 12.14).

12.162 Opportunistic scavenging species such as great skua, fulmar and gannet may benefit from foraging opportunities created by construction works. As such, the magnitude of construction related impacts on these species, were assessed as negligible (Table 12.14).

Impact significance

Species	Sensitivity to construction activity	Impact magnitude	Rationale	Consequence	Significance
Red-throated diver	Medium	Negligible	Only present outside breeding season and in very low numbers.	Negligible	Not Significant
Fulmar	Low	Negligible	Flexible and wide ranging foraging pattern.	Negligible	Not Significant
Gannet	Low	Negligible	Flexible and unlikely to respond to noise.	Negligible	Not Significant
Cormorant	Medium	Negligible	Mainly present outside breeding season.	Negligible	Not Significant
European shag	Medium	Minor	Any displacement expected to be limited to small area.	Minor	Not Significant
Eider	Medium	Negligible	Mainly present outside breeding season.	Negligible	Not Significant
Great skua	Low	Negligible	Flexible foraging pattern.	Negligible	Not Significant
Arctic skua	Low	Negligible	Flexible foraging pattern.	Negligible	Not Significant
Kittiwake	Low	Negligible	Unlikely to respond to noise.	Negligible	Not Significant
Common gull	Low	Negligible	Mainly present outside breeding season.	Negligible	Not Significant
Great black-backed gull	Low	Negligible	Mainly present outside breeding season.	Negligible	Not Significant
Herring gull	Low	Negligible	Mainly present outside breeding season.	Negligible	Not Significant
Arctic tern	Low	Negligible	Unlikely to respond to noise.	Negligible	Not Significant
Guillemot	Medium	Minor	Possible short range displacement.	Minor	Not Significant
Razorbill	Medium	Minor	Possible short range displacement.	Minor	Not Significant
Black guillemot	Medium	Minor	Possible short range displacement.	Minor	Not Significant
Puffin	Medium	Minor	Possible short range displacement.	Minor	Not Significant

Table 12.14: Details of species sensitivity and vulnerability to overall (i.e. direct and indirect) construction impacts and the significance of any impacts

MITIGATION IN RELATION TO IMPACT 12.4

- No specific mitigation measures are proposed as no significant impact predicted. Operational monitoring will be implemented in order to confirm the impact predications made here (see Section 12.12).

12.6.5 Impact 12.5: Effects of onshore infrastructure construction activities on terrestrial birds

12.163 The species which could potentially be affected by construction of the onshore infrastructure for the onshore Project include ones of very high sensitivity (with regards to their conservation status, e.g. hen harrier and golden plover). Construction activity may disturb breeding birds within the immediate vicinity of the site. However, the heath and bog habitats at the onshore Project site upon which breeding birds are likely to be reliant are of relatively small extent and are fragmented by the more extensive grasslands. Whilst it is feasible that nesting golden plover, dunlin and greenshank could occur on the onshore Project site, blanket bog is the preferred nesting habitat of all three of these species (Ratcliffe, 1990), and only

small areas (<14ha in total) of modified bog occur within the assessment area over which phase 1 habitat mapping was undertaken. Therefore, if they are present, numbers will be small and of little consequence relative to the breeding populations of these three species found across the Caithness and Sutherland Peatlands SPA.

12.164 Wintering wildfowl species listed for the Caithness Lochs SPA are Greenland white-fronted goose, greylag goose (Icelandic breeding population) and whooper swan. These species could potentially forage at low intensity within the areas of onshore development. However, the proposed development sites are unlikely to be of particular importance since they from part of a much larger expanse of similar habitat which covers much of the north Caithness coast. Therefore, the potential impact on these species of the loss of habitat due to the onshore developments is considered to be negligible.

12.165 Construction impacts will be of a temporary nature, and it is apparent that SPA species are unlikely to be dependent on the habitats within the affected area. In addition, the areas of the onshore Project are small and hold very small areas of key habitats relative to their availability in the surrounding areas, so even under a highly unlikely worst-case scenario only very small proportions of the SPA populations could be at risk of impact.

12.166 Breeding waterfowl species that form part of the SPA (wigeon and common scoter) are very unlikely to be affected by onshore construction activities as no suitable breeding habitat is located within any potential disturbance zone. Breeding birds are unlikely to forage within the development area.

Sensitivity	Impact magnitude	Consequence	Significance
Very high	Negligible	Minor	Not Significant

MITIGATION IN RELATION TO IMPACT 12.5

- Although no significant impacts are predicted, once specific onshore Project areas are known, further, targeted investigation will be undertaken to ascertain the status, distribution and habitat use of birds within the Project footprint and surrounding environment.

12.7 Impacts during Operations and Maintenance

12.7.1 Impact 12.6 Disturbance / displacement due to maintenance activity

12.167 Disturbance due to maintenance activity is expected to be of a similar nature to that discussed in relation to vessel traffic discussed above (Impact 12.1). However, since maintenance activity will be at a lower intensity and frequency than during the construction period (although it could occur sporadically over a long-term period), the impacts will all be of lower negligible magnitude.

Sensitivity	Impact magnitude	Consequence	Significance
Very high	Negligible	Minor	Not Significant

MITIGATION IN RELATION TO IMPACT 12.6

- No specific mitigation measures are proposed as no significant impact predicted. Operational monitoring will be implemented in order to confirm the impact predications made here (see Section 12.12).

12.7.2 Impact 12.7: Accidental spillage from vessels

12.168 The vessels to be used for during operations and maintenance operations will be smaller than those used during construction and installation and will therefore have similar inventories, of oil. The likelihood of spillage, mitigation measures and residual impacts are the same as those described for vessel spillage during construction (Impact 12.3).

12.7.3 Impact 12.8: Accidental leakage of pollutants from turbines

12.169 The tidal turbines will contain an inventory of fluids including oil, hydraulic fluid and coolant. The impact from loss of fluids from the tidal turbines will be limited. Leaks will be localised to the immediate vicinity of the turbine and will be rapidly dispersed in the tidal conditions present in the Inner Sound. The quantities and types of fluids to be used will also be a limiting factor to the overall impact, based on the candidate technologies being considered, turbine inventories will be 645 to 1,500 litres. The fluids will be mostly water based, biodegradable and have low aquatic toxicity.

12.170 To determine the magnitude of impact and the associated significance, the vulnerability of each species to surface pollutants (although note that these were derived for oil based pollutants, Williams *et al.*, 1995) is combined with the impact magnitude estimated in the Accidental Events section (Section 24). These are presented in Table 12.15. In this assessment seasonality is taken into account in the determination of impact magnitude through consideration of the peak period of bird presence in the Inner Sound.

Impact significance

Species	Sensitivity to surface pollutants[1] (see notes)	Predicted magnitude	Rationale	Consequence	Significance
Red-throated diver	Very high	Negligible	Only present outside breeding season and in very low numbers.	Minor	Not Significant
Fulmar	Medium	Negligible	Peak density in winter.	Negligible	Not Significant
Gannet	High	Negligible	Present in very low numbers.	Minor	Not Significant
Cormorant	High	Negligible	Present in very low numbers.	Minor	Not Significant
European shag	Very high	Negligible	Present throughout year.	Minor	Not Significant
Eider	Medium	Negligible	Mainly present in winter.	Negligible	Not Significant
Great skua	Very high	Negligible	Mainly present in summer.	Minor	Not Significant
Arctic skua	Very high	Negligible	Mainly present in summer.	Minor	Not Significant
Kittiwake	Medium	Negligible	Present in very low numbers.	Negligible	Not Significant
Common gull	Medium	Negligible	Present in very low numbers, peaks in winter.	Negligible	Not Significant
Great black-backed gull	High	Negligible	Present in very low numbers, peaks in winter.	Minor	Not Significant
Herring gull	Medium	Negligible	Present in very low numbers, peaks in winter.	Negligible	Not Significant
Arctic tern	Medium	Negligible	Occasional presence during summer.	Negligible	Not Significant

Species	Sensitivity to surface pollutants[1] (see notes)	Predicted magnitude	Rationale	Consequence	Significance
Guillemot	High	Negligible	Numbers peak in summer.	Minor	Not Significant
Razorbill	High	Negligible	Numbers peak in summer.	Minor	Not Significant
Black guillemot	Very high	Negligible	Present throughout year.	Minor	Not Significant
Puffin	High	Negligible	Numbers peak in summer.	Minor	Not Significant

Notes:
1 – Vulnerability to surface pollutants was derived from the Oil Vulnerability Index of Williams et al. (1995)

Table 12.15: Details of species sensitivity and vulnerability to inventory leakage from turbines and significance of any impacts

MITIGATION IN RELATION TO IMPACT 12.8

- Although no significant impact has been identified, mitigation measures have been provided as a precautionary approach to ensure this remains the case.
- Only recognised marine standard fluids and substances will be used in the turbine hydraulic systems.
- Hydraulic fluids will be mostly water based, biodegradable and be of low aquatic toxicity.
- Project specific emergency response procedures will be implemented and include contingency arrangements in the unlikely event of a pollution incident.

12.7.4 Impact 12.9: Displacement due to the presence of the turbines

12.171 The worst case impact assessed as a potential consequence of birds being displaced by the presence of the turbines was that those individuals affected would be forced to forage in alternative locations which would not provide sufficient prey to enable those birds to successfully breed. Since the minimum distance between sea surface at Lowest Astronomical Tide (LAT) and the rotor tips will be 8m, only those species of bird which dive to 8m or more to forage are considered to be at risk of displacement impacts due to the presence of the turbines (diving depths from BirdLife International, 2011). Since potential impacts were only considered to affect reproduction, only those species recorded during the breeding season were assessed: gannet, cormorant, shag, common guillemot, razorbill, puffin and black guillemot. This assessment was focussed on just the turbine deployment area (1.1km^2) since this is the maximum extent of disturbance reasonably expected due to the turbines. Sensitivity was derived from a combination of the numbers seen in the turbine deployment area and the size of the estimated population at risk.

12.172 Very few gannets were seen foraging in the survey area during the breeding season (peak count 1 individual). Compared to the potential population from which they could be drawn (approximately 177,000 within a mean maximum foraging range of >300km, Mitchell *et al.,* 2004), this species was not considered at risk of impacts due to displacement. Therefore this low sensitivity species is considered to be at risk of a negligible magnitude impact (Table 12.16).

12.173 No cormorants were not observed during the boat surveys and the land based surveys recorded this species at low levels, with no more than three individuals observed on any one survey. Very few birds were observed during the breeding season, therefore this species was not considered at risk of impacts due to displacement. Therefore this low sensitivity species is considered to be risk of a negligible magnitude impact (Table 12.16).

12.174 Similarly, very few common guillemot were seen foraging in the survey area during the breeding season (peak count 27 individuals). Compared to the potential population from which they could be drawn (approximately 279,000, JNCC Seabird Monitoring Programme database), this species was not considered at risk of impacts due to displacement. Therefore this medium sensitivity species is considered to be at risk of a negligible magnitude impact (Table 12.16).

12.175 For the remaining species of diving birds (shag, razorbill, puffin and black guillemot) the impact on the breeding populations of displacement of the peak abundance of breeding adults was determined using population modelling (for further details of the models see the Ornithology Technical Annex; RPS, 2011b. For the purposes of this assessment it was assumed that displaced individuals fail to breed. The population at risk for each species was estimated using the Seabird Monitoring Programme (SMP) database (downloaded November 2011 from: http://jncc.defra.gov.uk/smp/) and the estimated foraging range (BirdLife International, 2011).

12.176 The estimated breeding population of shag within mean maximum foraging range (16km) of the site is 628 individuals. The peak abundance of breeding birds on the survey area was 14. If all of these individuals failed to breed the predicted population growth rate will fall from 3.3% year^{-1} to 3.1% year^{-1}. Therefore, this medium sensitivity species was assessed as being at risk of an impact of negligible magnitude (Table 12.16).

12.177 The estimated breeding population of razorbill within mean maximum foraging range (31km) of the site is 6,971. The peak abundance of breeding birds on the survey area was 5 individuals. If all of these individuals failed to breed the predicted population growth rate will be unchanged. Therefore, this medium sensitivity species was assessed as being at risk of an impact of negligible magnitude (Table 12.16).

12.178 The estimated breeding population of puffin within mean maximum foraging range (62km) of the site is 4,088. The peak abundance of breeding birds on the survey area was 8 individuals. If all of these individuals failed to breed the predicted population growth rate will fall from 3.19% year^{-1} to 3.18% year^{-1}. Therefore, this medium sensitivity species was assessed as being at risk of an impact of negligible magnitude (Table 12.16).

12.179 The estimated breeding population of black guillemot within mean maximum foraging range (12km) of the site is 455 individuals. The peak abundance of breeding birds on the survey area was 7 individuals. If all of these individuals failed to breed the predicted population growth rate will fall from 1.36% year^{-1} to 1.2% year^{-1}. Therefore, this medium sensitivity species was assessed as being at risk of an impact of a negligible magnitude (Table 12.16).

Impact significance

Species	Sensitivity (based on numbers in survey area)	Impact magnitude	Consequence	Significance
Gannet	Low	Negligible	Negligible	Not Significant
Cormorant	Low	Negligible	Negligible	Not Significant
European shag	Medium	Negligible	Negligible	Not Significant
Guillemot	Medium	Negligible	Negligible	Not Significant

Species	Sensitivity (based on numbers in survey area)	Impact magnitude	Consequence	Significance
Razorbill	Medium	Negligible	Negligible	Not Significant
Puffin	Medium	Negligible	Negligible	Not Significant
Black guillemot	Medium	Negligible	Negligible	Not Significant

Table 12.16: Details of species sensitivity to displacement impacts due to the turbines and the significance of any impacts

MITIGATION IN RELATION TO IMPACT 12.9
▪ No specific mitigation measures are proposed as no significant impact predicted. Operational monitoring will be implemented in order to confirm the impact predications made here (see Section 12.12).

12.7.5 Impact 12.10: Collision risk to diving birds

12.180 Only species of bird recorded during the breeding season, which dive to depths of 8m or more (minimum distance between sea surface at LAT and rotor tips) are considered at risk of collision impacts. These species are; gannet, shag, common guillemot, razorbill, puffin and black guillemot. This assessment was undertaken for the worst case 86, 1MW turbines. The full details of the exposure time modelling and the population modelling on which these assessments are based is provided in the Ornithology Technical Annex (RPS, 2011b). In its current form, the modelling process does not include behavioural and ecological factors which might be expected to influence the likelihood of collisions between diving birds and tidal turbines (e.g. maximum bird swim speed, ability of birds to detect turbines underwater, probability that a single transit through a spinning rotor blade will result in a collision, etc.). These have been omitted since little is known at present about how diving birds may interact with tidal turbines. Thus, in the exposure time model the entire volume of water in which a rotor is located represents equivalent levels of exposure to collision. Consequently this approach is considered highly precautionary in its outputs. For species which are estimated to be at relatively high risk of impacts due to exposure to turbines, foraging behaviour and ecology have also been taken into account in order to determine the expected impact magnitude and significance. This was not considered necessary for those species with relatively low estimated exposure risks (e.g. species which don't dive to more than 8m). In addition to the above list of species, one additional deeper diving species was assessed; cormorant. None were seen during the boat surveys, therefore no density estimates can be calculated for this species in the survey area, which precludes assessment using the exposure model. However, since a few were observed during the land surveys a qualitative assessment is provided for this species. Sensitivity was derived from a combination of the numbers seen in the turbine deployment area and the size of the estimated population at risk.

12.181 An estimated 90,600 individual gannet breed within the mean maximum foraging range of the turbine deployment area. Using observed monthly density estimates derived from the boat surveys and published diving information it was estimated that the individual annual exposure time on the site was 0.000053s. Given this level of exposure, to generate an additional rate of mortality sufficient to trigger a population decline, the predicted collision rate would need to be 91 collisions between gannets and the turbines for every second that the regional population spends at rotor depths within the turbine deployment area. With a peak site abundance of 1, such a collision rate is considered very unlikely. Therefore, this low sensitivity species was assessed as being at risk of an impact of a negligible magnitude (Table 12.17).

12.182 No cormorants were observed during the boat surveys, therefore it is not possible to estimate the density of birds within the turbine deployment area, thus it is also not possible to undertake a quantitative assessment of the potential exposure time. While this species can dive to depths at which collisions with tidal turbines are possible (Grémillet *et al.,* 1999), given the very low abundance on the site, particularly during the breeding season, this low sensitivity species is assessed as being at risk of an impact of a negligible magnitude (Table 12.17).

12.183 An estimated 628 shag breed within this species' mean maximum foraging range of the turbine deployment area. Using observed monthly density estimates derived from the boat surveys and published diving information it was estimated that the individual annual exposure time on the site was 42.3s. To generate an additional rate of mortality sufficient to trigger a population decline, there would need to be 0.0008 collisions between shags and the turbines for every second that the regional population spends at rotor depths within the turbine deployment area (this equates to approximately 1 collision every 21 minutes). With a peak site abundance of 21 individuals, such a collision rate is considered possible. Shag forage on both pelagic and benthic species, and are strongly associated with the sandy sediments which are home to sandeels, their primary prey (BirdLife International, 2011). Sandeels have been found to represent 90% of their diet by weight (BirdLife International 2011). Suitable habitat for sandeels is restricted to the edges of the Inner Sound, while the turbine deployment area itself comprises scoured bed rock with only limited patches of thin sediment. It therefore seems unlikely that the turbine deployment area is an important foraging area for shags. In addition, this species forages exclusively by day, which will increase the likelihood that the birds will detect and be able to avoid the turbines. Therefore, given the foraging ecology of this medium sensitivity species, the risk of an impact was assessed as being of a minor magnitude (Table 12.17).

12.184 An estimated 71,000 common guillemot breed within this species' mean maximum foraging range of the turbine deployment area. Using observed monthly density estimates derived from the boat surveys and published diving information it was estimated that the individual annual exposure time on the site was 0.032s. To generate an additional rate of mortality sufficient to trigger a population decline, there would need to be 1.6 collisions between common guillemots and the turbines for every second that the regional population spends at rotor depths within the turbine deployment area. With a peak site abundance of 27 individuals, such a collision rate is considered highly unlikely. Therefore, this medium sensitivity species was assessed as being at risk of an impact of negligible magnitude (Table 12.17).

12.185 An estimated 6,971 razorbill breed within this species' mean maximum foraging range of the turbine deployment area. Using observed monthly density estimates derived from the boat surveys and published diving information it was estimated that the individual annual exposure time on the site was 0.023s. To generate an additional rate of mortality sufficient to trigger a population decline, there would need to be 0.7 collisions between razorbills and the turbines for every second that the regional population spends at rotor depths within the turbine deployment area. With a peak site abundance of 9 individuals, such a collision rate is considered unlikely. Therefore, this medium sensitivity species was assessed as being at risk of an impact of a negligible magnitude (Table 12.17).

12.186 An estimated 4,088 puffin breed within this species' mean maximum foraging range of the turbine deployment area. Using observed monthly density estimates derived from the boat surveys and published diving information it was estimated that the individual annual exposure time on the site was 0.95s. To generate an additional rate of mortality sufficient to trigger a population decline, there would need to be 0.028 collisions between puffins and the turbines for every second that the regional population spends at rotor depths within the turbine deployment area (this equates to approximately 1 collision every 36 seconds). With a peak site abundance of 14, such a collision rate is considered unlikely. Therefore, this medium sensitivity species was assessed as being at risk of an impact of a negligible magnitude (Table 12.17).

12.187 An estimated 445 black guillemot breed within this species' mean maximum foraging range of the turbine deployment area. Using observed monthly density estimates derived from the boat surveys and published diving information it was estimated that the individual annual exposure time on the site was 19.5s. To generate an additional rate of mortality sufficient to trigger a population decline, there would need to be 0.0006 collisions between black guillemots and the turbines for every second that the regional population spends at rotor depths within the turbine deployment area (this equates to approximately 1 collision every 26 minutes). With a peak site abundance of 16, such a collision rate is considered possible. Black guillemot primarily forage at the seabed in shallow inshore waters. In Scottish waters they have been found to favour rocky vegetated habitats, reflecting the preferences of their main prey species, butterfish *Pholis gunnellus* (BirdLife International, 2011). While the benthic survey of the Inner Sound (ASML, 2011) found the turbine deployment area to consist of scoured bedrock, to the south large swathes of kelp forest

were recorded, of the type favoured by butterfish. In addition, black guillemot are considered to favour moderate current speeds of 0.3-0.7m/s for foraging (BirdLife International, 2011), which is considerably lower than the current speeds experienced in the turbine deployment area. It therefore seems likely that individuals of this species will spend comparatively little time foraging in the vicinity of the turbines and the turbine deployment area itself is not considered likely to represent an important foraging area for this species. Therefore, this medium sensitivity species was assessed as being at risk of an impact of a minor magnitude (Table 12.17).

Impact significance

Species	Sensitivity (based on numbers in the survey area)	Impact magnitude	Consequence	Significance
Gannet	Low	Negligible	Negligible	Not Significant
Cormorant	Low	Negligible	Negligible	Not Significant
European shag	Medium	Minor	Minor	Not Significant
Guillemot	Medium	Negligible	Negligible	Not Significant
Razorbill	Medium	Negligible	Negligible	Not Significant
Puffin	Medium	Negligible	Negligible	Not Significant
Black guillemot	Medium	Minor	Minor	Not Significant

Table 12.17: Details of species sensitivity to collision impacts due to the turbines and the significance of any impacts

MITIGATION IN RELATION TO IMPACT 12.10

- No specific mitigation measures are proposed as no significant impact predicted. Operational monitoring will be implemented in order to confirm the impact predications made here (see Section 12.12).

12.7.6 Impact 12.11: Indirect effects on birds

12.188 Bird species which forage in the Inner Sound may be at risk of effects due to impacts from operational turbines on their prey.

12.189 The fish baseline description (Section 13) indicates that very few fish species considered to be important prey for the seabird species present in the Project area (e.g. sandeel, herring, butterfish, etc.) are present in significant numbers. The potential for significant collision risk impacts on the fish species present was assessed as minor or negligible, although it was noted that while this is based on the best information available, there is currently a lack of empirical evidence on how fish may respond to tidal turbines.

12.190 It appears plausible to assume therefore, that the Project will not significantly reduce the availability of fish prey within the area (e.g. through elevated mortality), although it is possible that fish will relocate from the immediate area of the turbines. As such, the Project may lead to local re-distribution of fish and those species which prey on them. This effective displacement of seabirds is considered unlikely to have an impact on their populations (see results of the displacement assessment above; Impact 12.9).

12.191 A potential additional consequence of prey displacement may also be to reduce the risk of diving bird collisions with the turbines. However, there is also the possibility that the support structures will provide sheltered areas which fish are able to utilise, thereby increasing the prevalence of fish within the Project area. This could potentially lead to increased seabird foraging within the Project area, with a consequent increase in collision risk. At this stage it is not possible to determine whether fish abundance will increase or decrease within the Project area, therefore the indirect impacts on foraging seabirds may be negative or positive. Since there is no evidence to indicate that the Project site provides foraging opportunities of a critical nature within the region, the impacts are considered unlikely to be more than negligible in magnitude.

12.192 The substrate within the Project area comprises scoured rock, with localised patches of very thin layers of sediment (ASML, 2011). These are not considered to represent suitable habitat for the shellfish prey of species such as eider, therefore no indirect impact is considered for these species.

Sensitivity	Impact magnitude	Consequence	Significance
Very high	Negligible	Minor	Not Significant

MITIGATION IN RELATION TO IMPACT 12.11

- No specific mitigation measures are proposed as no significant impact predicted. Operational monitoring will be implemented in order to confirm the impact predications made here (see Section 12.12).

12.7.7 Impact 12.12: Effects of operation of onshore infrastructure on terrestrial birds

12.193 Terrestrial birds could conceivably be impacted through loss of habitat resulting from the presence of buildings constructed for the Project. The Caithness and Sutherland Peatlands SPA and Caithness Lochs SPA are the most likely to be affected by any such impacts that may occur to terrestrial bird populations. Of the qualifying species for these two SPAs, hen harrier, merlin, short-eared owl, golden plover, dunlin and greenshank all depend heavily upon heath and bog habitats for nesting (Pearce-Higgins *et al*., 2009). The mix of heath, grassland and scrub could also provide foraging habitats for these raptors, whilst breeding golden plover (and to a lesser extent dunlin) depend heavily on grasslands for foraging, as do wintering geese (Bibby, 1986; Pearce-Higgins *et al*., 2003; Arroyo *et al*., 2009; Madsen *et al*., 1999).

12.194 The heath and bog habitats at the Project site are of relatively small extent and are fragmented by the more extensive grasslands. The proposed sites for the buildings (PCC) occur entirely on grassland habitats with the exception of part of the Ness of Quoys PCC option. This covers an area of approximately 0.085km^2 of mixed wet heath, acid grassland and modified bog habitat (Xodus 2011a). However, these are unlikely to be suitable for ground nesting raptors because these species generally require extensive areas of these habitats for nesting (Redpath *et al*., 1998). Whilst it is feasible that nesting golden plover, dunlin and greenshank could occur on the Project site, blanket bog is the preferred nesting habitat of all three of these species (Ratcliffe, 1990), and only small areas (<14ha in total) of modified bog occur. Therefore, if they are present, numbers will be small and of little consequence relative to the breeding populations of these three species found across the Caithness and Sutherland Peatlands SPA. Breeding wigeon and common scoter are very unlikely to be affected by operational infrastructure, as no suitable nesting or foraging habitat will be lost. The potential impacts on wintering wildfowl from the Caithness Lochs SPA (Greenland white-fronted goose, greylag goose and whooper swan) are considered to be very small, given the extensive areas of suitable habitat within the region.

12.195 Thus, permanent habitat loss is likely to mainly affect habitats of lesser importance to bird populations (e.g. grassland), with other areas of dwarf shrub heath and one small area of modified bog in the development area overlapping with the potential cable routes, where habitat loss will be temporary only. In addition, it is apparent that SPA species are unlikely to be dependent on the habitats within the affected

area, and the areas of the Project are considered to be comparatively small, so that only very small proportions of the SPA populations are at risk of impact. Therefore the impacts of the onshore infrastructure on these very high sensitivity species are assessed as of negligible magnitude.

Sensitivity	Impact magnitude	Consequence	Significance
Very high	Negligible	Minor	Not Significant

MITIGATION IN RELATION TO IMPACT 12.12
▪ Once specific onshore Project areas are known, further, targeted investigation will be undertaken to ascertain the status, distribution and habitat use of birds within the Project footprint and surrounding environment. The results of the survey will be used to confirm the impact assessment.

12.8 Impacts during Decommissioning

12.196 The potential impacts during decommissioning are expected to be, at worst of the same nature and magnitudes as those during the construction period. The impacts considered during construction which would also be applicable during decommissioning include:

- Disturbance / displacement due to increased boat traffic;
- Accidental spillage of inventories from vessels; and
- Disturbance / displacement due to offshore decommissioning activities.

12.197 None of the impacts predicted for these activities during construction and installation are not considered significant.

12.9 Potential Variances in Environmental Impacts

12.198 The impact assessment above has assessed the worst case Project options with regards to impact on birds. This section provides a brief overview of the potential variances between the worst case Project option assessed and alternative Project options.

12.199 For the collision risk assessment, a worst case of 86, 20m rotor turbines was used. The installation of smaller rotor (16 or 18m diameter) turbines or a lower number of higher capacity turbines would reduce the assessed risk of collision for diving bird species. This is generally a safe assumption - in normal collision risk modelling the reduction in rotor diameter outweighs increases in collision risk due to slightly faster rotational speeds associated with smaller turbines.

12.200 In terms of construction noise impacts, the installation of the gravity base TSSs would generate less noise during installation, due to there not being a requirement to drill, this installation method would not release drill cuttings or fluids into the marine environment during installation. Although diving bird species are not considered to have hearing adapted for underwater, the use of 86 turbines of 1MW during operation will result in a lesser noise impact than if 36 turbines of 2.4MW are used.

12.201 The assessment of displacement due to turbine presence considers the exclusion of species able to dive to turbine depths within the whole of the turbine deployment area (1.1km^2). The turbine array will take up a much smaller area than assessed and therefore impacts are likely to be significantly reduced.

12.202 All onshore and offshore construction activities will not conducted in parallel. Activities will concentrate on specific areas before moving to the next phase of construction, therefore construction will not be spread across the whole project area at any given time and disturbance and displacement impacts are likely to be lower than assessed.

12.10 Cumulative Impacts

12.10.1 Introduction

12.203 MeyGen has in consultation with Marine Scotland and The Highland Council identified a list of other projects (MeyGen, 2011) which together with the Project may result in potential cumulative impacts. The list of these projects including details of their status at the time of the EIA and a map showing their location is provided in Section 8; Table 8.3 and Figure 8.1 respectively.

12.204 Having considered the information presently available in the public domain on the projects for which there is a potential for cumulative impacts, Table 12.18 below indicates those with the potential to result in cumulative impacts from an ornithological perspective. The consideration of which projects could result in potential cumulative impacts is based on the results of the project specific impact assessment together with the expert judgement of the specialist consultant.

Project title	Potential for cumulative impact	Project title	Potential for cumulative impact	Project title	Potential for cumulative impact
MeyGen Limited, MeyGen Tidal Energy Project, Phase 2	✓	SHETL, HVDC cable (onshore to an existing substation near Keith in Moray)	✗	OPL, Ocean Power Technologies (OPT) wave power ocean trial	✗
ScottishPower Renewables UK Limited, Ness of Duncansby Tidal Energy Project	✓	Brough Head Wave Farm Limited, Brough Head Wave Energy Project	✓	MORL, Moray Offshore Renewables Ltd (MORL) offshore windfarm	✓
Pelamis Wave Power, Farr Point Wave Energy Project	✓	SSE Renewables Developments (UK) Limited, Costa Head Wave Energy Project	✓	SSE and Talisman, Beatrice offshore Windfarm Demonstrator Project	✓
Sea Generation (Brough Ness) Limited, Brough Ness Tidal Energy Project	✓	EON Climate & Renewables UK Developments Limited, West Orkney North Wave Energy Project	✓	BOWL, Beatrice Offshore Windfarm Ltd (BOWL) offshore windfarm	✓
Cantick Head Tidal Development Limited, Cantick Head Tidal Energy Project	✓	EON Climate & Renewables UK Developments Limited, West Orkney South Wave Energy Project	✓	Northern Isles Salmon, Chalmers Hope salmon cage site	✗
SSE, Caithness HVDC Connection - Converter station	✗	ScottishPower Renewables UK Limited, Marwick Head Wave Energy Project	✓	Northern Isles Salmon, Pegal Bay salmon cage site	✗
SSE, Caithness HVDC Connection - Cable	✗	SSE Renewables Developments (UK) Limited, Westray South Tidal Energy Project	✓	Northern Isles Salmon, Lyrawa salmon cage site	✗
RWE npower renewables, Stroupster Windfarm	✗	EMEC, Wave Energy test site (Billia Croo, Orkney)	✗	Scottish Sea Farms, Bring Head salmon cage site	✗
SSE, Gills Bay 132 kV / 33 k V Substation Phase 1: substation and overhead cables (AC)	✗	EMEC, Tidal energy test site (Fall of Warness, Orkney)	✗	Northern Isles Salmon, Cava South salmon cage site	✗
SSE, Gills Bay 132 kV / 33 k V Substation Phase 2: HVDC converter station and new DC buried cable	✗	EMEC, Intermediate wave energy test site (St Mary's Bay, Orkney)	✗	Scottish Sea Farms, Toyness salmon cage site	✗
SHETL, HVDC cable (offshore Moray Firth)	✗	EMEC, Intermediate tidal energy test site (Head of Holland, Orkney)	✗	Northern Isles Salmon, West Fara salmon cage site	✗

Table 12.18: Summary of potential cumulative impacts

12.205 The following sections summarise the nature of the potential cumulative impacts for each potential project phase:

- Construction and installation;
- Operations and maintenance; and
- Decommissioning.

12.10.2 Potential cumulative impacts during construction and installation

12.206 The Ness of Duncansby Tidal Energy project is the only project that may potentially be constructed at the same time as the MeyGen Tidal Energy Project, Phase 1. However, cumulative impacts arising from coincident installation are not anticipated as the majority of impacts are expected to be localised (e.g. increased turbidity) and therefore very unlikely to generate significant cumulative impacts on birds.

12.207 The Pentland Firth is subject to relatively high levels of ship movements and it is therefore considered that the additional vessel activity related to the construction of these energy developments will not constitute a significant cumulative impact. Given the rare nature of accidental inventory spillage events, the likelihood for cumulative impacts (i.e. accidental events occurring in the same time period at one or more projects) for seabirds is considered extremely remote and therefore not significant.

12.208 The potential for a cumulative impact of tidal and wave energy devices on prey availability for bird species is likely to depend on the extent to which foraging occurs within development areas, the extent of construction impacts on fish prey species, the extent to which construction activities coincide across sites (and the proximity of such activity) and on the type of prey taken by the different bird species. Fish will be expected to relocate away from sources of disturbance, thus limiting effects on stocks but requiring that species dependent on them also relocate. Overall the likelihood of construction causing fish mortality is considered to be very low and therefore no significant indirect cumulative impacts due to construction are predicted.

12.209 Construction of the onshore infrastructure is unlikely to overlap with the construction of any other onshore developments, and thus no cumulative impacts are predicted.

12.10.3 Potential cumulative impacts during operations and maintenance

12.210 It is possible for cumulative impacts to arise from operations and maintenance of the Project in combination with the operation and maintenance of other marine renewable projects in the Pentland Firth. The main impacts will be disturbance and displacement due to vessel operations and the installed devices themselves and potential mortality due to collisions with moving parts.

12.211 With regards to disturbance caused by vessel traffic, in the context of the existing level of ship movements through the Pentland Firth, it is not considered that maintenance activities will constitute a significant cumulative impact.

12.212 Displacement is defined here as the prevention of individuals from a seabird species from undertaking their normal behaviour within areas previously utilised, due to the presence of a novel stimulus. For the purposes of this assessment, the novel stimulus is considered to be the energy devices themselves (and associated structures) but does not include the related vessel traffic (e.g. maintenance vessels). For devices located wholly underwater (such as the proposed tidal turbines) the zone of impact is limited to the turbine deployment area, as it seems probable that beyond this birds will be unaware of their presence. Devices which are visible on the surface (e.g. wind turbines and wave energy devices) may also displace birds from a surrounding region. No significant impacts are identified with regards to displacement from the MeyGen Project area alone, in large part due to the very low numbers of individuals at risk of such effects. Since other proposed developments are likely to generate impacts of a similar magnitude the likelihood of a cumulative displacement effect is considered to be very small and of no significance.

12.213 The marine renewable projects considered most likely to contribute to a cumulative collision impact with the Project are the other proposed tidal projects within the Pentland Firth region; Ness of Duncansby, Brough Ness and Cantick Head. Wave energy projects were excluded from this list on the basis that the technologies proposed to harvest wave energy will be located at the surface, will be more visible and will have less rapidly moving parts. Therefore, these devices are considered to constitute a much lower collision risk to diving seabirds.

12.214 Currently each of the tidal developments plan to use a different form of turbine; Cantick Head intend to use devices with enclosed blades, Brough Ness intend to use twin turbines mounted to a fixed tower and Ness of Duncansby is expected to use open turbines (similar to those to be used for the MeyGen Project). It is plausible that each of these devices will present different potential collision risks to diving seabirds, complicating attempts to estimate cumulative impacts.

12.215 Gannet and cormorant are determined to be at negligible risk of significant impacts from underwater collisions, since the rates of collision required to trigger population level impacts are considerably higher than the peak number observed on the MeyGen survey area. Therefore, any potential additional risk from other developments is considered very unlikely to lead to a significant cumulative effect. While gannets are also at risk of collision with offshore wind turbines, the very low numbers observed on the MeyGen survey area exclude this as a potential cumulative impact with collisions with tidal turbines.

12.216 Common guillemot, razorbill and puffin were assessed to be at minor risk of collision impacts from the Project and there is therefore the potential for significant combined impacts with other tidal projects. However, the populations of these species within foraging range of the various sites are large, and the peak number of individuals assessed as being at risk of collision on the MeyGen Project area were very small, therefore the likelihood of a significant impact is assessed as being small.

12.217 Shag and black guillemot have smaller local populations and were seen more frequently on the MeyGen survey area. Therefore these species are considered to be at the greatest risk of population impacts due to collisions. Two of the other tidal developments under consideration, Brough Ness and Cantick Head, are located 11km from the MeyGen Project site which is near the upper range of the mean maximum foraging range for both these species. While this does not rule out the possibility that individuals from the same population may forage across all three sites, the probability of this is considered to be low, therefore the potential for a cumulative collision impact in combination with these two projects is considered sufficiently small to be insignificant.

12.218 The Ness of Duncansby site is located 3km from the MeyGen site and therefore there is a higher probability that individuals from the same population may be present on both sites, leading to a potential for cumulative impacts on the same populations. However, given the seabed conditions expected to be present at sites of high tidal flow such as these (scoured bedrock), and the favoured current speeds (which are much lower than those present at either location), it seems highly unlikely that either of these two locations (i.e. Inner Sound and Ness of Duncansby) represents prime habitats for favoured prey of either species (e.g. sandy substrates for sandeels and vegetation for butterfish). Therefore the likelihood that either of these species will use the turbine deployment areas for foraging, particularly during periods of turbine operation, is considered to be small. Therefore no significant cumulative impact is predicted for either of these species.

12.219 Based on the findings of the fish assessment baseline description (Section 13) very few fish prey species are expected to be present in significant numbers in the Inner Sound and seabed habitats present in the site are unsuitable for fish spawning. Since this is assumed to be a consequence of the strong tidal flow within the site, it seems likely that similar conditions will be found within the other proposed tidal development sites. Hence, all of the tidal sites are considered to provide sub-optimal foraging opportunities for seabird species preying on benthic invertebrates (e.g. eider).

12.220 Fish present in the water column may be displaced by the presence of the tidal turbines, or alternatively the support structures may provide them with areas of shelter. Thus it is possible that the devices may lead to either a decrease or an increase in fish abundance at the site. Variations in local conditions between developments will also be expected to influence the probability of changes in fish abundance. It should be noted however that any reduction in abundance would only be expected to occur within the

immediate vicinity of the turbines themselves, and this would be unlikely to be reflected in changes in abundance at a wider scale. Currently it is not possible to determine how tidal turbines may affect fish densities, however there is no compelling evidence that significant indirect cumulative impacts on foraging seabirds will result from the installation of the marine renewable developments under consideration.

12.10.4 Potential cumulative impacts during decommissioning

12.221 Although it is possible that a number of the impacts which may occur during decommissioning (e.g. noise emissions, vessel traffic), there is limited scope for these to act cumulatively with other developments since it is highly unlikely that the other developments within the region would be decommissioned at the same time. Therefore no significant cumulative impacts of decommissioning are predicted.

12.10.5 Mitigation requirements for potential cumulative impacts

12.222 No mitigation is required over and above the Project specific mitigation.

12.11 Habitat Regulations Appraisal

12.223 For projects which could affect a Natura site, a competent authority (in this case Marine Scotland for offshore and The Highland Council for onshore) is required to determine whether the Project will have a likely significant effect on the qualifying interests of any Special Protection Areas (SPAs) and any Special Areas of Conservation (SACs). Depending on the outcome of this determination, the competent authority will undertake an Appropriate Assessment of the implications of the Project for the Natura site's conservation objectives. The responsibility for provision of information with which to inform the Appropriate Assessment rests with the applicant.

12.224 The Project lies within part of the seaward extension of the North Caithness Cliffs SPA, which given the presence of qualifying species from this SPA in the site, automatically triggers the requirement for an Appropriate Assessment. Due to the distances over which bird species for which SPAs are designated can travel, there has been a need to investigate the Likely Significant Effects on a number of SPA sites. This assessment is presented in a separate HRA report (see HRA document on the supporting studies CD, MeyGen, 2012).

12.12 Proposed Monitoring

12.225 Potential impacts on birds have been assessed as being negligible or minor. Although the results conclude that the Project does not pose a significant risk to birds, MeyGen recognises that due to the emerging nature of the tidal energy industry there is uncertainty about some potential impacts especially where these have yet to be verified by operational monitoring in the industry.

12.226 Where impacts cannot be fully quantified (e.g. turbine collision risk), MeyGen is committed to developing a bird monitoring program. This program will be based on the 'Survey, Deploy and Monitor' strategy in accordance with Scottish Government policy (currently available in draft).

12.227 MeyGen has recognised that being the first application for a commercial scale tidal stream project in Scotland and the first from The Crown Estate's Pentland Firth and Orkney Waters leasing round, has meant that there is potential for the Project to form part of an industry wide strategic monitoring program that will benefit future projects as well.

12.228 Where strategic monitoring is appropriate, MeyGen would look to a collaborative effort between the Project, wider industry, regulators and stakeholders to take this forward in the most efficient way for the interest of the Project and future projects elsewhere in Scotland and the UK.

12.229 As part of this EIA and the MeyGen commitment to post-installation monitoring, the draft SNH survey and monitoring guidance (MacLeod *et al*. 2011, Sparling *et al*. 2011) has been reviewed. Although this guidance does not, and cannot, give specific details of what ornithology monitoring should take place, based on the general approaches described and on current knowledge of the site (obtained from the extensive baseline surveys), it is likely that the monitoring programme could include some or all of the following:

Disturbance and displacement (birds at sea)

- Targeted boat or land-based observations of all bird species to determine how area use or behaviour may have changed over time. Critical periods of the year are the breeding season; and
- Collection of underwater noise measurements of the candidate prototype tidal turbines. The data collected will be used to validate the underwater noise modelling completed to inform the impact assessment.

Collision risk (birds at sea)

12.230 MeyGen believes that understanding diving bird behaviour around tidal turbines and the risk of collisions occurring is fundamental for the industry to progress. It is therefore proposed that this potential impact is considered as strategic research and therefore monitoring approaches should be developed in cooperation with regulators, stakeholders and other developers. Monitoring could include:

- Installation of one or more active monitoring systems on one or more tidal device to better understand the near-field response of bird species to operating tidal devices; and
- Other strategic research such as expanding current research on the extent of connectivity between the site and local breeding colonies. Fitting individual birds with geo-locating tags and dive data loggers will provide information on this and would also contribute to collision risk monitoring.

12.231 MeyGen will work with the regulator (Marine Scotland) and its advisory bodies (e.g. SNH) to agree the details of appropriate monitoring and will ensure that the monitoring programme is aligned with industry best practice. Methods for assessing disturbance and displacement impacts and collision risk can potentially be linked with similar effort required for Section 11 Marine Mammals and Section 13 Fish Ecology.

12.232 Where monitoring indicates that specific mitigating measures may be reasonably required, MeyGen is committed to put these in place.

12.233 With regards to the onshore aspects of the Project, once the final onshore development areas are known, a pre construction bird survey will be undertaken, the scope of which will be agreed with SNH.

12.13 Summary and Conclusions

12.234 During the MeyGen commissioned surveys of the Pentland Firth Inner Sound conducted between October 2009 and September 2011, 28 species of seabird, seaduck or diver were recorded. Many of these are qualifying interests for SPAs within the region and are thus afforded European protection status. The seabirds observed make use of the Inner Sound for a range of activities (e.g. loafing, foraging) and different species have shown different seasonal trends in site presence and abundance. Species recorded on the sea surface during the boat surveys which were present predominantly over winter were; common gull, herring gull, great black-backed gull, red-throated diver and eider. Species recorded on the sea surface during the boat surveys which were present in greatest numbers during the breeding season were; great skua, common guillemot, razorbill and puffin. Of the remaining species recorded on the sea surface during the boat surveys, gannet and kittiwake were seen in most months, albeit at very low densities, while fulmar, shag and black guillemot were seen in most months at higher densities. Cormorant and Arctic tern were observed occasionally during the land based observations, cormorant predominantly during winter and Arctic tern only in the breeding season.

12.235 Potential impacts associated with the construction, installation, operation, maintenance and decommissioning of the development on bird ecology have been assessed. This assessment identified a number of key issues associated with bird ecology, including disturbance and displacement caused by construction activity and vessel operation, disturbance and displacement caused by the turbines themselves, collision risk with the turbines and accidental spillage of pollutants from vessels (both construction and maintenance) and from the turbines.

12.236 Disturbance and displacement impacts due to vessel traffic during construction were assessed on the basis of each species' sensitivity to vessels and site usage (e.g. if species are present only in winter the risk of construction impacts are small). The combination of the small scale of the Project, the proposed choice of construction vessels and the sensitivity of each species to these sources of disturbance resulted in impacts of negligible / not significant or minor / not significant being assessed.

12.237 Disturbance due to maintenance vessels was considered to cause and even lower levels of impact than during construction, since this will involve smaller vessels present for shorter periods of time, hence impacts of no more than negligible / not significant or minor / not significant were assessed.

12.238 Disturbance and displacement impacts due to construction activities, in particular in relation to drilling for piles were assessed on the basis of direct noise impacts on diving birds and also indirect ones on potential fish prey species. The hearing sensitivity of diving seabirds is not well understood. However, given that the impacts on fish, which have much more sensitive underwater hearing, were considered at worst to result in strong avoidance of the noise source to a distance of 10m (Section 13), the impacts were assessed for diving seabirds as not significant.

12.239 Displacement of diving seabirds due to the presence of the turbines was assessed on the basis of potential sub-lethal impacts. As a worst case, displaced birds could fail to breed successfully. Using population models to explore reduced reproduction at the population level, all of the species assessed (those diving species present in greatest numbers during the breeding season) were found to be at risk of negligible / not significant impacts.

12.240 Collision risk for diving species was assessed for those species considered to be at potential risk on the basis of foraging ecology. These species were gannet, shag, cormorant, common guillemot, razorbill, black guillemot and puffin. Assessment of potential impacts used a combination of exposure time modelling and population modelling to determine the likelihood that sufficient mortality due to collisions with turbines could occur in order to cause a population level impact. Gannet and cormorant were determined to be at negligible / not significant risk of collision impacts, while shag, common guillemot, razorbill, puffin and black guillemot were assessed to be at risk of minor / not significant collision impacts. No specific mitigation measures were identified for this impact, however MeyGen is committed to working with the regulator to undertake monitoring to reduce uncertainty in the assessment of this potential impact.

12.241 The risk of impacts due to accidental spillage of pollutants from either vessels or turbines, and also during drilling operations, was assessed in relation to seabird sensitivity to surface pollutants and the likelihood of such events. No significant impacts were identified. Mitigation measures identified for this impact in relation to vessels include standard measures to prevent the risk and minimise the impact should a spill occur, and in relation to turbines the use of low toxicity and biodegradable fluids wherever possible.

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13 FISH ECOLOGY

13.1 The table below provides a list of all the supporting studies which relate to the fish ecology impact assessment. All supporting studies are provided on the accompanying CD.

Details of study	Location on supporting studies CD
Benthic survey for Phase 1 of the MeyGen tidal stream energy project, Inner Sound, Pentland Firth (ASML, 2011)	OFFSHORE\Seabed interactions
MeyGen EIA Coastal Processes Modelling – Modelling setup, calibration and results (DHI, 2012)	OFFSHORE\Seabed interactions
Underwater noise impact study, Inner Sound, Pentland Firth (Kongsberg, 2012)	OFFSHORE\Marine Wildlife\Underwater noise
Distribution and abundance of marine mammals and basking sharks in the Inner Sound and wider Pentland Firth and Orkney waters (RPS, 2011a)	OFFSHORE\Marine Wildlife\Marine mammals

13.1 Introduction

13.2 This section assesses the effects of the proposed Project on fish ecology. A separate section (Section 14) considers potential impacts on commercial fisheries. The assessment has been undertaken by Xodus.

13.3 Scottish waters are estimated to support 250 fish species, with 166 commercial and non-commercial fish species recorded from the north-eastern coast of Scotland (Barnes *et al*., 1996). This section provides a baseline description of the fish populations in the Inner Sound of the Pentland Firth and puts them into context of Scottish, UK, European and World-wide conservation.

13.2 Assessment Parameters

13.2.1 Rochdale Envelope

13.4 In line with the Rochdale Envelope approach, this assessment considers the maximum ('worst case') project parameters. Identification of the worst case scenario for each receptor (i.e. Environmental Impact Assessment (EIA) topic) ensures that impacts of greater adverse significance would not arise should any other development scenario be taken forward in the final scheme design. Table 13.1 describes the detail of the project parameters that have been used in this assessment and explains why these are considered to be worst case. The potential impacts from alternative Project parameters have been considered in Section 13.9.

Project parameter relevant to the assessment		'Maximum' Project parameter for impact assessment	Explanation of maximum Project parameter
Turbine	Number	86 turbines	The maximum number of turbines poses the greatest encounter rate.
	Layout	45m cross-flow spacing and 160m down-flow spacing	An indicative layout for 86 turbines has been used to inform the modelling. The indicative layout is based on 45m cross-flow spacing and 160m down-flow spacing. This results in 6 rows of 11 turbines and 1 row each of 5, 7 and 8 turbines
	Rotor diameter	16m for collision risk 20m for barrier effect	Collision risk: The 16m rotor diameter results in the highest encounter probability for the fish encounter model. Barrier effect: For the barrier effect the 20 m rotor results in a higher swept area and a greater proportion of the Pentland Firth being occupied by the turbine rotors.
	Blade thickness	N/A	This Project parameter does not influence the fish impact assessment. Blade thickness is not an input parameter to the fish collision risk model.
	Blade width	2.3m	The blade width is a key input parameter to the fish encounter model and the maximum width results in the highest encounter rate.
	Blade pitch	10º	The blade pitch is a key input parameter to the fish encounter model and the pitch of 10º results in the highest encounter rate.
	Number of blades per rotor	3	The 3 bladed rotor results in a higher encounter rate than the 2 bladed rotors.
	Rotational speed	20rpm	The highest rotational speed results in the highest encounter rate.
	Minimum clearance between sea surface and turbine blade	8m	The minimum clearance is considered for estimating encounters with the turbine. The minimum represents the worst case. Fish are assumed to pass over the turbine.
	Clearance from blade tip to seabed	4.5m	The minimum clearance is considered for estimating encounters with the turbine. The minimum represents the worst case. Fish are assumed to pass under the turbine.
	Operational noise	26 x 2.4MW turbines for noise generation	The 2.4 MW turbine produces the highest noise and an array of 36 turbines of 2.4MW produces higher noise emissions than an array of 86 turbines of 1MW.
	Decommissioning	All turbines removed at decommissioning	All turbines will be removed at decommissioning.
Turbine support structure	Maximum drilling cuttings released into marine environment	86 monopile Turbine Support Structure (TSS)	The drilled monopile TSS will result in the maximum release of drill cuttings to the marine environment. Assuming the maximum number of 86 TSSs, the maximum amount of drill cuttings that can be generated from turbine support installations is 17,200m^2 (total for 86 TSSs).
	Maximum seabed footprint	86 Gravity Base Structure (GBS) TSS	Each GBS TSS has a maximum footprint of 40m x 30m. The total footprint for 86 turbines is 0.103km^2.
	Installation noise	Pin-pile TSS	Pin pile drilling produces higher noise output than monopole drilling based on available data. Pin pile source levels are 178 dB re 1 µPa at 1 m.
	Decommissioning	86 Monopile	86 Monopile TSSs will be cut at the seabed. The bottom on the piles below the seabed will remain in-situ.
	Maximum amount of compressor lubricant released into the marine environment	86 monopile TSS	Monopile drilling operations will take approximately 4 hours per pile. A compressor is used to pump air into the drilled holes to lift cuttings clear. The lubricant will be discharged to sea along with the cuttings at a maximum rate of 5 litres per hour, i.e. 20m^3 per monopile and 1,720m^3 for all 86 installed over 3 years.
Cable connection to shore	Maximum cable footprint on seabed	86, 120mm unbundled cables each 1,300m in length with split pipe armouring	The maximum physical area of the seabed occupied by the cables has been calculated as 0.027km^2. Based on a maximum 1.3km of cable from Horizontal Directional Drill (HDD) bore exit to turbine, and a cable diameter of 120mm (x2 to account for split pipe armouring) for 86 turbines.

Project parameter relevant to the assessment		'Maximum' Project parameter for impact assessment	Explanation of maximum Project parameter
	Decommissioning	86, 120mm unbundled cables, each 1,300m in length	All cables laid on the seabed will be fully removed at decommissioning.
	Electromagnetic fields (EMF)	0.013km^2 of 6.6kV cables	The maximum area of the seabed affected by the magnetic field of the cables has been calculated as 0.013km^2. Based on a maximum 1.3km of cable from HDD bore exit to turbine and maximum cable diameter of 120mm for 86 turbines.
Cable landfall	Maximum drilling cuttings released into marine environment	29, 0.6m HDD bores, drilled from either Ness of Quoys or Ness of Huna	The majority of drill cuttings generated from the drilling of the HDD bores will be returned to shore and not discharged to sea; however it is estimated that the contents of the last 10m of each bore could be discharged to sea and the seabed breakthrough. Of the two potential HDD scenarios, the greatest potential volume of cuttings discharged to sea at breakthrough will result from last 10m of 29 boreholes of 0.6m diameter 82m^2).
Vessels	Installation vessel physical presence	1 Dynamic Positioning (DP) vessel for the duration of the installation for year 1 and 2 2 DP vessels for year 3 installation	Installation activities will be carried out by a single DP vessel during year 1 and 2, all installation activities to be undertaken using a single DP vessel. If other smaller vessels used to undertake some of the work of the DP vessel, no concurrent multiple vessel activities will take place, i.e. no more than one vessel on site at any one time. Year 3 installation will require a maximum 2 DP vessels for TSS installation. These two vessels may be present on site at the same time during year 3.
	Installation vessel noise	Tug vessel noise	Tugs represent the noisiest vessels and are used to represent the highest possible noise source during installation operations. Tug source levels are 172 dB re 1 µPa at 1 m.
	Maintenance vessel physical presence	1 DP vessel present every 2.8 days	Based on a maximum 86 turbine array, 1 DP vessel will be present a maximum of 130 times (i.e. single slack tide operation) per year i.e. the DP vessel present on site every 2.8 days.
	Maintenance vessel noise	Tug vessel noise	Tugs represent the noisiest vessels and are used to represent the highest possible noise source during installation operations. Tug source levels are 172 dB re 1 µPa at 1 m.
Onshore Project components	-	N/A	As there are no proposed works in the intertidal area along the coast the onshore aspects of the Project do not influence the fish ecology impact assessment.

Table 13.1: Rochdale Envelope parameters for the fish ecology assessment

13.2.2 Area of assessment

13.5 It is also important to define the geographical extent of the assessment. The focus of the impact assessment is potential impacts on fish ecology using the Project area and adjacent waters. There is variation in the area over which impacts occur and the area over which an impact may occur can vary significantly between species based on their ecology and the range over which their populations can be found. Therefore, potential impacts have been set in the context of a wider study area over which fish encountered in the Project area are thought to range.

13.6 It should be noted that at the time of undertaking the assessment the distance from the shore at which the HDD bores would emerge was considered to be between 700 and 2,000m, although the exact distance was unknown. The assessment here is based on the worst case, where the cables emerge from shore at 700m.

13.3 Legislative Framework and Regulatory Context

13.3.1 Legislation

13.7 The relevant legislation and policy is set out in Section 3. The following is of particular relevance to the assessment of fish ecology:

- EU Habitats Directive (Directive 92/43/EEC);
- The Habitats Regulations 1994 (as amended in Scotland) implements species protection requirements of the Habitats Directive in Scotland, on land and inshore waters;
- UK Biodiversity Action Plan (UK BAP); UK Governments response to the convention on Biological Diversity (CBD), which the UK signed up to in 1992 in Rio de Janeiro;
- Conservation of European Wildlife and Natural Habitats Convention (Bern convention);
- Wildlife and Countryside Act 1981, and
- The Convention on International Trade in Endangered Species of Wild Fauna and Flora.

13.8 The following sections provide further details on the specific aspects of the above conservation and management legislation relevant to fish ecology.

13.3.2 Environmental Impact Assessment guidance

13.9 In addition to the EIA guidance published by Marine Scotland and SNH the guidelines developed by the Centre for Environment Fisheries and Aquaculture (CEFAS) (2004) for undertaking EIA in support of licensing of offshore wind farm developments under the Food and Environment Protection Act 1985 (FEPA) and the Coast Protection Act 1949 (CPA) are largely applicable. Although of the Marine Licence has replaced the FEPA and CPA licences, the CEFAS (2004) guidance is still considered to be applicable.

13.10 The CEFAS (2004) guidance states that there is potential for the construction, development and use of offshore wind farms (in the present case, tidal arrays) to impact fish resources, and it details a number of factors an EIA should take into account when assessing impacts on those resources. The EIA should present information that describes fish resources within the tidal array site and in the wider area. The presence and relative importance of fish resources should be described and assessed. Important fish resources include those species:

- Of significant importance in commercial and recreational fisheries;
- Of conservation importance;
- Susceptible to the effects of electromagnetic fields (EMF); and
- Restricted geographical distribution and/or locally abundant in the area.

13.11 For those fish resources identified as important the following aspects of their ecology should be considered:

- Spawning grounds;
- Nursery grounds;

- Migration routes; and
- Feeding grounds.

13.12 In addition to the above guidance the Institute of Ecology and Environmental Management (IEEM) have developed guidance for ecological impact assessment in Britain and Ireland for the marine and coastal environment. Although the IEEM guidance does not contain specific guidance for fish impact assessment they have been considered where relevant in this chapter.

13.3.3 EU Habitats Directive

13.13 The EU Habitats Directive 92/43/EEC (as amended) lists eight fish species in Annex II. To meet the requirements outlined in Article 3 of the Habitats Directive, Special Areas of Conservation (SACs) have been designated in UK waters to contribute to the European network of important high-quality conservation sites that will make a significant contribution to conserving these species. Of those fish species listed on Annex II of the Directive, Atlantic salmon (*Salmo salar*) and sea lamprey (*Petromyzon marinus*) have the potential to be present in the Pentland Firth (Table 13.2).

13.14 There are a number of SACs designated for Atlantic salmon which have been identified during the EIA from which Atlantic salmon have the potential to pass through the Inner Sound during their migrations. These are identified in Figure 13.1. The nearest SAC for any fish species to the Project is the River Thurso, designated for supporting Atlantic salmon, located approximately 21 km to the west.

13.3.4 Biodiversity Action Plans

13.15 The UK Biodiversity Action Plan (UKBAP) identifies a list of species of conservation concern in response to the Convention on Biological Diversity. A Caithness Local Biodiversity Action Plan (CLBAP) was published in 2003 by the Caithness Biodiversity Group (2003), where it states that 'the plan attempts to set out what can be done in the next five to ten years'. In addition, the Orkney Local Biodiversity Action Plan published in 2002-2007 (OLBAP) has been reviewed following its expiration and a further Plan (2008-2011) has been published which sets out to guide the conservation and enhancement of key features of biodiversity in Orkney over the coming years (OLBAP Steering Group, 2008). There are a number of sea fish species listed on the above BAPs that have the potential to be present in Pentland Firth (Table 13.2).

13.3.5 Priority Marine Features

13.16 A draft list of priority marine features (PMF) in inshore waters adjacent to Scotland, including those for which future Marine Protected Areas (MPA) will be designated under the Marine (Scotland) Act 2010, has recently been drawn up and circulated for consultation (Scottish Natural Heritage (SNH), 2011). The list, which is provisional and may be subject to future revision, includes a number of fish species that may be present in the Pentland Firth (refer to Table 13.2).

13.3.6 The Convention for the Protection of the Marine Environment of the North East Atlantic

13.17 The Convention for the Protection of the Marine Environment of the North East Atlantic (OSPAR) is the mechanism by which 15 governments of Western Europe work together to protect the marine environment of the north-east Atlantic. In 2003, the UK government committed to establishing a well-managed, ecologically coherent network of Marine Protected Areas (known as the OSPAR MPA commitment). Marine SACs designated under the Habitats Directive (Section 13.3.3) have been submitted as the UKs initial contribution to the OSPAR network.

13.18 A list of marine habitats and species considered to be under threat or in decline within the north-east Atlantic has been produced by OSPAR (OSPAR, 2008). A number of fish species on the list may be present in the Pentland Firth (Table 13.2).

13.3.7 International Union for Conservation of Nature

13.19 The International Union for Conservation of Nature (IUCN) has compiled a Red list of threatened species that are facing a high risk of global extinction. The list (IUCN, 2011) includes fish species that are potentially or known to present in the Pentland Firth and identifies their conservation status (Table 13.2).

Species	Legislation / environmental sensitivity or management plan									
	Annex II of the EU Habitats Directive	EPSp	BAP species	Priority Marine Feature	OSPAR	IUCN Red List	Bern Convention Appendix II	Bern Convention Appendix III	CITES Appendix II	EU Management Plans
Angler fish, (*Lophius piscatorius*)			X	X (juv.)						
Atlantic salmon, (*Salmo salar*)	X		X	X	x					
Basking shark, (*Cetorhinus maximus*)			X	X	x	X (v)	X		X	
Blue shark, (*Prionace glauca*)			X			X (nt)		X		
Cod, (*Gadus morhua*)			X		x	x (v)				X
Common skate, (*Dipturus sp.*)			X	X	x	X (ce)				
European eel, (*Anguilla anguilla*)			X	X	x	X (ce)				X
Haddock, (*Melanogrammus aeglefinus*)						X (v)				
Hake, (*Merluccius merluccius*)			X							X
Halibut, (*Hippoglossus hippoglossus*)			X			X (v)				
Herring, (*Clupea harengus*)			X							X
Kitefin shark, (*Dalatias licha*)						X (nt)				
Ling, (*Molva molva*)			X	X						
Mackerel, (*Scomber scombrus*)			X	X						
Monkfish, (*Squatina squatina*)			X							
Norway pout, (*Trisopterus esmarkii*)				X						
Plaice, (*Pleuronectes platessa*)			X							X
Porbeagle, (*Lamna nasus*)			X		x			X		
Saithe, (*Pollachinus virens*)				X (juv.)						
Sandeel, (*Ammodytes marinus*)			X	X						
Sand goby, (*Pomatoscistus minutus*)				X						
Sea lamprey (*Petromyzon marinus*)	X		X	X	X			X		
Sea trout, (*Salmo trutta*)			X							
Shortfin mako, (*Imagelsurus oxyrinchus*)						X (v)		X		
Spiny dogfish (*Squalus acanthias*)						X (v)				
Spotted ray, (*Raja montagui*)					x					
Spurdog, (*Squalus acanthias*)			X		x	X (v)				
Tope, (*Galeorhinus galeus*)			X			X (v)				
Whiting, (*Merlangius marlangus*)			X							

Table 13.2: Finfish species potentially present in the Pentland Firth with specific conservation / environmental sensitivities and/or management plans. juv. = juvenile, v = vulnerable, nt = near threatened, ce = critically endangered

13.3.8 The Convention on the Conservation of European Wildlife and Natural Habitats

13.20 The Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention) principle aims are to ensure conservation and protection of wild plant and animal species and their natural habitats (listed in Appendices I and II of the Convention), to increase cooperation between contracting parties, and to regulate the exploitation of those species (including migratory species) listed in Appendix 3

of the convention. To implement the Bern Convention in Europe the European community adopted, amongst others, the EU Habitats Directive (Section 13.3.3). In the UK the Bern Convention was implemented into UK law by the Wildlife and Countryside Act (1981 as amended). Seventeen fish species are listed on Appendix II of the Bern Convention and are strictly protected against disturbance, capture, killing or trade. Approximately 120 fish species are listed on Appendix III of the Convention, and although these species are afforded protection, exploitation is permitted (in exceptional circumstances), with prohibitions on particular hunting methods and equipment.

13.3.9 Wildlife and Countryside Act 1981

13.21 Basking sharks are protected under Schedule 5 of the Wildlife and Countryside Act (1981 as amended) which prohibits the killing, injuring or taking by any method of those wild animals listed on Schedule 5 of the Act. The Nature Conservation (Scotland) Act 2004, Part 3 and Schedule 6 make amendments to the Wildlife and Countryside Act (1981 as amended), strengthening the legal protection for threatened species to include 'reckless' acts. The Act makes it an offence to intentionally or recklessly disturb basking sharks. Licensing requirements under the Wildlife and Countryside Act (1981 as amended) are similar to those for European Protected Species (EPS) protected under Annex IV of the Habitats Directive.

13.3.10 The Conservation on International Trade in Endangered Species of Wild Fauna and Flora

13.22 CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora) is an international agreement which aims to ensure that international trade in specimens of wild animals and plants does not threaten their survival. Species listed under Appendix II are those identified as not currently threatened with extinction but will become so if their trade or any products made from them, are not subject to strong regulations. Basking shark is the only fish species listed under Appendix II relevant to the Pentland Firth area (Table 13.2).

13.3.11 European Union management plans

13.23 Certain commercially important fish stocks have been assigned specific management plans by the EU in order to ensure long term management, protection and (where appropriate) recovery of these stocks. There are a number of fish species that have the potential to be present in the Pentland Firth which have specific management plans. These management plans are summarised in Table 13.3 below. Species specific management plans aim to help EU countries meet targets to aid recovery of depleted populations and to maintain commercially exploited stocks.

Species	EU management plan summary
Cod	Multi-annual plans are in place for several stocks, including the North Sea and West of Scotland.
European eel	EU management plans specify that EU countries need to enable 40% of adult eels to escape to the sea for spawning purposes, Plans aim to protected eels by limiting fisheries, making it easier for eels to migrate through rivers and through restocking suitable inland waters with young eel.
Hake	The northern stock (present in the North Sea), is considered by the EU as stable (no further information was available at the time of writing).
Herring	The west of Scotland herring stock is covered by a long term EU management plan. Atlanto-Scandian stocks are jointly managed by Norway under a long-term management plan. The main aim of the EU management plan is for establishment of multi-annual plan with the objective to ensure stock exploitation at a maximum sustainable yield.
Plaice	The majority of plaice stocks are stable, with the objective of the EU management plan to return stocks to a level within safe biological limits to protect and conserve stocks. Multi-annual management plans have been developed in consultation with Norway, with the aim to preserve stocks by exploiting the maximum sustainable yield. Attainment of this objective through fishing effort limitation is set for 2015.

Table 13.3: Outline of EU Management Plans concerning species relevant to the Pentland Firth

13.4 Assessment Methodology

13.4.1 Environmental Impact Assessment scoping and consultation

13.24 Since the commencement of the Project, consultation on fish ecology issues has been ongoing. Table 13.4 summarises all consultation relevant to fish ecology. In addition, relevant comments from the EIA Scoping Opinion are summarised in Table 13.5, together with responses to the comments and reference to the Environmental Statement (ES) sections relevant to the specific comment.

Date	Stakeholder	Consultation	Topic / specific issue
7th April 2011	Marine Scotland and SNH	Pre-Scoping meeting	EIA surveys and studies required and the data needs for each EIA study.
27th May 2011	Marine Scotland, statutory consultees and non statutory consultees	Submission of EIA Scoping Report	Request for EIA Scoping Opinion from Marine Scotland and statutory consultees and request for comment from non statutory consultees.
6th June 2011	Marine Scotland and SNH	Meeting	Discussion on SACs to be assessed within the HRA process and species to be considered.
30th June – 2nd July 2011	Local stakeholders	Public Event - EIA Scoping	Public event to collate information/opinions on proposed EIA scope.
8th August 2011	Marine Scotland and SNH	Submission of document for comment	Submission of HRA Screening Report.
30th September 2011	Marine Scotland and SNH	Letter	Response to HRA Screening Report.
31st September 2011	Marine Scotland, The Highland Council, statutory consultees and non statutory consultees	Receipt of EIA Scoping Opinion	Receipt of response to EIA Scoping Report and other comments from non statutory consultees.
3rd October 2011	Marine Scotland	Project update meeting	EIA progress and specific discussion on data requirements for fish ecology impact assessment and collision modelling requirements.
27th October 2011	Lord Thurso	Meeting	Discussion regarding the project, potential Atlantic salmon issues and consultation going forward.
2nd November 2011	Marine Scotland, Marine Scotland Freshwater Laboratory and SNH	Meeting	Discussion of assessment methodology; data requirements; preliminary assessment results and HRA requirements. Discussion on the collision model and use of SNH Collision Risk Model for birds and wind farms for assessing fish encounter rate.
23rd November 2011	Marine Scotland and SNH	E-mail	Confirmation of the SACs to be considered for Atlantic salmon within the HRA.
6th – 7th December 2011	Local stakeholders	Public Event – pre application consultation	Public event to communicate the findings of the EIA to local stakeholders.
2nd March 2012	Marine Scotland and SNH	Meeting	Final meeting to close out HRA approach to the Project and discuss results of encounter studies.
9th March 2012	Caithness District Salmon Fishery Board	Meeting	Consultation with salmon fisheries board to discuss potential issues and approach to impact assessment.

Table 13.4: Consultation undertaken in relation to fish ecology

Name of organisation	Key concerns	Response	ES section within which the specific issue is addressed
Whale and Dolphin Conservation Society (WDCS)	Basking sharks potentially occurring in the Inner Sound requiring monitoring and protection.	Observation surveys commissioned by MeyGen has included reporting any basking sharks seen. Operational monitoring for basking sharks will be incorporated in the marine mammal monitoring protocol.	Section 11 Marine Mammals.
SNH	Data sources & survey design for fish and shellfish - Marine Scotland Science is the primary source for information on commercial fish and shellfish in Scottish waters. For spawning information, the applicant should also be aware of Ellis *et al* (2010)	Scope of work for the fish ecology impact assessment was agreed with Marine Scotland, within which a fish and shellfish survey was not required to inform the baseline. Ellis *et al*. (2010) has been utilised.	Section 13.5 Baseline Description.
SNH	Spawning and nursery grounds are not spatially or temporally fixed, potentially moving according to the conditions of the substrate, seabed habitats, climate and hydrodynamic regimes. Marine Scotland Science and CEFAS should be able to advice on the most appropriate data sources relating to spawning and nursery grounds, and whether any additional surveys are required. They should also be contacted to discuss mitigation measures if there is any overlap between the development site and the location of spawning events/nursery grounds.	Original discussions with Marine Scotland (7th April 2011) and also later discussions (3rd October 2011) identified the most recently available data and that the proposed approach (without the collection of additional survey information) was appropriate. The need for mitigation measures has been determined by the likelihood of spawning grounds to be in the Inner Sound and the proportion of the wider spawning ground affected.	Section 13.5 Baseline Description Sections 13.6.1 Loss of Spawning Grounds and 13.6.2 Loss of Nursery Grounds
SNH	Many fish and shellfish have strong associations with particular habitats or substrate types, sometimes varying for different life-history stages of a species.	Associations of fish with particular habitats and substrate types and changes with the life-history stages of fish have been taken into account	Section 13.5 Baseline Description
SNH	Fish and shellfish to consider: In determining species to consider within the EIA, we recommend that in addition to the UK Biodiversity Action Plan (BAP) the applicant includes the OSPAR Threatened and Declining and the Scottish Priority Marine Features (PMF)13 list as part of the criteria. These include some commercial species of fish, and for some the juvenile life stages	Fish species listed on BAP, OSPAR Threatened and Declining and the Scottish (PMF) have all been considered as part of the EIA.	Section 13.3 Legislative Framework and Regulatory Context and Section 13.5 Baseline Description
SNH	The impacts of underwater noise on the spawning behaviour of fish is a potential concern, and should be considered with regard to installation, operation, maintenance and decommissioning of the array. It should be noted that different species of fish have differing sensitivities to underwater noise, and this should be considered in the EIA.	Species likely to spawn in the Project area and their sensitivity to underwater noise have been considered in the impact assessment. Differing fish species sensitivities have also been considered in the impact assessment.	Section 13.6.3 Impact 13.3 Noise, Section 13.7.3 Impact 13.14: Noise and Section 13.8 Potential Impacts During Decommissioning.
SNH	Other potential impacts which should be considered include disturbance due to EMF and the barrier effect. Benthic and demersal species are more likely to be vulnerable to the potential barrier effects of EMF than pelagic species and should be considered accordingly. The ES should consider the vulnerability of different species (e.g. benthic / demersal / pelagic / migratory), their likely levels of sensitivity, and to what extent cable protection / armouring can limit exposure to EMF.	The potential impacts of EMF and barriers to movement have been considered as part of the EIA and the vulnerability of different species have been considered accordingly during the impact assessment.	Section 13.7.4 Electromagnetic Fields.
SNH	Collision risk will also need to be considered.	The collision risk has been considered in the impact assessment.	Section 13.7.6 Impact 13.17: Collision
SNH	Impacts on migratory species (e.g. barrier effects and disturbance) are correctly identified as a matter to be considered in the ES. However, this currently appears to only give consideration to diadromous species. Many fully marine fish and shellfish also exhibit migratory behaviour, usually associated with the breeding/spawning cycle (e.g. between shallow and deeper water). The ES should consider the potential for impacts on these species also.	The risk to other fully marine species during migrations from spawning and nursery grounds has been considered where appropriate.	Section 13.6 Impacts during Construction and Installation, Section 13.7 Impacts during Operations and Maintenance and Section 13.8 Impacts during Decommissioning
SNH	Basking sharks may use the area for passage and/or feeding.	The impact assessment presents as much data as possible on the known distribution of basking sharks in the Project area. The presence of basking sharks and their conservation status has been considered throughout the impact assessment.	Section 13.6 Impacts during Construction and Installation, Section 13.7 Impacts during Operations and Maintenance and Section 13.8 Impacts during Decommissioning.
SNH	We would advise that European eel and sea trout should be considered together with Atlantic salmon.	These three species have been considered during the impact assessment.	Section 13.5.2 Diadromous Fish, Section 13.6 Impacts during Construction and Installation, Section 13.7 Impacts during Operations and Maintenance and Section 13.8 Impacts during Decommissioning
SNH	Noise will be produced during the installation. Information on levels of noise production should be provided and, using published literature, decide what impact, if any, this will have on fish movements through the area. In this regard the recent review commissioned by SNH may be helpful: it considers the current state of knowledge with regard to the potential impacts of noise, associated with marine renewable energy, on Atlantic	The potential impact of noise generated during installation on fish species passing through the Project has been considered as part of the impact assessment. The SNH commissioned report has been utilised where appropriate.	Section 13.6.3 Impact 13.13 Noise

Name of organisation	Key concerns	Response	ES section within which the specific issue is addressed
	salmon, sea trout and European eel.		
SNH	Operational noise - Once the devices are installed and operational, there is the potential for the development to generate noise over the longer term. It is unclear what levels of noise will be generated and what impact this may have on fish. Noise monitoring work undertaken at EMEC may help to address this	The potential impact of noise generated during operation on fish species passing through the Project has been considered as part of the impact assessment. It was the intention for MeyGen to use underwater noise data measured from candidate tidal turbines to inform the noise modelling and impact assessment. To date it has not been possible to record the underwater noise from candidate turbines operating. Alternative data sources were used to inform the impact assessment. MeyGen intends to use underwater noise data collected from candidate turbines to verify the modelling work.	Section 13.7.3 Impact 13.14 Noise
SNH	Electromagnetic effects (EMF) - The response of fish to EMF is poorly understood and the applicant should consider this The SNH review may be helpful in considering EMF with regard to Atlantic salmon, sea trout and European eel.	The response of fish to EMF and the current poor understanding of this is considered in the impact assessment. The SNH review has been used to inform the impact assessment.	Section 13.7.4 Impact 13.15 Electromagnetic Fields
SNH	The above impacts should also be considered in terms of cumulative and in-combination impacts. They should also be considered for the different life stages of the species concerned	The cumulative and in-combination impacts have been considered as part of the impact assessment and HRA.	Section 13.10 Cumulative Impacts
SNH	Atlantic salmon of River Thurso SAC, Berriedale and Langwell Waters SAC, River Borgie SAC, River Naver SAC, River Oykel SAC, River Moriston SAC, River Spey SAC, and Little Gruinard River SAC. The proposed tidal array may be located within the migratory pathways of Atlantic salmon from these designated sites. Construction and operational noise/vibration may give rise to disturbance of Atlantic salmon. There is also the potential for collision risk and disturbance from EMF. We advise that there is potential for the proposal to have likely significant effects on Atlantic salmon.	This section and the HRA report have considered the impacts to SAC fish species.	Section 13.10 Cumulative Impacts
SNH	Indirect impacts on fish regarding reduced/impaired foraging resources, due to impacts on benthic ecology.	A comprehensive benthic ecology baseline has been established through a field survey, upon which the impact assessment is based.	Section 10 Benthic habitats and Ecology and Section 13.5.1

Name of organisation	Key concerns	Response	ES section within which the specific issue is addressed
Marine Scotland	Marine Scotland agrees that the area is unlikely to be a key spawning ground for the fish species mentioned on page 30 of the EIA Scoping Report. However, the possibility of cumulative effects from the displacement of predatory fish and fishing activity would need to be investigated, along with the potential cumulative effects from surrounding sites, to rule out any adverse effects on nearby spawning grounds to the east and west of Stroma.	The potential cumulative effects from the displacement of predatory fish and fishing activity have been considered as part of the impact assessment.	Section 14 Commercial Fisheries and Section 13.10 Cumulative Impacts
Marine Scotland	Marine Scotland also agrees with the elasmobranch species listed in the EIA Scoping Report, Common skate, Spiny dogfish, Thornback Ray, White Skate, Basking Shark and Cuckoo Ray. The Marine Conservation Society has also sighted Basking Sharks in the area.	The presence of these species within the Project area has been considered as part of EIA. Basking shark sightings data including that from the MeyGen Marine Mammals boat-based observation survey, from the Marine Conservation Society and from local wildlife observers has been utilised in the assessment.	Section 13.5 Baseline Description, Section 13.6 Impacts during Construction and Installation, Section 13.7 Impacts during Operations and Maintenance and Section 13.8 Impacts during Decommissioning
Marine Scotland	Landing figures for the area suggest a high concentration of Spiny dogfish (*Squalua acanthias*) within the ICES statistical rectangle 46E6. The presence and abundance of this critically endangered, IUCN Red listed species within the area of search, along with the species mentioned above, should be investigated using a suitable fish survey.	The spiny dogfish is a demersal species. There is no trawl fishing activity currently taking place within the Project area, fishing is instead dominated by small potting vessels. As a result it is unlikely that catches of spiny dogfish within 46E6 were within the Project area.	Section 14 Commercial Fisheries and Section 13.5 Baseline Description
Marine Scotland	Consideration should be given to the impact of EMF on elasmobranchs in the area through aggregation, displacement, avoidance or disruption to feeding behaviours.	The potential impacts of EMF on fish ecology have been considered as part of the EIA.	Section 13.7.4. Impact 13.15: Electromagnetic Fields
Marine Scotland	With regards to migratory fish, advice should be sought from Marine Scotland Science Freshwater Laboratory regarding possible migratory fish impacts. Tagged salmon from rivers along the northern coast of Scotland have been recaptured both east and west of the rivers of release indicting that the species may migrate through the proposed site as there can be a preference for post-smolt migratory routes to be relatively close to shore (2.5-5 km). Marine Scotland Science Freshwater Laboratory will be best placed to advise on possible issues and measures that may need to be taken into account.	Through discussion with the Marine Scotland Freshwater Laboratory (13th October 2011) it has been established that Atlantic salmon are likely to travel through the Project area. However, the distance that smolts travel from shore is considered to be unknown at this time although there is evidence to suggest from other countries that smolts may travel 2.5-5km from the shore during migrations (Iain Malcolm pers. comm.) Advice was sought on the information available and how this could be addressed within the ES.	Section 13.5 Baseline Description, Section 13.6 Impacts during Construction and Installation, Section 13.7 Impacts during Operations and Maintenance and Section 13.8 Impacts during Decommissioning
Marine Scotland	Offshore renewable developments have the potential to directly and indirectly impact diadromous fish of	The potential impacts to these species have been considered as part of the EIA.	Section 13.5 Baseline Description, Section 13.6 Impacts during Construction

Name of organisation	Key concerns	Response	ES section within which the specific issue is addressed
	freshwater fisheries interest including Atlantic salmon, anadromous brown trout (sea trout) and European eel. These species use the coastal areas around Scotland for feeding and migration and are of high economic and / or conservation value. As such they should be considered during the EIA process. Developers should also note that offshore renewable projects have the potential to impact on fish populations at substantial distances from the development site.		and Installation, Section 13.7 Impacts during Operations and Maintenance and Section 13.8 Impacts during Decommissioning
Marine Scotland	In the case of Atlantic salmon information will be required to assess whether there is likely to be any significant effect of developments on rivers which are classified as Special Areas of Conservation (SAC's) for Atlantic salmon under the Habitats Directive. Where there is the potential for significant impact then sufficient information will be required to allow Marine Scotland to carry out an Habitats Regulations Appraisal.	It is recognised by the Marine Scotland Freshwater Laboratory that there is currently a lack of information on salmon. However, there is data available on the 'wetted area' of rivers available and this combined with a smolt estimate from the North Esk can be used to determine the proportion of the population from these rivers that will pass through the Inner Sound. This information along with the published review of information available on salmon will be used to determine the impacts to Atlantic salmon in the EIA and the Habitats Regulations Appraisal.	Section 13.11 Habitats Regulations Appraisal and HRA Report (MeyGen, 2012)
Marine Scotland	In order that Marine Scotland is able to assess the potential impacts of marine renewable devices on diadromous fish and meet legislative requirements the developer should consider the site location (including proximity to sensitive areas), type of device, and the design of any array plus installation methodology. Specifically we request that developers provide information in the following areas: 1. Identify use of the proposed development area by diadromous fish (salmon, sea trout and eels) (a) Which species use the area? Is this for feeding or migration? (b) At what times of year are the areas used? (c) In the case of salmon and sea trout what is the origin / destination of fish using the area? 2. Identify the behaviour of fish in the area (a) What swimming depths do the fish utilise (b) Is there a tendency to swim on or offshore. 3. Assess the potential impacts of deployed devices on diadromous fish during deployment, operation and decommissioning phases. Potential impacts could include: (a) Strike (b)	The presence and utilisation of the Project area for salmon, sea trout and eels has been considered as part of the impact assessment. The cumulative impacts of multiple deployments in the area have also be considered as part of the EIA process. Through discussion with the Marine Scotland Freshwater Laboratory (13th October 2011) it has been established that Atlantic salmon are likely to travel through the Project area. However, the distance that smolts travel from shore is considered to be unknown at this time although there is evidence to suggest from other countries that smolts may travel 2.5-5km from the shore during migrations (Iain Malcolm pers. comm.) Advice was sought on the information available and how this could be addressed within the ES. Scientifically robust methods of determining the origin and destination of diadromous fish species have not been developed. The movements of diadromous fish in the North Sea and North Atlantic	Section 13.5 Baseline Description, Section 13.6 Impacts during Construction and Installation, Section 13.7 Impacts during Operations and Maintenance, Section 13.8 Impacts during Decommissioning and Section 13.12 Proposed Monitoring
	Avoidance (including exclusion from particular rivers and subsequent impacts on local populations) (c) Disorientation that could potentially affect behaviour, susceptibility to predation or by-catch, or ability to locate normal feeding grounds or river of origin (d) Delayed migration. 4. Consider the potential for cumulative impacts if there are multiple deployments in an area. 5. Assess 1-4 above to determine likely risk. (a) If there are insufficient data to determine use of the development area, these should be obtained (b) If there are insufficient data on the origin / destination of fish using the area then these should be obtained (c) Where it is not possible to obtain site specific data, the developer should make a convincing argument why this is the case and apply appropriate expert judgement based on published information. 6. If there is any remaining doubt as to the potential impacts of a particular development, then the developer should recommend a scientifically robust monitoring strategy to assess any impacts either on stocks as a whole, or on particular rivers as necessary.	are considered to be a wider strategic issue and it would be impossible for a single developer to undertake this level of study. However, MeyGen intends to work with The Crown Estate, Marine Scotland and the wider industry to further understand this issue.	
Marine Scotland	Marine Scotland Science has completed a review of migratory routes for Atlantic salmon, sea trout and eels relevant to Scotland. This will assist the developers in identifying what pre-existing information is available and what supplementary site specific data will be required.	This document has been utilised in the impact assessment.	Section 13.5 Baseline Description, Section 13.6 Impacts during Construction and Installation, Section 13.7 Impacts during Operations and Maintenance and Section 13.8 Impacts during Decommissioning
SEPA	The ES should consider how the risks of introducing marine non-native species (MNNS) will be minimised.	MNNS will be considered within the ES and if required appropriate mitigation measures identified.	Section 13.6.11 Impact 13.11 Marine Non-Native Species (MNNS).

Table 13.5: Scoping comments relevant to fish ecology

13.4.2 Desk based study

13.25 This ES section and more specifically, the fish ecology baseline description is, in its entirety, based upon a comprehensive desk-based study. Data sources used to determine the fish ecology baseline were as follows:

- Landings statistics from ICES rectangle 46E6 from Marine Scotland as presented in the Section 14 Commercial fisheries;

- Technical reports and reviews for offshore energy Strategic Environmental Assessments (SEA) (e.g. DECC, 2009; Faber Maunsell, 2007);
- Species spawning and nursery ground maps and spawning periods (Coull *et al*., 1998; Ellis *et al*., 2010);
- Marine Scotland report on migratory fish (Malcolm *et al*., 2010);
- National Biodiversity Network (NBN http://data.nbn.org.uk/) and Marine Life Information Network (MarLIN; www.marlin.ac.uk/) websites;
- Marine Conservation Society (MCS) basking shark sightings reports (MCS, 2008; 2009);
- Sightings of specific fish species recorded during the MeyGen commissioned marine mammal and bird observation surveys (RPS, 2011);
- Stakeholder consultation/scoping opinions; and
- Video data from benthic survey carried out between the 25th and 27th July 2011.

13.4.3 Field survey

13.26 Through consultation with Marine Scotland, a site specific fish ecology survey was not considered a requirement for the proposed Project. The highly energetic conditions of the Inner Sound create conditions difficult for equipment deployment and recovery and fishing practices which surveys would use to collect data are not practised in the Inner Sound for this very reason (see Section 14 Commercial Fisheries). Large sea areas would also need to be covered to sample some of the wider ranging species i.e. Atlantic salmon and this level of survey is not feasible. A detailed and comprehensive literature search was undertaken to collate data on the species likely to be present in Inner Sound and to investigate their ecological requirements of the area. As many fish species are highly mobile the baseline investigation considers data available for the wider Pentland Firth area and for migratory fish the rivers they migrate from and the routes they take through the Project area were considered. As such the species list may be considered to include a greater range than regularly use the proposed Project area.

13.4.4 Significance criteria

13.27 The EIA process and methodology are described in detail in Section 8. Each assessment section is, however, required to develop its own criteria for the 'sensitivity of receptor' and 'magnitude of impact' aspects since the definition of these will vary between different topics. For fish ecology, the significance criteria used in this section is based on the methodology described in Section 8 but the sensitivity of the receptor and magnitude of impact are defined in Table 13.6 and Table 13.7 respectively.

13.28 The environmental consequences of impacts are then considered by reference to the relevant criteria in the EIA Regulations. The significance of impacts in relation to the EIA Regulations is defined in Section 8, Table 8.2.

Sensitivity of receptor	Definition
Very High	▪ Fish species affected are designated under international legislation (e.g. IUCN red list, EU Habitats Directive). ▪ In the context of a particular impact, species which are considered extremely sensitive to the impact[1].
High	▪ Fish species affected are designated under UK and Scottish legislation. ▪ In the context of a particular impact, species which are considered highly sensitive to the impact[1].
Medium	▪ Fish species affected are designated under local legislation (e.g. Local BAP species) and are vulnerable to the impacts in question. ▪ In the context of a particular impact, species which are moderately sensitive to the impact[1].
Low	▪ Fish species that are not designated under national or international legislation. ▪ In the context of a particular impact, species which are not very sensitive to the impact[1].
Negligible	▪ Fish species with little or no local importance or sensitivity to the impacts in question. ▪ In the context of a particular impact, species which show no sensitivity to the impact[1].

Note:
[1]In the context of some impact certain species may be very sensitive to the impact (e.g. herring and noise) but are not designated under certain the legislation that would make them of very high sensitivity. In addition there may be some receptors that are very high sensitivity due to their designation under international legislation but in the context of the particular impact they demonstrate no sensitivity to the impact and can be considered of low sensitivity.

Table 13.6: Definitions for sensitivity of receptor

Magnitude of impact	Definition
Severe	▪ Prolonged / widespread disturbance to fish species to the baseline condition, with long term or permanent effects on any or all of the following: spawning grounds, nursery grounds, migration routes and / or feeding grounds. ▪ These would result in long term changes in population size. ▪ Impact highly likely to occur.
Major	▪ Medium-term and localised disturbance or change to the baseline condition to fish species, with medium-term and recoverable affects in the medium-term on: spawning grounds, nursery grounds, migration routes and / or feeding grounds. ▪ Populations would recover in the medium term. ▪ Impact likely to occur.
Moderate	▪ Short-term and localised disturbance or change to the baseline condition to fish species, with short-term and recoverable affects on: spawning grounds, nursery grounds, migration routes and / or feeding grounds. ▪ Populations would show recovery in the short-term. ▪ Impact will possibly occur.
Minor	▪ Detectable disturbance or change to the baseline condition to fish species and no long-term noticeable effects above the level of natural variation experiences in the area. ▪ Impacts are not sufficient to be observed at the population level. ▪ Impact unlikely to occur.
Negligible	▪ Imperceptible or no changes to the baseline condition including to: spawning grounds, nursery grounds; migration routes; and / or feeding grounds. ▪ No changes experienced at the population level. ▪ Impact highly unlikely to occur.
Positive	▪ An enhancement of an ecosystem or population parameter.

Table 13.7: Definitions for magnitude of impact

13.4.5 Data gaps and uncertainties

13.29 The desk based review provides some indication of the presence (or absence) of fish species within the area and whether spawning and nursery grounds are present. In addition the behaviour of fish species within the Project area can not be directly observed and how these species may use the site directly is also not available and would be unlikely to be obtained from undertaking fish surveys due to the temporal and spatial variability inherent in marine fish populations. Therefore, some assumptions have to be made in order to carry out the assessment. In the case of spawning and nursery grounds, which may change location and be temporally variable, information on the area of which spawning has been recorded or can be expected has been used. This information is of very coarse quality and can only be used in the context

it is provided. In this respect if the spawning ground covers the Project area it is assumed spawning takes place here, unless there is evidence to the contrary.

13.30 For migratory species the exact routes they will take on their movements to and from feeding and spawning grounds are not always known. Where information is available it has been used to determine whether species travel through the Project area or to make assumption on the migratory routes taken. If these data are not available then an assumption has been made that migration through the Project area occurs. As a result there is still some uncertainty over the impacts related to migratory fish species. However, the assessment may over-rate the impacts that are predicted through the use of precautionary assumptions.

13.31 For many of the impacts that are discussed in Section 13.6, Section 13.7 and Section 13.8, there has been some research into the potential for these impacts to occur and the severity of these impacts. In some instances (e.g. Electromagnetic Fields (EMF)) the evidence is inconclusive and a precautionary approach has been taken.

13.32 Where there is no current evidence available (i.e. collision risk) approaches applied to other receptors (e.g. seabirds) have been adapted for fish or professional judgement and experience has been used in order to assess any impacts.

13.5 Baseline Description

13.5.1 Benthic environment

13.33 A number of surveys of the seabed of the Inner Sound have been undertaken which provide an indication of the seabed substrata present in the area (iXSurvey, 2009; Moore, 2009; 2010; Moore and Roberts 2011; ASML, 2011). A complete description of the benthic environment and these surveys is in Section 10 Benthic Habitats and Ecology. In summary the seabed in the Inner Sound is heterogeneous, but the majority of the deployment area is composed of scoured bedrock, with patches of sand, megarippled sand and sandbanks with coarse gravel only present in isolated patches directly south and south-west of Stroma. The scoured bedrock extends into the cable corridor although this area is more dominated by kelp forest/park. The benthic communities on the scoured bedrock of the deployment area were dominated by scour-tolerant fauna including the barnacle *Balanus crenatus* and the hydroid *Tubularia indivisa*.

13.5.2 Diadromous fish

13.34 This section reviews the presence of diadromous fish (also known as migratory fish) that are known to be present in the Pentland Firth.

13.35 Diadromous fish are species of fish which spend part of their life at sea, but migrate up rivers in order to breed. Several species of fish living in Scottish rivers migrate between the sea and the upper reaches of rivers during their life cycle.

13.36 This section concentrates on three species of diadromous fish, the Atlantic salmon (*Salmo salar*), sea trout (*Salmo trutta*) and European eel (*Anguilla anguilla*) that have the potential to be present in the Pentland Firth. Atlantic salmon and sea trout are anadromous (migrating from the sea to fresh water to spawn) whereas European eel are catadromous and migrate from fresh water to the sea to spawn.

Atlantic salmon

13.37 Atlantic salmon are widely distributed in Scotland and salmon populations are recognised as being of national and international importance.

13.38 The juvenile life stage of salmon takes place in fresh water, which typically lasts between one to four years before surviving fish migrate to the sea as smolts. Following entry to the sea, fish are known as post-smolts until the spring of the following year. After one winter at sea a salmon is called a grilse. Atlantic salmon grow rapidly by feeding at sea before returning to their native rivers to spawn. The length of time a salmon spends in the sea before returning to their river of origin to spawn varies from one to five winters (Marine Scotland, 2011a).

13.39 The adult fish may spawn in quite small headwater streams as well as in suitable areas in larger water courses. Adult fish enter rivers from the sea at almost any time of year, but they migrate into smaller spawning streams on elevated flows following rainfall in the autumn. Spawning takes place between late October and early January (CEFAS, 2004), after which a small proportion of the adult fish return seaward over a period of up to several months (salmon returning to the sea following spawning are termed kelts). The proportion of adults returning to the sea following spawning is in the region of 20 to 36% (Hendry and Cragg-Hine, 2003).

13.40 Catches of Scottish salmon between 2003 and 2007 accounted for 60% and 12% of the UK and European nominal catch (fish killed and retained), respectively (Malcolm *et al*., 2010). Atlantic salmon have been identified as a species of conservation importance; they are listed in Annex II of the Habitats Directive, a UK BAP Priority species, a Scottish PMF and are included on the OSPAR list of marine habitats and species considered to be under threat or decline in the north-east Atlantic (Section 13.3.6). In recognition of the importance of Scottish salmon populations, 17 rivers have been designated SACs for Atlantic salmon. During consultation all 17 of these SACs were identified to potentially be influenced by the Project, where Atlantic salmon from these sites could pass through the Project area during their migration. These sites are shown in Figure 13.1.

13.41 The nearest designated SAC salmon river to the lease area is the River Thurso, located approximately 21km to the west (Figure 13.1). The river supports a higher proportion of multi sea-winter salmon than is found in many rivers further south in the species' range. The more northerly location of the river and the cooler ambient water temperature, results in slower-growing juveniles which smolt at an older age, and tend to return to the river to spawn as older multi-winter salmon.

13.42 There is limited information available on the at sea migrations of salmon. Smolts are believed to move offshore in schools to deep-sea feeding areas. Adult and sub-adult salmon from Scottish rivers pass through or make use of areas around west Greenland, east Greenland and the Faroe Islands (Malcolm *et al*., 2010). The routes by which they depart and return to rivers in the north of Scotland, including the River Thurso are not known, but it is assumed that on return they swim along the coast seeking olfactory[1] cues that help them identify the correct river (Lockwood, 2005).

13.43 Salmon post-smolts originating in Scottish rivers are thought to use near-shore areas at the commencement of their marine navigation but based on current information it is not possible to describe how migratory routes vary with river of origin, or to define the duration or extent of their initial dependence on near and offshore areas (Malcolm *et al*., 2010). However, evidence does suggest smolts originating from east coast rivers do travel through the Pentland Firth on their way to feeding grounds. In terms of the migratory behaviour of smolts less is known. Some evidence from Canada shows that smolts stay relatively close to shore, (Lacroix *et al*., 2005), although these studies have not been conducted in Scotland, and where coastal currents are substantial there is evidence to suggest smolts avoid these areas (Malcolm *et al.,* 2010). Evidence also suggest that smolts spend most of their time in the top 1 to 6m of the water column (Davidson *et al.,* 2008; Plantelech Manel-La *et al*., 2009), although again these studies were conducted in Norweigian fjords rather than open water surrounding Scotland. The fact that many smolts are caught in surface trawls also suggests that smolts spend most of their time in the top few metres of the water column (Malcolm *et al.,* 2010).

13.44 During a review of adult salmon tagging studies in Scottish waters, Malcolm *et al*. (2010) reported that as well as Atlantic salmon from the east coast moving through the Pentland Firth in a easterly direction towards their natal rivers, movement from the east to the north coast in a westerly direction may be relatively common for both grilse and multi-winter salmon. However, the numbers involved in the westerly movement are likely to be lower than the main movement east. Some fish tagged on the east coast of Scotland, including near Montrose and the Black Isle, have been later recaptured on the north coast of Scotland, indicating that these fish would have passed through the Pentland Firth area. The coastal

[1] Olfactory: Of, relating to, or contributing to the sense of smell.

tagging studies identified by Malcolm *et al*. (2010) reported very few re-captures within the Pentland Firth, including in the Inner Sound itself.

13.45 Whilst at sea salmon typically spend most of their time close to the surface, but they often dive, sometimes to depths of 280m. The complex nearshore directional movements of salmon remain poorly understood and their behaviour at this stage may be linked to a range of local environmental conditions such as tidal movements, home river discharges, diurnal rhythms and other biological and physical cues.

13.46 Based on the available information and taking a precautionary approach it is assumed that Atlantic salmon do pass through the Inner Sound during their migrations to and from the sea as well as the rest of the Pentland Firth. It is also assumed that both Adult salmon and smolts pass through the turbine deployment area although evidence may point to the contrary; that smolts and adult salmon may pass over the turbines or avoid areas of high current velocities.

Sea trout

13.47 Sea trout are the migratory form of brown trout and have a very similar life history to Atlantic salmon. The main difference between the two species is that immature sea trout often return to fresh water to overwinter. Also in contrast to salmon, sea trout appear to remain within nearshore waters rather than undergoing extensive migrations offshore (DECC, 2009).

13.48 The NBN gateway provides data records from the Biological Records Centre database for freshwater fishes of sea trout at a number of river mouths to the west of the Inner Sound. Records of sea trout originate from the rivers Link, Heilen, Harland, Murkle and Thurso (Figure 13.1). The closest of these river mouths is that of the Link, located approximately 7km to the west of the proposed Project area.

13.49 Trout spawn in winter from October to January. The eggs are shed in redds cut by the female in the river gravel, usually in upstream reaches, although many spawn in gravel below weirs. Most sea trout tend to remain in coastal waters once they leave freshwater systems (Kallio-Nyberg *et al*., 2002).

13.50 Malcolm *et al*. (2010) concluded that given the data available to date, no reliable conclusions can be drawn on the marine distribution of adult sea trout. In addition there is limited information on swimming depths for adult sea trout, although data from Norway suggests shallow swimming depths (<3m) with frequent dives to approximately 30m (Malcolm *et al*., 2010).

13.51 However, given the close proximity of sea trout sightings to the Project area and their known behaviour, a precautionary approach assumes that sea trout will pass through the Inner Sound. As for salmon, it is also assumed that sea trout pass through the turbine deployment area although evidence may point to sea trout passing over the turbines or avoiding areas of high current.

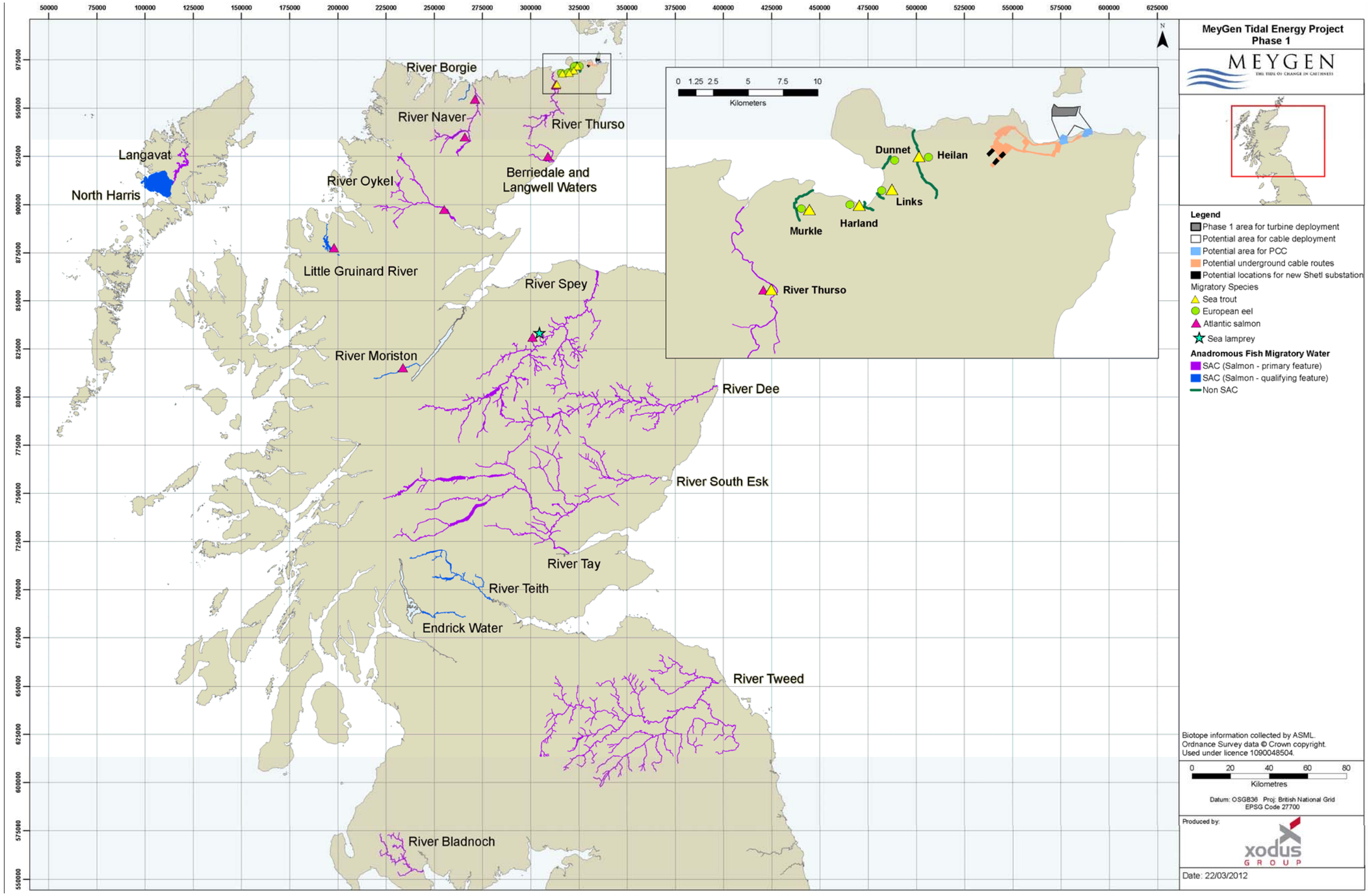

Figure 13.1: Diadromous fish rivers and SACs

European eel

13.52 The life cycle of the European eel is well known. Spawning occurs in the Sargasso Sea (in the mid Atlantic Ocean), after which larval eels cross the Atlantic Ocean. By the time they reach the European continental shelf, including the UK, they have metamorphosed into 'glass eels' at around 5cm in length. Some of these glass eels remain in the sea, some ascend European rivers and some move back and forth between marine, estuarine and fresh water environments. During this time, they develop pigmentation and are referred to as 'yellow eels'. After the continental growth stage which can last from 30-60 years, the yellow eels metamorphose into 'silver eels' and begin the return migration to the Sargasso Sea (Malcolm *et al*., 2010).

13.53 Very little is known about the routes undertaken or the nature of eel migrations as juveniles and as adults. However, for both migrations it is possible that a significant proportion of the total European population may pass through the seas around Scotland (Malcolm *et al*., 2010). The timing of migration peaks in Scottish waters is poorly recorded but Malcolm *et al*. (2010) inferred that glass eels pass through Scottish waters principally from September to December. In addition, glass eels destined for Scottish rivers must remain in coastal regions until April to May before river temperatures rise sufficiently for them to enter fresh water. The majority of return silver eel migration is likely to take place between September and January.

13.54 Both juvenile and adult eels can be found throughout the water column (up to 300m) and the depth selected can vary with the time of day and the state of the tide.

13.55 There is evidence to suggest that the Pentland Firth is used widely by eels that colonise the eastern seaboard, where there is a high probability of eels being encountered in the northern Scottish rivers (Malcolm *et al*., 2010).

13.56 The NBN gateway holds data records of European eel at a number of river mouths to the west of the Inner Sound, from the Biological Records Centre database for freshwater fishes. Records are from the rivers Link, Heilen, Harland, Dunnet, Murkle and Thurso (Figure 13.1). The closest of these river mouths is that of the Link located approximately 7 km to the west proposed Project area. Although there is very little information available that would indicate the European eel pass through the Inner Sound area, the close proximity of sightings to the Project area, and the use of the wider Pentland Firth by European eel a precautionary approach assumes that European eel do pass through the Inner Sound.

Sea lamprey

13.57 Lampreys belong to a small group of fish known as Agnatha (jawless), the most primitive of all living vertebrates. Although not true fish they are referred to here for convenience. Sea lamprey (*Petromyzon marinus*) spawn in gravel beds of freshwater streams and mature in the open sea. However relatively little is known about the precise habitats occupied by adult sea lampreys (Maitland, 2003) as it is uncommon in the UK (DECC, 2009). The main population of this species are found in the Bristol Channel and adjacent offshore waters (DECC, 2009). Notably, there are no records on the NBN gateway of lamprey species in the north-east coast of Scotland. River Lamprey are generally found no further north than the Great Glenn (Maitland, 2003) and sea lamprey are absent from most northern rivers. Many northern Scottish rivers are unsuitable due to their high flow rates (Maitland, 2003). Based on this evidence it is unlikely that sea lamprey will be present within the Project area.

13.58 However, as sea lamprey is present in the River Spey there is the potential for migrants of this species to be present within the Inner Sound. In addition the River Spey SAC is one of the rivers that are provided by SNH as requiring HRA and as a result the sea lamprey is considered within this impact assessment, although the impacts are very much considered in general terms to all fish species.

13.5.3 Elasmobranchs

13.59 Elasmobranchs are fish species which include sharks, rays and skates. All elasmobranchs are cartilaginous fishes, whose skeletons are composed of cartilage, rather than bone. These animals are collectively referred to as elasmobranchs because they are in the Class Elasmobranchii.

13.60 Shark species expected to be to be present in the Pentland Firth include basking shark (*Cetorhinus maximus*), spurdog (*Squalus acanthias*), tope (*Galeorhinus galeus*), lesser spotted dogfish (*Scyliorhinus canicula*) and porbeagle (*Lamna nasus*) (Faber Maunsell, 2007). Kitefin shark (*Dalatias licha*), shortfin mako (*Isurus oxyrinchus*), blue shark (*Prionance glauca*) nurse hound (*Scyliorhinus stellaris*) and spiny dogfish (*Squalua acanthias*) may also be present in the Pentland Firth (MarLIN, 2011; Scottish Government pers comm., 2011).

13.61 The main species of skate and ray on the north coast of Scotland are thornback ray (*Raja clavata*), cuckoo ray (*Raja naeus*) and spotted ray (*Raja montagui*) (Faber Maunsell, 2007). Common skate (*Dipturus intermedia* and *Dipturus flossata*) a species of conservation concern, may also be present in the Pentland Firth and the Inner Sound area. Records of this species (including records of egg cases) suggest that waters surrounding Orkney, the Pentland Firth and north of Scotland may be used by the common skate.

Nursery grounds

13.62 The Pentland Firth has been identified as nursery ground for spurdog, tope, thornback and the spotted rays (Ellis *et al.,* 2010) Figure 13.2 displays the areas in which nursery grounds may occur. However, the specific location of nursery grounds may change from year to year depending on a number of environmental variables and the seabed conditions within specific areas.

Basking shark

13.63 The basking shark is the largest fish in the North Atlantic and the second largest in the world, growing up to 10m. Basking sharks generally live in open waters but migrate towards the shore during the summer months, where they can be seen swimming slowly feeding on plankton in the surface waters with their mouths wide open. While basking sharks will spend most of their feeding time at the surface they do swim beneath the surface when they are not feeding. However, the depths at which they swim are not very clear. Basking sharks are viviparous, producing live pelagic young.

13.64 The Marine Conservation Society (MCS) has been collating UK-wide sightings of basking sharks since 1987 in a project called Basking Shark Watch, through which they have temporal and spatial data of over 21,000 sharks from over 5,200 records. Sighting distribution maps show large concentrations of sightings on the west coast of Scotland, however sightings have been recorded along the majority of the north Scottish coast, including within the Pentland Firth (MSC, 2008). Sightings in the Pentland Firth in this database are as recent as 2009 (MCS, 2009). Sightings in Scotland in 2008 accounted for 6% of the total (n=67) reported sightings for the whole of the UK. The annual variability in sightings in Scotland from 2004 to 2009 indicates that the number of sightings in Scotland have decreased significantly. Since 2007 sightings in Scotland have decreased by 81% from 345 to 67 (MSC, 2009). The decrease in sightings in Scotland should be considered with caution as they may be an artefact of reduced sightings effort or poor sighting conditions.

13.65 Over 90% of basking shark sightings in the UK are reported between the months of May and August, when sightings peak earliest in the southwest UK and lastly in Scotland around August (MSC, 2008). Sightings in 2009 were highest in the months of July to September (MSC, 2009).

13.66 A number of wildlife tours operate around the Stroma, including the John o' Groats to Orkney Ferry Company and North Coast Marine Adventure. These companies, alongside individuals, often report basking shark sightings to Caithness Sea Watching (www.caithness-sea-watching.co.uk). Basking shark sightings sent to Caithness Sea Watching in 2011 on the whole are very low for the north coast of Scotland. In 2011 to date there have been two recorded sightings of a basking shark just off John o' Groats Harbour, within the Inner Sound. In 2010 there were four sightings of basking sharks north of John o' Groats Harbour and one in Gills Bay, all in the Inner Sound. Individual basking shark sightings were also recorded off Duncansby Head (three sightings) and Thurso Bay (five sightings) to the east and west of the Inner Sound, respectively. In 2009, two sightings were reported just off the coast of John o' Groats, with an additional one to the north of Stroma and one to the west of Stroma. Also there were three sightings in Thurso Bay and two in the Pentland Firth.

13.67 During the marine mammal and bird observation surveys between October 2009 and September 2011 conducted within the Inner Sound and covering the Project area, one basking shark was observed, in

September 2010 (RPS, 2011). The survey results coupled with the historic data suggest the frequency of basking sharks is low with 1 to 5 spotted in any given year.

Spurdog

13.68 The spurdog is a widely distributed pelagic species and occurs mainly at depths between 10 and 100m. They tend to aggregate in large shoals of the same size or sex. They are viviparous and produce live young of between 20 and 30cm in length. There is some evidence that they may undertake extensive migrations. Mature females migrate inshore to give birth to their young. North Sea landings of spurdog have declines markedly, and the north-east Atlantic stock is estimated to be at approximately 5% of the biomass after the second word war. Spurdog in the North Sea are currently managed by a quota, with the TAC (Total Allowable Catch) reduced by 87% between 1999 and 2005 (ICES, 2011a).

13.69 The Pentland Firth is part of a spurdog nursery, although the main nursery grounds are located to the west of the Project (Ellis *et al*., 2010; Figure 13.2). Conditions within the Inner Sound maybe unsuitable for juvenile spurdog, hence the location of the main nursery grounds to the west of the Project.

Tope

13.70 The tope is a pelagic species with a widespread distribution at depths down to about 50m. They are viviparous, producing live pelagic young. They tend to be solitary, migrating offshore in winter. They arrive in coastal waters in September peaking in October/November before migrating to deep-water in January (Faber Maunsell, 2007). Tope are active and strong swimming sharks and are predominantly encountered near the seabed. Tope are very popular with recreational fishers as it is one of the largest shark species that can be targeted in UK waters (Shark Trust, 2009a). Ellis *et al*. (2010) identified the Pentland Firth as a nursery for tope (Figure 13.2) and the wider nursery area includes the Project. Adult Tope are also likely to be present within the area.

Lesser spotted dogfish

13.71 The lesser-spotted dogfish is very common in UK waters. It is a bottom dwelling shark most usually found over sand, mud, algae, gravel and rocky bottoms from the shallow sublittoral to depths of about 60m. It is an opportunistic predator feeding on a wide range of macrobenthic fauna with hermit crabs, cockles and whelks being dominant prey items (Shark Trust, 2009b). Spawning takes place in shallow water and the large egg purses are found close inshore where they attach to the substrate by tendrils (Faber Maunsell, 2007).

13.72 It is one of the few sharks that appear to be increasing in biomass, thought to be because most individuals caught by trawls survive when they are returned to the sea (Faber Maunsell, 2007).

Porbeagle

13.73 The porbeagle, is a pelagic shark that is widely distributed in the northern North Sea from the surface to about 145m depth. It is mainly an offshore species although it is not uncommon closer inshore. It appears to migrate northwards in the summer. Occasional fisheries have developed especially on the west coast of Scotland and off Shetland. It is often found around man-made structures such as North Sea oil and gas platforms (Faber Maunsell, 2007).

Kitefin shark

13.74 The kitefin shark is a deepwater, sporadically distributed species. The shark is encountered more commonly on the outer continental shelf to at least 1,800m, although is has been found as shallow as 37m. It is most common encountered below 200m. It is normally encountered either on or near the seabed but readily ranges from well off the bottom and is often caught in the water column (Shark Trust, 2009c). Thus species is likely to be relatively uncommon within the Project area as it is generally found in much deeper water.

Shortfin mako

13.75 The shortfin mako is an oceanic and coastal pelagic species which can be found in surface waters down to depths of 700m. It is a powerful and active shark and is thought to be the fastest species of shark reaching speeds of up to 80kph (Barnes, 2008a). It feeds primarily on bony fish such as mackerel, herring, cod and whiting (Shark Trust, 2009d). The shortfin mako is more likely to be found further offshore and although they may be occasional visitors to the area they are unlikely to be present in large numbers.

Blue shark

13.76 Blue sharks are a pelagic species and are probably the most widely ranging shark found in the main oceans and seas of the world, from the surface to at least 400m. It is a migratory species and it undertakes north-south migrations in the north-east Atlantic, seasonally visiting British and Irish waters in the summer months. The blue shark feeds on relatively small prey, especially squid and bony fishes (Queiroz, 2007). Blue shark may be occasional visitors to the area but are most likely to be found further out to sea.

Nurse hound

13.77 The nurse hound is a large cat-shark that can reach up to 1.6m in length. It is found throughout Britain and Ireland in both inshore waters and offshore continental shelves. It is commonly found over rough and rocky or coralline grounds and seaweed beds (such as those within the proposed cable corridor), down to a depth of up to 100m. It is commonly encountered on or just above the seafloor (Barnes, 2008b). It feeds on a variety of benthic organisms, including fish, crustaceans and cephalopods.

Thornback ray

13.78 Of the ray species, the thornback ray is likely to be the most commonly encountered ray species in the Pentland Firth. As with all ray species it is demersal and occurs in depths between 2 and 60m (Faber Maunsell, 2007). It frequents a wide variety of seabed types from mud, sand, shingle and gravel, although it is less frequently recorded on coarser sediment types. They are also found on patches of sediment among rocky outcrops and boulders and maybe found in these areas within the Project area. However, the substrate types in the Project Area are unlikely to be the favoured habitat of this species. Thornback ray feed on fish such as sand eels, herring, sprats and small flatfish; however shore and swimming crabs and brown shrimps are its main food source. Although it is a non migratory species, it often moves close inshore during the spring (Wilding & Snowden, 2008).

13.79 Waters to the west of the Pentland Firth have been identified as nursery grounds for the thornback ray (Ellis *et al*.., 2010; Figure 13.2).

Cuckoo ray

13.80 The cuckoo ray is relatively common and small bodied species of ray that is found around the majority of the UK. It is typically more of an offshore species than the spotted ray or thornback ray and therefore is likely to be only be an occasional visitor to the Project area. It is found over most types of ground in depths of 12 to 290m around the British Isles. It feeds on small crustaceans, worms and small fish, such as sandeels (Ellis *et al*., 2008).

Spotted ray

13.81 The spotted ray inhabits inshore and shallow shelf seas, in depths of 8 to 283m, though it is most abundant in waters less than 100m. Juveniles tend to occur closer inshore on sandy sediments, where adults are more common offshore on sand and coarse sand-gravel substrates. These substrates are uncommon in the Project area (characterised by rocky biotopes (Section 10 Benthic Ecology) and therefore the spotted ray is unlikely to be common within the area that turbines are deployed. Juveniles feed on small crustaceans, with adults feeding on larger crustaceans and fish (Ellis *et al.*, 2008). Spawning grounds for spotted ray are found throughout the Pentland Firth (Ellis *et al*., 2008, Figure 13.2).

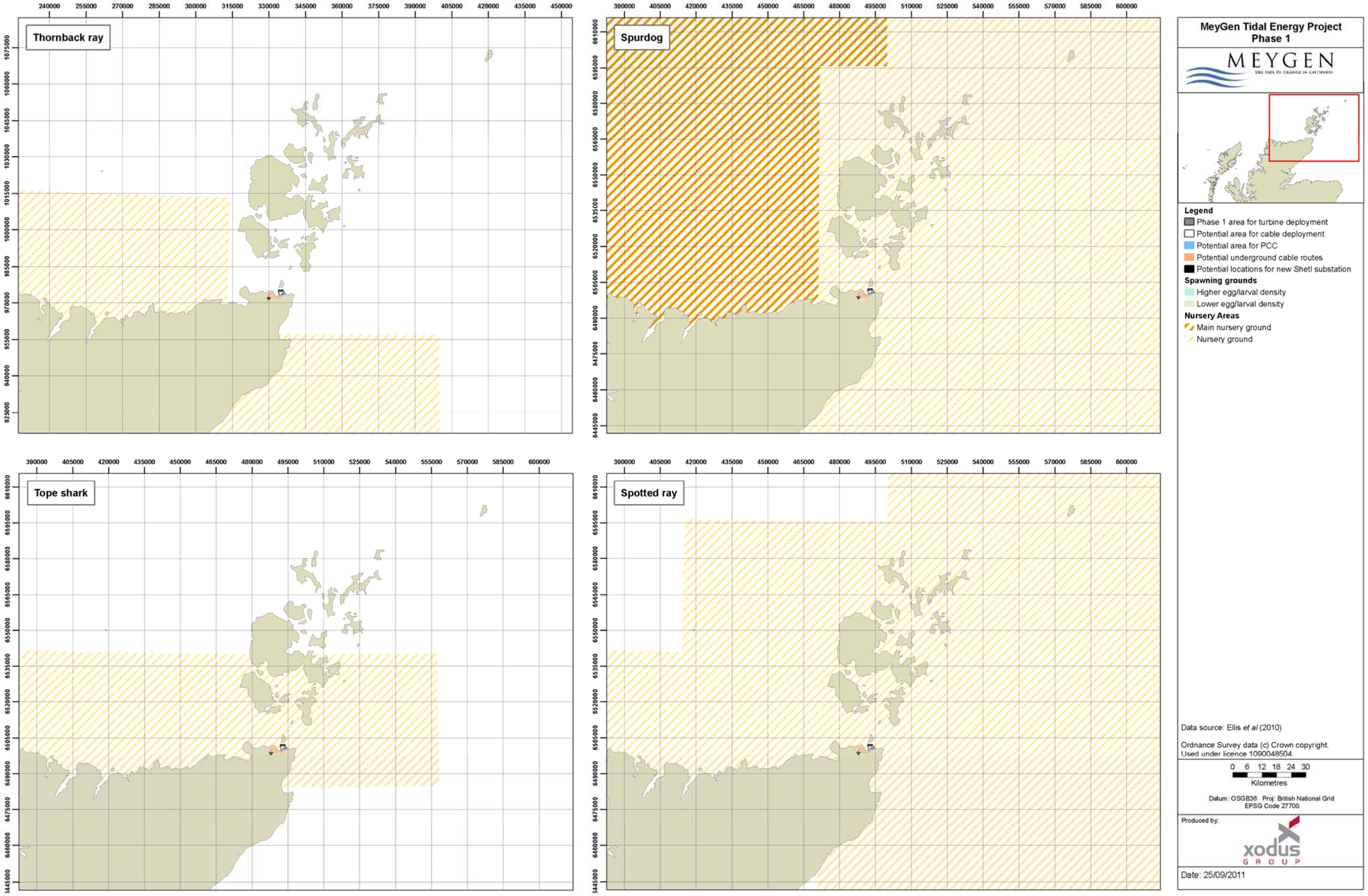

Figure 13.2: Sharks and ray nursery ground areas around the Project area and wider Pentland Firth (Ellis *et al*., 2010)

Common skate

13.82 The common skate is a large demersal ray with a long pointed snout, occurring on sandy and muddy substrates, feeding on flat fish, sand eels, crabs and bristle worms. Adult common skates occupy depths of 10 to 600m, whereas juveniles inhabit shallower waters. Common skate are listed in the IUCN Red List as 'critically endangered', due to continuing population declines. The habitat types most commonly occupied by this species are not present within the Project area and therefore this species is likely to be uncommon in the project area.

Spiny dogfish

13.83 The spiny dogfish is a coastal shark species well known for their voracious and opportunistic predatory behaviour. Swimming in large "packs," they will attack schools of fishes smaller than themselves, including cod, haddock, mackerel and herring (McMillan & Morse, 1999). They are considered to be the most abundant shark species globally. They prefer to swim close to the seabed and are a slow swimming species. They can be found over the continental and upper slopes down to approximately 900m (Shark Foundation, 2011).

13.84 Landings data analysed as part of the Commercial Fisheries section (Section 14) for ICES rectangle 46/E6 identified spiny dogfish in catches. However, this species is caught mostly using mobile gear and tidal currents within the Project area are largely unsuitable for trawling. As a result it is highly unlikely that the catches of this species within the rectangle equate to catches within the Project area. However, given the species ubiquitous nature and their prey species there is the potential for spiny dogfish to be present within the Project area.

13.5.4 Other finfish

13.85 In order to identify the presence of, and obtain an indication of the abundance of other finfish species in the Pentland Firth, including the Inner Sound, fisheries landings data for the period of 2006-2010 have been analysed. These analyses are given in the Commercial Fisheries section (Section 14) and as such will not be repeated. Pelagic, demersal and shellfish are landed in ICES rectangle 46/E6 where demersal fish species accounted for 25-38% and pelagic species 13-28 % of the total landings (see Section 14). Shellfish landings accounted for the remainder.

13.86 It is recognised that fishing methods and species targeted by fishermen are to a large extent, market driven. As a result, in addition to landings data, other sources have been used to determine the presence of finfish species. As part of the EIA process it is not considered necessary to assess potential impacts on each of the species listed in Table 13.8. Only those species that are considered to be important have been reviewed in further detail below. The criteria for importance include:

- Species identified of conservation importance or that have specific EU management plans (Section 13.3);
- Those species which spawn within or have nursery grounds within the Pentland Firth;
- Species that are considered to be important ecologically or particularly sensitive to activities associated with the Project (e.g. sandeels and herring); and
- Species that are considered to be commercially important (landing value greater than £5,000 per year – Section 14 Commercial Fisheries).

Finfish species	
Blue ling, (*Molva dypterygia*)	Monkfish, (*Lophius piscatorius*)
Blue whiting, (*Micromesistius poutassou*)	Norway pout, (*Trisopterus esmarkii*)
Cod, (*Gadus morhua*)	Ocean sunfish, (*Mola mola*)
Conger eels, (*Conger conger*)	Plaice, (*Pleuronectes platessa*)
Greater forked beard, (*Phycis blennoides*)	Poor cod, (*Trisopterus minutus*)
Haddock, (*Melanogrammus aeglefinus*)	Pollock, (*Pollachius pollachius*)
Hake, (*Merluccius merluccius*)	Red gurnard, (*Aspitriglia cuculus*)
Halibut, (*Hippoglossus hippoglossus*)	Red mullet, (*Mullus surmuletus*)
Herring, (*Clupea harengus*)	Saithe, (*Pollachius virens*)
Horse mackerel, (*Trachurus trachurus*)	Sandeels, (*Ammodytes spp*)
John dory, (*Zeus* faber)	Sole, (*Solea solea*)
Lemon sole, (*Microstomus kitt*)	Sprat, (*Sprattus sprattus*)
Ling, (*Molva molva*)	Torsk, (*Brosme brosme*)
Mackerel, (*Scomber scombrus*)	Turbot, (*Scophthalmus maximus*)
Megrim, (*Lepidorhombus whiffiagonis*)	Whiting, (*Merlangius merlangus*)

Table 13.8: Finfish species not considered within the EIA (Coull *et al*., 1998; Ellis *et al*.; 2010; Faber Maunsell, 2007; RPS, 2011; Scottish Government, pers. comm.; 2011; ASML, 2011)

Spawning and nursery grounds

13.87 Coull *et al*. (1998) and Ellis *et al*. (2010) identified areas within which spawning and nursery activities may take place for a number of fish species of commercial and conservation importance in UK waters. These species and the areas in relation to the Project are displayed in Figure 13.3, Figure 13.4 and Figure 13.5. However, it is worth noting that these areas are indicative of the area within which spawning and nursery activities may take place, where spawning and nursery areas may change from year to year depending on environmental conditions.

13.88 The Pentland Firth has been identified as part of a main nursery area for blue whiting and anglerfish; it is also is part of the nursery grounds for hake, mackerel, ling, sandeel, saithe, herring, haddock, lemon sole, whiting and cod. The main nursery areas for whiting and herring are located to both the east and west of the Pentland Firth, along the western and eastern Scottish coast and mackerel's main nursery areas are to the west of Scotland, and Ireland (Ellis *et al.,* 2010, Coull *et al.*, 1998: Figure 13.3, Figure 13.4 and Figure 13.5).

13.89 The Pentland Firth is part of the spawning grounds for sandeel, where coastal regions to the southeast of the Pentland Firth have been identified as areas of higher egg/larval density during these spawning periods (Figure 13.5; Ellis *et al*., 2010). Sandeel spawn between November and February (Coull *et al*., 1998; Table 13.9). The waters surrounding Orkney, including the Pentland Firth have also been identified as spawning grounds for herring (Coull *et al*., 1998; Table 13.9). The herring located in these waters have been identified as spawning between July and September (CEFAS, 2007; Table 13.9). Lemon sole have also been identified as using the waters surrounding Orkney and north Scotland for spawning between April and September (Coull *et al*., 1998; Table 13.9). Although not within the Pentland Firth Ellis *et al*. (2010) have identified that in the adjacent ICES rectangle of 46E7 (February to June (Coull *et al*., 1998; Table 13.7), high densities of whiting egg and larvae are present during spawning (Figures 13.3b).

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Herring							✓	✓	✓			
Lemon sole				✓	✓	✓	✓	✓	✓			
Sandeel	✓	✓									✓	✓
Whiting		✓	✓	✓	✓	✓						

Table 13.9: Seasonal spawning periods for fish species in the Pentland Firth (Coull *et al*., 1998; Cefas, 2007)

Haddock

13.90 Haddock is a widely distributed demersal species throughout Scottish waters, where adults occur at depths between 40 and 300m, over rock, sand gravel or shells (Barnes, 2008d). Spawning takes place in deeper waters away from the Pentland Firth. In their first year of life haddock are pelagic and carry out vertical migrations (Faber Maunsell, 2007). The nursery grounds are widely distributed around the Scottish coast, where the waters both to the west and east of the Inner Sound, but not directly within the Inner Sound have been identified as nursery grounds for haddock (Coull *et al*., 1998; Figure 13.3).

13.91 Haddock is a commercially valuable species, where it is caught in mixed demersal fisheries alongside cod and whiting. Haddock have been identified to be of conservation importance where they are categorised as vulnerable on the IUCN red list.

Lemon sole

13.92 The lemon sole is a commercially important flatfish occurring throughout the Scottish waters, where it is in greatest abundance around the Outer Hebrides, Orkney and Shetland (Faber Maunsell, 2007). It is commonly found on stony bottoms between depths of 20 and 200m (Barnes 2008g).

13.93 Spawning for lemon sole occurs from April to July in deep water and the pelagic eggs and larvae occupy progressively deeper water as they develop (Faber Maunsell, 2007). The Pentland Firth is part of identified nursery and spawning grounds for lemon sole (Coull *et al*., 1998; Figure 13.3) and these cover the area of the Inner Sound.

Herring

13.94 Herring is a pelagic species that is widely distributed in Scottish waters. During the day they remain close to the sea bottom or in deep water, and they undertake diurnal feeding migrations into surface waters, often at dusk (Faber Maunsell, 2007). They are filter feeders that feed on a variety of planktonic organisms. The pelagic larvae, feed on copepods and other small planktonic organisms. Calanoid copepods are the predominant prey items during the juvenile life stages, but euphausids, hyperiid amphipods, juvenile sandeels, and fish eggs are also eaten. Larger herring predominantly consume copepods with small fish, arrow worms and ctenophores (ICES, 2011b).

13.95 Based on the spawning area and the timing of spawning herring have been divided into sub-populations. As previously discussed the waters surrounding Orkney, including Pentland Firth and the Inner Sound have been identified as herring spawning grounds during August and September (Coull *et al*., 1998; Figure 13.3). This area is part of the wider Buchan/Shetland spawning ground of the most northerly race of herring, which spawn off the northeast of Scotland as well as around Orkney and Shetland (Faber Maunsell, 2007).

13.96 Although herring are reported to deposit their sticky demersal eggs on a variety of substrates ranging from boulders, rock, small stones, coarse sand, shell fragments, macrophytes and man-made structures such as lobster pots; gravel is widely considered to be the preferred spawning substrate (Drapeau, 1973; Rogers & Stock, 2001). The eggs adhere to the seabed, forming extensive egg beds. According to Reid *et al*. (1999), spawning occurs in areas of well-mixed water with reasonably strong tidal currents (1.5 to 3 knots) often on shoals and banks in relatively shallow water (approximately 15 to 40m). These high-energy environments provide aeration and reduce siltation and accumulation of metabolites (Stevenson & Scott, 2005).

13.97 After hatching the larvae are pelagic and drift with the currents and the juvenile nursery grounds tend to be close inshore. The nearest to the Pentland Firth is south, in the coastal waters of the Moray Firth, as far north as Wick on the east coast of mainland Scotland (Coull *et al*., 1998). After about a year they migrate further offshore to the adult feeding grounds before returning to spawn in their well defined areas.

13.98 As outlined above and in Section 10 Benthic Ecology the surveys conducted of the Inner Sound reported that the majority of the seabed within the Inner Sound, including the Project area is comprised of current scoured bedrock. The small areas of sediment to the north of the proposed Project area comprise of patches of shelly gravel and are likely to be unsuitable for herring, particularly given the high tidal flows of up to 3.6 knots (see Physical Environment and Sediment Dynamics, Section 9).

Blue whiting

13.99 Blue whiting is a widely distributed oceanic and benthoplegic species found off western and northern Scotland, the North Sea and western coasts of Ireland and the British Isles. It inhabits the continental slope and shelf down to a depth of more than 1,000m, where it may take nocturnal vertical migrations to the surface (Barnes, 2008c). They are commonly found in shoals 30 to 400m from the surface in water between 150 to 3,000m deep (DECC, 2009). They feed primarily on small crustaceans such as euphausiids.

13.100 Blue whiting is very abundant in deep waters to the north of Orkney in February, and spawning takes place between February and April along the continental slope to the west of Scotland at depths of 300 to 600m. After spawning fish migrate to the North and Norwegian Seas to feed. Juvenile blue whiting remain in their nursery grounds for between two and four years before returning to spawn for the first time (DECC, 2009). The Pentland Firth is on the eastern boundary of the main blue whiting nursery area, which covers a wide area including the west of Shetland and northern North Sea (Ellis *et al*., 2010; Figure 13.4). Due to their depth range this species is unlikely to be present within the Inner Sound and the Project area.

Cod

13.101 Cod is a widely distributed demersal species that occurs throughout UK waters. Tagging has revealed that cod migrate in late summer and early autumn from the west coast to the north coast and return in the late winter and early spring (Faber Maunsell, 2007). Cod are batch spawners, where spawning can take place in 10 to 20 batches during a two to three month period. The larvae are planktonic and feed on various species of zooplankton, however after a couple of months the juveniles become more benthic in habit and begin to school (FAO, 2004).

13.102 Cod spawn away to the south of the Pentland Firth during January to April; however the Pentland Firth is part of a larger cod nursery area which occurs over much of the North Sea (Ellis *et al*., 2010; Figure 13.4).

13.103 Atlantic cod are omnivorous, feeding on a variety of invertebrate and fish species, including crabs, gobiid and some gadoid (cod-like) fish and zooplankton (Hop *et al*., 1992). Cod is an important exploited fish species on the North Atlantic, where the North Sea cod population was the first EU fish stock to be brought under long-term management. Cod is caught within ICES rectangle 46E6 and landings have shown an increase over the last few years (Section 14). However, stocks of cod in the North Atlantic are considered to be seriously depleted and outside safe biological limits (Baxter *et al*., 2011).

Hake

13.104 Hake is a demersal species that is usually found between 70 and 350m, but may also occur within a wider depth range from inshore waters (30 to 1,000m). It is commonly observed feeding alone on the bottom especially during the daytime and in shoals in the water column during the night (FAO, 2011; Barnes, 2008e). It is a top predator in the demersal community of the north-east Atlantic; mainly preying on blue whiting, horse mackerel and clupeids such as herring (Murua, 2010).

13.105 The spawning period for hake is very long and varies with populations, with the west Scotland population spawning between May and August. In their first three years juveniles live on muddy bottoms, where they feed on crustaceans (especially euphausiids and amphipods) and are unlikely to be found within the Project area which is mostly rocky substrate (ASML, 2011). Adults feed mainly on fish (small hake, anchovies, sardines and gadoid species) and squid (FAO, 2011). The Pentland Firth is part of a hake nursery ground, which extends over the majority of the northern and central North Sea and the west coast of the British Isles (Ellis *et al*., 2010; Figure 13.4).

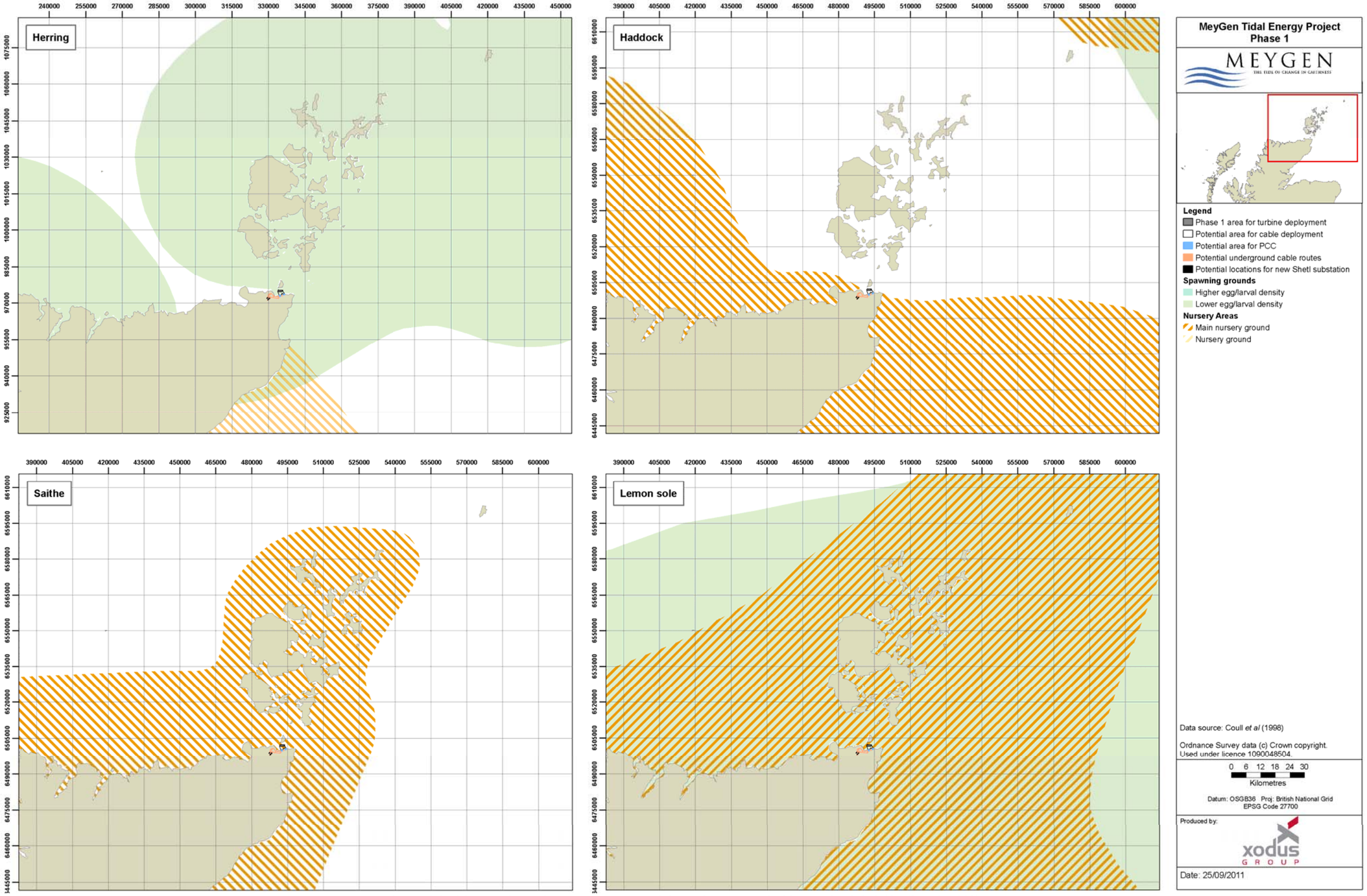

Figure 13.3: Fish spawning and nursery areas around the Project area and wider Pentland Firth (Coull *et al*., 1998)

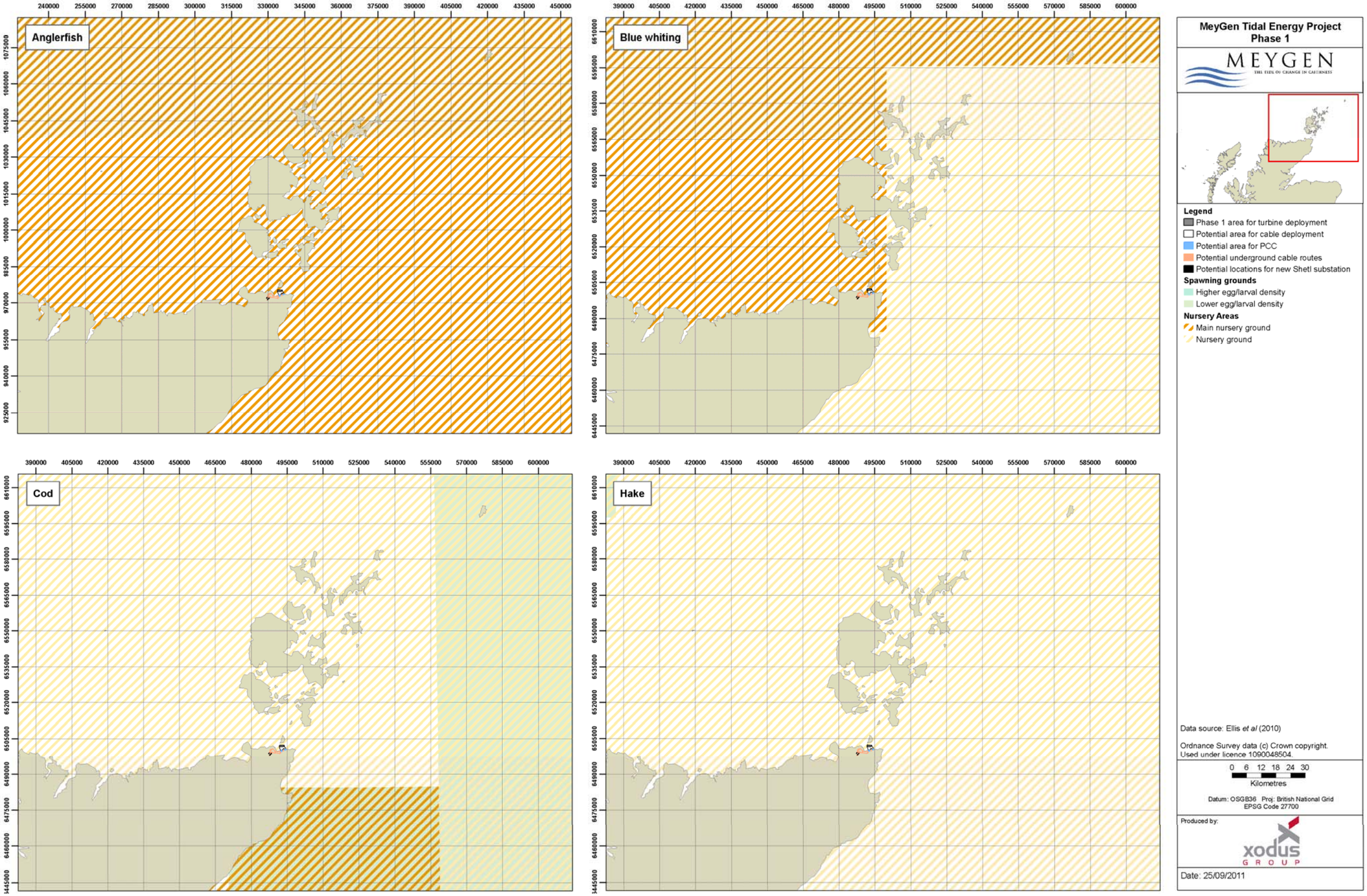

Figure 13.4: Fish spawning and nursery areas around the Project area and wider Pentland Firth (Ellis *et al.*, 2010)

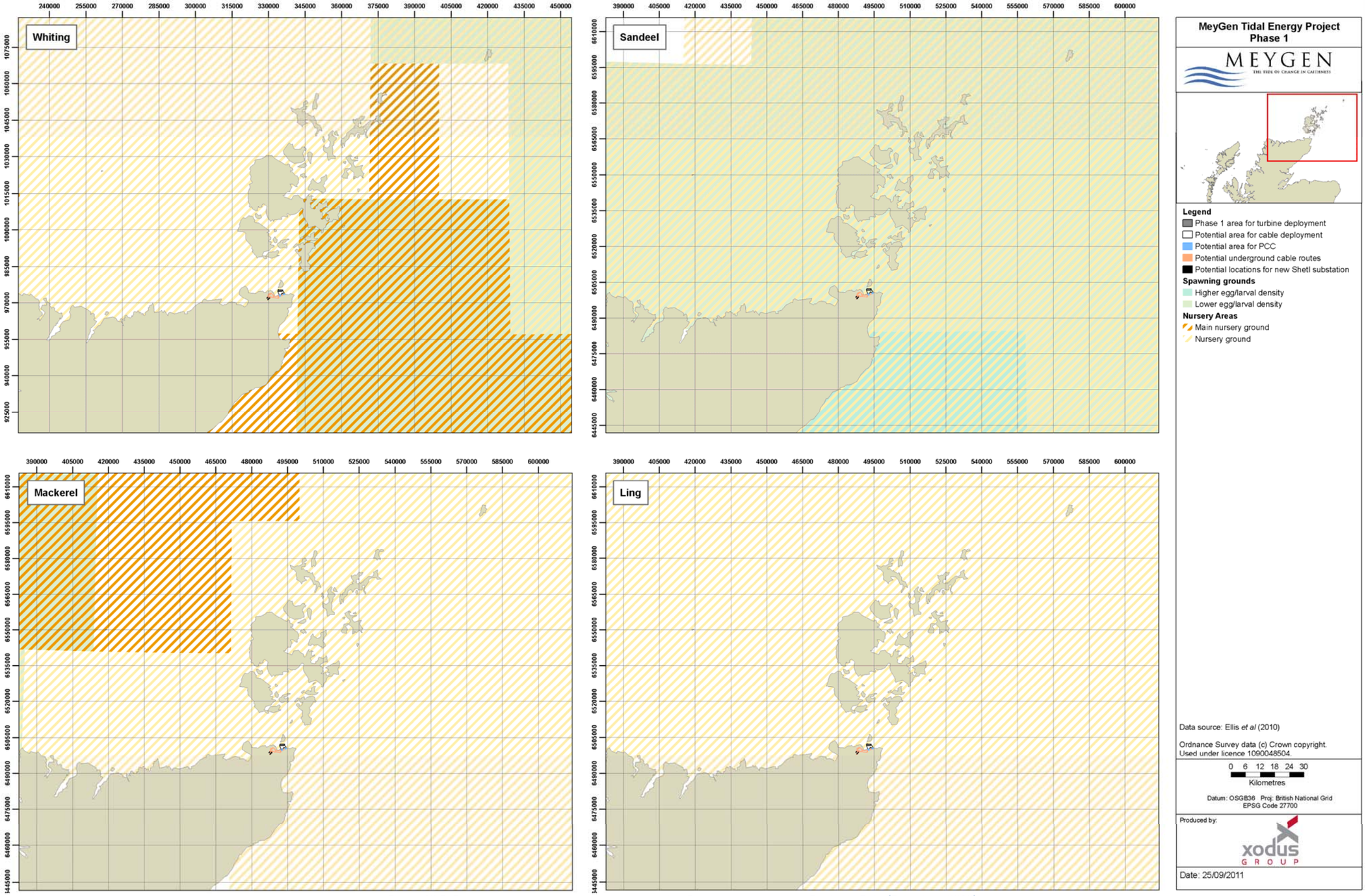

Figure 13.5: Fish spawning and nursery areas around the Project area and wider Pentland Firth (Ellis *et al*., 2010)

Halibut

13.106 Halibut is mainly a benthic and demersal species and more infrequently pelagic. They are usually found on sand, gravel, or clay substrates and not on soft mud or on a rocky seabed. Historically they were found throughout British waters although the current distribution is relatively unknown. It is a highly sought after commercial species, being the largest flatfish in the world, reaching up to 2.5m in length (Barnes, 2008f). High fishing intensity has resulted in depletion of stocks in several areas of the north-east Atlantic (Glover *et al*., undated).

13.107 Halibut spawn in deep water (between 300 and 700m) between December and March, after which adult halibut leave the spawning grounds and travel to both deep and shallow waters, inshore and offshore. Juvenile halibut adopt a benthic lifestyle and coastal areas, around the Norwegian coast in waters of depths of 20 to 60m often serve as nursery areas before halibut under take their migrations further offshore into the north-east Atlantic (Glover *et al*., undated).

13.108 Landings of halibut in ICES rectangle 46E6 have been very low over the last few years although the relative value of such landings is still comparatively high (Section 14). The species is unlikely to be found in any great numbers within the Project area due to the lack of suitable habitat (as they are not found in areas of rocky substrate).

Ling

13.109 Ling is the largest species of the cod (gadoid) family and they are widely recorded around the British Isles. It is a deep water species found at depths of up to 600 m but juveniles and occasionally adults are found as shallow as 10 m. This species is primarily solitary and benthic in habit, found amongst rocks, crevices and wrecks in deep water (Rowley, 2008).

13.110 The waters surrounding Orkney, including Pentland Firth and the Inner Sound have been identified as ling nursery grounds during August and September (Ellis *et al*., 2010; Figure 13.5).

Mackerel

13.111 Mackerel are a pelagic species whose presence in Scottish waters is transitory. The spawning grounds for the western stock of mackerel lie to the south and west of the British Isles and after spawning the fish migrate northwards to feeding ground in the northern North Sea and the Norwegian Sea. The migration route generally follows the edge of the continental shelf; however some enter coastal waters in June and remain throughout the summer (Faber Maunsell, 2007).

13.112 The Pentland Firth is part of the wide nursery area for the western stock, where the main nursery area extends along the entire outer continental shelf to the west of the British Isles (Ellis *et al*., 2010; Figure 13.5).

13.113 Mackerel is a commercially important species. However landings of mackerel in ICES rectangle 46E6 have decreased in recent years (Section 14) but it is likely that Mackerel are present in the Project area during the summer.

Megrim

13.114 Megrim is a demersal flatfish that occurs around the majority the British Isles coastline. It is found mostly on soft mud or muddy sands at depths between 50 and 300m. Megrim prey on other small fish including sandeels, dragonets and gobies (Picton & Morrow, 2010). It spawns between January and April, with spawning peaks occurring in February and March (Seafish, 2011).

13.115 Megrim is a high valued species caught in ICES rectangle 46E6 (Section 14) and is likely to be caught as part of the mixed demersal fishery which includes Nephrops, monkfish and cod. However, Megrim are unlikely to be present within the Project area due to their preference for muddy sediments.

Monkfish

13.116 The monkfish is widely distributed around Scotland both on the shelf and on the continental slope to depths of approximately 1,000m. They are primarily ambush predators, enticing prey, mainly fish, towards their large gaping mouths with a lure that extends from the top of their head (Faber Maunsell, 2007).

13.117 Spawning takes place in deep water with each female thought to produce just one batch of eggs between January and June. Juvenile monkfish descend to the seabed after 3 to 4 months spent in the water column and are generally found in shallower water than adults. Female monkfish do not mature until they are at least seven years old and so the species is particularly vulnerable to overfishing (DECC, 2009). Adults of up to 13 years have been reported from Scottish waters (Faber Maunsell, 2007). Spawning is shown to take place throughout the Pentland Firth (Figure 13.4)

13.118 Monkfish are a highly valued commercial species, and statistics show them as being caught in ICES rectangle 46/E6 these landings are likely to be mis-reported (Marine Scotland, pers. comm.) and it is unlikely that monkfish are present within the Project area.

Norway pout

13.119 Norway pout is a small, abundant gadoid fish that attains a length of about 20cm and lives for about three years. The adults are widely distributed throughout UK waters depths between 40 and 100m (Faber Maunsell, 2007). Juvenile Norway pout feed mainly on copepods and planktonic tunicates, with adults feeding on a range of crustaceans and small fish (ICES, 2011c). Spawning occurs over a wide area to the west, north and east of Orkney, which is also mirrored in the nursery areas (Coull *et al*., 1998).

13.120 Norway pout is an important food item for a number of commercially important species including hake, cod, whiting, mackerel and pollock (Sweet, 2009).

Plaice

13.121 Plaice is a widely distributed demersal flat fish, which is found throughout British waters from intertidal areas to depths of 8m (Faber Maunsell, 2007). Plaice mostly live on sandy bottoms; although they also live on gravel and mud. They are often seen on sand patches in rocky areas and may potentially be present in the Project area in small numbers. Young fish in their first year live in very shallow water, after which they being to move into deeper water when they become about 15cm in length (Ruiz, 2007). Plaice feed on a range of benthic organisms including razor clams and cockles, sand eels, worms, brittle stars and crustaceans.

13.122 Plaice spawn throughout their adult stage, at localised spawning locations. Spawning is from December to March and the eggs and larvae are pelagic. The nursery grounds are found in sandy areas. The nearest spawning and nursery grounds to the Pentland Firth for plaice are to the south along the east coast of Scotland approximately 20km from the Inner Sound (Ellis *et al*., 2010).

Saithe

13.123 Adult saithe are found in the deeper waters (approx 100 - 200m) at the edge of the continental shelf. Spawning takes place from January to April east of Shetland and to the west of the Outer Hebrides.

13.124 The nursery areas are in the inshore waters of the west of Scotland and around Orkney and Shetland, where young fish remain for two to three years before migrating to deeper waters. The Pentland Firth is included in part of the large saithe nursery ground within includes the majority of the coastal waters of mainland Scotland (Coull *et al*., 1998; Figure 13.3).

13.125 The diet of juvenile saithe is a similar diet to adults, where they are known to consume a wide range of fish species such as herring, cod, and sandeel as well as benthic invertebrates. Adult saithe feed on a range of demersal prey, including crustaceans and fish species such as sandeel, Norway pout, and haddock (Rogers & Stocks, 2001).

Sandeel

13.126 Although there are five species of sandeel in Scottish waters approximately 90% of the commercial catch of sandeels consists of the species *Ammodytes marinus* (Faber Maunsell, 2007). Sandeels are a shoaling species which lie buried in the sand during the night, and hunt for prey in mid-water during daylight hours. They feed primarily on planktonic prey such as copepods and crustacean larvae, but they can also consume polychaete worms, amphipods, and small fish including other sandeels. Sandeels have neither swim bladder, nor fins capable of compensatory movements, and in order to remain clear of the bottom they must swim continually (Rogers & Stocks, 2001).

13.127 During the winter sandeel remain in the sediment only emerging to spawn. They reach sexual maturity at around age two and spawn in December/January. The eggs are demersal and are laid in clumps that stick to sandy substrata until they hatch during February and March, after which the larvae are found in the water column. After metamorphosis they settle in sandy seabeds amongst the aggregations of adults (van Deurs *et al*., 2009). As a result there is very little movement between spawning and feeding grounds.

13.128 The Pentland Firth is part of a sandeel spawning ground with low egg/larval density. Higher egg and larval density spawning grounds can be found to the south of the Pentland Firth along the north-east Scottish coast. As outlined above and in Section 10 Benthic Habitats and Ecology the surveys conducted of the Sound on Stroma reported that the majority of the seabed within the Inner Sound, including the majority of the Project area is comprised of current scoured bedrock. As a result it is unlikely that sandeels use the Project area directly as a spawning ground, due to the lack of available suitable habitat. During grab sampling of the small area of sediment within the lease area ASML (2011) reported one individual sandeel in one grab sample.

13.129 The Pentland Firth is also part of a wider nursery ground for sandeel (Ellis *et al*., 2010; Figure 13.5). Therefore the Inner Sound can be considered an area of low importance for sandeel populations.

13.130 As well as being a major component of commercial fisheries in Scottish waters, sandeels are an important resource for predatory fish and seabirds. No sandeels were landed from ICES Rectangle 46E6 over the last five years of data collection (Section 14).

Whiting

13.131 Whiting is a widely distributed demersal species occurring at depths between 30 and 100m throughout Scottish waters. It can be found near mud and gravel bottoms, but also above sand and rock (Barnes, 2008h).

13.132 Whiting has a prolonged spawning period from February to June (Table 13.9) throughout its range but with the main spawning areas being to the west of Shetland and east coast of Scotland. The eggs and larvae are pelagic and the young, often associated with jellyfish, remain pelagic until they attain a length of about 10cm when they adopt a demersal habit. The nursery grounds tend to be located inshore (including within sea lochs) and juveniles will remain in these areas for one or two years (Faber Maunsell, 2007). The eastern outer reaches of the Pentland Firth have been identified as spawning grounds for whiting and the whole Pentland Firth is part of a wider area identified as a whiting nursery ground (Ellis *et al*., 2010; Figure 13.5).

Other fish sightings

13.133 One ocean sunfish was observed during the marine mammal and bird observation surveys (RPS, 2011). The fish are large pelagic ocean ranging species and this sighting is considered to have been a rare occurrence for the Pentland Firth.

13.5.5 Sensitivity to tidal array development

13.134 The Scottish Marine Renewables SEA (Faber Maunsell, 2007) identifies the sensitivity of fish species to impact associated with wave and tidal developments. Table 13.10 has been adapted from the information contained in the SEA and lists those fish species or species groups that potentially are present within the Project area and may be considered to be sensitive to the proposed tidal energy development.

Species	Smothering	Change in suspended sediment	Increased turbidity	Substratum loss	Decrease in water flow	EMF	Underwater noise
Spurdog	Not sensitive	Not relevant	Unknown	Not relevant	Not relevant	Yes	Unknown
Lesser spotted dogfish	Low	Not relevant	Unknown	Not relevant	Not relevant	Yes	Unknown
Basking shark	Not sensitive	Low	Unknown	Not relevant	Not relevant	Yes	Unknown
Porbeagle	Not sensitive	Not relevant	Unknown	Not relevant	Not relevant	Yes	Unknown
Tope	Not sensitive	Not relevant	Unknown	Not relevant	Not relevant	Yes	Unknown
Thornback ray	Low	Not relevant	Unknown	Not relevant	Not relevant	Yes	Low
Common skate	Low	Not relevant	Not sensitive	Low	Not relevant	Yes	Not sensitive
Herring	High (demersal eggs)	Medium (filter feeder)	Medium	High (spawning areas)	High (spawning areas)	Not sensitive	High
Salmon	Not sensitive	Not relevant	Unknown	Not relevant	Not relevant	Yes	Medium
Sea trout	Not sensitive	Not relevant	Unknown	Not relevant	Not relevant	Yes	Unknown
Cod	Not sensitive	Not relevant	Unknown	Not relevant	Not relevant	Yes	High
Haddock	Not sensitive	Not relevant	Unknown	Not relevant	Not relevant	Not sensitive	Unknown
Whiting	Not sensitive	Not relevant	Unknown	Not relevant	Not relevant	Not sensitive	Unknown
Norway pout	Not sensitive	Not relevant	Unknown	Not relevant	Not relevant	Not sensitive	Unknown
Saithe	Not sensitive	Not relevant	Unknown	Not relevant	Not relevant	Not sensitive	Unknown
Sandeel	High (especially demersal eggs)	Low	Unknown	High (spawning areas)	Medium	Not sensitive	Unknown
Mackerel	Not sensitive	Not relevant	Unknown	Not relevant	Not relevant	Not sensitive	Unknown
Lemon sole	Low	Low	Unknown	Not relevant	Not relevant	Not sensitive	Low
Plaice	Low	Low	Unknown	Not relevant	Not relevant	Yes	Low

Table 13.10: Sensitivity of certain fish species to impacts from tidal arrays (Faber Maunsell, 2007)

13.135 Available data indicate that, of the potential effects caused by tidal energy development, the possible effects of EMF on elasmobranch and migratory fish behaviour, and substratum loss and smothering for fish species that have demersal eggs are of greatest concern.

13.6 Impacts during Construction and Installation

13.136 This section assesses the potential impacts during the construction and installation phase of the Project. The assessment of direct habitat disturbance upon the benthic community within the Project site is presented in Section 10 Benthic Habitats and Ecology. It is estimated that the total footprint of the Turbine Support Systems (TSS) and the cables on the seabed will be 0.130km^2.

13.6.1 Impact 13.1: Loss of spawning grounds

13.137 The Pentland Firth has been identified (using CEFAS data, Coull *et al*., 1998; Ellis *et al*., 2010) as being part of wider spawning grounds for herring, lemon sole, sandeel and whiting.

13.138 The Project has the potential to result in the direct loss of spawning grounds through the placement of structures on the seabed, including tidal devices and cables.

13.139 Both sandeel and herring are demersal spawners, where the placement of eggs on the seabed takes place in suitable sandy or gravelly habitats. The seabed in the Project area is considered to be unsuitable for both herring and sandeel spawning, and as such are unlikely to be using the area for spawning. In addition, whiting spawning grounds, although identified within the Pentland Firth, are understood to be located to the east of the Project, and as such, whiting are assumed to not use the Project area for spawning. As a result the Project is likely to cause no significant effect on herring, sandeel or whiting spawning grounds.

13.140 The wider spawning ground for lemon sole covers an area of 209,549 km^2 and the construction phase of the Project will impact upon much less than 0.01% of this total spawning area. Although lemon sole spawn in the summer months (Table 13.9) which is when the majority of installation works are to take place, the small area that may be impacted coupled with the fact that lemon sole produce pelagic eggs rather than requiring specific spawning substrate or areas mean that the magnitude of the impact of the Project on lemon sole spawning is negligible. Based on the fact that sandeel and herring are unlikely to spawn in the Inner Sound and that the lemon sole do not have specific spawning ground requirements the sensitivity of the receptor is considered to be negligible also.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Negligible	Negligible	Negligible	Not Significant

MITIGATION IN RELATION TO IMPACT 13.1
▪ No mitigation measures proposed as no significant impact predicted.

13.6.2 Impact 13.2: Loss of nursery grounds

13.141 The Pentland Firth has been identified (using CEFAS data, Coull *et al*., 1998; Ellis *et al*., 2010) as being part of wider nursery grounds for blue whiting, angler fish, hake, mackerel, ling, sandeel, saithe, herring, haddock, lemon sole, whiting, cod, spotted ray, spurdog and tope. Given the size of the nursery grounds for these species, the fact that many nursery grounds for some of these species are found on substrate not present within the Project area and that the Project will affect much less than 0.01% of the nursery grounds for these species the impacts are expected to be have minimal effect, if at all.

13.142 As juveniles blue whiting, mackerel, saithe, cod, haddock, whiting, herring, ling, lemon sole, anglerfish, hake, spotted rays, spurdog and tope are highly mobile, and as such if any individuals are present within the Project site at the time of construction they are likely to vacate the area once construction begins. As there is similar habitat close to the Project area disturb individuals will be able to quickly find new habitat and any disturbance will be temporary and short-lived.

13.143 It is therefore unlikely that any change to the baseline condition of these species caused by the Project will be detectable against natural variations in juvenile and population numbers and the impact magnitude will be negligible. Due to the area affected being such a small proportion of the nursery grounds of species in the vicinity of the Project the sensitivity of the receptor is considered to be negligible.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Negligible	Negligible	Negligible	Not Significant

MITIGATION IN RELATION TO IMPACT 13.2
▪ No mitigation measures proposed as no significant impact predicted.

13.6.3 Impact 13.3: Noise

13.144 An underwater noise impact study within the Inner Sound was conducted by Kongsberg Maritime Ltd (Kongsberg, 2012), which included acoustic modelling to investigate the underwater noise propagation from the Project (a copy of this report is provided on the supporting studies CD).

13.145 The main activities during construction and installation that have the potential to cause impact to fish species through the generation of noise are the drilling for the monopiles and cable bore holes and vessels. Noise is generated during drilling principally through the action of the drill bit on the surrounding rocks; whereas noise from vessels can be generated as a result of a number of components, including propeller blade rotation, engine cylinder firing and flow through the water.

13.146 During Year 1 and 2 the turbines will be installed one at a time, and drilling will only take place at one location at any given time. However, during Year 3 it may be necessary to have parallel drilling operations, therefore the worst case scenario for noise generation will be during the installation of later turbines when installation noise will be coupled with operational noise from the previously installed and operating turbines. It is this worst case multiple source noise event that is assessed in this section.

13.147 Kongsberg (2012) used existing examples of noise levels recorded from an oil drilling rig for drilling noise (McCauley *et al.,* 1998) and a range of vessels to input into the acoustic models to assess the impacts of construction noise. However, Kongsberg (2012) could not be certain if the underwater noise as recorded by McCauley *et al.* (1998) was due entirely to the action of the drill bit on the seabed rock or included other noise emissions such as the drill vessel.

13.148 Kongsberg (2012) reported that very few tidal turbines have been installed in UK waters and of these, only data pertaining to the MCT turbine, Bristol Channel is publicly available (Richards *et al*., 2007). The MCT turbine is a horizontal axis, single rotor turbine with an output of 300kW. This is much smaller than the 2.4 MW turbine proposed here as the worst case scenario for sound under the principles of the Rochdale Envelope, but it is the only turbine for which detailed noise measurements are available. To account for the size difference Kongsberg (2012) extrapolated the noise data from the MCT turbine to account for the differences in turbine size at Bristol Channel and Inner Sound, to generate data comparable with a 2.4MW device.

13.149 The potential impacts of underwater noise on fish are dependant on species specific hearing capabilities and sound detection apparatus. When species specific ranges are calculated, which compare the source noise with the hearing threshold of the target species (the minimum noise level species are able to hear), is evident that 'unweighted' ranges are unrealistic.

13.150 According to Vella *et al*., (2001) the sensitivity of fish species to noise is dependant upon:

- The audible threshold;
- The presence of a swim bladder and its size and physical coupling to the ear;
- The resonance frequency of the otolith system; and
- Behavioural factors, such as aggregation or shoaling behaviour.

13.151 The hearing ability of fish varies greatly across species types. Typically, fish sense sound via particle motion in the inner ear which is detected from sound-induced motions in the fish's body. The detection of sound pressure is restricted to those fish which have air filled swim bladders; however, particle motion (induced by sound) can be detected by fish without swim bladders (Faber Maunsell, 2007).

13.152 Table 13.11 displays a summary of fish species, their differing levels of hearing specialism and hearing sensitivity. Highly sensitive species such as herring, have elaborate specialisations of their auditory apparatus, where these species are characterised by the presence of a otic bulla, a gas-filled sphere, connect to the swim bladder, which enhances hearing ability. The gas filled swim bladder in species such as cod and salmon may be involved in their hearing capabilities, so although there is no direct link to the inner ear, these species are able to detect lower sound frequencies and as such are considered to be of medium sensitivity to noise. Flat fish and elasmobranchs have no swimbladders and as such are considered to be relatively less sensitive to sound pressure (Nedwell *et al.*, 2004). As a result within this impact assessment herring has been used as the most sensitive species that could be affected by noise from the Project, as it is the most sensitive species that has the potential to be present in the Inner Sound.

Species	Family	Swimbladder connection	Sensitivity
Atlantic salmon	Salmonidae	None	Medium
European eel	Anguillidae	None	Medium
Herring	Clupeoidea	Prootic auditory bullae	High
Cod	Gadidae	None	Medium
Haddock	Gadidae	None	Medium
Hake	Merluccidae	None	Medium
Plaice	Pleuronectidae	No swimbladder	Low
Common skate	Rajidae	No swimbladder	Low
Mackerel	Scombridae	None	Medium

Table 13.11: Summary of hearing specialisation levels in fish species potentially present in the Project area (Nedwell *et al.*, 2004)

13.153 Noise measurements taken in the Inner Sound have indicated that the background noise levels are generally high, as a result of the strong tides and turbulent waters which naturally generate noise under water (Kongsberg, 2011). The noise assessment presents background underwater noise data for the Inner Sound as narrowband Pressure Spectral Density levels in dB re.1μPa^2.Hz-1 over the frequency range from 20 Hz to 150 kHz. Background noise levels in the Inner Sound are variable, lying in the range 106 – 139 dB re 1 μPa.

13.154 Consequently, fish species are only likely to be impacted when noise generated during installation and commissioning activities are above these high background levels.

13.155 The effects of noise on fish can be divided into three main categories (Hastings and Popper, 2005) (closest to source of noise and greatest severity of impact first):

- Lethal and physical injury;
- Hearing damage (temporary and permanent hearing loss); and
- Behavioural responses and masking of biological relevant sounds.

13.156 Kongsberg (2012) presents a detailed investigation to assess the potential impact of noise generated as part of the proposed Project. Based on a detailed literature review the following criteria are used:

- 240 dB re 1 μPa (peak exposure limit) – lethality;
- 90 dB_{ht} above species specific hearing threshold – strong behavioural reaction; and
- 75 dB_{ht} above species specific hearing threshold – mild behavioural reaction.

13.157 Behavioural response and auditory injury from underwater sound is often assessed by comparing the received sound level with the auditory threshold of the receptor. Nedwell *et al*. (2005 and 2007) and Parvin *et al*. (2006) compare the underwater noise with receptor hearing threshold across the entire receptor auditory bandwidth in the same manner that the dB(A) is used to assess noise source in air for human subjects. This dB_{ht}[2] criteria, used in these studies is behavioural based, where received sound levels of 90 dB above hearing threshold (comparable with 90dB(A) in air) are considered to cause a strong behavioural avoidance, and levels of 75dB above hearing threshold invoke a mild behavioural response. It is understood that this criterion has not been validated by either rigorous peer-review or experimental study. It is recognised there are limitations on these assessment criteria and further work in this area is required. MeyGen will be monitoring noise to verify the assessment of noise generated by the Project. These criteria are the best currently available and have therefore been applied to this assessment.

13.158 As outlined in Section 11 acoustic impact criteria have been developed for species of marine mammal sensitive to noise. Yelverton and Richmond (1981) stated that marine mammal fatalities arise when peak pressures exceed 240 dB re 1 μPa and this may be applied to fish as well. Hearing damage criteria have also been developed for marine mammals (Section 11), but have yet to be developed for fish species as there have been difficulties in translating the results gained under controlled laboratory experiments to open water (Popper and Hastings 2009).

13.159 Consequently because marine mammals are considered to be more sensitive to underwater noise when compared to fish species, the outcomes of the modelling for marine mammals (based on the available marine mammal criteria) are considered to represent the worst case hearing damage impacts for fish species, where overall, the impact to fish species is likely to be much less than that of marine mammals. Further details on the acoustic impact criteria for marine mammals can be found in Section 11.

13.160 The broadband source level for vessel noise is considered as 172dB re 1μPa at 1m based on a tug vessel being the noisiest vessel being used during installation operations. Analysis of published drilling noise measurements indicate that a broadband source level of 144dB re 1μPa at 1m is considered representative for the activities at the Inner Sound site.

13.161 Kongsberg (2012) report that underwater pin pile drilling tends to be a low noise level operation, at least compared with other activities. In a relatively noisy environment such as the Inner Sound, it may be assumed that the drilling noise will propagate over only short distances before it falls below background noise levels. The modelling undertaken for the Inner Sound confirms this, with drilling noise falling to background noise levels at a range of 0.5km from the noise source.

13.162 The source level for drilling activities is considerably below the level at which lethal injury to fish might occur and it is therefore unlikely that any marine animals will be killed by the underwater noise from pile drilling. For construction activities Kongsberg (2012) reported that no behavioural reactions are likely to be seen in hearing generalist fish. They are the most insensitive of generic species to the man-made noises that may be generated by the Project. Drilling noise is sufficiently low that hearing generalists would need to be less than 1m from the source of the drilling activity to elicit any (strong or mild) behavioural response.

13.163 Kongsberg (2012) reported that for hearing specialist fish, no strong behavioural reactions to any Project related man made noises are likely. When exposed to vessel noise, mild behavioural avoidance may occur out to a maximum distance of approximately 14m (Kongsberg, 2012). Hearing specialists would need to be less than 1m from the source of the drilling activity to elicit a strong behavioural response.

13.164 For marine mammal species the noise levels associated with vessels were sufficiently low such that the hearing damage impact criteria were not met, and as such it can be confidently extrapolated that there is not likely to be a hearing damage impact to fish species from vessels.

[2] The dBht method has been developed based on work by Nedwell *et al.* (2005, 2007) and Parvin *et al.* (2006) where the underwater noise is compared with receptor hearing threshold across the entire receptor auditory bandwidth. This dB_{ht} criteria is behavioural based, where received sound levels of 90 dB above hearing threshold are considered to cause a strong behavioural avoidance, and levels of 75 dB above hearing threshold invoke a mild behavioural response.

13.165 Kongsberg (2012) reported that the noise arising from the TSS pile drilling is considerably lower than that generated during the operation of the turbines. As a result the noise generated from socket drilling of an additional turbine would have no discernable increase in sound levels compared to the operation of the turbines alone. Kongsberg (2012) reported that the operational noise from 36 turbines[3] would result in a mild behavioural avoidance in hearing specialist fish up to 68m from the array and a strong behavioural avoidance within 18m of the array Hearing generalist would only elicit a behavioural response (mild or strong) if they were less than 1m from the tidal array.

13.166 Based on the modelling conducted by Kongsberg (2012), none of the installation (and operation) scenarios would generate noise levels that would result in lethal or physical injury to marine mammals. Therefore, fish species are also unlikely to be exposed to noise that would cause mortality or injury.

13.167 During EIA scoping SNH raised concerns over the impacts of underwater noise on fish spawning. As outlined in Section 13.5.1 the seabed in the Project area is considered to be unsuitable for both herring and sandeel spawning, and as a result it is only possible that lemon sole could use the Project area for spawning. Lemon sole are flatfish species which do not have swim bladder, and as such can be considered be of low sensitivity to underwater noise. Modelling conducted by Kongsberg (2012) determined that hearing generalist fish would be unable to detect drilling and vessel noise unless they were within 1m of the noise source. As such it is not likely that their spawning behaviour would be affected significantly as a result of the noise generated during construction and installation operations.

13.168 The most sensitive receptor (hearing specialist fish) are used to undertake the assessment using a precautionary approach and as a result the sensitivity of the receptor is considered to be high. However, as the noise levels are relatively low, unlikely to cause injury or mortality and the ranges for behavioural reactions are very small, any impacts are likely to be imperceptible. Therefore, the impact magnitude is considered to be negligible. Hearing generalist fish (e.g. Atlantic salmon) are likely to experience an impact of lesser significance.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
High	Negligible	Minor	Not Significant

MITIGATION IN RELATION TO IMPACT 13.3
▪ Although no significant impact has been identified, mitigation measures have been provided on a precautionary approach to ensure this remains the case. ▪ Where possible the use of soft start (gradual ramping up) of operations that will emit noise into the Project area will be used. ▪ MeyGen accepts that there is some uncertainty over the noise generated during drilling and turbine operation and as a result commits to conducting noise monitoring for the initial turbines installed and candidate turbine technology to validate the noise modelling.

13.6.4 Impact 13.4: Increased turbidity

13.169 Activities related to the construction of the Project, such as cable laying and device placement can result in temporary increases in turbidity through sediment resuspension (release of drill cuttings material is covered in Section 13.6.9). Increased turbidity can have effects on foraging, social and predator/prey interactions (Faber Maunsell, 2007). Table 13.12 provides a summary of risks associated with increased concentrations of suspended sediments.

[3] A 36 turbine array of 2.4MW turbines has been used in the assessment as it produces greater noise than an array of 86 turbines of 1MW rated power

Sediment increase (mg/l)	Risk to fish and their habitat
0	No risk
<25	Very low risk
25-100	Low risk
100-200	Moderate risk
200-400	High risk
>400	Unacceptable risk

Table 13.12: Risk to fish and their habitats by sediment concentration (Department of Fisheries and Oceans, Canada, 2000)

13.170 Resuspension of existing sediment, resulting in increased turbidity from the placement of turbines and cables on the seabed during installation operations is likely to be very low in magnitude, due to the lack of existing sediment on the seabed in the Project area (Table 13.12).

13.171 The increase in turbidity during offshore installation will be short term and will only affect localised areas. Coarser sediment fractions are likely to be re-deposited on the seabed within approximately 50m of the works (Faber Maunsell, 2007). The naturally occurring sediments in the study area, although limited, are mainly coarse grained. Therefore, the majority of re-suspended material will fall out of suspension within 50m of the works and the effect on turbidity will be localised and minimal.

13.172 Herring have a medium sensitivity to increases in suspended sediment concentrations (Faber Maunsell, 2007 Table 13.12) and are taken forward as the most sensitive species. Therefore the sensitivity is considered to be medium. The Scottish renewables SEA states that all other fish species (relevant to this EIA), for which sensitivity is known, have low or no sensitivity to this impact (Faber Maunsell, 2007). The increases in sediment are expected to be low and therefore the magnitude of the impact is assessed as minor.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Medium	Minor	Minor	Not Significant

MITIGATION IN RELATION TO IMPACT 13.4
▪ No mitigation measures proposed as no significant impact predicted.

13.6.5 Impact 13.5: Smothering

13.173 Activities related to the construction of the Project, such as cable laying and placement of gravity based TSSs can result in temporary increases in turbidity through sediment resuspension (as discussed in Section 13.6.4, the release of drill cuttings material is covered in Section 13.6.9). However, as the sediment resettles on the seabed there is the potential for the settling sediment to smother important fish habitats.

13.174 Smothering of fish habitat could occur within the immediate vicinity of the seabed of disturbing works, including turbine installation (including placement of gravity based TSS) and cable laying. The impact is only expected to be temporary, as excess material deposited will be re-suspended and distributed by natural hydrodynamic processes (Faber Maunsell, 2007).

13.175 Based on the sensitivity data available from MarLIN most fish species within the Pentland Firth are not sensitive to, and therefore not affected by, the impacts of smothering (Faber Maunsell, 2007). However, certain demersal species: lesser spotted dogfish, thornback ray, common skate, lemon sole and plaice which are likely to be present in the Pentland Firth all have a low sensitivity to smothering (Faber Maunsell, 2007). In addition the spawning areas of herring and sandeels are highly sensitive to smothering impacts (Faber Maunsell, 2007, Table 13.10). As discussed in Section 13.5.1, the nature of the habitat in the Project area is considered to be unsuitable for both herring and sandeel spawning, and

as such these species are unlikely to be using the area for spawning. Such habitat does exist to the east and west of the Project. However, as shown in Section 9 the impacts to the sediment in these areas as a result of the Project are negligible and sediment from these areas is not removed from this area or disturbed. Therefore, it is unlikely that any spawning areas associated with these species will be affected by the Project.

13.176 Smothering associated with the deposition of sediments disturbed or generated by the installation of the turbines, cables and bore holes is expected to be a temporary impact, as excess material deposited will be re-suspended and distributed by natural hydrodynamic processes (Faber Maunsell, 2007). The naturally turbulent conditions should ensure any deposition on the seabed is quickly dispersed and does not accumulate into large deposits (see Section 9 Physical Processes and Sediment Dynamics).

13.177 As most fish species within the Pentland Firth are not sensitive to the impacts of smothering (Faber Maunsell, 2007) the sensitivity is considered as low. Given that the spawning and nursery grounds in the Project area represent a very small proportion of the wider spawning and nursery grounds the magnitude of the impact is considered to be negligible.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Low	Negligible	Negligible	Not Significant

MITIGATION IN RELATION TO IMPACT 13.5

- Although no significant impact has been identified, mitigation measures have been provided on a precautionary approach to ensure this remains the case.
- Minimise as far as practicable the depth and diameter of the turbine foundation piles (without compromising technical performance).
- Minimise as far as practicable the volume of drill cuttings released into the marine environment during breakthrough of HDD bores, by implementing a closed loop recycling system to return drill cuttings and fluid from the HDD to shore.

13.6.6 Impact 13.6: Changes to prey species

13.178 The potential for the Project to cause changes to prey species such as benthic invertebrates and bony fish is limited (Section 10). As discussed in this section the main prey species of other fish are small clupeids such as herring and sandeels, other small fish such as Norway pout and juvenile cod, whiting, saithe and other gadoids. The nursery areas for most of these species are unlikely to be impacted and it is unlikely that the availability of juvenile fish will change to an extent that they will be less available to predators. The same can be said for herring and sandeels as the Project area represents unsuitable substrate for spawning animals. It is also likely that vessel noise will cause most fish species to move away from the area so that they will still be available to predators that have also moved from the area.

13.179 As the majority of fish species in the area are free ranging and roam large areas of the sea they are unlikely to be resident in the Project area. In addition the small area that the Project covers is unlikely to provide a refuge habitat for most of these species to hide from predators. Therefore, any fish species that move from the area during construction will not become more available to predators by making them more concentrated in surrounding areas or by removing important habitat that is used to avoid predators. Therefore, increased predation on prey species that could affect population sizes is very unlikely to occur.

13.180 Given that impacts to benthic and fish prey species are considered to be generally negligible the magnitude of impact is also considered to be negligible. The species that feed in the Pentland Firth are highly mobile and will be able to access food resources in other areas or once they have passed through the Project area. Therefore the sensitivity is considered to be negligible.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Negligible	Negligible	Negligible	Not Significant

MITIGATION IN RELATION TO IMPACT 13.6

- No mitigation measures proposed as no significant impact predicted.

13.6.7 Impact 13.7: Release of sediment bound contaminants

13.181 The release of contaminated sediments during device and cable installation may cause potentially detrimental effects on species that are sensitive to contamination. However there is no indication that any of the limited sediments present in the Project area have been contaminated. There is a general lack of development in the area, however the Dounreay reactor represents the only major potential contamination pathway within the vicinity of the Project. Radiochemical analysis of grab samples from the benthic survey, showed no evidence of contamination from artificial radioactivity in any of the samples (ASML, 2011). As outlined in Section 10, there is a dredge spoil disposal site located in the proposed turbine deployment area that has not been in use since the 1970's. The seabed surveys identified the whole area to be composed of bedrock, indicating that in the high energy tidal environment sediments disposed at the site have since dispersed away from the site.

13.182 The sediment adjacent to the turbine deployment area will settle very close to where it was disturbed as it consists of large sized particles that are likely to travel a very short distance. The models in Section 9 suggest there is no net transport of sediment from the area and the natural sediment transport within the Project area will be unaffected. As a result it is unlikely that contaminated sediments (if they are present) will be disturbed in a manner that may affect the fish species present in the Project area.

13.183 The potential impacts on water quality have been discussed further in Section 9 and have been shown to be negligible. Combined with a lack of evidence for any contamination in the area the magnitude of impact is considered to be negligible. The sensitivity of fish in the Project area is considered medium due to the likelihood of fish being able to avoid any pollution events. Protected species that occur in the area have much higher sensitivity to the impact but again their mobility will allow them to move away from areas of pollution and again their sensitivity will be medium

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Medium	Negligible	Negligible	Not Significant

MITIGATION IN RELATION TO IMPACT 13.7

- No mitigation measures proposed as no significant impact predicted.

13.6.8 Impact 13.8: Accidental spillage from vessels

13.184 The discussion around this impact focuses on the potential impacts associated with the release of a large inventory of fuel oil from a vessel. This is considered to be the worst case potential accidental pollution impact. Other smaller inventories of polluting substances may potentially be released during the course of the Project. These impacts and their potential consequences are discussed further in accidental events (Section 24).

13.185 The total oil inventory for the large DP installation vessels is likely to be in the region of 6,000,000 to 8,000,000 litres of marine diesel stored in a number of separate tanks. The worse case spill from a single

tank rupture is likely to be in the region of 600,000 litres of marine diesel released into the marine environment.

13.186 Oil spills can have a number of environmental impacts. Actual effects will vary depending on a wide range of factors including the volume and type of oil spilt and the sea and weather conditions at the time of the spill. Effects will also be dependent on the presence of environmental sensitivities in the path of the spill.

13.187 Even in the event that an oil spill resulted in the loss of inventory from a DP vessel, fish are highly mobile and are able to detect these pollutants and as a result are expected to avoid areas where pollution has occurred. The main sensitivities for fish species are nursery and spawning areas and the Inner Sound for fish species that occur in the vicinity of the Project only represents a small portion of these areas or is not suitable for spawning or populations of juvenile fish due to the strong tidal currents.

13.188 The sensitivity of fish is considered medium due to the fact it is expected fish are to some extent able to move away from polluted areas. In the event a large spill does occur the magnitude of impact is considered to be major.

13.189 The potential for a loss of a large fuel oil inventory from a vessel is defined as extremely remote (see Impact 24.1, Section 24).

Impact significance (see Section 24 for impact ranking methodology)

Sensitivity of receptor	Magnitude of impact	Consequence	Likelihood *(See section 24)*	Impact significance *(See section 24)*	Significance (EIA Regs) *(See section 24)*
Medium	Major	Major	Extremely remote	Negligible	Not Significant

MITIGATION IN RELATION TO IMPACT 13.8

Although no significant impacts have been identified, mitigation measures have been provided due to the potential consequence of the event:

- All vessels associated with Project operations will comply with IMO/MCA codes for prevention of oil pollution and any vessels over 400 GT will have onboard Ship Oil Prevention Emergency Plans (SOPEPs).
- All vessels associated with Project operations will carry onboard oil and chemical spill mop up kits.
- Where possible vessels with a proven track record for operating in similar conditions will be used.
- Vessel activities associated with installation, operation, routine maintenance and decommissioning will occur in suitable conditions to reduce the chance of an oil spill resulting from the influence of unfavourable weather conditions.

13.6.9 Impact 13.9: Release of drill cuttings and fluid

13.190 As outlined in Section 10, drill cuttings and fluid will be released into the marine environment during pile drilling for the turbine foundations and during break through for the cable bores.

Pile drilling

13.191 Monopile drilling operations will take approximately 4 hours per pile and a total of 30 hours to complete the preparations for each turbine support structure. Drilling the holes for each pile will generate rock cuttings which will be discharged directly to the seabed. Seawater (with no additives) will be used as the drilling fluid to lubricate the drill bit and aid in the removal of cuttings from the hole. A compressor will be used to pump air into the drilled holes in order to lift the cuttings clear as required. This compressor will use a lubricant which will be discharged to sea along with any cuttings to a maximum of 5 litres per hour (i.e. 200m^3 per turbine support structure, or 17,200m^3 for all 86 turbines installed over a 3 year period).

HDD drilling

13.192 For HDD operations the lubricant to be used is bentonite which is non-toxic. Therefore, the main potential environmental impact is likely to result from the physical settlement of rock cuttings onto the seabed with benthic fish species being the most susceptible to exposure to these cuttings. The drill cuttings are likely to consist predominantly of a fluid paste (incorporating the finest silt and clay-sized particles) with occasional larger fragments up to pebble-sized flakes, all of which are mobile in the marine environment. The largest and heaviest particles will settle relatively quickly to the seabed in the close vicinity of the drilling centre, whilst in this energetic locality the finest particles will remain in suspension for some time.

13.193 The cables to shore will be routed through bores directionally drilled from onshore. The maximum volume of drill cuttings that will be discharged at bore breakthrough is 82m^2. As with the drill cuttings, benthic fish species are most likely to be exposed to the contents of the breakthrough of the bore holes.

13.194 The dynamic environment (resulting from intense wave action and tidal activity) into which the operational discharge will be released means that drill cuttings will be dispersed into the wider marine area; the Pentland Firth is one of highest energy coastal environments in the UK (see Section 9). The lack of sediment across almost all of the Project area and the likely cable corridors indicates a dynamic environment in which solids are unlikely to accumulate.

13.195 As outlined in Section 10, the release of drill cuttings and fluids in the marine environment is not likely to cause a significant impact to the benthic ecology of the Project area. As a result, no indirect impacts on fish prey species are anticipated. In addition, the fish species in the Inner Sound are highly mobile (more so than benthic invertebrates) and will be able to move away from areas where drill cuttings are discharged. The area affected will also represent a significantly small (<0.01%) of the area available to fish species that spawn and have nursery areas within the Inner Sound.

13.196 As outlined in Table 13.10 the sensitivity of some of some fish species, including plaice, dogfish and plaice to smothering is considered to be low (Faber Maunsell, 2007). Sensitivity is considered to be high for herring and sandeel demersal eggs, however, as highlighted previously it is not anticipated that either of these species use the Project area for spawning.

13.197 As most fish species within the Pentland Firth are not sensitive to the impacts of increased sedimentation (Faber Maunsell, 2007) the sensitivity is considered low. Given that the volumes released will be relatively low the magnitude of the impact is considered to be minor.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Low	Minor	Minor	Not Significant

MITIGATION IN RELATION TO IMPACT 13.9

- Although no significant impact has been identified, mitigation measures have been provided on a precautionary approach to ensure this remains the case.
- Minimise as far as practicable the depth and diameter of the turbine foundation piles (without compromising technical performance).
- Lubricant used in the compressor to drive air into the drilled piles will be non-toxic and seawater will be used as a drilling fluid, negating the need for any additional chemical input.
- Minimise as far as practicable the volume of drill cuttings released into the marine environment

during breakthrough of HDD bores, by implementing a closed loop recycling system to return drill cuttings and fluid from the HDD to shore.

13.6.10 Impact 13.10: Collisions

13.198 The risk of collision during installation operations is only likely to arise through the interaction with installation vessels. Of the fish species that are present within the Project area, basking sharks are particularly slow moving, and swim close to the surface, especially when feeding and, therefore, potential does exist for collisions to occur between this large fish species and vessels used in construction and installation operations. Their slow moving nature makes basking sharks the most at risk fish species from collision during installation operations. However, it is worth noting that the numbers and density of basking sharks in the area is considered to be very low suggesting the potential of such an interaction is very low.

13.199 As basking sharks are afforded protection similar to that of a EPS under the Wildlife and Country side Act (1981 as amended) they are considered to be of very high sensitivity. The magnitude of the impact is based on the number of vessels using the Inner Sound and the limited period over which vessel activity will increase as a result of the Project. A negligible magnitude impact is assumed.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Very high	Negligible	Minor	Not Significant

MITIGATION IN RELATION TO IMPACT 13.10
▪ No mitigation measures proposed as no significant impact predicted.

13.6.11 Impact 13.11: Marine non-native species

13.200 Invasive Marine Non-Native Species (MNNS) pose a significant threat to biodiversity as they may have negative impacts on native species and threaten regional ecosystems. Should a non-native fish species be introduced into the marine environment of the Inner Sound there is no guarantee that the species will be tolerant of the conditions and it is in fact more likely that the species will be unable to reproduce and initiate a local population. For such a population to develop the species would need to be tolerant of the environmental conditions of the Inner Sound (e.g. temperature, salinity, suspended sediment, high flow velocities), make use of existing food sources (e.g. organic content of sediment, prey species) and be able to outcompete the native species. Alternatively it must be able to exploit a previously unfilled ecological niche. Where these conditions are met then the native populations may experience a reduction in numbers or a complete failure. The only viable vector through which non-native fish species could be introduced into the Inner Sound would be through ballast water from vessels used during construction and installation. However, the majority of vessels that will be employed on the Project are likely to have been operating within the North Sea and North Atlantic and are therefore unlikely to be carrying any species that may be considered non-native.

13.201 The impact of MNNS could in theory extend, in the long term, over a large area. This could lead to a high ranking for magnitude of impact. However, the impact is considered extremely unlikely to occur and to balance the scale of impact against the likelihood of impact occurring, a magnitude of impact of minor is assigned. Sensitivity of receptor is considered to be medium.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Medium	Minor	Minor	Not Significant

MITIGATION IN RELATION TO IMPACT 13.11
▪ Although no significant impact has been identified, mitigation measures have been provided on a precautionary approach to ensure this remains the case. ▪ All vessels involved in all stages of the Project will adhere to all relevant guidance and legislation (including the IMO guidelines and the International Convention for the Prevention of Pollution from Ships (MARPOL)) regarding ballast water and transfer on non-native marine species

13.7 Impacts during Operations and Maintenance

13.7.1 Impact 13.12: Loss of habitat

13.202 The placement of the turbines and cables on the seabed will be likely to impact on fish habitat available within the Inner Sound. The placement of the turbines and cables onto the seabed will exclude the seabed habitats directly beneath from use by species found in the region for the life of the Project as feeding, spawning and nursery areas. As shown in Impact 13.1 and Impact 13.2 the total area affected for spawning and nursery grounds is much less than 0.01% of the total area available to all the species that spawn in the Inner Sound and wider Pentland Firth, north coast of Scotland and North Sea. In addition the area lost to the placement of turbine foundations and cables represents a very small proportion of the Inner Sound, with a total of 0.103km^2 being occupied by these structures. Therefore it is unlikely that feeding areas will be restricted or significantly reduced.

13.203 As the area of impact is so small and the fish species recorded in the area are highly mobile, the impact on fish species ability to feed is expected to be equally small. The area of spawning and nursery ground is also small and unlikely to significantly affect the ability of these species to reproduce. Therefore, it is unlikely that any effects to the fish populations in the Inner Sound will be experienced due to the presence of the turbines and cables on the seabed and the magnitude is considered negligible. Herring and sandeel are particularly sensitive to loss of habitat for spawning but are unlikely to spawn in the area. As a result the sensitivity of the receptor is considered low as most species have large spawning grounds and are highly mobile, able to move to other areas to spawn and feed. The magnitude of the impact is considered to be negligible due to the very small are of habitat affected and the small proportion of the Inner Sound and wider Pentland Firth occupied by the Project infrastructure.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Low	Negligible	Negligible	Not Significant

MITIGATION IN RELATION TO IMPACT 13.12
▪ No mitigation measures proposed as no significant impact predicted.

13.7.2 Impact 13.13: Increase of available habitat

13.204 The device foundations and cable protection are likely to be colonised by numerous marine organisms (Section 10). Evidence from offshore wind farms, indicates that the array structures could act as a refuge for some fish and prey species (Linley *et al*., 2007). As a result the colonisation by fauna on the structures could result in an increase in food availability. In addition the physical structure of the foundations may attract some fish species, as they could provide protection against predation or the prevalent current and thus save fish energy (OSPAR, 2004). This increase in prey species and available habitat might not cause a direct increase in productivity, but could result in a spatial shift in the fish resource such as acting as a fish aggregation device (CEFAS, 2004). Anecdotal evidence from deployment of tidal turbines at EMEC suggests the foundations of tidal devices have a similar effect (Alex Alliston pers. comm., 2011).

13.205 Post construction monitoring at offshore wind farms in the UK have not identified any short term negative environmental impacts on fish populations caused by the construction of wind farms (BoWind, 2009; npower renewables, 2008). In fact, at Horns Rev offshore wind farm monitoring revealed a marked increased in fish fauna diversity, with shoals of cod, bib and whiting observed around the turbine bases (Leonhard & Pedersen, 2004). However, these increases are expected to be imperceptible in the context of the wider population. Therefore the magnitude of the impact is expected to be minor. Given that fish species do not show significant increases in population this suggests low sensitivity to this impact.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Low	Minor positive	Minor positive	Positive

MITIGATION IN RELATION TO IMPACT 13.13
▪ No mitigation measures proposed as no significant impact predicted.

13.7.3 Impact 13.14: Noise

13.206 As outlined in Kongsberg (2012) and Section 13.6.3 an underwater noise impact study within the Inner Sound was conducted by Kongsberg Maritime Ltd, which included acoustic modelling to investigate the underwater noise propagation from the Project. Further details on the modelling conducted can be found in Kongsberg (2012).

13.207 The main activity during operation of the turbines that has the potential to cause impact to fish species through the generation of noise is from the operating turbines themselves, including rotating machinery noise and water movement noise. The worst case scenario for operational noise comes from the operation of all 36, 2.4MW turbines in the Inner Sound. It is this multiple source noise event that is assessed in this section.

13.208 Kongsberg (2012) used extrapolated data from the MCT turbine (Richards *et al*., 2007) to conduct the noise modelling used in this impact assessment.

13.209 As outlined in Section 13.6.3 the effects of underwater noise can be separated into three main categories.

- Lethal and physical injury;
- Hearing damage (temporary and permanent hearing loss); and
- Behavioural responses and masking of biological relevant sounds.

13.210 As outlined in Section 13.6.3 hearing damage criteria have not been developed for fish species. They have been developed for marine mammals (Section 11). Consequently because marine mammals are considered to be more sensitive to underwater noise compared to fish species, the outcomes of the modelling for marine mammals (based on the available criteria) are considered to represent the worst case hearing damage impacts for fish species, where overall, the impact to fish species is likely to be much less that that of marine mammals.

13.211 Behavioural response and auditory injury from underwater sound is often assessed by comparing the received sound level with the auditory threshold of the receptor. Nedwell *et al*. (2005 and 2007) and Parvin *et al*. (2006) compare the underwater noise with receptor hearing threshold across the entire receptor auditory bandwidth in the same manner that the dB(A) is used to assess noise source in air for human subjects. This dB_{ht} criteria, used in these studies is behavioural based, where received sound levels of 90dB above hearing threshold (comparable with 90dB(A) in air) are considered to cause a strong behavioural avoidance, and levels of 75dB above hearing threshold invoke a mild behavioural response. It is understood that this criterion has not been validated by either rigorous peer-review or experimental study. Observations of behavioural avoidance with concurrent acoustic measurements in the field are sparse, and hence the behavioural avoidance criteria must be treated with some caution.

13.212 Based on the modelling conducted by Kongsberg (2012), the operation of 36, 2.4MW turbines[4] would generate noise levels that are below those levels that would result in lethal or physical injury to marine mammal species within the Project area and wider Inner Sound area. Therefore, it is unlikely that lethal or physical injury effects to fish would occur, including hearing sensitive species such as herring and European eel.

13.213 Operational activities tend to give rise to higher levels of underwater noise compared with drilling activities (Kongsberg, 2012). The background noise levels in the Inner Sound are variable, lying in the range 106 – 139dB re 1μPa, and therefore have the potential to drown out the operational noise on occasion. When background levels are at their highest, operational noise may fall to background levels within 300m of the turbines. This distance may increase to in excess of 14km when background noise levels are at their lowest (Kongsberg, 2012). There is also likely to be a direct correlation between background noise and the noise generated by the turbine. As background noise falls due to decreases in tidal flow, the noise generated by the turbine (as the turbine slows) will also decrease.

13.214 During the operation of 36, 2.4MW turbines, using weighted impact criteria, the thresholds for strong and mild reactions for hearing generalists are not met. Hearing generalists would need to be less than 1m from the source of the noise to exhibit a behavioural response. Kongsberg (2012) reported that for the operation of 36, 2.4MW turbines strong behavioural reactions in hearing specialists (e.g. herring) would occur up to 18m from the tidal array and mild behavioural reactions up to 68m from the tidal array. In terms of hearing damage, Kongsberg (2012) determined that neither temporary nor permanent hearing damage criteria would be met for cetaceans as a result of the operation, and as such hearing damage is also unlikely to occur for fish species present in the Project area.

13.215 During EIA scoping concerns were raised over the impacts of underwater noise on fish spawning. As outlined in Section 13.5.1 the seabed in the Project area is considered to be unsuitable for both herring and sandeel spawning, and as a result it is only possible that lemon sole could use the Project area for spawning. Lemon sole are flatfish species which do not have a swim bladder, and as such can be considered to be of low sensitivity to under water noise. Modelling conducted by Kongsberg (2012) determined that strong behavioural reaction would take place within 1m of the turbine array for these types of fish species. However, the nature of the reaction is unknown but there is the potential it would illicit an avoidance reaction. Also, it is unlikely that spawning behaviour would be affected as the area over which this might occur will represent less than 0.01% of the entire spawning area for species that spawn in the vicinity of the Project.

13.216 Further concerns have been raised regarding the impact of noise on migratory fish species. Salmon are considered to have relatively low sensitivity to sound and given the impact to other fish species is considered to be relatively low (including hearing specialist species such as herring and European eel) it is unlikely that any impacts will occur to salmon other than behavioural reactions as they approach the turbines. However, salmon are unlikely to hear the turbines until they are very close to them as the noise generated by the turbines is very localised (see Kongsberg, 2012). Being hearing generalists salmon would not hear the noise generated by the array until they were less than 1m from the closest turbine.

13.217 The most sensitive fish species is considered for the assessment of this impact. Herring and cod are considered to be the most sensitive to noise (Table 13.10) and therefore the receptor is considered to be of high sensitivity. The magnitude of the impact is considered to be negligible due to the noise not resulting in mortality or injury and the range at which behavioural reactions could be observed being only a few meters. There is uncertainty in the reaction of fish to the noise generated by the turbines however fish are only likely to be exposed to noise while they pass close to the array. Therefore, the impact is highly unlikely to occur given the small proportion of the Inner Sound and the fish population ranges the Project covers.

[4] A 36 turbine array of 2.4MW turbines has been used in the assessment as it produces greater noise than an array of 86 turbines of 1MW rated power

13.218 The most sensitive receptor (hearing specialist fish) are used to undertake the assessment using a precautionary approach and as a result the sensitivity of the receptor is considered to be high. However, as the noise levels are relatively low, unlikely to cause injury or mortality and the ranges for behavioural reactions are very small, any impacts are likely to be imperceptible. Therefore, the impact magnitude is considered to be negligible. Hearing generalist fish (e.g. Atlantic salmon) are likely to experience an impact of lesser significance.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
High	Negligible	Minor	Not Significant

MITIGATION IN RELATION TO IMPACT 13.14
▪ Although no significant impact has been identified, mitigation measures have been provided on a precautionary approach to ensure this remains the case. ▪ Where possible the use of soft start (gradual ramping up) of operations that will emit noise into the Project area will be used. ▪ MeyGen accepts that there is some uncertainty over the noise generated during drilling and turbine operation and as a result commits to conducting noise monitoring for the initial turbines installed and candidate turbine technology to validate the noise modelling.

13.7.4 Impact 13.15: Electromagnetic fields (EMF)

13.219 Ambient electric (E) and magnetic (B) fields detected within the marine environment are generated by both natural and anthropogenic sources. The predominant naturally occurring EMF in the marine environment is from the earth's geomagnetic field, however, E-fields can also be naturally emitted as a result of biochemical, physiological and/or neurological process within an organism, known as bioelectric fields (Gill & Bartlett, 2010). Anthropogenic sources of EMF include those from subsea power cables.

13.220 Power cables, such as those used to export electricity generated from tidal arrays, produce E- and B-fields when current passes through them. The B-field is detectable outside of the cable structure and this in turn creates a further induced E field (iE). Studies have shown that EMF radiate beyond the cable into both seawater and the seabed. However, the field emitted by the cables are limited spatially and the field decays rapidly with horizontal and vertical distance from the cables (Normandeau *et al*., 2011). Figure 13.5 is a simplified overview of the fields associated with industry-standard submarine cables, highlighting the magnetic and induced electrical fields that are of interest for fish species.

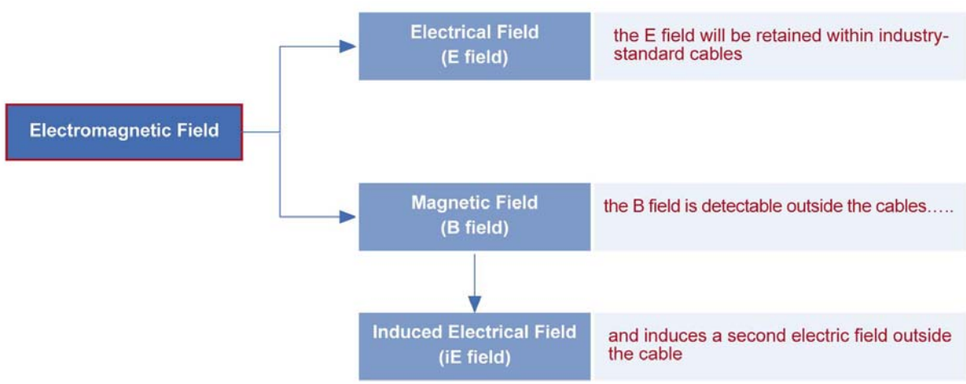

Figure 13.5: Overview of the fields associated with subsea power cables (Gill *et al*., 2005).

13.221 A number of fish species found in Scottish waters are known to be able to detect electric and magnetic fields and thus will be able to detect EMF emitted from subsea power cables. Elasmobranch species are the main group of organisms which are known to be able to detect E-fields. They possess specialised electroreceptor pores in their skin from which they detect bioelectric emissions from prey, conspecifics[5] and potential predators/competitors. Other fish species, including migratory species, that are electrosensitive do not possess specialised electroreceptors but are able to detect induced voltage gradients associated with water movements and geomagnetic emissions. These include European eel, cod, plaice and Atlantic salmon, which all have the potential to be present in the Project area (Gill *et al*., 2005). Fish species that are able to detect magnetic fields include all species able to detect induced electrical fields, and those able to detect magnetite. In addition to those species already listed, sea trout and mackerel are also capable of detecting B-fields. However, in general, open water species of fish, including salmonids, are not considered to be as reliant of this sense and are therefore considered to be significantly less sensitive than elasmobranchs to EMF (Faber Maunsell, 2007).

13.222 The University of Liverpool Centre for Marine and Coastal Studies (CMACS) and Cranfield University have undertaken studies, largely funded through COWRIE, (although recently a report was commissioned by SNH) to investigate EMF emission from typical offshore subsea cables, in the context of the E- and B-fields (e.g. CMACS, 2003, Gill *et al*., 2005; 2009; Gill & Bartlett, 2010). These studies have largely been driven by the need to consider the effects of EMF resulting from offshore wind farm subsea cabling.

13.223 During the course of the above detailed research, desk-based, laboratory and field studies have been undertaken. However, it is still generally considered that the current state of knowledge regarding the EMF emitted from subsea power cables is too variable and inconclusive to make an informed assessment of any possible environmental impact of EMF.

13.224 The first report of the COWRIE EMF study (CMACS, 2003) based on offshore wind developments made the following findings:

- There is no direct generation of an E-field outside of the cable;
- B-fields generated by the cable created induced E-fields (iE) outside of the cable, irrespective of shielding;
- B-fields are present in close proximity to the cable and the sediment type in which a cable is buried has no effect on the magnitude of B-field generated;
- The magnitude of the B-field on the 'skin' of the cable (i.e. within millimetres) is approximately 1.6μT which will be superimposed on any other B-fields (e.g. Earth's geomagnetic field); and
- The magnitude of the B-field associated with the cable fall to background levels within 20m.

13.225 Considering the results of the modelling undertaken as part of the research, in respect of significance to electro-sensitive fish, the report found the following:

- EMF emitted by a industry standard subsea cable will induce E-fields;
- Cables will emit approximately 91μV/m at the seabed adjacent to a cable buried to 1m. This level of E-field is on the boundary of E-field emissions that are expected to attract and those that repel elasmobranchs;
- The iE-fields calculated from the B-field were also within range of detection by elasmobranchs;
- Changing the permeability or conductivity of the cable may effectively reduce the magnitude of the iE-field;

[5] Belonging to the same species

- To reduce the iE-field that is below the level of detection of elasmobranchs will require a material of very high permeability, hence any reduction in E-field emission would minimise the potential for an avoidance reaction by a fish if it encountered the field but may still result in an attraction response; and

- The relationship between the amount of cabling present, producing iE-fields and the available habitat of electro-sensitive species is an important consideration.

13.226 In addition to this, further research funded by COWRIE conducted by Gill *et al*. (2009) in which the impact of controlled EMF within mesocosm (with the magnitude and characteristics associated with offshore wind farm) on electro-sensitive fish was conducted. From which the following was found:

- There is evidence that benthic elasmobranch species studied did respond to the presence of EMF emitted by a subsea cable. The responses were, however, variable within a species and also during times of cable switch on and off, day and night;

- The overall spatial distribution of fish was non-random, and dogfish were more likely to be found within the zone of EMF emission during times when the cable was switched on; and

- There did not appear to be any differences in the fish response by day or night or over time.

13.227 Gill and Bartlett (2010) were commissioned by SNH to review the current state of knowledge with regard for the potential for Atlantic salmon, European eel and sea trout to be affected by marine energy developments, focusing on an understanding of EMFs (as well as noise), on behaviour of the three species. The main findings of the report in relation to EMF were:

- Atlantic salmon and European eel can use the earths magnetic field for orientation and direction during migrations. Juvenile sea trout respond to both the earths magnetic field and artificial magnetic fields;

- Current knowledge suggests that EMFs from subsea cables and cabling orientation may interact with migrating eels (and possibly salmonids) if their migration or movement routes take them over the cables, particularly in shallow waters (<20m). The effect if any could be a relatively trivial temporary change in swimming direction, or potentially a more serious avoidance response or delay to migration. Where this will represent a biologically significant effect cannot yet be determined;

- All three species are likely to encounter EMF from subsea cables either during adult movement phases of their life or their early life stages during migration within shallow, coastal waters adjacent to the natal rivers; and

- The review identified no clear evidence that either attraction or repulsion due to anthropogenic EMF will have an effect on any of three fish species identified in the report.

13.228 A recent report produced for the Department of the Interior in the US (Normandeau *et al*., 2011) provides a comprehensive review of studies to date on potential effects of EMF on marine fauna. The report modelled the expected EMF's from a range of power cables and reviewed the available information on sensitive marine species. The report drew the following conclusions:

- The field is strongest directly over the cable and decreases rapidly with horizontal and vertical distance from the cable;

- The cable magnetic field is perpendicular to the direction of the cable. A water current or organism moving parallel to the cable magnetic field will not generate an induced electric field. Orientation of the cables relative to the flow of water and migration routes can reduce the potential impacts;

- Marine species are more likely to react to the magnetic fields of DC cables than AC cables. DC cables were found to have a greater impact as they can influence the intensity of the local geometric field;

- The risk of interference only exists in the areas surrounding the cables where sensory capabilities overlap with the cable EMF; and

- Magnetic fields can be minimised by placing the cables close together, allowing the field vectors to cancel each other out.

13.229 At a worst case the cabling for the array will include 1.3km of subsea cabling from the devices to the subsea boreholes which cover a maximum of be 0.013km^2 or 0.07% of the Inner Sound. The cables are designed with a screen that completely surrounds the conductor, resulting in the E-field being present between the conductor and the screen therefore the E-field outside the cable will be zero.

13.230 The magnetic field from the cables will be well below that of the Earths magnetic field which is between 30 and 70μT and may not be detectable by the fish species that are present in the area as they move across the cables. It is not known to what extent the exact magnitude of the iE-field emissions will be from the cables used for the array but it is considered likely to be low. This implies that the iE-field would be lower than the range that could either attract or repel electrosensitive fish species (Gill *et al*., 2009). There is currently no clear evidence to suggest that either attraction or repulsion will have a detrimental impact on elasmobranch or salmonid species.

13.231 The direction of the field will also influence the potential impact on sensitive species. As indicated by Normandeau *et al*., (2011) the cable magnetic field is perpendicular to the direction of the cable and an organism moving parallel to the cable magnetic field will not generate an induced electric field. Given that the cables will be laid across the flow and many fish species (particularly salmon) will move with the flow through the Inner Sound the impact from the iE-field will be reduced. For other species that are not migrating through the area this will mean that impacts will only occur when fish are orientated in the same direction as the cables. Based on 1,300m of cable along the seabed (and 700m of cable beneath the seabed in boreholes) the cables cover 0.07% of the Inner Sound seabed the potential for this to occur is considered low. In addition the use of AC cables rather than DC cables also has the potential to reduce the impacts (Normandeau *et al*., 2011).

13.232 During periods of slack water, low tidal velocities and high tidal velocities when the turbines are not generating (27% of the time) electricity the cables will not produce any iE-fields as power will not be travelling through them. Thus, there will be periods when no electricity is being produced and any fish passing over the cables will not be exposed to EMF. During periods of the highest tidal velocities when magnetic fields are at their highest there is the potential that fish will be moving passively with the tidal flows and will be exposed to the cables for a much shorter period. Many species may avoid the area at the highest flows and will therefore not come into contact with the cables and their associated field during periods when the field is at its highest.

13.233 There are insufficient data available with which a judgement can be made about the potential for EMF to impact on a particular species. However it is considered that the effects will be influenced to some extent by their habitat preferences. Bottom dwellers such as skates, rays and dogfish use electroreception as their main sense for food detection. More open water species such as tope and mako, may encounter EMF near the seabed but will spend a significant amount of time in the water column hunting. As a result the potential for impact is considered to be highest for species that depend on electroreception to detect benthic prey (CMACS, 2005).

13.234 The Inner Sound is potentially inhabited by a number of benthic elasmobranch species of national and international conservation concern, in addition other potentially sensitive fish species including salmonids may use the Inner Sound during their migration through the Pentland Firth which are also of national and international conservation concern. However, the fact that the maximum iE-field is likely to be less than the earth's magnetic field, the field strength will vary with the tidal phase, fish will potentially travel parallel to the field, and the small area of the Inner Sound occupied by the cables would suggest the potential for any negative impacts on magnetically or electrically sensitive species as a result of EMF would be low.

13.235 Elasmobranchs are considered the most sensitive species to this impact and are therefore taken forward as the receptor for this particular impact. Therefore, sensitivity is considered to be high.

13.236 Based on the small proportion of the Inner Sound covered by cables, the very low levels of EMF produced by the cable, the orientation of the field with the direction of water flow and that the iE-field is likely to be significantly lower than that of the earth's magnetic field the magnitude of the impact is considered to be minor. Impacts are not expected to result in noticeable changes in the fish populations in the vicinity of the Project.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
High	Minor	Moderate	Significant

MITIGATION IN RELATION TO IMPACT 13.15

- Where cables are not within boreholes they will be laid where possible within natural crevices and cracks within the seabed ensuring that the majority of the cable is below the seabed.
- The length of the drilled boreholes for the cable will be (as far as technically and commercially possible) to increase the length of cable under the seabed.
- Cables will be bundled into groups of 3 minimising the magnetic field by placing the cables close together, allowing the field vectors to cancel each other out.
- In addition ongoing research by Marine Scotland and their advisors which will be monitored for further indications of successful mitigation strategies.

Residual impacts

13.237 Increasing the length of cable that would be beneath the seabed would be greatly reduce the impact of the magnetic fields by further shielding and field produced by the cables. Placing the cables within natural crevices and within cracks in the seabed will also reduce the potential for exposure to fish species. Bundling of the cables will ensure the field vectors cancel each other out further reducing the field that fish species will be exposed to. With all these measures implemented the potential for fish to be exposed to EMF is further reduced so that the impact magnitude is reduced to negligible. This is because any changes will be imperceptible.

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
High	Negligible	Minor	Not Significant

13.7.5 Impact 13.16: Barriers to movement

13.238 Tidal array developments have the potential to form a barrier to usual migration and transit patterns of marine, elasmobranch and anadromous fish species. The array has the potential to act as a barrier due to physical presence, aversive reactions to underwater noise, EMF or perceptions of devices and associated infrastructure. This impact is particularly pertinent in more constrained environments, such as mouths of sea lochs or in narrow sounds.

13.239 A barrier effect is most likely to be perceived by mobile fish species which frequently transit through the Project area. As outlined above although there is no direct data to confirm, as a precautionary approach it is assumed that Atlantic salmon, sea trout and European eel do pass through the Inner Sound during their migrations. Sea trout may pass through the array itself but evidence from Norway suggests that they tend to use the top 6m of the water column and make occasional dives to deeper water (Malcolm *et al*., 2010). However, there is still some uncertainty over whether this behaviour occurs in Scottish waters. There are no marine fish or elasmobranch species which are known to use the Inner Sound during specific migrations, although marine and elasmobranch species do exhibit migratory behaviour between spawning and nursery grounds. Some fish species are considered to inhabit this particular stretch of water as juveniles (nursery grounds) and may migrate away from the waters when they migrate to join the adult population.

13.240 A maximum of 86 turbines will be located in water that is deeper than 31.5 m. At a worst case the minimum clearance from the blade tip to the sea surface will be 8m. The 86 turbines are likely to be positioned in nine rows from 5 to 11 wide (Figure 5.6, Section 5). Table 13.13 provides the width in metres that each row could potentially occupy as a physical barrier to the movement of fish in relation to the width of the Inner Sound at that point.

Turbine row	Number of turbines	Width of row (m)[1]	Width of the Inner Sound at that point (m)	% of the width of the Inner Sound influenced by the Project
1: Most western	5	194	3,201	6.06
2	7	289	3,112	9.29
3	8	336	3,078	10.92
4	11	480	3,020	15.89
5	11	480	3,100	15.48
6	11	480	3,158	15.53
7	11	480	3,091	15.53
8	11	482	3,098	15.56
9: Most eastern	11	482	3,031	15.90
Notes:[1] The total width between northern and southern turbine.				

Table 13.13: Linear distances of the Inner Sound between Caithness and Stroma that is occupied by each row of the turbine array

13.241 The maximum width of the Inner Sound that will be taken up by the array is 482m which occurs on the two most eastern rows. This equates to a maximum of 6.89% of the narrowest point of the Pentland Firth (7km wide at its narrowest point) where a physical barrier to movement is present. Therefore at a minimum 93.1% of the Pentland Firth will not be acting as a physical barrier to fish species.

13.242 If a cross section is taken through the Pentland Firth and the swept area of the turbines at their widest point is used, we can calculate the area of the water column occupied by the turbines. If we consider that the first and second rows are staggered behind each other in order to ensure the wake from the turbine in front does not affect the turbine behind it, the first two rows can be considered a single row. Therefore, the swept area of 22 turbines is 0.007km^2. At the same point the Inner Sound, based on the width of each of the depth contours the cross section of the Pentland Firth is 0.33km^2. Therefore the area available for fish to migrate through without the turbines present is more than 98% of the Pentland Firth.

13.243 However, there is the potential that the noise generated by the turbines may add an additional barrier to that already presented by the physical presence of the turbines, extending the barrier a further 63m (the mild avoidance threshold from Kongsberg (2012)) from the turbine blades at the edge of the array and to the water surface above the array. For 86 turbines of 1MW the mild avoidance criteria distance is 63m. If this distance is added to each of the ends of the widest row the array takes up 608m or 9.2% of the Pentland Firth in terms of the width.

13.244 On a cross sectional basis the barrier effect is less. Using the maximum depth of the turbine deployment area of 38m and adding the additional area of the noise form the tips of the most northerly and southerly turbines to the width of the array the cross sectional area of the potential barrier is 0.023km^2. This represents approximately 7.0% of the Pentland Firth cross section. Therefore 93% of the Pentland Firth is still available for fish to swim through without experiencing a barrier effect.

13.245 The most sensitive species to the barrier effect are those that migrate through the Pentland Firth and it is not anticipated that the array will be perceived by these species as a barrier. If this assumption were to prove to be incorrect, the array will occupy only a small fraction of the potential area of the Inner Sound, leaving the majority of the Inner Sound and wider Pentland Firth available for migration.

13.246 It is not known whether salmon smolts use the Inner Sound exclusively during their migrations to feeding grounds at sea and it is thought the Pentland Firth as a whole will be utilised by the east coast population. As the Inner Sound only represents a small proportion of the total area of the Pentland Firth there is the potential that a only a small proportion of the smolt population migrates through the Project area. There is some evidence from Norway to suggest that smolts will utilise the top part of the water column and will move quickly through the Inner Sound reducing the likelihood that they will encounter the array and experience a barrier effect although there is no evidence to say that the Scottish population shows similar behaviour. In addition, in areas of strong currents there is evidence that they will tend to stay close to the coast rather than move into the stronger currents and so may well avoid the area completely as they move through the Inner Sound.

13.247 Adult salmon returning to their natal rivers may also experience barrier effects but they are also likely to use the entire Pentland Firth and not just the Inner Sound. Adult eels are also likely to use the entire Pentland Firth during their migrations and being hearing specialists they have a much larger range at which behavioural reactions to the noise of the turbines will occur. However, it is not understood how fish species will react to the turbine noise. Again as the Inner Sound only represents a small proportion of the total area of the Pentland Firth there is the potential that only a small proportion of the population migrates through the Project area, with the remainder using the wider Pentland Firth. Therefore, there is the potential for the majority of the population to avoid the array and use the remaining accessible space to complete their migrations. In addition, the barrier effect will only present itself when the turbines are operational. For 58.1% of the time the turbines are getting up to speed and will only rotate at the rated speed for 14.6% of the time, so are turning for 73% of the time. Therefore, for the remaining 27% of the time the turbines are not rotating and do not present a barrier to movement.

13.248 In order to assess the impacts from barrier effects the most sensitive species are considered as the receptor, i.e. migratory fish species that use the Pentland Firth during their migrations to and from feeding and / or breeding grounds. Of these species the European eel is probably the most sensitive due to its sensitivity to noise. Therefore the sensitivity of the receptor is considered to be very high due to the eel being protected under Annex II of the Habitats Directive. As an impact is considered to be highly unlikely to occur the magnitude is considered to be negligible.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Very high	Negligible	Minor	Not Significant

MITIGATION IN RELATION TO IMPACT 13.16
▪ No mitigation measures proposed as no significant impact predicted.

13.7.6 Impact 13.17: Collision with turbines

13.249 Collision with rotating turbines is considered to be a key potential effect during device operation (Faber Maunsell, 2007). A collision here is understood to be an interaction with a fish and a marine renewable energy device that may result in physical injury, however slight. Due to the low number of active devices and lack of established commercial-scale deployments, data derived from monitoring programmes to directly quantify encounters with turbines, whether collisions occur and the proportion of near-misses are not yet available. This section examines encounter rate (but will refer to collision risk studies where relevant) as it is not clear at this stage whether a collision will occur. An encounter may lead to a collision, but only if the animal in question is not able to take appropriate avoidance or evasive reaction. Many species that occupy the same part of the water column as the turbines are predatory and/or preyed upon; therefore they are manoeuvrable and aware of their environment.

13.250 Each device will have a minimum clearance of 4.5m from the seabed and therefore it is expected that demersal and benthic species will pass under the device without encountering the device. In addition the turbines will have a minimum clearance of 8m from the sea surface, and as such species such as basking shark, are likely to pass over the structures when they are positioned close to the surface within the water column. As a result it is generally considered that pelagic and bentho-pelagic fish will be the most likely to be at risk of collisions with devices as their diurnal vertical migration behaviours forces them to occupy all depths of the water column at some time during the day or night (Faber Maunsell, 2007). The Project area is potentially utilised by a number of pelagic and bentho-pelagic species of International conservation importance: Atlantic salmon, sea trout, European eel, spurdog, tope, shortfin mako and cod.

13.251 To support the Scottish Marine Renewables SEA, Wilson *et al*. (2007) were commissioned to investigate collision risk[6] between marine renewable energy devices and fish. The study identified the following:

- Collision risks are not well understood for any marine vertebrates;
- Man-made collision risks are more diverse and common than generally supposed;
- Underwater collision risks typically become well studied after they have become a conservation concern;
- Animals appear to behave illogically when faced with novel situations;
- Subtleties of device design (e.g. shape, colour) as well as environmental conditions (e.g. turbidity, flow rate) can markedly change collision rates;
- Objects in the water column will naturally attract fish and their predators;
- Stationary objects in flowing water can herd fish upstream until they become exhausted limiting their behavioural options;
- The proximity and relative orientation to other objects will impact escape options and the combined collision risk while topography will impact escape options and animal approach angles;
- Collision risk will vary with age of organism, with juveniles likely to be more at risk than adults because of reduced abilities or experience;
- The potential for animals to escape collisions with marine renewable energy devices will depend on their body size, social behaviour (e.g. schooling), foraging tactics, curiosity, habitat use, underwater agility and sensory capabilities; and
- A variety of warning devices and renewable device adaptations have been developed for fish recognition of underwater collision issues.

13.252 In addition to this study, ABPmer (2010) were commissioned by the Marine Renewable Energy Strategic Framework for Wales (MRESF) to produce a report that would provide further evaluation of the fish collision risk with wave and tidal stream energy devices. The key conclusions of the study were that:

- There is a general lack of information on relevant characteristics of devices that might inform the evaluation of collision risk. Where data are available, it relates to a single prototype device and there is little, if any, information available on the environmental characteristics of devices and arrays of devices in particular;
- The opportunity for fish to engage in long range avoidance is likely to be a function of the source levels of underwater noise associated with devices, background noise levels and the particular hearing sensitivities of different fish species. For hearing sensitive fish (e.g. herring) analysis suggests that they maybe able to detect and avoid individual operational tidal stream devices at distances between 120 and 300m (depending on the depth of water) even when background noise levels are comparatively high. However, for hearing insensitive fish, the projected source noise

[6] Collision risk is the risk or probability that a collision with a turbine occurs. This differs from encounter rate in that it estimates that probability that the turbine blade and an object will come into physical contact resulting in injury or mortality.

levels of tidal devices are unlikely to be below levels at which these species might exhibit an avoidance reaction;

- The extent to which fish might exhibit close range evasion of tidal stream devices is a function of the visibility of the devices, details of device structure and operation, the visual acuity and maximum swimming speeds of different species of fish and near-field behavioural responses. There are no published direct observational studies on the near-field interaction of fish with tidal stream devices and it remains unclear how fish might respond on encountering such devices; and

- The extent of damage to fish associated with collision with a tidal stream device is largely a function of the characteristics of the device. The position of the device in the water column is also important in governing the exposure of fish to collision risk.

13.253 ABPmer (2010) presented risk matrices (Table 13.14) to provide a broad evaluation on the contribution of the three main factors; long range avoidance, close range evasion and potential physiological damage cause by collision with different types of wet renewable devices. Based on these risk matrices diadromous fish (such as Atlantic salmon) are at medium to high risk of physiological damage, as a result of a collision with a horizontal axis turbine. However, the ability of diadromous fish to evade devices at long distance were assessed as low to high (depending on hearing capabilities). Because Atlantic salmon are considered hearing generalists (Fay and Popper, 1997) their ability to avoid devices at long distances is considered to be medium. The ability to avoid turbines at close range was assessed as medium to high for diadromous fish such that they should be able to evade the device from between 20 and 50m and are unlikely to get very close to a turbine.

Factor	Pelagic bony		Pelagic elasmo-branch	Demersal elasmobr-anch	Demersal bony		Diadromous			Confidence
Hearing sensitivity[1]	High	Medium	Low	Low	Medium	Low	High	Medium	Low	-
Ability to avoid device at long distances	High	Very low	Very low	Very low	High	Very low	High	Low	Very low	Low
Ability to evade device at close range	Medium – high		Medium-low	No pathway	Medium-high		Medium – high			Low
Potential physiological damage	Medium – high		Medium – high	No pathway	Medium – high		Medium – high			Low
Ability to avoid device at long distances	High: Exhibit signs of avoidance at distances > 50m from device Medium: Exhibit signs of avoidance at distances > 20m from device Low: Exhibit signs of avoidance at distances > 10m from device Very low: Likely to exhibit signs of avoidance at distances <10m from device									
Ability to evade device at close range	High: Most fish should easily be able exhibit an evasion response with very few strikes predicted Medium: Most fish should easily be able to exhibit an evasion response although some strikes are possible Low: Some fish will have difficulty evading the device with strikes possible. No pathway: No pathway as an evasion response is not required.									
Potential physiological damage	High: High risk of physiological damage and/or mortality to many individuals Medium: Moderate risk of physiological damage to some individuals Low: Low risk of physiological damage.									
Note: [1]The different types of hearing sensitivity only apply to the 'ability to avoid a device at long distances'. The range of hearing sensitive fish categories that were considered by APBmer (2010) reflect the availability of audiogram and/or hearing threshold information which could be applied to the matrix.										

Table 13.14: Risk matrices for a single horizontal axis turbine for differing fish groups; derived by ABPmer (2010)

13.254 Wilson *et al*. (2007) modelled potential encounter rates for a horizontal axis turbine array (100 x 8m radius turbines) for herring, as an example species, off the Scottish coast. The model incorporated a number of assumptions about the vertical distribution of herring, their swimming speeds and distribution. The model also assumed that the fish were neither attracted to nor avoided the immediate area around the turbine (i.e. did not actively avoid or be attracted to the turbines). While these assumptions could be refined further, the intention of the model was to derive an estimate for the number of potential physical encounters between rotors and animals. The model predicted that in a year of operation 2% of the herring population would encounter the rotor blades. It is important to emphasise that encounters are not collisions and that the encounter rate provides an indication of the proportion of the population that could occupy the same space as the turbines. It is also worth noting that the model used by Wilson *et al*. (2007) did not allow for laminar flow effects which may carry smaller animals (such as salmon smolts) around the rotors, thus minimising the potential for and encounter with a turbine to occur. Up to rated power the flow around the turbines will be laminar. Post rated power the blades will be deliberately stalled to shed power.

13.255 In the case of salmon the Inner Sound only represents a small proportion of the total area of the Pentland Firth. Therefore, there is the potential that only a small proportion of the east and north coast smolt and adult population migrates through the Project area, reducing the potential for encounters with the turbine to occur. In addition there is some evidence from Norway to suggest that smolts will use the top part of the water column and so may not come into contact with the array unless they undertake dives to deeper water to feed. Given that in areas of strong currents there is evidence that smolts will tend to stay close to the coast rather than move into the stronger currents (Malcolm *et al*., 2010) this further reduces the possibility of encountering the Project. As discussed above there is the potential that noise emitted by an array or turbine may provide fish with early warning of the turbines location so that they can avoid it. Despite the noise from the turbines being relatively low and salmonids only being able to detect it less than 1m from the array there remains the potential they could evade a turbine further reducing the potential for an encounter.

13.256 In order to assess the potential impact of encounter rates on fish Xodus (2012) undertook an encounter study to estimate the proportions of fish encountering the turbines. The migrations of salmon take them though the Pentland Firth and the turbine deployment area of the Project and this 'pinch point' makes them the worst case from a modelling perspective. Many other species will have a much wider distribution and the entire regional population will not pass through the same point all at once. As a result salmon are taken to be the most sensitive species to this impact and impacts are addressed in the context of this species. Other migratory fish that pass through the Pentland Firth are considered to be as sensitive as salmon but due to less data being available the study focused on salmon. Other marine fish species are considered to be less sensitive or equally as sensitive depending on their ecology in comparison to salmon and are assessed based on the results of the study on salmon.

13.257 In order to provide an estimate of the probability of either a smolt (a young salmon migrating to feeding grounds from their home river) or adult salmon; adult salmon were separated into 1SW (one sea winter or grilse salmon) and MSW (multi-sea winter salmon) categories based on the differences in these two groups life history strategies[7].

13.258 A number of steps were undertaken to estimate the probability of a salmon (smolt, 1SW and MSW) encountering the array as they migrate through the Pentland Firth:

- Calculate the proportion of the salmon population that passes through the Pentland Firth (estimated as 90% based on anecdotal evidence on poaching of salmon from Orkney (J. Godfrey pers. comm., 2011), small salmon runs in the lochs of Orkney (Headley, 2012) and occasional catches of salmon in Shetland;

- Calculate the area, in cross section, of the Pentland Firth occupied by the tidal array. The swept area of a single row of 11 turbines is 0.0035km^2 which covers 1.04% of the Pentland Firth. However, the turbine rows are staggered in order to ensure the wake from the turbine in front does

[7] One sea winter salmon will only spend one winter at sea before retuning to spawn whereas multi-sea winter salmon will spend between 2 and 5 winters at sea before returning to spawn and they can vary greatly in size, which has the potential to affect the probability that they will encounter the turbines.

not affect the performance of the turbine behind. As a result the first two rows of 11 turbines cover 2.08% of the Pentland Firth. Taking a precautionary principle this is considered to represent the cross sectional area of the Pentland Firth the array covers and the probability that the tidal array will be encountered;

- Establish the probability that the turbines are operational. For 58.1% of the time the turbines are getting up to speed and will only rotate at the rated speed for 14.6% of the time. Therefore, in total the turbines will be turning for 72.7% of the time; and

- Establish the potential salmon encounter rate with turbines using the model developed by Band (2000) and Band *et al*., (2007) for birds encountering wind turbines using the same principle that an object of *x* width and *y* length will encounter a rotor of *z* diameter rotating at a known speed.

13.259 Each step is combined to estimate the probability of a potential turbine encounter experienced by each component of the salmon population migrating through the Pentland Firth both as adults and smolts. These data are then applied to population estimates of smolt and adult populations derived from data provided by Marine Scotland (G. Smith, pers. comm., 2011) and ICES (2011).

13.260 Due to a lack of data in relation to salmon ecology a number of assumptions were made in undertaking the study. In most instances a precautionary assumption was made in order to provide a worst case estimate of the probability of an encounter taking place. The overriding assumptions made in undertaking the study were:

- Salmon smolts from the east coast of Scotland migrate along the east coast and then through the Pentland Firth. A small proportion (around 10%) migrate through the Orkney Islands and the Fair Isle Channel; and

- There is some movement by adults east and west along the north coast and so some adult salmon returning to the north coast may also pass through the Pentland Firth.

Encounter model

13.261 In order to provide an estimate of the probability of an encounter for a fish moving through the turbine blades the model for bird encounters with wind turbines developed by Band (2000) and Band *et al*., (2007) was utilised by Xodus (2012). During consultation with Marine Scotland and SNH the Band model was recommended as a potential model to estimate encounter rate for salmon as the principles underlying the model for birds travelling through the air are applicable to fish moving through the water column.

13.262 The model considers that birds use a linear passage through an area (with flow/against flow) as they fly through wind turbines. A similar process is assumed for salmon moving through water that is occupied by tidal turbines. The Band model is a well established model within the wind farm industry and has been peer reviewed on a number of occasions.

13.263 The model uses physical details on the size and speed of a bird, to compute encounter rates for a bird flying through a rotating rotor. A similar principle is assumed for salmon, in that the physical dimensions and swimming speed of a salmon are used instead of those of a bird and the wind turbine dimensions are replaced by those of a tidal turbine.

13.264 In the Band model (Band (2000) and Band *et al*. (2007)) a bird is simplified in shape to a flying cross with length, wingspan, and speed, and is assumed to be always flying perpendicularly towards the rotor. The same is assumed for a salmon but wing span is replaced by width of the salmon.

Model inputs

13.265 The process uses input parameters on the number of blades on the turbine, the rotation speed of the blades, the width of the blade and the pitch of the blade. In providing the inputs for the model the data used was provided by the worst case scenario developed under the principles of the Rochdale Envelope (Table 13.1).

13.266 Rotor blades are assumed to be laminar (i.e. with zero blade thickness) but they have length (20m diameter, 10m radius), a chord width (2.3m) which varies along the length of the blade tapering towards the tip, and a pitch angle (the angle between the blade and the rotor plane of 10°) which also varies along the length of the blade.

13.267 Based on the evidence that smolts are likely to travel passively with the tide (A. F. Youngson, pers. comm., 2012) a mean tidal current speed of $2.5ms^{-1}$ has been assumed as the speed at which smolts will travel through the area of the turbines. For adults that move with the tide as they return to their natal rivers the same average tidal speed has been assumed. For adults this is likely to be precautionary as they are most likely to travel at speeds above that of the tidal current (Hawkins *et al*., 1979).

13.268 The input parameters on the size of the object that passes through the rotor are considered within the original Band model as bird length and wingspan. These parameters now become the length and width of a salmon. In order to gain an estimate of the width of a salmon girth data is used, assuming that a fish is a circle in cross section. Equations developed to estimate the weight of a fish from its length and girth are rearranged to allow the girth of a fish to be estimated from length and weight data. The equation used is:

$$G = \sqrt{800W/L}$$

13.269 where *G* is the girth of a salmon, *W* is the weight in pounds and *L* is the length in inches. The measurements are then converted to cm. Data on the length and weight of one sea winter (1SW) and multiple sea winter (MSW) fish were then taken from data provided by Marine Scotland (2011b). These data were also used to estimate the girth and width of fish, so that an average width and length of 1SW and MSW fish could be used within the model. A 1SW fish has an average length of 67cm with a width of 12 cm and a MSW fish has an average length of 79cm and a width of 14cm based on the data from Marine Scotland (2011b). The length of a smolt was considered to be maximum of 15cm (R. Gardiner, pers.comm., 2012). A fish of this size is assumed to have a width of 2cm.

Population estimates for adult salmon and smolts

13.270 In order to provide some context to the probabilities estimated by the encounter study population data for smolts and 1SW and MSW salmon were required. These data, once applied to the probability of encounter would allow the implications of the encounters to be understood at a population level and whether impacts to the population would be significant or not. Data on salmon in Scotland are not readily available. Data that was available has been applied to the east coast population to allow an estimate of the numbers passing through the Pentland Firth to be estimated.

13.271 In order to estimate the population size of smolts data on the number of smolts form the North Esk was used as it is the only data set available on smolt population size. An estimate of the number of smolts per m^2 could then be estimated based on the wetted area[8] of the North Esk. This density was then used as an estimate of smolt density for all rivers on the east and north coast of Scotland so that a population size of smolts could be estimated. Based on the number of smolts between 2005 and 2009 in the North Esk and the wetted area of river catchments on the east coast of Scotland the number of salmon smolts migrating through the Pentland Firth was calculated. Making the assumption that all east coast river smolts and a proportion from north coast rivers migrate through the Pentland Firth (a precautionary 50%) and using the 2.5%ile of the 'wetted area' a total of 8,342,569 fish was estimated. Data were provided by the Marine Scotland Freshwater Laboratory and represents the best available data on smolt populations in Scotland (G. Smith pers. comm., 2011).

13.272 For adults ICES publish estimates of 1SW and MSW salmon for Scotland on an annual basis. In order to calculate the population of adults passing through the area data form ICES (2011) was taken for 1SW and MSW adult salmon. To provide an east coast estimate the total catches of 1SW and MSW for the north,

[8] The area of the river that is suitable habitat for salmon. The estimate has been made using Monte Carlo re-sampling of habitat availability estimates and the 2.5%ile represents the lowest estimate.

east and west coasts were examined to provide a proportion of the population that migrate to each coast (data provided Marine Scotland Freshwater Science, G. Smith, pers. comm., 2011). Based on these catches 88% of the population is assumed to migrate to east coast rivers. This was used to estimate the east coast populations of 1SW and MSW adult salmon as it represented a higher than expected proportion and was considered precautionary. Using these data 272,188 1SW and 202,969 MSW salmon migrate through the Pentland Firth.

Encounter probability and population effects on salmon

13.273 The first step in analysing the encounter rate for salmon was to understand the probability of an encounter with the array taking place. This combined each of the probabilities outlined above to provide an overall probability of encounter. These probabilities were then applied to the estimated numbers of smolts, 1SW and MSW salmon to put them into the context of population level effects. Avoidance rates are then applied to account for the ability of adult salmon to actively avoid the turbines and the likelihood that smaller smolts may get swept around the blades.

13.274 The Band model estimated the probability of an encounter occurring between a smolt based on the size of the smolt and the worst case turbine parameters as 0.120. For adult salmon the encounter rate was estimated as 0.282 for 1SW adults and 0.330 for MSW adults. Combined with the probability of travelling through the Pentland Firth (0.9), the probability of encountering the array in the Pentland Firth (0.011) and the probability of the turbines being operational (0.727) the probability of a smolt encountering the turbine was estimated as 1.63×10^{-3}. Applied to the overall population of smolts migrating through the Pentland Firth this represents approximately 13,614 fish or 0.16% of the smolt population that migrates through the Pentland Firth.

13.275 For adults the probability was estimated as 3.83×10^{-3} and 4.49×10^{-3} for 1SW and MSW adults respectively. This represented 1,044 (0.38% of the east coast population) 1SW and 911 (0.45% of the east coast population) MSW adult salmon.

13.276 With the application of avoidance rates the probability of a encounter decreases considerably. Although smolts are likely to be swept passively along by the tide they have the potential to be swept by laminar flow around the blades and may also have the ability to move up or down or side to side within the flow moving them through the Pentland Firth. In the case of adult salmon they are expected to have the capability to see, hear and feel the effect of the operating turbines before they arrive at the area where the blades are rotating. They will also have the strength to be able to avoid the array by swimming above, below or around and be able to evade the turning blades at close range and can be considered equally as capable as birds at avoiding turbine blades. Thus a range of avoidance rates from 50% to represent the passive sweeping of smolts in the laminar flow around the blades to a high avoidance rate of 99.5% used for some bird populations (Urquhart, 2010) were applied. The results of this process are shown in Table 13.155.

Avoidance rate	Probability	Smolts	1SW	MSW
50%	0.50	8.16×10^{-4}	1.92×10^{-3}	2.24×10^{-3}
75%	0.25	4.08×10^{-4}	9.59×10^{-4}	1.12×10^{-3}
80%	0.20	3.26×10^{-4}	7.67×10^{-4}	8.98×10^{-4}
90%	0.10	1.63×10^{-4}	3.83×10^{-4}	4.49×10^{-4}
95%	0.05	8.16×10^{-5}	1.92×10^{-4}	2.24×10^{-4}
96%	0.04	6.53×10^{-5}	1.53×10^{-4}	1.80×10^{-4}
99%	0.01	1.63×10^{-5}	3.83×10^{-5}	4.49×10^{-5}
99.5%	0.005	8.16×10^{-6}	1.92×10^{-5}	2.24×10^{-5}

Table 13.15: Probability of encounter at avoidance rates from 50 to 99.5%

13.277 The results show that the application of an avoidance rate for smolts reduce the probability of an encounter to between 8.16×10^{-4} for a 50% avoidance rate to 8.16×10^{-6} for a 99.5% avoidance rate. These probabilities equate to between 6,807 and 68 smolts or 0.08% to less than 0.001% of the smolt population that migrates through the Pentland Firth. For 1SW adults the probabilities range from 1.92×10^{-3} to 1.92×10^{-5} which equates to between 522 and 5 1SW salmon or 0.19% to 0.002% of the 1SW population. For MSW adults slightly higher probabilities are seen, from 2.24×10^{-3} to 2.24×10^{-5}, resulting in numbers of MSW fish of between 455 and 5 or between 0.22% and 0.002% of the MSW population.

13.278 At a population level this proportion is unlikely to have any significant population effects even if we were to assume that every encounter resulted in a physical injury, disorientation or mortality. Application of avoidance rates of between 50 and 99.5% show that population level effects are further reduced and even with a low avoidance rate of 50% are reduced to 0.1% or less of the regional population of smolts and 0.2% or less for both 1SW and MSW adults. With higher avoidance rates which are consistent with the conclusions drawn by ABPmer (2010) and the assumption that fish are equally as capable at avoiding moving objects as birds, the encounter rate is further reduced. At the assumed rate of 95% the proportion of the population of 1SW and MSW adults is less than 0.002% and smolts 0.001%.

13.279 In addition evidence may suggest smolts swim in the surface waters and that adults spend significant time in the top 10m of the water column (Malcolm *et al*., 2010). If a probability of smolts and adult salmon encountering the array based on the height they swim in the water column was applied to the model then the encounter probability and numbers of fish encountering the array would be further reduced.

13.280 The encounter study (Xodus, 2012) also included a much smaller area than may be used for migration by using the narrowest part of the Pentland Firth. However even with the precautionary approach the numbers that are estimated, even without applying avoidance criteria, are relatively small and are unlikely to affect the total numbers of fish that reach their rivers each year. It is likely that the vast majority of fish would make it back to their rivers. In addition the study did not take into account the potential that smolts and adult salmon will spend a significant proportion of their time in surface waters during their migrations based on data from Norway and Canada (Malcolm *et al*., 2010). Smolts may be found in the first 6m of the water column column (Davidson *et al.,* 2008; Plantelech Manel-La *et al*., 2009) and adults between 4 and 10m of the surface (Holm *et al*., 2005; Starlaugsson, 1995). Adults will they often dive, sometimes to depths of 280m in order to feed but the lack of food species (e.g. herring, sandeels and juvenile fish) in the Project area would suggest these dives are unlikely. Therefore, the probability of encounter may be further reduced if the depth at which smolts and adults swim is also considered. In addition, it is likely that smolts may hug the coastline on their initial migrations (Malcolm *et al*., 2010), further reducing the probability that they will encounter the turbines. Areas of high current such as the Inner Sound may also be avoided (J. Godfrey, pers. comm., 2011) so that smolts and adults may only move through the Inner Sound at slack tides when the turbines and not operational.. This will further reduce the encounter rates estimated by Xodus (2012) ensuring any population effects are minimal.

Impacts to other migratory species

13.281 In terms of the impacts to other migratory fish species it is likely that any impacts will be lesser than those experienced by salmon. For instance adult eels may also use the Pentland Firth during their migrations and being hearing specialists they have a much larger range at which behavioural avoidance of the noise of the turbines will occur (see Table 13.14). Therefore, encounters for these fish may be less likely than for salmon, if not the probabilities of an encounter will at least be similar. Therefore, there is the potential for the majority of the population to avoid the array and use the remaining accessible space to complete their migrations. Given the results of the encounter modelling above it is unlikely that a significant proportion of the eel population would be affected.

13.282 For sea trout the encounter rate will be no greater than that of salmon and is potentially reduced as there is some evidence from Norway to suggest sea trout spend most of their time in the top 6m of the water column (Malcolm *et al.,* 2010). Sea trout also dive in order to feed but the lack of prey speciesin the Inner Sound suggests this behaviour would be unlikely. These dives are relatively infrequent and given the results for salmon it is unlikely that sea trout will be affected to any greater extent.

13.283 Sea lamprey may also be affected but would not be expected to be impacted to any greater extent than sea trout and eels. The migratory habits of sea lamprey are not known but they are not expected to migrate in large numbers through the Pentland Firth in the same way as salmon. Therefore, encounter rates are expected to be much lower.

Impacts to marine fish species

13.284 For other fish species it is difficult to estimate the populations that pass through the Pentland Firth. Most of these species are highly mobile and range over most of the North Sea, Northeast Atlantic and the north coast of Scotland. Data is not available on the proportion that passes through the Project area or even the Pentland Firth. Populations that do not undergo extensive migration in the manner of salmonids and eels their much wider distribution and marine based life histories make them less susceptible to population level impacts from encounters with the turbine array.

13.285 Table 13.14 suggest that pelagic bony fish will be able to avoid the devices at close range and the hearing sensitivity of some species enables them to detect the turbine array at long range (i.e. herring). Overall their ability to evade the turbines is considered to be equally as good as salmon and if they do encounter the array they will be able to avoid it in a similar way to salmon. A similar ability to avoid the turbines is considered for demersal fish which have a similar hearing capability to salmon (medium, see Section 13.6.3). For demersal elasmobranchs the 4.5m clearance above the seabed ensures that impacts are unlikely. Pelagic elasmobranchs are considered less able to evade the turbines. However, given the low density of basking sharks (the main species of concern in this category) impacts are likely to be very low. Other pelagic elasmobranchs such as shortfin mako are highly manoeuvrable predators that chase fast moving prey and are likely to be able to take evasive action. They are also expected to be present in low numbers. As a result the impacts to other marine fish species, either due to their wide distribution, hearing capabilities, ability to evade the turbines or their low densities, are expected to be similar or lower than impacts to salmon.

Impact significance

13.286 Taking Atlantic salmon forward into the assessment their sensitivity to the impact is considered to be very high due to their migrations taking the vast majority of the east coast population through the Pentland Firth and their conservation status under Annex II of the Habitats Directive. However, based on the results suggesting that the proportion of the population affected is likely to be imperceptible among natural variation in the population the magnitude of the impact is considered to be negligible.

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Very high	Negligible	Minor	Not Significant

MITIGATION IN RELATION TO IMPACT 13.17

- Although no significant impact has been identified, mitigation measures have been provided on a precautionary approach to ensure this remains the case and impact predictions made here are correct.
- MeyGen accepts that there is uncertainty about some potential impacts from the Project and is committed to undertaking a post installation monitoring programme in order to determine the nature of those impacts. Appropriate monitoring will be agreed with Marine Scotland.
- To the extent further mitigation is required over and above the first mitigation proposed for Impact 13.15, MeyGen is committed to working with the regulator to identify reasonable measures to mitigated against this impact.
- As a result no specific mitigation measures for this impact have been identified but ongoing research by Marine Scotland and their advisors which will be monitored for further indications of successful mitigation strategies.

13.7.7 Impact 13.18: Changes in water flow

13.287 The changes in water flow resulting from extraction of tidal energy will potentially impact on habitats and species that are sensitive to changes in tidal flows and wave exposure. For fish species this impact mainly applies to herring spawning grounds and sandeel, which have high and medium sensitivity (Faber Maunsell, 2007, Table 13.10).

13.288 However, as noted above herring spawning grounds and sandeels are not present in the vicinity of the turbine deployment area. Therefore, the sensitivity of receptor is considered negligible. Modelling undertaken to understand the impact on the hydrodynamic regime in the vicinity of the Project shows no impact to water flow in the area (see Section 9) and the magnitude of impact is therefore considered to be minor.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Negligible	Minor	Negligible	Not Significant

MITIGATION IN RELATION TO IMPACT 13.18

- No mitigation measures proposed as no significant impact predicted.

13.7.8 Impact 13.19: Changes to prey species

13.289 The potential for the Project to cause changes to prey species such as benthic invertebrates and bony fish is limited (Section 10 Benthic Habitats and Ecology, Section 13.6 and Section 13.7). As discussed in this section the main prey species of other fish are small clupeids such as herring and sandeels, other small fish such as Norway pout and juvenile cod, whiting, saithe and other gadoids. The nursery areas for most of these species are unlikely to be impacted and it is unlikely that the availability of juvenile fish will change to an extent that they will be less available to predators. The same can be said for herring and sandeels as the Project area represents unsuitable substrate for spawning animals. It is also likely that turbine noise will cause most fish species to move away from the area so that they will still be available to predators that have also moved from the area. However, there is the potential for some prey to find refuge in the turbine array making them unavailable to predators that no longer move within the area occupied by the turbines.

13.290 As the majority of fish species in the area are free ranging and roam over large areas of the sea they are unlikely to be resident in the Project area. Even if they do move into the turbine array area they will not be resident for long and any population overspill (due to limited increases in populations) will add to the populations available both within and outside the array. In addition the small area that the Project covers is unlikely to provide a refuge habitat for most of these species to hide from predators. Any fish species that move from the area during operation will not become more available to predators by making them more concentrated in surrounding areas as they are generally mobile and will not be concentrated within particular areas. Therefore, increased predation on prey species that could affect population sizes is very unlikely to occur.

13.291 Given that impacts to benthic and fish prey species are considered to be generally negligible the magnitude of impact is also considered to be negligible. The species that feed in the Pentland Firth are highly mobile and will be able to access food resource sin other areas or once they have passed through the Project area. Therefore the sensitivity is also considered to be negligible.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Negligible	Minor	Negligible	Not Significant

MITIGATION IN RELATION TO IMPACT 13.19

- No mitigation measures proposed as no significant impact predicted.

13.7.9 Impact 13.20: Accidental spillage from vessels

13.292 The vessels to be used during operations and maintenance will be the same size or smaller than those during construction and installation and will therefore have similar inventories of oil. The likelihood of spillage, mitigation measures and residual impacts are the same as those described for vessel spillage during construction and installation (Impact 13.8).

13.8 Impacts during Decommissioning

13.293 The potential impacts during decommissioning are expected to be, at worst of the same nature and magnitudes as those during the construction phase. The impacts considered during the construction phase which would also be applicable to decommissioning include:

- Changes to spawning and nursery grounds and prey species;
- Noise generated during recovery and vessel activities;
- Disturbance due to removal activities;
- Increased turbidity and potential smothering due to removal activities;
- Disturbance and release of sediment bound contaminants;
- Introduction of non-native marine species; and
- Accidental spillage from vessels.

13.294 The mitigation proposed to minimise potential impacts will be the same as the mitigation proposed during construction and installation.

13.9 Potential Variances in Environmental Impacts

13.295 The impact assessment above has assessed the worst case Project options with regards to impact to fish ecology. This section provides a brief overview of the potential variances between the worst case Project option assessed and alternative Project options. The Project option that could potentially be used, but has not been assessed specifically above is the use of gravity and pin piles based TSSs instead of monopiles.

13.296 The installation of gravity based TSSs would have a lesser impact on fish ecology than the installation of the monopiled TSSs. The installation of the gravity base TSSs would generate less noise during installation, due to there not being a requirement to drill, the installation would not release drill cuttings or fluids into the marine environment during installation; reducing the risk of smothering and changes to turbidity.

13.297 For impacts to the seabed the footprint of the gravity based TSSs has been assessed as this would result in a larger footprint on the seabed (30 x 20m for each gravity based TSS compared to 10 x 10m for monopiled). The use of the monopile TSS would reduce the areas lost from fish spawning and nursery grounds and indirect impacts on benthic prey species.

13.298 For drill cuttings and release of fluids the use of pin piles will reduce the volume of cuttings produced. For monpiles the amount of drill cuttings released per socket will be 200m^3 whereas pin piles will only produce 5m^3 per socket, a total of 15m^3 per TSS.

13.299 In addition, should the export cable boreholes emerge from the seabed closer to the array site and therefore occupy a smaller physical area of the seabed this has the potential to reduce a number of impacts. These impacts include a reduction in a loss from fish spawning and nursery grounds, indirect impacts on benthic prey species through a reduction in direct seabed footprint and the potential for impact from EMF, as EMF emitted from the cables could be dampened as they transmit through the bedrock before they reach the seabed surface.

13.300 In terms of noise impact, the use of 86 turbines of 1MW will result in a lesser noise impact than if 36 turbines of 2.4MW are used. The range at which hearing specialists elicit a strong avoidance will be reduced by 4m and a mild avoidance by 5m.

13.301 When the barrier effect is considered the 36 turbines of 2.4MW will represent a less wide barrier even if the effect of a noise barrier is considered as each row will only contain less turbines, thus reducing the barrier presented to fish even if the greater noise form the 2.4MW devices is considered.

13.302 For collision risk the installation of 36 turbines of 2.4MW will further reduce the probability of salmon (or any fish) encountering the array. The area of the Pentland Firth occupied by the array will be much smaller, therefore, the probability of encountering a turbine will be greatly reduced.

13.10 Cumulative Impacts

13.10.1 Introduction

13.303 MeyGen has in consultation with Marine Scotland and The Highland Council identified a list of other projects (MeyGen, 2011a) which together with the Project may result in potential cumulative impacts. The list of these projects including details of their status at the time of the EIA and a map showing their location is provided in Section 8; Table 8.3 and Figure 8.1 respectively.

13.304 Having considered the information presently available in the public domain on the projects for which there is a potential for cumulative impacts, Table 13.616 below indicates those with the potential to result in cumulative impacts from a Fish Ecology perspective. The consideration of which projects could result in potential cumulative impacts is based on the results of the project specific impact assessment together with the expert judgement of the specialist consultant.

Project title	Potential for cumulative impact	Project title	Potential for cumulative impact	Project title	Potential for cumulative impact
MeyGen Limited, MeyGen Tidal Energy Project, Phase 2	✓	SHETL, HVDC cable (onshore to an existing substation near Keith in Moray)	✓	OPL, Ocean Power Technologies (OPT) wave power ocean trial	✓
ScottishPower Renewables UK Limited, Ness of Duncansby Tidal Energy Project	✓	Brough Head Wave Farm Limited, Brough Head Wave Energy Project	✗	MORL, Moray Offshore Renewables Ltd (MORL) offshore windfarm	✓
Pelamis Wave Power, Farr Point Wave Energy Project	✓	SSE Renewables Developments (UK) Limited, Costa Head Wave Energy Project	✗	SSE and Talisman, Beatrice offshore Windfarm Demonstrator Project	✓
Sea Generation (Brough Ness) Limited, Brough Ness Tidal Energy Project	✓	EON Climate & Renewables UK Developments Limited, West Orkney North Wave Energy Project	✗	BOWL, Beatrice Offshore Windfarm Ltd (BOWL) offshore windfarm	✓
Cantick Head Tidal Development Limited, Cantick Head Tidal Energy Project	✓	EON Climate & Renewables UK Developments Limited, West Orkney South Wave Energy Project	✗	Northern Isles Salmon, Chalmers Hope salmon cage site	✗
SSE, Caithness HVDC Connection - Converter station	✗	ScottishPower Renewables UK Limited, Marwick Head Wave Energy Project	✗	Northern Isles Salmon, Pegal Bay salmon cage site	✗
SSE, Caithness HVDC Connection - Cable	✗	SSE Renewables Developments (UK) Limited, Westray South	✗	Northern Isles Salmon, Lyrawa salmon cage site	✗

Project title	Potential for cumulative impact	Project title	Potential for cumulative impact	Project title	Potential for cumulative impact
		Tidal Energy Project			
RWE npower renewables, Stroupster Windfarm	×	EMEC, Wave Energy test site (Billia Croo, Orkney)	×	Scottish Sea Farms, Bring Head salmon cage site	×
SSE, Gills Bay 132 kV / 33 k V Substation Phase 1: substation and overhead cables (AC)	×	EMEC, Tidal energy test site (Fall of Warness, Orkney)	×	Northern Isles Salmon, Cava South salmon cage site	×
SSE, Gills Bay 132 kV / 33 k V Substation Phase 2: HVDC converter station and new DC buried cable	×	EMEC, Intermediate wave energy test site (St Mary's Bay, Orkney)	×	Scottish Sea Farms, Toyness salmon cage site	×
SHETL, HVDC cable (offshore Moray Firth)	×	EMEC, Intermediate tidal energy test site (Head of Holland, Orkney)	×	Northern Isles Salmon, West Fara salmon cage site	×

Table 13.16: Summary of potential cumulative impacts

13.305 The following sections summarise the nature of the potential cumulative impacts for each potential project phase:

- Construction and installation;
- Operations and maintenance; and
- Decommissioning.

13.10.2 Potential cumulative impacts during construction and installation

13.306 All of the projects listed above have the potential to contribute cumulatively during construction and installation to all of the potential impacts identified and discussed throughout the fish ecology impact assessment. These impacts include:

- Changes to spawning and nursery grounds and prey species due to activities which affect the seabed;
- Noise generated during vessel activities;
- Increased turbidity and potential smothering;
- Disturbance and release of sediment bound contaminants;
- Introduction of non-native marine species; and
- Accidental pollution events.

13.307 Currently there is no information regarding proposed installation dates and therefore it is difficult to assess whether they will occur at the same time as the MeyGen Project. However, cumulative impacts arising from installation of multiple marine renewable projects at the same time as the proposed installation are not anticipated as the majority of impacts are expected to localised (e.g. turbidity, smothering and release of drill cuttings and fluids[9]). It is however possible for cumulative and in-combination impacts to fish to arise from operation and maintenance of the MeyGen Project and the construction, installation operation and maintenance of these other projects in the Pentland Firth and the wider east coast of Scotland.

13.308 The installation of additional projects in the Pentland Firth and the wider east coast of Scotland has the potential to contribute to increased loss of fish spawning and nursery grounds. The spawning and nursery grounds within which the MeyGen Project is located are part of much wider areas, where these areas are not necessarily fixed spatially or temporally. As a result it is unlikely that cumulative impacts of increased loss of spawning and nursery grounds within the Pentland Firth will have an impact magnitude of greater than minor. In addition any impacts from increased sedimentation, introduction of non-native marine species and the release of sediment bound contaminants are unlikely to have a cumulative impact as the projects will all be at different stages of development. For these impacts a cumulative impact of a magnitude of minor or less would be expected.

13.309 In terms of accidental events, the likelihood of an oil spill at two project sites simultaneously is considered to be extremely remote and as a result cumulative impacts are unlikely to occur. In the event that such an incident did occur, measures will be in place to ensure the incident is tackled immediately and contingency plans to minimise environmental impacts implemented. Given the nature of an accidental event i.e. non routine, the likelihood for cumulative impacts is considered to be extremely remote. However, given that operations may be ongoing simultaneously there will be a slight increase in the risk of oil spills. Other projects will also have management and mitigation in place to reduce/remove the likelihood of an accidental event. As a result it is considered that any impacts will be remain not significant.

13.310 The installation of additional projects in the Pentland Firth and the wider east coast of Scotland has the potential to contribute underwater noise which could impact fish species. Of the noise generated during construction, vessel and drilling noise was considered to be undetectable by all fish species greater than 1m of the source and no mortality of injury was considered to result from the noise generated. The other proposed projects are some distance from the current Project (see above) and as a result there is little likelihood of in-combination or cumulative noise impacts from the current Project and other proposed projects in the vicinity.

13.10.3 Potential cumulative impacts during operations and maintenance

13.311 All of the projects listed above have the potential to contribute cumulatively during operations and maintenance of the Project. These impacts include:

- Noise generated during vessel activities and turbine operation;
- Risk of encountering the turbines during operation (only for the tidal stream project listed in Table 13.6);
- Barrier effects during operation (only for the tidal stream project listed in Table 13.6);
- EMF disruption due to installation of offshore electrical cables; and
- Accidental pollution event during maintenance operations.

13.312 The installation of additional projects in the Pentland Firth and the wider east coast of Scotland has the potential to contribute underwater noise which could impact fish species. Of the noise generated during all phases of the MeyGen Project, it could at worse cause mild behavioural impact to fish species up to 68m from the array (operation of 36 turbines of 2,4MW). There are no other proposed projects within this distance of the current Project (see above) and as a result there is little likelihood of in-combination or cumulative noise impacts from the current Project and other proposed projects in the vicinity.

[9] Cumulative impacts from discharges of drill cuttings would only be a potential impact if other developers used piled foundations.

13.313 The installation of additional projects in the Pentland Firth and the wider east coast of Scotland and their associated cabling increases the sources from which EMF could be emitted. However, as outlined in Section 13.7.4 the possible negative effects of EMF are considered to be localised in nature as a result it is unlikely that cumulative impacts of EMF from multiple marine renewable projects in the Pentland Firth will result in an impact magnitude of greater than minor.

13.314 Marine renewable developments have the potential to form a barrier to usual migration and transit patterns of fish species. In general such developments have the potential to act as a barrier because of the physical presence of the turbines, aversive reactions to underwater noise, EMF or perceptions of devices and associated infrastructure. As outlined in Section 13.7.5 this impact is particularly pertinent in more constrained environments, such as mouths of sea lochs or in narrow sounds. The Pentland Firth is a wide (~15km) channel and all the proposed marine renewable projects within it are not located in the centre of the channel. As a result it is not anticipated that the cumulative impacts of barriers to movements from multiple marine renewable projects in the Pentland Firth will result an impact magnitude of greater than minor.

13.315 As outlined in Section 13.7.6 encounters with marine renewable energy devices is considered to be a key potential effect during device operation (Faber Maunsell, 2007). Of the proposed marine renewable projects in the Pentland Firth the largest areas that potentially could be developed are the Ness of Duncansby tidal energy project and the MeyGen Tidal Energy Project, Phase 2. These projects also sit within the migration path of Atlantic salmon.

13.316 Given the results of the encounter study (Xodus, 2012) the population level effects are unlikely to be significant even if the proportions increased based on the presence of these projects. Given the scale of this development (95MW for the Ness of Duncansby and 312MW for the MeyGen Tidal Energy Project, Phase 2), there is the potential for a cumulative impact to occur. However, in relation to the width of the Pentland Firth it is considered unlikely that the magnitude of the impact will increase significantly. The number of turbines in a row for the MeyGen Tidal Energy Project, Phase 2 will not increase above that of Phase 1. The maximum number of turbines in a row will be 11. Therefore, the proportion of the width of the Pentland Firth occupied by the Project will remain the same and the encounter probability will not increase. For the Ness of Duncansby site the potential is that the encounter probability may double. However, given the probabilities estimated it is unlikely this will cause any significant effects. As both smolts and adults are likely to swim in the top 6 to 10m of the water column it is likely that that most tof the salmon population migrating through the Pentland Firth will also swim above the Ness of Duncansby site and the MeyGen Tidal Energy Project, Phase 2. Therefore, it is unlikely that any significant effects will occur. However, as outlined in Section 13.7.6 MeyGen accepts that there is uncertainty about some potential impacts from the Project and is committed to undertaking a post installation monitoring programme in order to determine the nature of those impacts. Appropriate monitoring will be agreed with Marine Scotland. The findings of this programme have the potential to further understand potential cumulative impacts of encounters from these other proposed marine renewable developments in the future.

13.317 Through EIA scoping, Marine Scotland expressed concerns over the possibility of cumulative effects from the displacement of predatory fish and fishing activity and the potential effects on nearby spawning grounds to the east and west of Stroma (Section 13.5). Section 14 Commercial Fisheries outlines that the local conditions and tidal currents within the development area are largely unsuitable for mobile gear types such as dredging and trawling and the main gear types used for fishing in the area are static and mainly take the form of creeling or pots targeting shellfish species. As a result there is no risk of the displacement of fishing activity for fish species adversely effecting nearby spawning grounds. Should the development result in the displacement of predatory fish it could also result in the displacement of prey fish species, marine mammals and bird species. As a result the displacement effects would largely be balanced out, and the perceived alteration in displacement would be minimal.

13.318 In terms of accidental events, the likelihood of an oil spill at two project sites simultaneously is considered to be extremely remote and as a result cumulative impacts are unlikely to occur. In the event that such an incident did occur, measures will be in place to ensure the incident is tackled immediately and contingency plans to minimise environmental impacts implemented. Given the nature of an accidental event i.e. non routine, the likelihood for cumulative impacts caused by accidental events (i.e. an accidental event occurring in the same time period at one or more of detailed projects and this Project) is considered to be extremely remote. However, given that operations may be ongoing simultaneously there will be a slight increase in the risk of oil spills. Other projects will also have management and mitigation in place to reduce/remove the likelihood of an accidental event. As a result it is considered that any impacts will be remain not significant.

13.10.4 Potential cumulative impacts during decommissioning

13.319 Although it is possible that a number of the impacts that may occur during decommissioning (e.g. noise emissions, seabed impact) could act cumulatively with other developments, there is limited scope for much of this since it is highly unlikely that the other developments would be decommissioned at the same time as this development, or that of the MeyGen Phase 2 project (which would likely be decommissioned at the same time as the proposed Project).

13.10.5 Mitigation requirements for potential cumulative impacts

13.320 No mitigation is required over and above the Project specific mitigation.

13.11 Habitats Regulations Appraisal

13.321 For projects which could affect a Natura site, a competent authority (in this case Marine Scotland for offshore and The Highland Council for onshore) is required to determine whether the Project will have a likely significant effect on the qualifying interests of any Special Protection Areas (SPAs) and any Special Areas of Conservation (SACs). Depending on the outcome of this determination, the competent authority will undertake an Appropriate Assessment of the implications of the Project for the Natura site's conservation objectives. The responsibility for provision of information with which to inform the Appropriate Assessment rests with the applicant.

13.322 There are few SACs designated for fish species within the direct vicinity of the Project. However, due to the migratory nature of fish species for which SACs are designated, sites from further afield may be require consideration and therefore there has been a need to investigate the potential Likely Significant Effects on a large number of SAC sites designated for their fish interests. This assessment is presented in a separate HRA report (see HRA document on the supporting studies CD, MeyGen, 2012).

13.12 Proposed Monitoring

13.323 The majority of potential impacts on fish have been assessed as being not significant. The potential impact of EMF impact was assessed to be potentially significant before mitigation but not significant with the implementation of appropriate mitigation measures. Although the results conclude that the Project does not pose a significant risk to fish, MeyGen recognises that due to the emerging nature of the tidal energy industry there is uncertainty about some potential impacts especially where these have yet to be verified by operational monitoring in the industry.

13.324 Where impacts cannot be fully quantified (e.g. turbine collision risk). MeyGen is committed to developing a fish monitoring programme. This programme will be based on the 'Survey, Deploy And Monitor' strategy in accordance with Scottish Government policy (currently available in draft).

13.325 MeyGen has recognised that being the first application for a commercial scale tidal stream project in Scotland and the first from The Crown Estate's Pentland Firth and Orkney Waters leasing round, has meant that there is potential for the Project to form part of an industry wide strategic monitoring programme that will benefit future projects as well.

13.326 Where strategic monitoring is appropriate, MeyGen would look to a collaborative effort between the Project, wider industry, regulators and stakeholders to take this forward in the most efficient way for the interest of the Project and future projects elsewhere in Scotland and the UK.

13.327 With particular regard to diadromous (migratory routes and behaviour) and elasmobranch (behaviour) fish species, there is overarching lack of scientific data. MeyGen is aware of the strategic research being carried out by the Scottish Government and academic institutions will help reduce that knowledge gap which will help verify this EIA and give greater confidence in future assessments. However, based on the

prohibitively high level of effort required and the non-site-specific nature it is not believed that this is something that an individual developer should be actively involved in.

13.328 As part of this EIA and the MeyGen commitment to post-installation monitoring, the draft SNH survey and monitoring guidance (MacLeod *et al*., 2011; Sparling *et al*., 2011) has been reviewed. Although this guidance does not, and cannot, give specific details of what fish monitoring should take place, based on the general approaches described and on current knowledge of the site (obtained from the extensive baseline surveys), it is likely that the monitoring programme could include the following:

- Disturbance and displacement;
- Collection of underwater noise measurements of the candidate prototype tidal turbines. The data collected will be used to validate the underwater noise modelling completed to inform the impact assessment; and
- Collision Risk. MeyGen believes that understanding fish behaviour around tidal turbines and the risk of collisions occurring is fundamental for the industry to progress. It is therefore proposed that this potential impact is considered as strategic research and therefore monitoring development in cooperation with regulators, stakeholders and other developers. Monitoring could include: Installation of one or more active monitoring systems on one or more tidal device to better understand the near-field response of fish species to operating tidal devices.

13.329 The EIA has concluded that the Project could have a potentially significant impact on elasmobranch species. The effect of EMF on these species is being researched by the Scottish Government and it is understood that this will give greater confidence in the assessment and the mitigation outlined. MeyGen does not propose any site-specific monitoring for EMF impacts.

13.330 MeyGen will work with the regulator (Marine Scotland) and its advisory bodies (e.g. SNH) to agree the details of appropriate monitoring and will ensure that the monitoring programme is aligned with industry best practice. Methods for assessing disturbance and displacement impacts and collision risk can potentially be linked with similar effort required for Section 11 Marine Mammals and Section 12 Ornithology.

13.331 Where monitoring indicates that specific mitigating measures may be reasonably required, MeyGen is committed to put these in place.

13.13 Summary and Conclusions

13.332 A wide number of finfish species have the potential to be present in the Pentland Firth. In terms of anadromous fish the Atlantic salmon, sea trout and European eel all the potential to be present and each of which have afforded a least some conservation recognition under various conventions and regulations.

13.333 A number of elasmobranch species also have the potential or are known to be present in the Pentland Firth. These include the basking shark, spurdog, tope, lesser-spotted dogfish, porbeagle, kitefin shark, shortfin mako, blue shark, nurse hound and thornback, cuckoo and spotted rays. The Pentland Firth has been identified as nursery ground for spurdog, tope, thornback and the spotted rays (Ellis *et al*., 2010). A number of these elasmobranch species have been identified as of conservation importance under a number of conventions and pieces of legislation, in particular the basking shark.

13.334 In addition, a number of other important finfish species are likely to be present within the Pentland Firth. These include species of commercial importance (monkfish, herring, haddock, whiting, cod, megrim and saithe), species that are known to use the waters as nursery and/or spawning grounds (haddock, herring, lemon sole, saithe, anglerfish, blue whiting, cod, hake, ling mackerel, sandeel and whiting) and species that are considered to be important ecologically or particularly sensitive to activities associated with the Project (sandeels and herring).

13.335 A number of potential impacts associated with the construction, installation, operation, maintenance and decommissioning of the Project of fish ecology have been assessed. This assessment identified a number of key issues associated with fish ecology, including loss of spawning and nursery grounds, noise from construction, installation, operation, maintenance and decommissioning, EMF from the installed subsea cables and encounters with the array during turbine operation.

13.336 The seabed of the Project area is considered to be unsuitable for both herring and sandeel spawning, and as a result it is only possible that lemon sole could use the Project area for spawning. But as pelagic spawners and the area being part of a much larger spawning area the overall impact of loss of spawning grounds was considered to be negligible / not significant. Similarly, although the Project area is located within identified nursery areas for a number of fish species, these are part of much wider nursery grounds for all of these species and as such the impact is considered to be negligible / not significant.

13.337 Underwater noise will be generated during installation and operation of the Project. Fish hearing sensitivity differs between species, where species with a gas filled swim bladder, including those with a link to the inner ear, such as herring and cod are considered to be more sensitivity to noise than fish with no swimbladders, such as flat fish and elasmobranchs. Underwater noise impact modelling conducted by Kongsberg (2012) indicated that in the worst case noise generation scenario (operation of all 36 turbines of 2.4MW) would not result in lethal or physical injury to fish species and is unlikely to result in hearing damage. Strong avoidance behaviour by hearing specialist fish would occur up to 18m from the tidal array and mild behavioural avoidance up to 68m from the tidal array. Given that fish species are only likely to be impacted when passing through the Project area, the impacts are only likely to result in behavioural changes. Once the fish move away from the area they will no longer be impacted and the impact is considered to be minor / not significant.

13.338 A number of electrosensitive fish species are potential present within the Inner Sound, these include a number of elasmobranch's, Atlantic salmon, European eel, sea trout, cod, plaice and mackerel. All of which are potentially at risk from the impacts of EMF, including salmonoids during their migrations. There is currently insufficient data available with which a judgement can be made about the potential for EMF to impact on a particular species. However, potential for impact is considered to be highest for species that depend on electroreception to detect benthic prey - skates, rays and dogfish (CMACS, 2005). The research conducted to date does not provide significant evidence to suggest any negative impacts on magnetically or electrically sensitive species as a result of EMF, however there is an overall degree of uncertainty over this issue. As a result the overall impact of EMF is considered to be moderate/ significant before the application of mitigation. Following application of mitigation measures including using natural crevices in the seabed to lay the cable, ensuring the cable bores are as long as possible and bundling the cables together the impact is reduced to minor/not significant. MeyGen is committed to continued consultation with Marine Scotland and SNH and wider marine renewable stakeholders to ensure the Project is completed and operated to the most up to date industry best practice.

13.339 Collision with rotating turbines is considered to be a key potential effect during device operation (Faber Maunsell, 2007). A number of reports have been commissioned in recent years which provide useful overviews of the factors likely to influence collision risks posed by marine renewable energy devices (Wilson *et al*., 2007; ABPmer, 2010). However, there is a lack of empirical knowledge it is still not possible to quantify the risk posed by the Project. Based on a precautionary encounter study based on the Band model for birds the overall impact of collision risk is considered to be minor/not significant. No specific mitigation measures were identified for this impact; however MeyGen is committed to working with the regulator to identify reasonable measures to mitigate against this impact. Additionally, MeyGen is committed to undertaking a post installation monitoring programme in order to determine the nature of this impact, with the appropriate monitoring to be agreed with Marine Scotland.

13.340 Overall through the implementation of proposed mitigation strategies and commitments the impact of the proposed Project on fish ecology is considered to be not significant.

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14 COMMERCIAL FISHERIES

14.1 The table below provides a list of all the supporting studies which relate to the commercial fisheries impact assessment. All supporting studies are provided on the accompanying CD.

Details of study	Location on supporting studies CD
Benthic survey for Phase 1 of the MeyGen tidal stream energy project, Inner Sound, Pentland Firth (ASML, 2011)	OFFSHORE\Seabed interactions
Navigation Risk Assessment (NRA) MeyGen Inner Sound (Anatec, 2012)	OFFSHORE\Navigational Risk Assessment

14.1 Introduction

14.2 This section assesses the effects of the Project on commercial fisheries. The assessment has been undertaken by Xodus.

14.3 To gain a better overall understanding of the baseline and potential impacts associated with commercial fisheries; consideration should also be given to the following Environmental Statement (ES) sections:

- Benthic habitats and ecology (Section 10);
- Fish ecology (Section 13);
- Navigation (Section 15); and
- Socio-economics (Section 21).

14.2 Assessment Parameters

14.2.1 Rochdale Envelope

14.4 In line with the Rochdale Envelope approach, this assessment considers the maximum ('worst case') project parameters. Identification of the worst case scenario for each receptor (i.e. Environmental Impact Assessment (EIA) topic) ensures that impacts of greater adverse significance would not arise should any other development scenario be taken forward in the final scheme design. Table 14.1 describes the detail of the project parameters that have been used in this assessment and explains why these are considered to be worst case. The potential alternative Project parameters have been considered in Section 14.9.

Project Parameter relevant to the assessment		'Maximum' Project parameter for impact assessment	Explanation of maximum Project parameter
Turbines	Maximum deployment area	Maximum area of seabed is 1.1km^2	The maximum potential area that fisherman will be unable to work due to deployment of turbines. This will be 1.1km^2.
	Decommissioning	All turbines removed at decommissioning	From a decommissioning perspective it is assumed that all turbines will be fully removed at decommissioning.
Turbine Support Structure	Decommissioning	All Turbine Support Structures (TSSs) removed at decommissioning	From a decommissioning perspective it is assumed that piled TSSs will be cut at the seabed. The piles below the seabed will remain in-situ.
Cable connection to shore	Maximum cable footprint on seabed	86, 120mm unbundled cables each 1,300m in length with split pipe armouring	The maximum physical area of the seabed occupied by the cables has been calculated as 0.027km^2. Based on a maximum 1.3km of cable from Horizontally Directionally Drilled (HDD) bore exit to turbine, and a cable diameter of 120mm (x2 to account for split pipe armouring) for 86 turbines. This assumes that the cables will emerge from the bores 700m from the shore.
	Decommissioning	86, 120mm unbundled cables, each 1,300m in length	All cables laid on the seabed will be fully removed at decommissioning.
Vessels	Safety zone for Dynamic Positioning (DP) vessel during installation and maintenance activities	500m radius area around vessel	A maximum safety zone of 500m is considered for the assessment. A 500m safety zone is industry standard. The size of the safety zone during construction will influence navigation and commercial fishing activities in the area.
	Installation vessel physical presence	1 DP vessel for the duration of the installation for year 1 and 2 2 DP vessels for year 3 installation	Installation activities will be carried out by a single DP vessel during year 1 and 2, all installation activities to be undertaken using a single DP vessel. If other smaller vessels used to undertake some of the work of the DP vessel, no concurrent multiple vessel activities will take place, i.e. no more than one vessel on site at any one time. Year 3 installation will require a maximum 2 DP vessels for TSS installation. These two vessels may be present on site at the same time during year 3.
	Maintenance vessel physical presence	1 DP vessel present every 2.8 days	Based on a maximum 86 turbine array, 1 DP vessel will be present a maximum of 130 times (i.e. single slack tide operation) per year i.e. the DP vessel will be present on site every 2.8 days.
Onshore Project components	-	N/A	Onshore Project parameters do not influence the commercial fisheries impact assessment.

Table 14.1: Rochdale Envelope parameters for the commercial fisheries assessment

14.2.2 Area of assessment

14.5 It is also important to define the geographical extent of the assessment area. The focus of the impact assessment is potential impacts on the commercial fisheries using the Project area and adjacent waters.

14.3 Legislative Framework and Regulatory Context

14.6 The EIA Regulations are the only legislation directly relevant to this assessment. The legislation and guidance relevant to the resources and habitats on which commercial fish species depend is summarised in Benthic Habitats and Ecology (Section 10) and Fish Ecology (Section 13).

14.4 Assessment Methodology

14.4.1 Scoping and consultation

14.7 Since the commencement of the Project, consultation on commercial fisheries issues has been ongoing. Table 14.2 summarises all consultation relevant to commercial fisheries. In addition, relevant comments from the EIA Scoping Opinion are summarised in Table 14.3, together with responses to the comments and reference to the ES sections relevant to the specific comment.

Date	Stakeholder	Consultation	Topic / specific issue
8th and 9th of March 2011	Local fisheries interests The Crown Estate Marine Energy Developers	The Crown Estate's Pentland Firth and Orkney Waters Fisheries Meetings	Fisheries issues and concerns discussed at a meeting chaired by The Crown Estate's Fisheries Liaison Officer.
7th April 2011	Marine Scotland and Scottish	Pre-Scoping meeting	EIA surveys and studies required and the data

Date	Stakeholder	Consultation	Topic / specific issue
	Natural Heritage (SNH)		needs for each EIA study.
6th May 2011	Local fishermen	Local fisherman's visit to view the Atlantis turbine at Invergordon	Turbine technology and discussions with fishermen regarding their concerns.
27th May 2011	Marine Scotland, statutory consultees and non statutory consultees	Submission of EIA Scoping Report	Request for EIA Scoping Opinion from Marine Scotland and statutory consultees and request for comment from non statutory consultees.
30th June – 2nd July 2011	Local stakeholders	Public Event - EIA Scoping	Public event to collate information/opinions on proposed EIA scope.
7th July 2011	Maritime and Coastguard Agency (MCA)	Meeting	The scope of work for the NRA was discussed with the MCA including the various data sources planned to be used to characterise baseline traffic levels.
24th August 2011	Five local fishing skippers (3 John o' Groats & 2 Scrabster)	Meeting	Discussion on local fishing activity and vessels that fish in the Project area. Target species, gear used and effort spent within the Project area.
22nd September 2011	Scottish Fishermen's Federation (SFF), Marine Scotland Compliance, Local fishermen and sailing representatives, Wick RNLI, Scrabster Harbour, Gill's Harbour, Pentland Ferries, John o' Groats Ferries	Hazard Review workshop	Project overview and baseline data review.
31st September 2011	Marine Scotland, The Highland Council, statutory consultees and non statutory consultees	Receipt of EIA Scoping Opinion	Receipt of response to EIA Scoping Report and other comments from non statutory consultees.
3rd October 2011	Marine Scotland	Project update meeting	Report on EIA progress and presentation of key findings of the impact assessment.
12th October 2011	Maritime and Coastguard Agency (MCA)	Meeting	The draft findings of the NRA were presented to the MCA. Specific comments were made which have been incorporated into the final NRA.
6th – 7th December 2011	Local stakeholders	Public Event – pre application consultation	Public event to communicate the findings of the EIA to local stakeholders.
9th March 2012	Caithness District Salmon Fisheries Board	Meeting	Consultation with salmon fisheries board to discuss potential issues and approach to impact assessment.

Table 14.2: Consultation undertaken in relation to commercial fisheries

Name of organisation	Key concerns	Response	ES section within which the specific issue is addressed
SNH	SNH recommend consultation with relevant Inshore Fisheries Groups (IFGs) in addition to other Fisheries associations. IFGs endeavour to comprise representation from all vessels fishing in the inshore area, including small independent fishers that may not be part of a major association. Vessels that are not based locally (i.e. east coast vessels that also operate on the west coast, and *vice versa*), should also be included.	No IFG has been set up in this area as yet; the North Coast Fisheries Group, in addition to Orkney Fisheries Association, has been consulted. Adequate consultation has been undertaken as confirmed by Marine Scotland (McLeod, pers.com. Marine Scotland, Marine Planning and Policy Officer, 2011). Relevant fisheries organisations were contacted as part of the consultation process, to establish the importance of fishery resources in the inshore area.	Refer to Section 14.4.1 Scoping and Consultation
SNH	It is noted that geo-referenced data regarding inshore fishing activity and catch is very limited because; (a) shellfish fisheries are largely unregulated and require very little catch reporting; and, (b) many of the vessels in the inshore area are less than 15m long and are not required to have satellite vessel monitoring systems (VMS). Consultation with the IFGs is likely to be helpful in establishing the importance of fishery resources within an area and the likely extent of displacement of fishing activity.	In the absence of IFGs in the area, consultation has been undertaken with the appropriate organisations in the area; including locally known fishermen and the Orkney Fisheries Association; to establish the importance of fishery resources in the inshore area and to assess the likely effect of displacement.	Refer to Section 14.4.1 Scoping and Consultation
SNH	Marine Scotland science and CEFAS should advise on appropriate data sources relating to spawning and nursery grounds, and whether any additional surveys are required. They should also be contacted to discuss mitigation measures and if there is overlap between the development site and the location of nursery / spawning grounds.	Marine Scotland has been consulted with and Centre for Environment Fisheries and Aquaculture Science (CEFAS) generated data used in regards to this matter.	Refer to the Fish Ecology, Section 13, for further consideration of spawning habitats.
SNH	Consideration should be given to benthic habitats or substrate types; particular sectors of the Scottish fishing industry are associated with particular substrate types, as well as species in different stages of their life-history.	Substrate type and benthic habitats are discussed further in the benthic habitats and ecology section.	Refer to the Benthic Habitats and Ecology; Section 10.
SNH	Consideration should be given to potential impacts of noise / vibration and EMF to shellfish species.	Impacts on shellfish are considered in the benthic ecology section, as they will be vulnerable to a similar range of impacts.	Refer to the Benthic Habitats and Ecology, Section 10.
SNH	The environmental effects of displacing (and potentially concentrating) fishing effort to other areas should be assessed by the applicant. Also to be considered is the potential of the development area to provide a refuge for particular species, potentially increasing biomass, with potential benefits to adjacent fishing grounds.	Displacement effects and potentially beneficial effects to adjacent fishing grounds are considered.	Refer to Sections 14.6.2 Impact 14.2: Displacement of fishing effort targeting new or alternative fishing grounds, 14.7.1 Impact 14.5: Displacement of fishing effort and 14.7.2 Impact 14.6: Change in abundance and distribution of target species.
Marine Scotland	In addition to the Scottish Fisherman's Federation and major fishing associations, the relevant Inshore Fisheries Group (IFG)	No IFG has been set up in this area as yet; the North Coast Fisheries Group, in addition to Orkney Fisheries Association, has been consulted. Adequate	Refer to Section 14.4.1 Scoping and Consultation

Name of organisation	Key concerns	Response	ES section within which the specific issue is addressed
	should also be consulted.	consultation has been undertaken as confirmed by Marine Scotland (McLeod, pers.com. Marine Scotland, Marine Planning and Policy Officer, 2011).	
Marine Scotland	To ensure liaison with the fishing industry is focussed and that key species with potential to be impacted by the development are identified, habitat associations for fish/shellfish and particular fishing types should be highlighted.	Benthic habitats within the footprint of the proposed development have been identified (refer to Section 10) and associated fishing industry types confirmed.	Refer to the Benthic Habitats and Ecology, Section 10 and Section 14.5.3 for details regarding benthic habitats and commercially valuable species occurring within the Project area.
Marine Scotland	The applicant should assess the effects of displacing fishing effort to other areas; the potential for the development area to provide a refuge for particular species, potentially increasing biomass with potential benefits to adjacent fishing grounds should also be considered.	Potential impacts of displacement of fishing effort and changes in abundance and distribution of target species have been considered.	Refer to Sections 14.6.2 Impact 14.2: Displacement of fishing effort targeting new or alternative fishing grounds, 14.7.1 Impact 14.5: Displacement of fishing effort and 14.7.2 Impact 14.6: Change in abundance and distribution of target species
Marine Scotland	Consideration should be given to the cumulative effects of displaced fishermen and fishing activity of any proposed exclusion zone; in or around the site.	Consideration of cumulative impacts includes displacement of fishermen from other proposed marine developments.	Refer to 14.10 Cumulative Impacts.
The Crown Estate's Pentland Firth and Orkney Waters Fisheries Meetings 08/03//2011	The inner sound is a route used by all small fishing vessels transiting that area. During winter it is not normally possible to transit to the north of Stroma. Concerns over the navigation of the Inner Sound included: The clearance depth above the turbines. The effects of the turbines on the water.	Impacts on navigation, including to commercial fishing vessels, are considered in the Navigation Section 15.	Refer to Navigation, Section 15.
The Crown Estate's Pentland Firth and Orkney Waters Fisheries Meetings	At a scoping meeting, fishermen raised concerns that adding another turbulence factor to the wave and tide environment could cause impassable conditions.	Coastal process modelling shows there will be insignificant changes to wave and tidal conditions in the vicinity of the Project.	Refer to the Physical Environment and Sediment Dynamics Section 9.

Table 14.3: Scoping comments relevant to commercial fisheries

14.4.2 Desk based study

14.8 To inform this section, information was collected from numerous sources including relevant data sets as listed below:

- Annual landings for vessels over 10m in length detailing species, species type, live weight, value, from the International Council for the Exploration of the Sea (ICES) Statistical Rectangle 46/E6 for the period 2006 to 2010; and
- Vessel Monitoring System (VMS) data for vessels over 15m within the Inner Sound and surrounding area including details of direction, gear type, activity and date for the period 2006 to 2009.

14.9 In addition to datasets, reports were consulted to provide information on the background and baseline commercial fishing conditions in the Inner Sound, including:

- Scottish Marine Renewables Strategic Environmental Assessment, Commercial Fisheries and Mariculture – Section 10 (Scottish Executive, 2007);
- 2009 Economic Survey of the UK Fishing Fleet (Curtis, H. and Brodie, C., 2011);
- The Economic Impact of Game and Coarse Fishing in Scotland for SEERAD (Radford and Riddington, 2004);
- Economic Impact of Recreational Sea angling in Scotland, prepared for the Scottish Government (Radford, A., Riddington, G. and Gibson, H., 2009);
- Strategic Research Assessment for Wet Renewables (Davies 2008); and
- Coull, K.A., Johnson, R. & Rodgers, S.I. (1998). Fisheries sensitivity Maps in British Waters. Published Distribution by UKOOA Ltd (updated by CEFAS 2011).

14.4.3 Field survey

14.10 Fieldwork undertaken as part of the benthic ecology assessment is relevant to commercial fisheries and where appropriate, has been referenced throughout this section. Fieldwork specific to commercial fisheries was not undertaken as part of the baseline.

14.4.4 Significance criteria

14.11 The EIA process and methodology are described in detail in Section 8. Each assessment section is, however, required to develop its own criteria for the 'sensitivity of receptor' and 'magnitude of impact' aspects since the definition of these will vary between different topics. For commercial fisheries, the significance criteria used in this section is based on the methodology described in Section 8 but the sensitivity of the receptor and magnitude of impact are defined in Table 14.4 and Table 14.5 respectively.

14.12 The consequences of impacts are then considered by reference to the relevant criteria in the EIA Regulations. The significance of impacts in relation to the EIA Regulations is defined in Section 8, Table 8.2.

Sensitivity of receptor	Definition
Very High	▪ Fishing activity is located only within the study area. ▪ Fishing activity is of very high intensity in the study area. ▪ Fishing activity relies on the resources in the study area.
High	▪ Fishing activity is located mostly within the study area, some fishing activity occurs outside the Project area. ▪ Fishing activity is of high intensity in the study area. ▪ Fishing activity relies mostly on the resources in the study area, some resources are exploited elsewhere.

Sensitivity of receptor	Definition
Medium	▪ Fishing activity is located within the study area 50% of the time with the remaining effort being expended outside the Project area. ▪ Fishing activity is of medium intensity in the study area. ▪ Fishing activity relies on resources in the study area for 50% of the time and from resources outside the study area for the remainder of the time.
Low	▪ Some fishing activity is located within the study area but most effort is expended outside the Project area. ▪ Fishing activity is of low intensity in the study area. ▪ Fishing activity relies on resources from outside the study area most of the time.
Negligible	▪ Fisheries are not sensitive to change.

Table 14.4: Definitions for sensitivity of commercial fisheries

Magnitude of impact	Definition
Severe	▪ Widespread total loss or very major alteration to the baseline conditions of commercial fisheries. ▪ Little or no recovery anticipated. ▪ Impact highly likely to occur.
Major	▪ Widespread change to the baseline conditions of commercial fisheries, leading to medium term effects. ▪ Recovery to baseline conditions anticipated after several years following decommissioning. ▪ Impact likely to occur
Moderate	▪ Change to commercial fisheries in a localised area (confined to Project footprint and immediate locality) for Project duration, but no lasting change to baseline conditions. ▪ Good recovery potential following decommissioning (approximately 2 years). ▪ Impact will possibly occur.
Minor	▪ Change from baseline conditions measurable but within scale of natural variability, and confined to project footprint. ▪ Temporary alteration or effects on commercial fisheries confined to a small percentage of locally available fishing grounds, with rapid recovery likely. ▪ Impact unlikely to occur.
Negligible	▪ No change or an imperceptible change to the baseline condition of commercial fisheries. ▪ Impact extremely unlikely to occur.
Positive	▪ An enhancement of ecosystem or population parameter. ▪ An enhancement in the availability or quality of a resource to the extent of potentially benefiting the well being of the persons utilising that resource benefiting from it in some way.

Table 14.5: Definitions for magnitude of impact in relation to commercial fisheries

14.4.5 Data gaps and uncertainties

14.13 Fish and shellfish landings are reported by ICES rectangles which are 30 minutes latitude and 1° longitude in size, approximately 30 nautical miles square. The Project falls within the ICES statistical rectangle 46E6, within the wider ICES statistical area of IVa (Figure 14.1). Therefore reporting landings from a small area, such as that covered by the offshore Project area, is not possible.

14.14 Analysis of Vessel Monitoring System (VMS) data provides information on the locations and intensity of fishing effort. However VMS data can also provide a misleading picture for a number of reasons; it is not a legal requirement for vessels under 15m to carry VMS equipment (notably all vessels known to fish in the vicinity of the Project are less than 15m). Additionally, VMS data is generally filtered to indicate when the vessel is fishing. In areas of unfavourable conditions such as the strong tidal currents experienced in the Inner Sound, transiting vessels can be travelling very slowly and therefore be misinterpreted as fishing. Marine Scotland is no longer able to provide VMS as raw data which limits the way that data can be manipulated and interpreted. As a result, consultation with local fishermen (Sea View Hotel, John o' Groats in August 2011) has been undertaken, to establish which vessels fish in the Inner Sound and which fish species are targeted.

14.5 Baseline Description

14.15 The MeyGen Inner Sound Agreement to Lease (AfL) area lies within ICES statistical rectangle 46E6; baseline establishment and impact assessment utilising landings data has focused on this rectangle. Refer to Figure 14.1 for further details regarding the location of the offshore Project area within ICES statistical rectangle 46E6.

14.16 The study area for this assessment encompasses the area where fishing activity may take place within the Inner Sound and includes the offshore aspects of the Project; from the shoreline down to a water depth of 48.6m below the lowest astronomical tide (LAT) (iX Survey, 2009). The turbine deployment area is located in the main Inner Sound channel, where the greatest depths are present; with an average depth of between 34 and 38m (LAT). The turbine deployment area is largely comprised of exposed bedrock; the majority of sediments have been transported away due to high currents. The cable corridor is comprised of exposed bedrock and areas of kelp. Further detailed information on hydrodynamic regime, bathymetry and seabed habitats is presented in Section 9 (Physical Environment and Sediment Dynamics) and Section 10 (Benthic habitats and ecology) respectively.

14.5.1 Fisheries management overview

14.17 Within Scotland, the National responsibility for fisheries management lies with the Sea Fisheries Division of Marine Scotland and is enforced by Marine Scotland Compliance (formerly the Scottish Fisheries Protection Agency). EU countries manage their fisheries in collaboration through the common fisheries policy (CFP). The policy utilises a range of measures with the aim of achieving a thriving and sustainable European fishing industry; as part of this the EU Fisheries Commission makes recommendations and proposals which are used to formulate management plans and decisions for specific species.

14.18 In 2011 the Commission set out proposals for a 2013 reform of the CFP. Aims of the reform include taking action against over fishing in favour of sustainable management of stocks, production of multi-annual plans governed by ecosystem approach, a ban on discards and measures beneficial to small scale fisheries.

14.19 Total Allowable Catches (TACs) are catch limits set for the most commercially significant fish stocks. TACs are proposed by the Fisheries Commission based on scientific advice from ICES, the Scientific Technical and Economic Committee for Fisheries (STECF) and are decided by the council of fisheries ministers. TACs are currently one of the principle management tools used by the EU, however the CFP is currently under review and management is focusing more on effort and technical conservation measures (TCM), such as equipment restrictions.

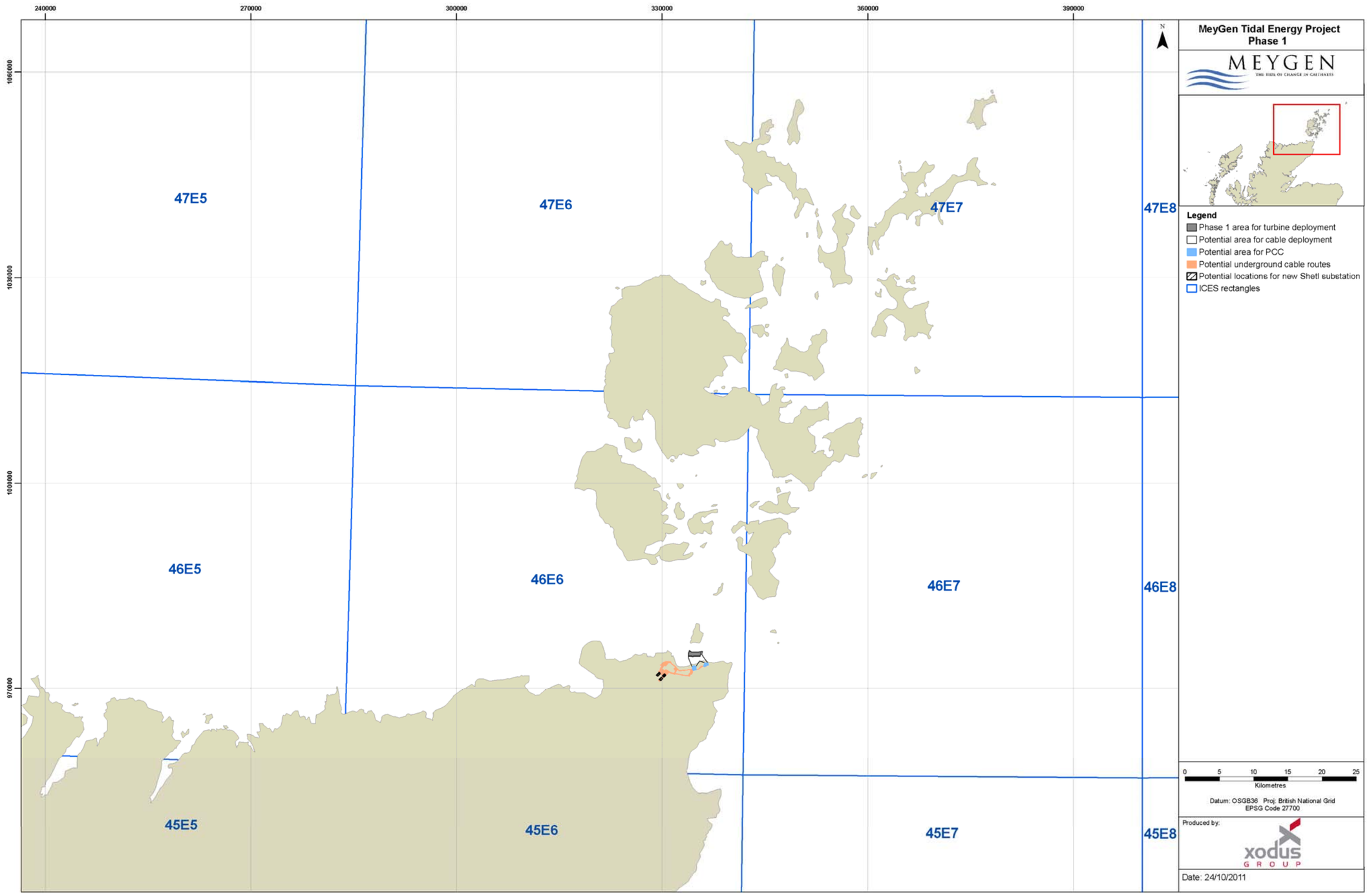

Figure 14.1: Location of the Project within ICES statistical rectangle 46E6

14.20 Notably, different quotas are applied to different species and are allocated on the basis of ICES division. The North Sea falls under the division of Subarea IV and the area is further divided into smaller divisions; the Project is located in the Division Iva (Fladen Ground). The ICES Advisory Committee (ACOM) provides annual advice which is updated throughout the year, on species important to specific subareas and divisions. This advice includes details on the current status of species, current management plans in place and recommendations for the future. For 2010, ICES published advice for Subarea IV regarding cod (*Gadus morhua*), haddock *(Malanogrammus aeglefinus*)), Norway pout (*Trisopterus esmarkii*), herring (*Clupea harengus*), Norway lobster (*Nephrops norvegicus)*, plaice (*Plueronectes platessa*), saithe (*Pollachius virens*), sand eels (*Ammodytes sp*.), sole (*Solea solea*), sprat (*Sprattus sprattus*) and whiting (*Merlangius marlangus*), in addition to advice specifically for Division IVa for Northern shrimp (*Pandalus borealis*). Updated advice for subarea IVa has been published for 2011 for herring and sand eels. However, through consultation it has been demonstrated that none of these species are targeted within the Inner Sound and the offshore Project area.

14.21 Certain species do not have quotas including lobster (Homarus gammarus), scallop (*Pecten sp*.), brown crab (*Cancer pagarus*) and velvetcrab (*Necora puber*); these are managed at local or national level through the Inshore Fishing (Scotland) Act 1984 (as amended 1994); giving Fisheries Division Managers the ability to control the activities of certain fishing gears and to open/close inshore areas. The Act is mainly exercised through the Inshore Fishing (Prohibition of Fishing and Fishing Methods (Scotland) Order 1989). Following consultation with the Scottish Inshore Fisheries and Advisory Group (SIFAG), the Deputy Minister for the Environment and Rural Development has announced that controls provided under the Act are to be reviewed.

14.22 Inshore Fisheries Groups (IFGs) in Scotland have been designed to allow fishing operators, stakeholders and other fishing interest groups to shape the management of local fisheries. Each IFG has an Executive Committee made up of commercial fishing interests and a spokesperson for non-affiliated fishermen. No IFG has been set up in the local area as yet; in the absence of a local IFG the North Coast Fisheries Group, the Orkney Fisheries Association and locally known fishermen have been consulted.

14.23 The Fisheries Committee is an advisory public body constituted under the Electricity Act 1989. It has a statutory remit to make recommendations to Scottish Ministers and people engaging in the generation of hydro-electric power; notably, tidal schemes are covered within the Committee's remit. The Committee provides advice on the effects of such schemes on fish, including making recommendations on how damage to fisheries or stocks of fish may be minimised or prevented.

14.5.2 Landings data

14.24 Landings data for the period 2006 – 2010 has been obtained from Marine Scotland. Table 14.6 details the value and liveweight tonnage for all species landed from ICES Statistical Rectangle 46E6 from 2006 – 2010. Notably, some of the data may be mis-reported such as the figures for monks & anglers (R. May pers comm., 2011). Mis-reporting of catches occur when a species is reported as being caught within a particular ICES rectangle (in this case 46E6), but the catches have actually been taken elsewhere (e.g. 46E7). Through consultation with local fishermen, it is known that shellfish comprise the main target species in the Inner Sound (lobster, brown crab, velvet crab).

Species	2006		2007		2008		2009		2010	
	Value (£)	Liveweight (Tonnes)	Value (£)	Liveweight (Tonnes)	Value (£)	Liveweight (Tonnes)	Value (£)	Liveweight (Tonnes)	Value (£)	Liveweight (Tonnes)
Blue ling	N/A	N/A	NA	NA	55	0.05	NA	NA	4	0.0
Bass	N/A	N/A	NA	NA	NA	NA	973	0.2	NA	NA
Catfish	N/A	N/A	27	0.1	100	0.05	34	0.0	NA	NA
Cockles	695	0.5	54	0.1	26	0.02	1,487	0.1	8,250	0.6
Cod	47,387	23.9	56,341	32.0	65,264	30.48	121,497	67.6	165,815	78.3
Conger eels	72	0.1	4	0.00	18	0.03	NA	NA	1	0.0
Common skate	N/A	N/A	NA	NA	NA	NA	304	0.4	NA	NA
Craw fish	N/A	N/A	29	0.00	NA	NA	2,739	0.1	20	0.0
Brown crabs	578,468	501.9	756,057	599.6	471,710	405.35	626,219	554.5	830,888	682.6
Velvet crabs	350,223	158.1	328,169	167.2	277,549	136.71	283,392	133.5	346,659	145.0
Green crab	21,312	39.2	21,367	35.8	21,612	39.86	20,374	36.8	23,701	40.5
Cuckoo Ray	NA	NA	NA	NA	NA	NA	NA	NA	59	0.2
Dabs	78	0.3	NA	NA	NA	NA	NA	NA	NA	NA
Greater Forked Beard	50	0.5	NA	NA	NA	NA	NA	NA	666	0.5
Gulper shark	NA	NA	NA	NA	0	0.01	NA	NA	NA	NA
Red gurnards	217	0.3	263	0.3	390	1.37	244	1.5	10	0.0
Haddock	28,188	24.5	25,226	22.7	48,715	47.40	183,407	191.7	177,738	164.4
Hake	743	0.5	3,991	2.8	2,117	0.99	1,214	2.0	493	0.3
Halibut	180	0.01	455	0.1	1,558	0.25	913	0.1	690	0.1
Herring	N/A	N/A	20,924	116.2	84,970	274.12	188,120	579.1	13,804	50.2
Horse mackerel	N/A	N/A	NA	NA	NA	NA	NA	NA	30,113	100.4
John Dory	4,850	1.5	1,570	0.4	2,813	0.33	1,395	0.4	2,179	0.4
Lemon sole	367	0.1	821	0.5	1,250	0.68	907	0.6	306	0.2
Ling	3,378	2.5	3,575	2.7	3,144	2.36	10,339	9.9	4,733	2.2
Lobster- squat	N/A	N/A	3,033	0.5	686	0.29	NA	NA	NA	NA
Lobsters	571,977	50.9	615,179	54.0	687,465	62.03	752,260	71.3	955,735	87.4
Long nosed skate	N/A	N/A	NA	NA	NA	NA	261	0.3	NA	NA
Mackerel	120	0.3	1,003	2.2	3,397	5.14	2,023	4.2	1,691	2.8
Megrim	115,062	40.9	76,323	34.1	29,784	11.78	17,284	7.9	33,153	12.8
Mixed clams	N/A	N/A	844	0.332	332	0.12	NA	NA	NA	NA
Monks and Anglers	857,719	309.1	744,636	310.3	780,949	283.65	568,755	182.6	374,212	110.8
Nephrops	51,159	11.8	66,358	15.9	70,616	24.81	19,665	4.0	17,111	4.7
Octopus	NA	NA	NA	NA	NA	NA	NA	NA	3	0.0
Other flatfish	230	0.1	18	0.0	141	0.08	59	0.1	35	0.0
Other or mixed demersal	199	0.2	150	0.1	251	0.15	492	0.3	628	0.3
Periwinkles	39,796	32.451	134,475	49.5	47,523	38.33	46,718	39.3	108,919	50.9
Plaice	8,056	9.4	506	0.7	744	1.10	749	1.3	434	0.6
Pollack	4,491	6.4	2,846		363	0.22	501	0.2	302	0.1
Portuguese Dogfish			1,163	1.7						
Queen Scallops	337	0.3	5,709	6.2	1,405	1.49	608	0.9	290	0.3
Rabbit fish	126	0.2	NA	NA						
Razor clam	3,829	1.4	NA	NA	793	0.24	108	0.0	816	0.3
Redfishes	N/A	N/A	NA	NA	NA	NA	NA	NA	4	0.0

Species	2006		2007		2008		2009		2010	
	Value (£)	Liveweight (Tonnes)	Value (£)	Liveweight (Tonnes)	Value (£)	Liveweight (Tonnes)	Value (£)	Liveweight (Tonnes)	Value (£)	Liveweight (Tonnes)
Red mullet	N/A	N/A	15	0.0	NA	NA	557	0.1	NA	NA
Roes	44	0.1	203	0.1	570	0.09	3	0.0	143	0.1
Saithe	2,801	3.0	7,529	16.4	5,039	9.56	9,353	14.8	23,557	27.5
Scallops	134,621	63.4	106,106	43.2	74,103	38.08	158,696	46.9	150,273	59.2
Skates and Rays	3,259	3.5	4620	4.1	2,599	3.96	1,574	1.9	1,761	1.7
Spotted Ray	N/A	N/A	NA	NA	NA	NA	NA	NA	68	0.1
Spurdog	7,104	7.4	7,231	9.6	8,324	5.68	21,800	19.1	708	0.9
Sole	N/A	N/A	NA	NA	NA	NA	10	0.0	NA	NA
Squid	9,611	3.6	3,487	1.2	5,865	2.21	12,644	5.6	23,670	9.3
Surf clams	258	0.3	NA	NA	NA	NA	NA	NA	NA	NA
Thornback Ray	N/A	N/A	NA	NA	NA	NA	196	0.2	5	0.0
Torsk	3,599	4.5	2,377	3.1	1,226	1.74	943	1.3	2,063	2.2
Turbot	204	0.1	691	0.1	681	0.09	135	0.0	628	0.1
Unidentified dogfish	N/A	N/A	NA	NA	8	1.66	40	0.0	12	0.0
Whelks	24,126	44.1	19,946	34.8	836	1.57	31,476	60.1	22,709	41.08
White skate	N/A	N/A	N/A	N/A	NA	NA	7	0.1	252	0.3
Whiting	2,433	2.4	4,755	4.1	7,439	6.85	21,039	17.7	21,970	21.3
Witch	95	0.1	503	0.6	NA	NA	221	0.2	136	0.1

Notes:
[1]Mis-reporting of catches occurs when a species is reported as being caught within a particular ICES rectangle (in this case 46E6) but the catches have actually been taken elsewhere (e.g. 46E7).

Table 14.6: Value and liveweight tonnage for all species landed from ICES statistical rectangle 46E6 2006 -2010 (Marine Scotland Statistics, 2011a). *Red text indicates key economic species*

14.5.3 Commercially important species occurring in the Project area

14.25 During the period from 2006 to 2010, the species of greatest commercial value in ICES Statistical Rectangle 46E6 were (in order of descending economic value) brown crab, lobster, velvet crab and scallops. Refer to Table 14.6 and Figure 14.2 and Figure 14.3 (below) for further details.

14.26 Between 2006 and 2010 the overall value for landings from ICES Statistical Rectangle 46E6 steadily increased, a slight decrease was recorded in 2008. This decrease is possibly (in part) due to a reduction in the landings for the most valuable species in 2008 (detailed in Figure 14.5 and Table 14.6). The overall annual live weight tonnage and annual economic value has shown an overall increase compared to those seen in 2006, as illustrated in Figure 14.4, Figure 14.5 and Table 14.7. However, despite an increase in total tonnage of landings in 2008 (in comparison to 2006), the economic value in this year showed a decrease in value of just under 6% (Table 14.7). This could be due to a significant decrease in the price recorded for one of the most regularly landed species (i.e. brown crabs or lobster).

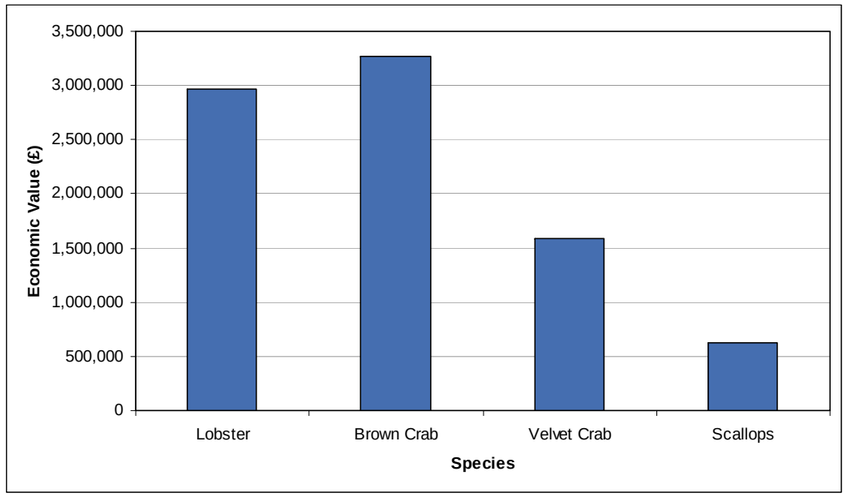

Figure 14.2: Total economic value for landings into ICES Statistical Rectangle 46E6, for the most valuable species (2006 – 2010), (Marine Scotland Statistics, 2011a)

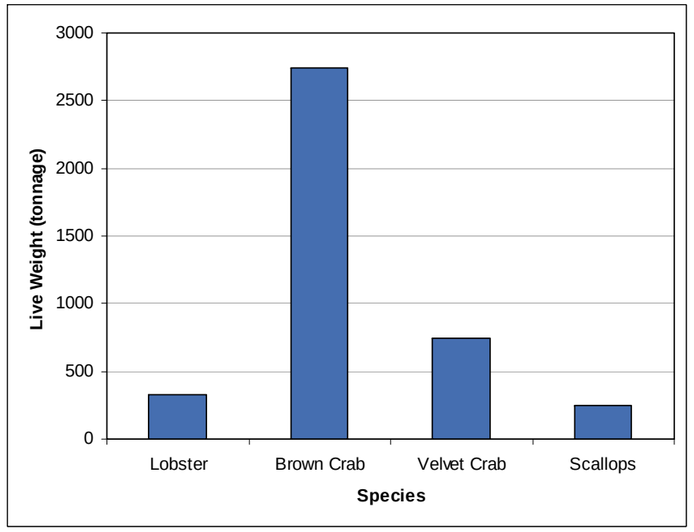

Figure 14.3: Total liveweight tonnage for landings into ICES Statistical Rectangle 46E6, for the most valuable species (2006 – 2010), (Marine Scotland Statistics, 2011a)

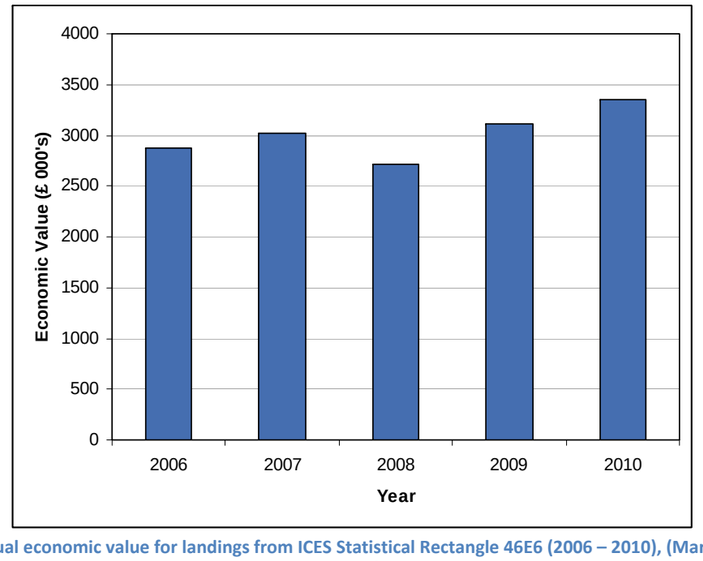

Figure 14.4: Total annual economic value for landings from ICES Statistical Rectangle 46E6 (2006 – 2010), (Marine Scotland Statistics, 2011a)

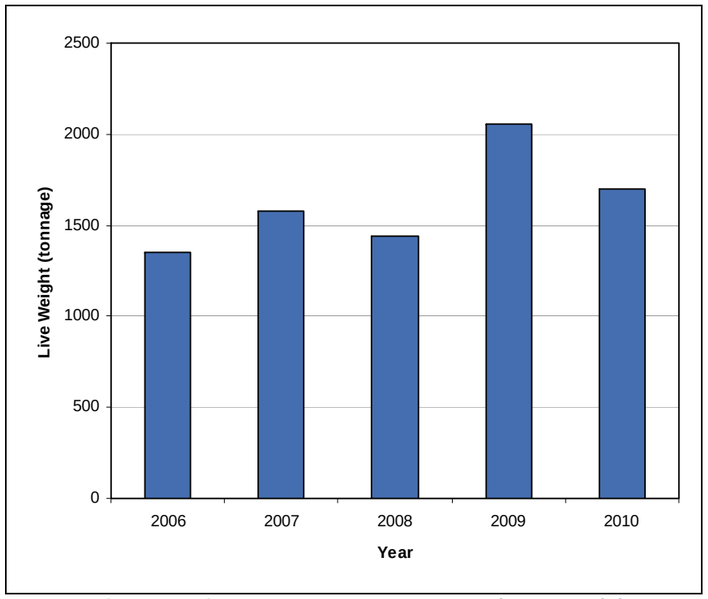

Figure 14.5: Total annual liveweight for landings from ICES Statistical Rectangle 46E6 (2006 – 2010), (Marine Scotland Statistics, 2011a)

Year	% Increase over in tonnage compared to 2006	% increase in value compared to 2006
2007	16.70%	4.99%
2008	6.75%	-5.74%
2009	52.53%	8.14%
2010	26.00%	16.33%

Table 14.7: Percent Change in landings in tonnes and value compared to 2006 (Marine Scotland Statistics, 2011a)

14.5.4 Spawning and nursery grounds

14.27 The Pentland Firth, including the offshore Project area, comprises spawning grounds for a number of commercial fish species; including sand eel, lemon sole and herring. This is detailed further in Section 13. None of the aforementioned species have significant landings or economic value for the ICES Statistical Rectangle 46E6, but are considered to be commercially important species in other areas (Coull *et al.*, 1998).

14.28 In addition to providing spawning grounds, the Pentland Firth (including the offshore Project area) provides a nursery area for a number of commercial fish species as detailed further in Section 13. Habitats within the Pentland Firth provide an important nursery area for blue whiting and anglerfish; in addition to comprising part of large nursery grounds for hake, mackerel, ling, sandeel, saithe, herring, haddock, lemon sole, whiting and cod. In terms of commercial fisheries, cod and haddock are known to have significant landings and economic value for Statistical Rectangle 46E6. However, consultation with local fishermen indicates that these species are not targeted within the offshore Project area.

14.5.5 Key commercial fish species

Lobster

14.29 Between 2006 and 2010, lobster accounted for 4.0% of the total liveweight tonnage for the ICES Statistical Rectangle 46E6. However due to the high economic value of lobster, landings accounted for 24% of the economic value for the period 2006 – 2010, making it the most valuable species for this time period with an economic value of £3,582,616. Both liveweight landings and economic value have increased each year between 2006 and 2010 (see Table 14.6).

14.30 Landings data for Scrabster shows that the most significant landings of lobster occur from August to October as presented in Table 14.8. Annual landings of lobster into Scrabster have fluctuated within a range of approximately 9 tonnes (42% of the 2006 value) in between 2006 and 2010, with a peak shown in 2009 (Table 14.9).

14.31 The preferred habitat of lobster is rocky substrata, with holes and excavated tunnels. Lobsters are found from the lower shore to depths of approximately 60m (Wilson, 2008). During the benthic survey carried out in the Project area between 25th and 27th July 2011, no lobsters were recorded (AMSL, 2011).

14.32 Lobsters are targeted by vessels using static gear (creels or pots). Given the strong tidal conditions in the vicinity of the offshore Project area, the offshore Project area is not considered important for lobster.

14.33 Consultation with local fishermen has confirmed that the turbine deployment area is targeted for lobster during the spring and summer months by at least one local fisherman, concentrating his efforts on the western area of the turbine deployment area. Fishing is limited in the turbine deployment area as it requires a combination of neap tides and good weather, due to the time it takes to deploy and haul creels between tides. The cable corridor to shore is fished more regularly.

Brown crab

14.34 Brown crabs, also known as edible crab, accounted for 33.8% of the total liveweight tonnage for the ICES statistical rectangle 46E6 between 2006 and 2010. With a total economic value of £3,263,342 brown crabs accounted for 22.0% of total landings value for the ICES statistical rectangle between 2006 and 2010; making brown crabs are the second most important species in terms of economic value. Both liveweight landings and economic value have shown a general increase between 2006 and 2010 for ICES statistical rectangle 46E6, with 2009 showing a peak for brown crab landings and 2007 showing a peak for economic value (see Table 14.9).

14.35 Landings data for Scrabster shows that the latter half of the year (from July onwards) shows the most significant landings for brown crab with a peak in landings in October (Table 14.8). Annual landings for brown crabs into Scrabster have fluctuated between 2006 and 2010 with peak landings shown in 2009 (Table 14.9).

14.36 Brown crabs have a preferred habitat of bedrock including under boulders, mixed coarse grounds and offshore in muddy sand. Brown crab is also found in the lower shore, shallow sublittoral and offshore to about 100m (Wilson, 2008). During the benthic survey carried out by ASML, brown crab were recorded on a number of occasions (ASML, 2011).

14.37 Brown crabs are targeted using static gears such as pots and creels. Consultation with local fishermen has confirmed that the turbine deployment area is sometimes targeted for brown crabs by a small number of vessels. Fishing is limited in the turbine deployment area as it requires a combination of neap tides and good weather, due to the time it takes to deploy and haul creels between tides. The cable corridor to shore is fished more regularly.

Velvet crab

14.38 Velvet crab accounted for 1% of the total liveweight tonnage for the ICES statistical rectangle 46E6 between 2006 and 2010. However due to the high economic value relative to weight, with a value of £1,585,992, velvet crab accounted for 10.5% of the total economic value for the ICES statistical rectangle 46E6 (between 2006 and 2010). Between 2006 and 2009, landings and value for velvet crab in the Statistical Rectangle 46E6 showed a gradual decline; between 2009 and 2010 this trend was reversed with an increase in both landings and value (Table 14.9).

14.39 Landings data for Scrabster shows that peak landings for velvet crab occur in August and December (Table 14.8). Between 2006 and 2009, landings of velvet crab into Scrabster showed a gradual decrease, a slight increase was recorded between 2009 and 2010. However, landings in 2010 still represent less than a third of the landings total for 2006 (Table 14.9).

14.40 Velvet crabs are found on stony and rocky substrata intertidally and in shallow water down to depths of 25m. They are most abundant on moderately sheltered shores (Wilson, 2008). During the benthic survey carried out in the Project area by AMSL, velvet crab was recorded (AMSL, 2011).

14.41 Velvet crabs are targeted using static gears such as creels or pots. Consultation with local fishermen has confirmed the cable corridor to shore is fished for velvet crabs.

Scallops

14.42 Between 2006 and 2010, scallops accounted for 3.1% of the total landings from ICES statistical rectangle 46E6. With a value of £623,799, scallops accounted for 4.1% of the total value for the ICES statistical rectangle 46E6, making them the fourth most commercially important species for this rectangle. Landings and value for scallops in the ICES statistical rectangle 46E6 have both fluctuated between 2006 and 2010. Both a peak in landings and value was seen in 2009 (Table 14.9).

14.43 Landings data for Scrabster shows that landings for scallop fluctuate throughout the year, with the most significant landings recorded in May and June and a smaller peak recorded in September – November (Table 14.8). Between 2006 and 2008, annual landings into Scrabster showed a gradual increase. Between 2008 and 2009 landings almost doubled, then between 2009 and 2010 landings more than halved to levels lower than landings recorded in 2006 (Table 14.9).

14.44 Scallops are usually found in shallow depressions in the seabed with a preference for mixed areas of clean firm sand and fine or sandy gravel and occasionally are found on muddy sand. Scallop distribution can therefore be described as patchy. During the benthic survey carried out by AMSL, scallops were not recorded (AMSL, 2011).

14.45 Given the type of seabed sediment found within the offshore Project area and the known preferred seabed habitat of scallops, it is unlikely that scallops will be encountered with any regularity in the vicinity of the Project area. Additionally, given the strong and rapidly changeable tidal conditions, scallop dredges are not a realistic option for this area. Consultation with local fishermen has confirmed that the offshore Project area is not used to target scallops and that the nearest site important for scallops is located considerably further east.

Month	Lobster		Brown crabs		Velvet crabs		Scallops	
	Live weight (Tonnage)	Economic value (£)	Live weight (Tonnage)	Economic value (£)	Live weight (Tonnage)	Economic value (£)	Live weight (Tonnage)	Economic value (£)
Jan	1.2	18,894	160.2	229,716	1.2	2,340	4.5	10,282
Feb	1.3	21,206	159.5	228,131	0.8	1,612	3.6	6,150
Mar	1.6	26,231	167.1	279,819	0.57	1,260.8	8.0	12,076
April	1.9	25,395	179.9	252,671	1.1	2,200	6.0	9,731
May	2.1	22,608	165.8	209,997	1.5	2,883	19.6	39,979
June	1.8	16,972	154.2	239,236	1.1	1,993	21.0	84,324
July	2.9	27,956	228.3	239,236	1.5	2,744	6.4	11,319
Aug	4.4	40,851	244.0	258,960	2.7	4,779	3.7	6,587
Sept	4.1	41,433	249.6	268,957	1.3	2,963	12.1	19,901
Oct	3.0	41,434	281.8	309,379	1.2	2,069	16.8	22,492
Nov	1.5	18,366	275.3	302,615	0.7	1,176	12.7	24,426
Dec	1.4	22,742	238.9	374,440	2.09	4,496	8.9	17,352

Table 14.8: Average monthly variation for landings of top economic species for ICES Statistical Rectangle 46E6 into Scrabster 2006 – 2010 (Marine Scotland Statistics, 2011).

Year	Lobster		Brown crabs		Velvet crabs		Scallops	
	Live weight (Tonnage)	Economic value (£)	Live weight (Tonnage)	Economic value (£)	Live weight (Tonnage)	Economic value (£)	Live weight (Tonnage)	Economic value (£)
2006	22.0	249,773	2,662	3,409,204	30.0	54,188	81.8	137,340
2007	29.8	369,457	2,769	3,763,944	19.6	41,577	83.9	152,332
2008	25.2	299,426	2,162	2,710,321	10.8	20,010	93.4	210,249
2009	31.2	347,788	2,870	3,319,613	9.4	17,680	170.2	485,768
2010	28.0	312,948	2,338	2,965,122	9.7	19,166	70.0	111,098

Table 14.9: Annual variations for landings of top economic species for ICES Statistical Rectangle 46E6 into Scrabster (2006 – 2010). (Marine Scotland Statistics, 2011)

14.5.6 Commercial Fisheries within the Project Area

Gear type

14.46 The local conditions and tidal currents in the area mean that it is largely unsuitable for mobile gear types such as dredging and trawling. The main gear types used for fishing in the area are static and predominantly take the form of creeling or pots targeting shellfish species. In 2008, 2009 and 2010, pots accounted for over 80 % of the fishing effort in terms of fishing days (Scottish Government, pers. Comm., 2011).

Vessel presence in the Inner Sound

14.47 Automatic Identification System (AIS) data collected as part of the Navigation Risk Assessment (Anatec, 2011) and presented in the Navigation section (Section 15). These data indicate that only a very small number of fishing vessels transit the Inner Sound; notably all recorded fishing vessels were steaming on passage through the Inner Sound and no fishing vessels were recorded in the Project area. These vessels predominantly use the south of the offshore Project area and show little change in transit numbers and routes from the summer to the winter.

Origin of fishing vessels

14.48 All of the vessels that landed from the ICES statistical rectangle 46E6 in the period between 2006 and 2010 were registered within the UK. Given the predominant gear type in the study area (pots and creels) this explains landings being from UK vessels; pots and creels are generally not left for a period of longer than 40 hours, making this method of fishing generally viable for local vessels only. Consultation with local fishermen indicates that all of the boats encountered and actively fishing in the vicinity of the offshore Project area are likely to originate from John o' Groats.

The local fishing fleet

14.49 Scrabster is the nearest major commercial fishing port, located to the west of the Project, reporting landings of 13,900 tonnes (live weight) in 2009, with employment of 170 fishermen through Scrabster Harbour (Marine Management Organisation (MMO), 2009). There are 107 vessels less than 10m in length currently listed as having their administrative port as Scrabster; nine of which have their home port in Wick, 10 have their home ports in John o' Groats and 58 have their home port in Scrabster. There are 18 vessels over 10m in length which list Scrabster as their administrative port; three of which have their home port in Wick, two in John o' Groats and two in Scrabster (DEFRA, 2011).

14.50 Consultation with local fishermen indicates that there are three John o' Groats based fishermen who regularly fish in the vicinity of and occasionally within the boundaries of the turbine deployment area. However, it should be noted that four vessels are operated by these fishermen:

- Abbyjack;
- Azur;
- Little Seal; and
- Kingfisher.

14.51 These vessels are all used to deploy creels. Generally a couple of strings will be deployed at a time each with approximately 30 pots on each string.

14.52 The area is used throughout the year and the chance of encountering these vessels in the area is not determined by season; tidal and weather conditions dictate when vessels will use the area, although the time of year may dictate which species will be targeted and where they will be fished for. Brown crab and velvet crab may be targeted in the Project area in the winter months but not at other times of the year. The strong and rapidly changeable tidal conditions in the turbine deployment area mean there are tight weather and tide windows for deploying and hauling creels. It is therefore not intensively fished since fishermen are reluctant to use static gear in such conditions.

Vessel Monitoring System (VMS) data

14.53 The Vessel Monitoring System (VMS) is a form of satellite tracking using transmitters onboard fishing vessels. The system is a legal requirement under EC Regulation 2244/2003 and Scottish SI 392/2004. The VMS unit automatically sends the following data on a pre determined timescale:

- Vessel identification;
- Geographical location;
- Date and time of fixing position; and
- Course and speed.

14.54 All EU, Faroese and Norwegian vessels which exceed 15m in length must be fitted with VMS units. Fisheries Monitoring Centres have been established to monitor VMS data.

14.55 VMS data obtained from Marine Scotland Statistics for the period 2006 – 2009 indicates that annually less than 26 fishing vessels of over 15m length were recorded in the vicinity of the Inner Sound. Consultation has indicated that fishing by these vessels does not take place in the offshore Project area. A more significant number of vessels were recorded to the west (Figure 14.6).

Aquaculture

14.56 There are no historic or active aquaculture sites located within the vicinity of the offshore Project area or surrounding environment. The closest aquaculture development is located off the Orkney island of Hoy at West Fara, approximately 14km northwest (Magic, 2011; Scottish Government, 2010). The site is operated by Northern Isles Salmon, which has a licenced maximum biomass of 900 tonnes (Pers. Comm., Northern Isles Salmon, 2011). Due to the distance from the Project this site will not be impacted. Due to the strong tidal conditions within the Inner Sound, it is considered highly unlikely that the area will ever be looked upon favourably for the development of aquaculture sites.

14.5.7 Socio-economics of commercial fisheries

14.57 The 2009 Economic Survey of the UK Fishing Fleet provides a detailed insight into the financial and operational performance of the fleet during 2009. Table 14.10 details the average daily and annual incomes for vessels using pots and traps. Consultation with local fishermen indicates that vessels most frequently found in the vicinity of the offshore Project area are less than 10m in length.

	Vessel less than 10m	Vessel 10 – 12m	Vessel over 12m
Average annual income per vessel (£)	44,280	93,707	248,017
Average daily income per vessel (£)	474	602	1,790

Table 14.10: Daily and annual incomes vessels from the UK fishing fleet using pots and traps (Curtis and Brodie, 2011)

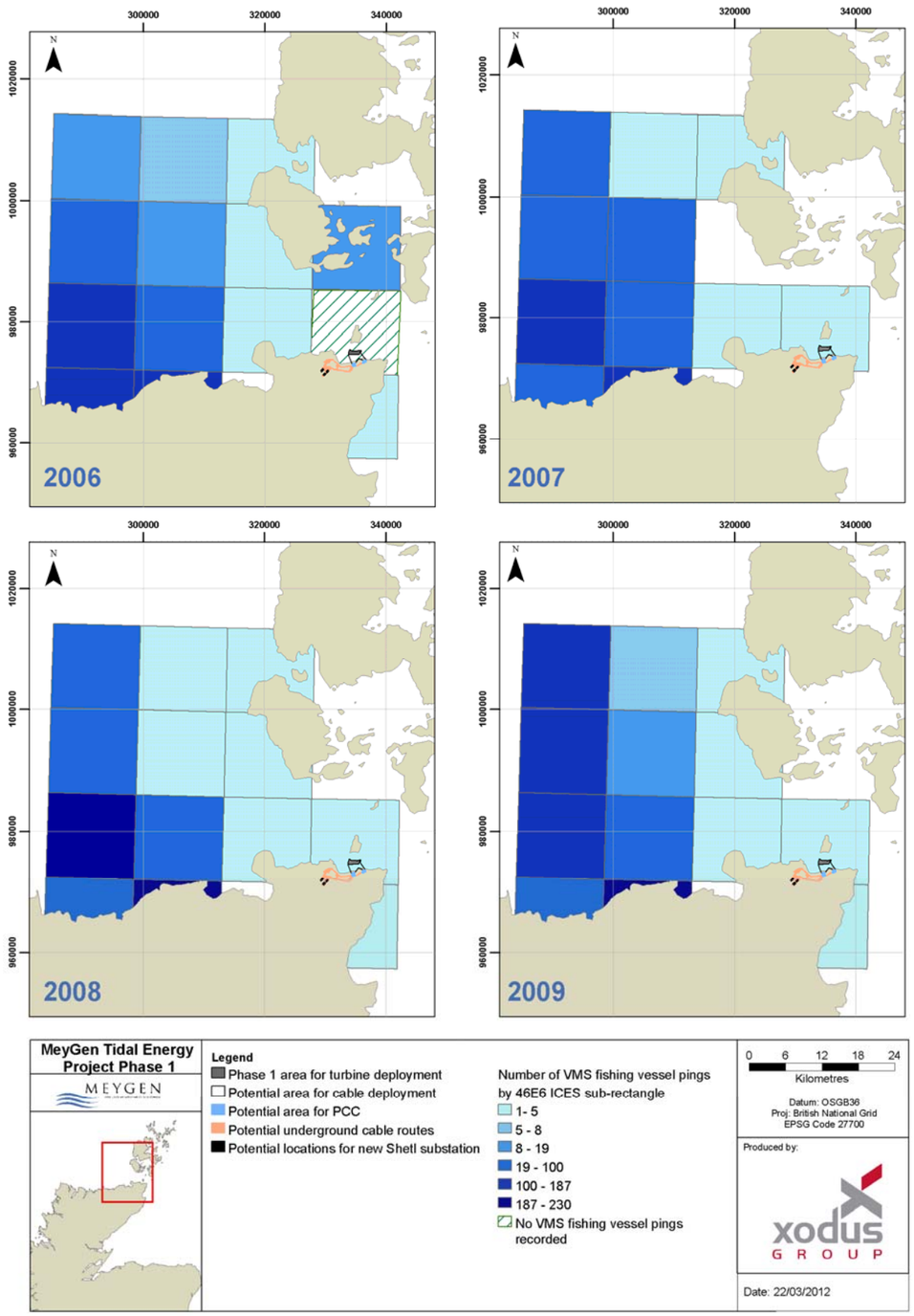

Figure 14.6: VMS data for Inner Sound and wider area 2006 – 2009 (Marine Scotland Statistics, 2011) Aquaculture

14.5.8 Recreational Fishing

Game fishing

14.58 A study into the economic impact of game and coarse fishing in Scotland estimated a total of 1.4 million angler days (annually) in Scotland; with the three most important regions being the Highlands, the Northeast and Central Scotland. Angling for brown trout in the Highlands is very popular, particularly amongst people from the Central Belt. Salmon fishing is also very popular and contributes approximately £35.4 million to the Highland economy, of which the vast majority comes from outside Scotland.

14.59 Out of all the regions in Scotland, the Highland region has the greatest angler expenditure per day at £140.04; this takes into accounts things such as transport, accommodation and food.

14.60 There are a number of largely unexploited hill lochs in the Highlands. Caithness and Sutherland are unusual in having successfully marketed angling in such lochs (Radford and Riddington, 2004). Salmon fishing takes place in a number of rivers across Scotland with the closest to the Project area being the Thurso River, 21km to the west. Catches of Scottish salmon between 2003 and 2007 accounted for 60% and 12% of the UK and European nominal catch (fish killed and retained), respectively (Malcolm *et al*., 2010). As demonstrated in Section 13, migrating salmon potentially pass through the Project area during their migrations to feeding grounds off the coast of Greenland and the Faroe Islands and on their return back to their home rivers.

Sea angling

14.61 In 2009 a study was carried out into the economic impact of recreational sea angling in Scotland. It estimated that a total of 144,346 annual sea angler days occur in the North of Scotland every year. Out of the seven areas considered, this was the fifth lowest total. It is estimated that a total of 299 full time jobs are currently supported by sea angling in the North of Scotland; this figure is made up from full time positions, part time positions and seasonal positions.

14.62 The nearest location to the Project which was identified as important local centre for sea angling is Thurso, which ranked in the top 26 most popular launch sites. The mean annual expenditure by an adult sea angler was reported to be £1,516. The survey identified that there is a belief among many sea anglers that there are fewer sea anglers now than there was 20 and 10 years ago and that this trend is likely to continue, with the main reason cited as a decline in fish stocks. The study concludes with the opinion that there is significant potential for growth in Scottish Sea angling (Radford *et al*., 2009). Consultation with local fishermen indicates that the area in the vicinity of the offshore Project area is used occasionally by recreational anglers, but is not considered to be a significantly important sea angling area.

14.6 Impacts during Construction and Installation

14.6.1 Impact 14.1: Temporary exclusion from fishing grounds

14.63 Commercial fisheries occurring in the offshore Project area are comprised of small vessels (less than 15m in length) using pots to target lobster, brown crab and velvet crab. One fisherman targeting lobster concentrates fishing effort to the western end of the Project area; local waters occurring within the offshore Project area are also occasionally fished during winter months for brown and velvet crabs. Notably, it is anticipated that marine works will take place in the spring, summer and autumn months when weather conditions are most favourable.

14.64 Satellite data within the NRA (Anatec, 2011) recorded 16 vessels within the offshore Project area; all but 1 vessel was travelling at greater than 5 knots, so recorded vessels were likely to be in transit through the Inner Sound and not fishing, suggesting that the offshore Project area is not a locally important area for trawling activities and other large vessels. However, consultation does suggest some creeling activity occurs within the offshore Project area, although the intensity of fishing is generally low and these grounds are not the only ones exploited by fishermen identified during consultation.

14.65 It is likely, that during the construction phase, fishermen will be unable to access waters in the immediate vicinity of the offshore Project area; due to the presence of construction vessels undertaking construction

works and related safety considerations. To reduce the risk of interactions between fishing vessels and construction works, a safety zone may be put in place around the area of construction; the size of the safety zone has yet to be confirmed. If enforced, the safety zone may extend to a maximum radius of 500m (0.79km^2) although a smaller radius is anticipated (Section 15). This may have implications for the lobster fisherman utilising waters in the area during the spring / summer months when construction works are most likely to take place. It is recognised that fishermen may not wish to fish in the offshore Project area or immediate surrounding waters to reduce the risk of causing accidental damage to fishing gear.

14.66 The sensitivity of the fishing activity in the area is assessed as low due to the Project area not being a regular or intensely fished area and the area being of low importance. However, there will be a change to the ability to fish in the area and as a result the magnitude of the impact is considered moderate.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Low	Moderate	Minor	Not Significant

MITIGATION IN RELATION TO IMPACT 14.1

- Although no significant impact has been identified, mitigation measures have been provided on a precautionary approach to ensure this remains the case.
- Ensure consultation with fishermen, which may involve the appointment of a Fisheries Liaison Officer to ensure fishermen are informed in advance of installation plans and to promptly answer any queries from fishermen.
- Details of the Project will be included in updated Kingfisher fishermen's awareness charts and FishSAFE.
- *Additional mitigation measures for all shipping and navigation have been identified in Section 15.*

14.6.2 Impact 14.2: Displacement of fishing effort targeting new or alternative fishing grounds

14.67 Fishing effort local to the Project is very low, comprising four vessels with the majority of fishing activity taking place in shallower waters outwith the turbine deployment area. Nevertheless, local fishing activity has the potential to occur all year-round. Alternative fishing areas (where pots may be used to target lobster and crab species) are located to the east and west of the offshore Project area and in waters close to the coast and these are already exploited to a greater degree by the vessels operating in the proposed Project area. It may be possible that fishermen can target the aforementioned species in peripheral waters surrounding the turbine deployment area; however, as discussed in Section 14.6.1, it is possible that for safety reasons, restrictions will be in place throughout the construction phase. The local fishing fleet may be able to temporarily modify commercial fishing activities throughout the construction phase; avoiding the offshore Project area to prevent interactions with installed marine infrastructure and collisions with construction vessels.

14.68 The sensitivity of the fishing activity in the area is assessed as low due to the Project area not being a regular or intensely fished area and the area being of low importance. However, there will be little change as fishermen already fish many areas outside the Project are and there displacement from the Project area is unlikely to change fishing effort in these areas. Therefore, the magnitude of the impact is considered minor.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Low	Minor	Minor	Not Significant

MITIGATION IN RELATION TO IMPACT 14.2

- Although no significant impact has been identified, mitigation measures have been provided on a precautionary approach to ensure this remains the case.
- Ensure consultation with fishermen, which may involve the appointment of a Fisheries Liaison Officer to ensure fishermen are informed in advance of installation plans, and to promptly answer any queries from fishermen.
- Details of the Project will be included in updated Kingfisher fishermen's awareness charts and FishSAFE.
- *Additional mitigation measures for all shipping and navigation have been identified in Section 15.*

14.6.3 Impact 14.3: Change in abundance and distribution of target species

14.69 It is acknowledged that the main fish species targeted within the offshore Project area and surrounding waters are predominantly benthic crustaceans (lobster, brown crab and velvet crab). Direct disturbance from installation activities may affect the local distribution and abundance of these species; both within the turbine deployment area and in immediate surrounding habitats. Impacts on benthic species, including disturbance, are discussed further in Section 10. Loss of benthic habitat will be limited to the footprint of the tidal turbine devices and cables and in total will impact upon a relatively small area of benthic habitat within the Inner Sound. Changes in tidal conditions may also result in changes to benthic habitats; the results of coastal process modelling has indicated that such changes will not be significant. Minor changes in benthic habitats will not likely affect the abundance and distribution of target species, with negligible impacts only (Section 10 and Section 9).

14.70 Velvet crabs, usually inhabit intertidal or shallow waters; therefore this species will not likely be present in the deeper waters within the offshore Project area where turbine deployment will take place, although velvet crabs will likely be present for a portion of the length of the cable corridor. Notably, the maximum estimated area of seabed likely to be directly affected by the cable corridor is 0.027km^{2,} a relatively small percentage of the total available seabed in the Inner Sound. Therefore, the total area that will be affected (i.e. where cables will be laid) is only 1.09% of the total cable corridor area for the Ness of Huna cable corridor and only 1.10% of the Ness of Quoys corridor. In deeper waters where tidal turbines will be placed at a depth of approximately 31 to 38m, lobster may be more likely to be present. Recent studies (Neal & Wilson, 2008 and Jackson *et al*. 2008) suggest that lobster and crab species have low sensitivity to habitat loss and effects of smothering; therefore, target species occurring within the offshore Project area are considered to have a low sensitivity to disturbance impacts from installation operations. Changes in the abundance and distribution of target species within the offshore Project area and immediate surrounding waters will therefore likely be minor.

14.71 The sensitivity of the fishing activity in the area is assessed as low due to the Project area not being a regular or intensely fished area and the area being of low importance. Due to the low sensitivity of the target species to disturbance there are unlikely to be changes to the available population of crabs and lobsters. Therefore, the magnitude of the impact is assessed as minor.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Low	Minor	Minor	Not Significant

MITIGATION IN RELATION TO IMPACT 14.3
▪ No mitigation measures proposed as no significant impact predicted.

14.6.4 Impacts 14.4: Risk of contamination (accidental spillage from vessels)

14.72 The discussion around this impact focuses on the potential impacts associated with the release of a large inventory of fuel oil from a vessel. This is considered to be the worst case potential accidental pollution impact. Other smaller inventories of polluting substances may potentially be released during the course of the Project. These impacts and their potential consequences are discussed further in accidental events (Section 24).

14.73 The total oil inventory for the large DP installation vessels is likely to be in the region of 6,000,000 to 8,000,000 litres of marine diesel stored in a number of separate tanks. The worse case spill from a single tank rupture is likely to be in the region of 600,000 litres of marine diesel released into the marine environment.

14.74 Oil spills can have a number of environmental impacts. Actual effects will vary depending on a wide range of factors including the volume and type of oil spilt and the sea and weather conditions at the time of the spill. Effects will also be dependent on the presence of environmental sensitivities in the path of the spill, but could include commercially important species present in the area i.e. lobster and crab.

14.75 An accidental event resulting in contamination to target species has the potential to result in cessation of fishing activities occurring in the offshore Project area and immediate surrounding environment. Should such an accidental event occur, only a small number of fishing vessels could be affected (a maximum of 4) and therefore the magnitude of impact is considered minor. Sensitivity of receptor is also considered low.

14.76 The potential for a loss of a large fuel oil inventory from a vessel is defined as extremely remote (see Impact 24.1, Section 24).

Impact significance (see Section 24 for impact ranking methodology)

Sensitivity of receptor	Magnitude of impact	Consequence	Likelihood *(See section 24)*	Impact significance *(See section 24)*	Significance (EIA Regs) *(See section 24)*
Low	Minor	Minor	Extremely remote	Negligible	Not Significant

MITIGATION IN RELATION TO IMPACT 14.4
▪ Although no significant impact has been identified, mitigation measures have been provided on a precautionary approach to ensure this remains the case. ▪ All vessels associated with Project operations will comply with IMO/MCA codes for prevention of oil pollution and any vessels over 400 GT will have onboard SOPEPs. ▪ All vessels associated with Project operations will carry onboard oil and chemical spill mop up kits. ▪ Where possible vessels with a proven track record for operating in similar conditions will be used. ▪ Vessel activities associated with installation, operation, routine maintenance and decommissioning will occur in suitable conditions to reduce the chance of an oil spill resulting from the influence of unfavourable weather conditions.

14.7 Impacts during Operations and Maintenance

14.7.1 Impact 14.5: Displacement of fishing effort

14.77 It is anticipated that the Project lifespan will be a minimum of 25 years, during this time, exclusion of fishing grounds would occur in the turbine deployment area and may occur infrequently and intermittently within the offshore Project area during essential maintenance operations (for safety reasons).

14.78 During operation, fishing is unlikely to take place in the vicinity of the tidal turbines for safety reasons. However, as stated earlier, the area is not fished regularly due to the difficult conditions and therefore there will be no large displacement of fishing effort from the turbine deployment area.

14.79 Maintenance operations are likely to involve enforcement of a 500m safety exclusion area surrounding the maintenance activities.

14.80 It is noted that only a small number of vessels (four boats in total) currently utilise waters within the offshore Project area, therefore potential changes in commercial fisheries are likely to be small in scale and occur intermittently over a long-term period (i.e. the lifespan of the Project).

14.81 Due to the low fishing effort within the Project area and the small number of vessels that fish the sensitivity of the fishing activity in the area is assessed as low. However, there will be a change to the baseline as fishermen will no longer be able to fish in the Project area. Therefore, the magnitude of the impact is considered moderate.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Low	Moderate	Minor	Not Significant

MITIGATION IN RELATION TO IMPACT 14.5
▪ No mitigation measures proposed as no significant impact predicted.

14.7.2 Impact 14.6: Change in abundance and distribution of target species

14.82 During Project operation, fishing is unlikely to place in the vicinity of the tidal turbines for safety reasons; it is therefore possible that turbine support structures may indirectly provide a refuge for brown crab and lobster, in addition to providing new substrate which rocky substrate species assemblages may find suitable to colonise. These 'refuge' areas may increase levels of general productivity, potentially increasing localised foraging resources for both lobster and brown crab. Increased foraging opportunities may enable lobster and brown crab populations to increase within the offshore Project area, particularly around the turbine support structures. Refer to Benthic Habitats and Ecology (Section 10).

14.83 The potential for increase in populations of target species may result in greater numbers of lobster and brown crab occurring in surrounding habitats outwith the turbine deployment area, which may increase the population available to local fisheries that target them. However, such effects are likely to be imperceptible to the local fishing fleet. Nevertheless, this long-term impact is considered positive, with potential for benefits to local benthic ecosystems and indirect benefits to the local fishing fleet.

14.84 In coastal areas adjacent to the offshore Project area, coastal process modelling has shown that there will be no discernable effect on coastal habitats (including subtidal and intertidal habitats); therefore impacts relating to changes in the abundance and distribution of the shallower water velvet crabs and velvet crab fisheries will likely be negligible.

14.85 Again due to the low fishing effort within the Project area and the small number of vessels that fish the sensitivity of the fishing activity in the area is assessed as low. Given that the Project has the potential to provide a benefit to the target populations of shellfish in the area, although potentially imperceptible, magnitude is assessed as a minor positive.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Low	Minor Positive	Minor Positive	Positive

MITIGATION IN RELATION TO IMPACT 14.6

- No proposed mitigation due to potential for beneficial effects to benthic ecosystems and local commercial fisheries.

14.7.3 Impact 14.7: Loss of fishing gear due to entanglement

14.86 It is possible that entanglement leading to loss of fishing gear, predominantly pots or creels, may occur during the operational life of the Project. No trawling takes place in Inner Sound. Therefore the only risk is considered to be from the local creel vessels. Consultation with the fishermen has indicated they would avoid fishing within the turbine array due to the danger of snagging. The main risk is likely to be with snagging the cables to shore. It may be that a situation may arise where tangled gear have to be cut free.

14.87 The low effort expended within the Project area and the small number of vessels that fish there the sensitivity of fishing activity in the area is assessed as low. However, once turbines are operational it is unlikely that fishing will take place within the turbine deployment area and it is unlikely that entanglement of gear will occur. Fishermen will also avoid areas where cables are present for the same reasons. Therefore, the magnitude of the impact is considered minor.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Low	Minor	Minor	Not Significant

MITIGATION IN RELATION TO IMPACT 14.7

- Although no significant impact has been identified, mitigation is still proposed to ensure this remains the case.
- Further consultation with the local fishing fleet to ensure the safe continuation of fishing effort in the cable deployment area once cables are installed.
- Consultation with the local fishing fleet, to ensure fishermen are aware of turbine locations.
- Provision of offshore Project area location data to local fishermen and Kingfisher Information Services (marine safety authority), to enable incorporation of offshore Project area location data into plotters.
- Project area will be depicted on charts. Turbines and cables will be depicted on appropriate scale charts.
- Cable route coordinates will be circulated to kingfisher and local skippers.
- Cables will be grouped (where feasible) to minimise overall footprint on the seabed.
- HDD bores will provide protection for at least part of the cable length from shore.
- Natural crevices will be used to avoid exposed cables being on the seabed surface as far as practicable.
- Additional material weighting will be used where necessary to ensure cable stability on the seabed.

14.7.4 Impact 14.8: Risk of Contamination

14.88 The vessels to be used during operations and maintenance will be the same size or smaller than those during construction and installation and will therefore have similar inventories of oil. The likelihood of spillage, mitigation measures and residual impacts are the same as those described for vessel spillage during construction and installation (Impact 14.4).

14.7.5 Impact 14.9: Indirect impacts to recreational fishing

14.89 In the vicinity of the Project there are fishing activities that take place that could potentially be impact by the operating turbines through their impact on fish species present in the Project area. These include both marine and migratory fish species. For sea anglers targeting fish within the Project area and the wider Pentland Furth the impact is unlikely to be of any significance due to the low importance of the area for recreational fishing. Section 13 assessed the overall impact to fish species as not significant. Therefore the target species of recreational sea anglers are unlikely to be affected by the Project and given the low effort expended in the Project area any effects of the Project are unlikely to be perceptible.

14.90 Salmon fishermen along the east and north coast of Scotland target salmon that have migrated through the Pentland Firth as smolts to their feeding grounds and have returned via the same route to their natal rivers to spawn. The Project therefore has the potential to impact the salmon population as it moves through the Pentland Firth and through the Inner Sound both as smolts and as adults, reducing the number of fish that return to the rivers and are available to be caught by fishermen targeting salmon. However Section 13 (Fish Ecology) assessed potential impacts to fish as a whole and to salmon as being not significant and that any impacts that do occur are likely to be imperceptible from changes in the population that occur naturally.

14.91 Salmon fishermen are considered to be receptors of high sensitivity due to fishery being highly sensitive to changes in salmon populations. However, the magnitude of the impact is considered to be negligible as changes to fish populations as a whole and to salmon populations were considered to be unlikely and imperceptible from natural variation in fish populations.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
High	Negligible	Minor	Not Significant

MITIGATION IN RELATION TO IMPACT 14.9
▪ No mitigation measures proposed specifically for recreational fishing activity as no significant impact predicted. However, measures will be implemented to mitigate impacts to fish populations (please refer to Section 13).

14.8 Impacts during Decommissioning

14.8.1 Impact 14.10: Disturbance of fishing grounds

14.92 Decommissioning of the tidal array will likely involve the removal of tidal turbines, turbine support structures and related offshore infrastructure. Impacts will include physical disturbance of benthic habitats, increased underwater noise, water column disturbance and an increase in local vessel activity. These impacts may result in temporary (disturbance related) displacement effects of target species.

14.93 Decommissioning works may also result in the temporary exclusion of fishing activities in the offshore Project area, for the duration of the decommissioning phase (for safety reasons). This will likely affect the temporary use of the waters in the Inner Sound by the local fishing fleet. The sensitivity of the receptor is considered low as only a few vessels will be affected during decommissioning. As the majority of vessels will not be fishing in the Project area and those that are will only be affected temporarily the magnitude of impact is considered minor.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Low	Minor	Minor	Not Significant

MITIGATION IN RELATION TO IMPACT 14.9
▪ Although no significant impact has been identified, mitigation has been proposed to ensure this remains the case. ▪ Ensure fishermen are aware of decommissioning activities and schedule. ▪ Details of the Project will be included in updated Kingfisher fishermen's awareness charts and FishSAFE.

14.8.2 Impact 14.11: Temporary changes in distribution and abundance of targeted species

14.94 As discussed in previous sections, target species occurring within the proposal footprint include lobster, brown crab and velvet crab. These species may be subject to disturbance impacts during the decommissioning stage; however, it is likely that disturbance impacts (if any) will be minor, localised and temporary. The tidal turbines will be removed from support structures to a recovery vessel and returned to shore. If piled foundations have been used the piles will be cut at the seabed and cables will be recovered to a vessel, with potential for disturbance impacts to benthic species (including target species), as the cables are moved over the seabed and the cable bores filled at the breakthrough location.

14.95 Disturbance and changes in the distribution and abundance of target species will likely occur in the same area that experienced impacts during construction and installation operations. Impacts will be of a similar or lesser magnitude as the impacts on target species described for the installation and operational phases and is therefore considered minor. The sensitivity to this impact will also remain low as it was for impacts during installation and operation.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Low	Minor	Minor	Not Significant

MITIGATION IN RELATION TO IMPACT 14.11
▪ No mitigation measures proposed as no significant impact predicted.

14.8.3 Impact 14.12: Risk of contamination

14.96 The vessels to be used during operations and maintenance will be the same size or smaller than those during construction and installation and will therefore have similar inventories of oil. The likelihood of spillage, mitigation measures and residual impacts are the same as those described for vessel spillage during construction ad installation (Impact 14.4).

14.8.4 Impact 14.13: Resumption of fishing activities in traditional fishing grounds

14.97 Following completion of decommissioning activities, the local fishing fleet will be able to resume traditional fishing activities in the Inner Sound to pre-construction levels, fully accessing all local traditional fishing grounds, including areas which may have been temporarily excluded during the construction phase or with restricted access during maintenance operations. This may be considered as a beneficial impact on the local fishing fleet; with long term effects on the activities of local commercial fisheries occurring throughout the Project lifecycle only.

14.98 The sensitivity of the receptor is considered minor due to the four vessels operating within the Project area. Following decommissioning of the Project these vessels will be able to resume fishing in the area and as it only represents a small proportion of their current fishing grounds the impact magnitude is considered a minor positive.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Low	Minor Positive	Minor Positive	Positive

MITIGATION IN RELATION TO IMPACT 14.13
▪ No proposed mitigation; impacts on the local fishing fleet will likely be positive, enabling resumption of fishing activities in traditional fishing grounds and a return of commercial fisheries activities to pre-Project conditions.

14.9 Potential Variances in Environmental Impacts

14.99 Consideration of the maximum potential impact has been undertaken throughout the commercial fisheries impact assessment. This has considered the entire footprint of offshore construction and installation activity including a maximum safety zone of 500m radius. It is likely that the safety zone will be reduced to allow navigation of the narrow channel still available to vessels transiting the area (see Shipping and Navigation, Section 15). This may increase the area available to fishing vessels, further reducing any impacts.

14.100 The area occupied by the turbines and cables during operation has also been considered in its entirety and as this is unlikely to change, the impacts assessed above are not considered to vary and the impacts as assessed above are considered to remain.

14.10 Cumulative Impacts

14.10.1 Introduction

14.101 MeyGen has in consultation with Marine Scotland and The Highland Council, identified a list of other projects (MeyGen, 2011) which together with the Project may result in potential cumulative impacts. The list of these projects including details of their status at the time of the EIA and a map showing their location is provided in Section 8; Table 8.3 and Figure 8.1 respectively.

14.102 Having considered the information presently available in the public domain on the projects for which there is a potential for cumulative impacts, Table 14.9 below indicates those with the potential to result in cumulative impacts from a commercial fisheries perspective. The consideration of which projects could result in potential cumulative impacts is based on the results of the project specific impact assessment together with the expert judgement of the specialist consultant.

Project title	Potential for cumulative impact	Project title	Potential for cumulative impact	Project title	Potential for cumulative impact
MeyGen Limited, MeyGen Tidal Energy Project, Phase 2	✓	SHETL, HVDC cable (onshore to an existing substation near Keith in Moray)	✗	OPL, Ocean Power Technologies (OPT) wave power ocean trial	✗
ScottishPower Renewables UK Limited, Ness of Duncansby Tidal Energy Project	✓	Brough Head Wave Farm Limited, Brough Head Wave Energy Project	✗	MORL, Moray Offshore Renewables Ltd (MORL) offshore windfarm	✗
Pelamis Wave Power, Farr Point Wave Energy Project	✗	SSE Renewables Developments (UK) Limited, Costa Head Wave Energy Project	✗	SSE and Talisman, Beatrice offshore Windfarm Demonstrator Project	✗
Sea Generation (Brough Ness) Limited, Brough Ness Tidal Energy Project	✗	EON Climate & Renewables UK Developments Limited, West Orkney North Wave Energy Project	✗	BOWL, Beatrice Offshore Windfarm Ltd (BOWL) offshore windfarm	✗
Cantick Head Tidal Development Limited, Cantick Head Tidal Energy Project	✗	EON Climate & Renewables UK Developments Limited, West Orkney South Wave Energy Project	✗	Northern Isles Salmon, Chalmers Hope salmon cage site	✗
SSE, Caithness HVDC Connection - Converter station	✗	ScottishPower Renewables UK Limited, Marwick Head Wave Energy Project	✗	Northern Isles Salmon, Pegal Bay salmon cage site	✗
SSE, Caithness HVDC Connection - Cable	✗	SSE Renewables Developments (UK) Limited, Westray South Tidal Energy Project	✗	Northern Isles Salmon, Lyrawa salmon cage site	✗
RWE npower renewables, Stroupster Windfarm	✗	EMEC, Wave Energy test site (Billia Croo, Orkney)	✗	Scottish Sea Farms, Bring Head salmon cage site	✗
SSE, Gills Bay 132 kV / 33 k V Substation Phase 1: substation and overhead cables (AC)	✗	EMEC, Tidal energy test site (Fall of Warness, Orkney)	✗	Northern Isles Salmon, Cava South salmon cage site	✗
SSE, Gills Bay 132 kV / 33 k V Substation Phase 2: HVDC converter station and new DC buried cable	✗	EMEC, Intermediate wave energy test site (St Mary's Bay, Orkney)	✗	Scottish Sea Farms, Toyness salmon cage site	✗
SHETL, HVDC cable (offshore Moray Firth)	✗	EMEC, Intermediate tidal energy test site (Head of Holland, Orkney)	✗	Northern Isles Salmon, West Fara salmon cage site	✗

Table 14.9: Summary of potential cumulative impacts

14.103 The following sections summarise the nature of the potential cumulative impacts for each potential project phase:

- Construction and installation;
- Operations and maintenance; and
- Decommissioning.

14.10.2 Potential cumulative impacts during construction and installation

14.104 Despite specific project details not being available for MeyGen Phase 2 and the other projects listed in Table 14.9, it is possible to qualitatively assess potential cumulative impacts. Both Phase 2 of the MeyGen Tidal Energy Project (additional 312MW) and the Scottish Power Renewables UK Limited Ness of Duncansby Tidal Energy Project have potential to result in cumulative impacts on local commercial fisheries. Cumulative impacts include disturbance and displacement of the local fishing fleet to alternative fishing grounds by project specific enforcement of temporary safety zones; with potential for increase in contamination risk through a general increase in vessel activity and offshore construction activity. However, the likelihood of a non-routine accidental event is considered remote and appropriate mitigation will be put in place across all projects, ensuring potential for cumulative impact remains minor.

14.105 There is the potential for safety zones to be employed for the construction and installation phase of each project which could be up to a maximum radius of 500m (0.79km^2). Given the distance between the closest project (Ness of Duncansby Tidal Energy Project) and the MeyGen Phase 1 Project is 3km, it is unlikely that safety zones will occur in close proximity to each other and there will be large areas of sea available for fishing activity to take place outside the safety zones. As a result the cumulative impact of these projects is considered to be insignificant.

14.106 Marine vessel traffic will likely increase in the wider area during the construction stage of the aforementioned marine renewables projects, potentially resulting in navigational safety issues for sea users (including the local fishing fleet) across the region. This is discussed further in the Shipping and Navigation section (Section 15).

14.10.3 Potential cumulative impacts during operations and maintenance

14.107 Operation of Phase 2 of the MeyGen Tidal Energy Project in concurrence with Phase 1 will increase the offshore area of turbine deployment in the Inner Sound, further decreasing the area of fishable waters in the Inner Sound. The aforementioned tidal energy projects elsewhere in the region will also be operational throughout the lifecycle of the Project; therefore there will be a further small reduction in the area of fishable waters. This may result in localised displacement of fishing effort; however the potential for cumulative impact on commercial fisheries is considered minimal, due to the low number of vessels (four) known to use the Inner Sound and the availability of alternative fishing grounds in the surrounding environment.

14.108 In addition, during maintenance operations, which are ongoing operations, it is likely that safety zones will be enforced. There is also the potential that each project could undertake maintenance operations at the same time (although this would not happen all the time) and therefore employ safety zones in concurrence. The size of these safety zones could be up to a maximum radius of 500m (0.79km^2). Given the distance between the closest project (Ness of Duncansby Tidal Energy Project) and the MeyGen Phase 1 Project is 3km, it is unlikely that safety zones will occur in close proximity to each other and there will be large areas of sea available for fishing activity to take place outside the safety zones.

14.109 Potential for loss of fishing gear through entanglement and contamination risk may increase due to the occurrence of tidal energy projects across the region; however it is anticipated that fishing activities will not take place in close proximity to offshore project areas for safety reasons. Therefore, cumulative impacts including disturbance and displacement due to maintenance operations are considered insignificant.

14.110 Additionally, there is potential for a cumulative minor positive impact to commercial fisheries, through an increase in populations of target species within project turbine deployment areas. As discussed in Section 14.7.2, the creation of localised 'refuge' areas may result in greater numbers of lobster and brown crab occurring in surrounding habitats outwith tidal energy project turbine deployment areas, which may increase the target population available to local fisheries. It is likely that such an effect would be imperceptible to the local fishing fleet, nevertheless the long-term cumulative impact is considered positive, with potential for benefits to local benthic ecosystems and indirect benefits to the local fishing fleet.

14.10.4 Potential cumulative impacts during decommissioning

14.111 It is unlikely that project decommissioning will occur at the same time across the region, therefore potential for cumulative impact from decommissioning to commercial fisheries is considered limited. It is likely that Project decommissioning will take place in combination with other offshore project activities the region; however only a small number of fishing vessels will be affected by disturbance and displacement effects and there is an abundance of alternative fishing habitat elsewhere in the region, therefore this impact is considered minor.

14.112 Following completion of decommissioning activities, traditional fishing activities will be able to resume in the offshore project footprints, with fishing vessels being able to fully accessing all local traditional fishing grounds, including areas which may have been temporarily excluded during project construction, maintenance and decommissioning phases. This may be considered as a beneficial impact on the local fishing fleet; with long term effects on the activities of local commercial fisheries occurring throughout project lifecycles only.

14.10.5 Mitigation requirements for potential cumulative impacts

14.113 No mitigation is required over and above the Project specific mitigation.

14.11 Proposed Monitoring

14.114 No monitoring specific to commercial fisheries is proposed. However, consultation with local fishermen will be ongoing throughout the duration of the Project to aid assessment of any long term project impacts, in addition to helping inform the decommissioning phase, ensuring disruption to the local fishing fleet is minimised where possible.

14.115 Vessel traffic behaviour will be monitored, more details are provided in Section 15 (Shipping and Navigation).

14.12 Summary and Conclusions

14.116 Throughout the Project life-cycle there are likely to be some effects of temporary exclusion to the local fishing fleet, including displacement from fishing grounds and access restrictions during installation and maintenance operations. However, such displacement and restriction impacts will be of a temporary nature only and will likely affect only a small number of fishing vessels (4 small boats) which are known to utilise fishing grounds within the Project area, targeting lobster, brown crab and velvet crab. However, it should be noted that these fishing grounds are not the only areas targeted by these boats and they represent only a small portion of their overall fishing area.

14.117 Notably the NRA (Anatec Ltd, 2011) highlighted that the fishing vessels in the Inner Sound are predominantly active in shallow areas outwith the turbine deployment area and that during operation the cable corridor will still be available for fishing activity. Therefore disturbance and displacement impacts likely to occur throughout the duration of the Project have been assessed as not significant.

14.118 Recreational fishing activity within the Project area is low and impacts to the target species are not significant and it is therefore unlikely that recreational angling activity will be affected by the Project. Salmon fisheries have a greater potential to be affected by the Project due to the sensitivity of the species they target. However, Section 13 (Fish Ecology) predicts that impacts to salmon from EMF and potential encounters with the turbine array will not be significant. Therefore it is unlikely salmon fisheries will be affected by the Project and impacts will be insignificant.

14.119 To conclude, the Project will impact upon local fisheries during the construction, operation and decommissioning phases. Likely impact on commercial fisheries including displacement of fishing effort, change in abundance and distribution of target species and risk of contamination have been assessed as not significant. The impact assessment has enabled comprehensive and cautious consideration of likely Project impacts on commercial fisheries; no significant impacts have been identified, therefore the overall effect of the Project on commercial fisheries is deemed not significant.

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15 SHIPPING AND NAVIGATION

15.1 The table below provides a list of all the supporting studies which relate to the Shipping and Navigation impact assessment. All supporting studies are provided on the accompanying CD.

Details of study	Location on supporting studies CD
MeyGen EIA Coastal Processes Modelling – Modelling setup, calibration and results (DHI, 2012)	OFFSHORE\Seabed interactions
Navigation Risk Assessment MeyGen Inner Sound (Anatec, 2012)	OFFSHORE\Navigational Risk Assessment

15.1 Introduction

15.2 This section summarises the work undertaken as part of the Navigation Risk Assessment (NRA) to assess the potential impacts of the Project on shipping and navigation. The assessment has been undertaken by Anatec Ltd.

15.3 To gain a better overall understanding of the baseline and potential impacts consideration should also be given to the following Environmental Statement (ES) sections:

- Physical Environment and Sediment Dynamics (Section 9)
- Commercial Fisheries (Section 14); and
- Socio-economics (Section 21).

15.2 Assessment Parameters

15.2.1 Rochdale Envelope

15.4 In line with the Rochdale Envelope approach, this assessment considers the maximum ('worst case') Project parameters. Identification of the worst case scenario for each receptor (i.e. Environmental Impact Assessment (EIA) topic) ensures that impacts of greater adverse significance would not arise should any other development scenario be taken forward in the final scheme design. Table 15.1 describes the detail of the Project parameters that have been used in this assessment and explains why these are considered to be worst case. The potential impacts from alternative Project parameters have been considered in Section 15.9.

Project parameter relevant to the assessment		'Maximum' Project parameter for impact assessment	Explanation of maximum Project parameter
Turbine	Number	86 turbines	The COLLRISK modelling which has been used to inform the impact assessment is based on 86 turbines. From a navigation perspective the worst case scenario is based on the 86 turbines being a mix of 18m and 20m diameter rotor turbines. A 20m diameter rotor turbine is used at turbine locations with the layout where an 8m underwater clearance to LAT can be maintained, the remainder are 18m rotors.
	Layout	86 turbines; an indicative turbine layout has been used to inform the modelling (see Figure 15.17)	An indicative layout for 86 turbines has been used to inform the collision modelling (Figure 15.17). The indicative layout is based on 45m cross-flow spacing and 160m down-flow spacing.
	Rotor diameter	18-20m	The COLLRISK modelling which has been used to inform the impact assessment is based on a mix of 18m and 20m rotor diameter turbines. From a navigation perspective the worst case scenario is based on the 86 turbines being a mix of 18m and 20m diameter rotor turbines. A 20m diameter rotor turbine is used at turbine locations with the layout where an 8m underwater clearance to LAT can be maintained, the remainder are 18m rotors.
	Number of rotor blades	N/A	The COLLRISK model assumes any vessel's hull passing through the area of water swept by the rotor blades will be involved in a collision.
	Minimum clearance between sea surface and turbine blade	8m	A minimum clearance of 8m below water level at LAT will be maintained at all turbine locations. At some turbine positions the underwater clearance will be greater than 8m and this is taken into account within the COLLRISK model.
	Minimum spacing between seabed and turbine blade	N/A	This Project parameter does not influence the shipping and navigation impact assessment.
	Decommissioning	All turbines removed at decommissioning	All turbines will be removed at decommissioning.
Turbine support structure	-	N/A	This Project parameter does not influence the shipping and navigation impact assessment.
Cable connection to shore	Maximum cable footprint on seabed	86, 120mm unbundled cables each 1,300m in length with split pipe armouring	The maximum physical area of the seabed occupied by the cables has been calculated as 0.027km^2. Based on a maximum 1.3km of cable from Horizontally Directionally Drilled (HDD) bore exit to turbine, and a cable diameter of 120mm (x2 to account for split pipe armouring) for 86 turbines.
	Decommissioning	86, 250mm unbundled cables, each 1,300m in length	All cables laid on the seabed will be fully removed at decommissioning.
Cable landfall	-	N/A	This Project parameter does not influence the shipping and navigation impact assessment.
Vessels	Safety zone during installation	500m radius area around installation activity	The size of the safety zone during construction will influence where vessels can navigate and how much space is available for vessels using the Inner Sound. The larger the safety zone the closer vessels may have to move towards the shore when travelling south of the Project, reducing the area available through which to navigate.
	Installation vessel physical presence	1 Dynamic Positioning (DP) vessel for the duration of the installation for year 1 and 2 2 DP vessels for year 3 installation	Installation activities will be carried out by a single DP vessel during year 1 and 2, all installation activities to be undertaken using a single DP vessel. If other smaller vessels used to undertake some of the work of the DP vessel, no concurrent multiple vessel activities will take place, i.e. no more than one vessel on site at any one time. Year 3 installation will require a maximum 2 DP vessels for TSS installation. These two vessels may be present on site at the same time during year 3.
	Maintenance vessel	1 DP vessel present every	Based on a maximum 86 turbine array, 1 DP vessel

Project parameter relevant to the assessment		'Maximum' Project parameter for impact assessment	Explanation of maximum Project parameter
	physical presence	2.8 days	will be present a maximum of 130 times (i.e. single slack tide operation) per year i.e. the DP vessel present on site every 2.8 days.
Onshore Project components	-	N/A	Onshore Project parameters do not influence the shipping and navigation impact assessment.

Table 15.1: Rochdale Envelope parameters for the shipping and navigation assessment

15.2.2 Area of assessment

15.5 It is also important to define the geographical extent of the assessment area. The focus of the impact assessment is potential impacts on the shipping and navigation using the Inner Sound, including potential displacement of shipping into the Outer Sound.

15.3 Legislative Framework and Regulatory Context

15.3.1 Legislation

15.6 This section considers the legislative framework and regulatory context relevant to the Project.

15.7 The EIA Regulations are the only legislation directly relevant to this assessment. However, there are a number of guidance documents available which provide further detail on the aspects of the Shipping and Navigation environment that should be assessed and how the assessment should be undertaken.

15.3.2 Primary guidance

15.8 The primary guidance used followed in the assessment was:

- DTI/BERR (in association with MCA and DfT) Methodology for Assessing the Marine Navigational Safety Risks of Offshore Windfarms, 7th September 2005; and
- MCA Marine Guidance Notice 371(M+F) – Offshore Renewable Energy Installations (OREIs) Guidance on UK Navigational Practice, Safety and Emergency Response Issues.

15.9 The guidance, which was predominantly prepared with a view to offshore wind farms, has been adapted where necessary for the Project, e.g., to take account of under keel clearance.

15.3.3 Other guidance

15.10 Other forms of guidance used in this assessment are listed as follows:

- MCA Marine Guidance Notice 372 (MGN 372 M+F) Offshore Renewable Energy Installations (OREIs) Guidance to Mariners Operating in the Vicinity of UK OREIs (2008);
- Department of Environment and Climate Change (DECC) Guidance Notes on Safety Zones, DECC (2007);
- IALA Recommendation O-139 On The Marking of Man-Made Offshore Structures, Edition 1, Dec 2008; and
- International Maritime Organisation (IMO), Guidelines for Formal Safety Assessment (FSA) (2002).

15.4 Assessment Methodology

15.4.1 Scoping and consultation

15.11 Since the commencement of the Project, consultation on shipping and navigation issues has been ongoing. Table 15.2 summarises all consultation relevant to shipping and navigation. In addition, relevant comments from the EIA Scoping Opinion are summarised in Table 15.3, together with responses to the comments and reference to the ES sections relevant to the specific comment.

Date	Stakeholder	Consultation	Topic / specific issue
8th and 9th of March 2011	Local fisheries interests The Crown Estate Marine Energy Developers	The Crown Estate's Pentland Firth and Orkney Waters Fisheries Meetings	Fisheries issues and concerns discussed at a meeting chaired by The Crown Estate's Fisheries Liaison Officer.
7th April 2011	Marine Scotland and Scottish Natural Heritage (SNH)	Pre-Scoping meeting	EIA surveys and studies required and the data needs for each EIA study.
6th May 2011	Local fishermen	Local fisherman's visit to view the Atlantis turbine at Invergordon	Turbine technology and discussions with fishermen regarding their concerns.
27th May 2011	Marine Scotland, statutory consultees and non statutory consultees	Submission of EIA Scoping Report	Request for EIA Scoping Opinion from Marine Scotland and statutory consultees and request for comment from non statutory consultees.
30th June – 2nd July 2011	Local stakeholders	Public Event - EIA Scoping	Public event to collate information/opinions on proposed EIA scope.
7th July 2011	Maritime and Coastguard Agency (MCA)	Meeting	The scope of work for the NRA was discussed with the MCA including the various data sources planned to be used to characterise baseline traffic levels.
16th August 2011	Scottish Fishermen's Federation (SFF)	Meeting	To obtain feedback on the Project and discuss which fishermen and organisations to consult with directly.
18th August 2011	Orkney Fisheries Association (OFA)	Telephone	Consultation on whether any Orkney skippers fish the Inner Sound.
24th August 2011	Five local fishing skippers (3 John o' Groats & 2 Scrabster)	Meeting	To identify local fishing activity that takes place in the site and concerns about project and effective mitigation through information circulation and other means.
24th August 2011	Wick Royal National Lifeboat Institute (RNLI)	Meeting	Review of historical incidents and potential issues with Project.
24th August 2011	Wick Harbour	Meeting	Review of current traffic visiting Wick, potential future developments and any issues with Project.
24th August 2011	Scrabster Harbour Trust	Meeting	Review of current traffic visiting Scrabster, port re-development and any issues with Project.
24th August 2011	Gills Harbour	Meeting	Discussion of current traffic visiting Gills and potential future developments, including possible use as a base for the MeyGen project.
25th August 2011	Pentland Ferries	Meeting	Information obtained about route between Gills and St Margaret's Hope, specification of the *Pentalina* and future plan. (Subsequent teleconference held with Master of *Pentalina* on 4th October 2011).
25th August 2011	Thurso Royal National Lifeboat Institution (RNLI)	Meeting	Review of historical incidents responded to by the station and any potential issues associated with the Project.
12th September 2011	Bremner Fishing	Telephone	Discussion with skipper of *Boy Andrew* fishing vessel regarding their transiting of the Inner Sound and Outer Sound.

Date	Stakeholder	Consultation	Topic / specific issue
12th September 2011	Marine Scotland Compliance, Fishery Office, Scrabster	Telephone	Consultation about fishing vessel activity in the Inner Sound and availability of data collected by Marine Scotland.
22nd September 2011	Wick RNLI, Fishing and Sailing representatives, Scrabster Harbour, Gill's Harbour, Pentland Ferries, John o' Groats Ferries	Hazard Review workshop	Navigational hazards were identified, discussed and potential risk control measures reviewed at this meeting involving a cross-section of local stakeholders.
29th September 2011	John o' Groats Ferries	Email	Correspondence to confirm how frequently the ferry passes near the Project area and if there would be any impacts on their route during Installation.
31st September 2011	Marine Scotland, The Highland Council (THC), statutory consultees and non statutory consultees	Receipt of EIA Scoping Opinion	Receipt of response to EIA Scoping Report and other comments from non statutory consultees.
3rd October 2011	Marine Scotland	Project update meeting	Report on EIA progress and presentation of key findings of the impact assessment.
3rd October 2011	Aberdeen MCA	Telephone	Discussion about how information on the MeyGen project could be included in Maritime Safety Information broadcasts by HM Coastguard.
12th October 2011	MCA	Meeting	The draft findings of the NRA were presented to the MCA. Specific comments were made which have been incorporated into the final NRA.
24-27th October 2011	Pentland Canoe Club, Caithness Kayak Club	Telephone & Email	Discussion about usage of the Inner Sound by sea kayakers and how information could be circulated to local clubs to minimise the impacts.
6th – 7th December 2011	Local stakeholders	Public Event – pre application consultation	Public event to communicate the findings of the EIA to local stakeholders.
26th January 2012	Northern Lighthouse Board (NLB)	Meeting	The draft findings of the NRA were presented to the NLB. Specific comments were made which have been incorporated into the final NRA, including draft plans for marking and lighting.
Various Dates	Royal Yachting Association (RYA) (Scotland), Cruising Association and Local Yachtsmen	Telephone & Email	Discussion of recreational vessel activity in the area and potential impacts of the MeyGen project.

Table 15.2: Details of consultation meetings undertaken in relation to shipping and navigation

Name of organisation	Key concerns	Response	ES section within which the specific issue is addressed
Chamber of Shipping	The area is of vital importance to both local and international commercial traffic and projects should be located in such a way that they do not pose unacceptable safety risks to vessels or cause significant rerouting.	Re-routeing and safety risks considered within the NRA for both local vessels and transiting vessels from further afield.	Section 15.6 Impacts during Construction and Installation Section 15.7 Impacts during Operations and Maintenance and Section 15.8 Impacts during Decommissioning
Chamber of Shipping	As identified in the PHA, there are clearly issues to be addressed regarding under keel clearance (UKC). MeyGen's target of ensuring device rotor sweep arcs are at least 8m below chart datum is likely to be insufficient if estimates of maximum vessel drafts of 6-8m are accurate. The Chamber ordinarily recommends a minimum clearance of 20m between the highest point of the device and chart datum at Lowest Astronomical Tide (LAT) in order to ensure sufficient UKC. With this is mind, we are somewhat concerned that that proposed location of the tidal array will not allow satisfactory clearance to be achieved and would therefore pose an unacceptable safety risk to local traffic.	Detailed under keel clearance modelling has been carried out as part of the NRA. This identifies that local vessels are at minimal risk of collision with the subsea turbine. A proportion of transiting vessels with deeper draughts are at risk in certain conditions of waves and tide but this can be managed through circulation of information to allow vessels to re-route within the Inner Sound or via the Outer Sound.	Section 15.7.1 Impact 15.4: Powered collision with subsea turbine Section 15.7.2 Impact 15.5: Drifting vessel collision with subsea turbine
MCA	A NRA will need to be submitted in accordance with MGN 371 (and 372) and the DTI/DfT/MCA Methodology for Assessing Wind farms. The standard methodology for assessing wind farms will be applied to tidal energy developments.	The NRA has been completed and is summarised in this ES section.	Section 15.5 Baseline Description
MCA	Particular attention should be paid to cabling routes and burial depth for which a Burial Protection Index study should be completed and, subject to traffic volumes, an anchor penetration study may be necessary.	Cables will not be buried as the substrate is rock but will be protected by drilling and using natural crevices where possible. There are no shipping anchorage areas in the vicinity.	Section 15.7.5 Impact 15.8: Anchor interaction
MCA	Potential cumulative and in combination issues should be carefully considered.	Details on all known developments have been gathered and considered within the NRA.	Section 15.1010 Cumulative Impacts
MCA	Casualty information from the MAIB and RNLI would also be good data sources, in establishing the risk profile for the area.	The most recent accident data sets from MAIB and RNLI have been analysed for the Project.	Section 15.5.8 Maritime incidents
MCA	Given that the layout of the individual wave generators within the farm have not been decided the principles of the Rochdale envelope should be used in the EIA.	An indicative layout for 86 turbines has been used to inform the collision modelling (Figure 15.17). The indicative layout is based on 45m cross-flow spacing and 160m down-flow spacing.	Section 15.2 Assessment Parameters and Table 15.1
MCA	The shipping and navigation study should include radar and manual observations in addition to AIS data to ensure vessels of less than 300gt are captured.	AIS track data, radar count data, visual observations during monitoring work and extensive local consultation have been combined to characterise the vessel activity in the Inner and Outer Sounds.	Section 15.5.3 AIS data analysis and Section 15.5.4 Radar data analysis
MCA	Particular consideration will need to be given to third party approval of the devices and associated mooring arrangements.	The candidate tidal turbines will be subject to 3rd party verification. Turbine Support Structures (TSSs) will be either gravity-based, pin pile or monopile and will be subject to 3rd party verification. Monitoring, alerting and emergency response plans will be in place to guard against loss of station.	Section 15.7.4 Impact 15.7: Loss of station
MCA	The offshore human environment should also include recreational and other sport activities. Any application for safety zones will need to be carefully	Recreational activity (including kayaking) have been identified and considered within the NRA. Safety zones during work on the site, e.g.,	Section 15.5.7 Recreational vessel activity analysis and Section 15.6.2 Impact

Name of organisation	Key concerns	Response	ES section within which the specific issue is addressed
	assessed and additionally supported by experience from the development and construction stages.	Installation, are discussed in the NRA. There are no plans for safety zones during normal operation.	15.2: Traffic re-routeing due to work vessels and associated safety zones
Marine Scotland / MCA	The ES should include details on collision risk, navigational safety, risk management and emergency response, marking and lighting of the Project and information to mariners, effect on small craft navigational and communication equipment, weather and risk to recreational craft which lose power and are drifting, adverse conditions, evaluation of the likely squeeze of craft into routes of larger commercial vessels, visual intrusion and noise.	The Navigational Risk Assessment has been completed taking these issues into account by following the MCA and DECC Guidance.	Section 15.6 Impacts during Construction and Installation, Section 15.7 Impacts during Operations and Maintenance and Section 15.8 Impacts during Decommissioning
NLB	We would require a formal Navigational Risk Assessment be made in accordance with MGN 371, and that shipping, fishing and leisure data information be used to formalise any risk and mitigation measures. We note that visual observation and radar data would assist in giving a more accurate reflection of the marine traffic transiting the area.	The Navigational Risk Assessment has been completed in accordance with MGN 371.	Section 15.5 Baseline description and Section 15.3 Legislative Framework and Regulatory Context
NLB	Such an assessment must take into account the available depth of water over the installed turbines and the effect of heavy seas and vessel movement in relation to under keel clearance of marine traffic. The cumulative effect of developments must be considered and information shared with other developers.	Subsea collision risk has been modelled taking into account the underwater clearance and the effect of waves, tides, ship draught and squat. Cumulative effects have also been assessed.	Section 15.7.1 Impact 15.4: Powered collision with subsea turbine Section 15.7.2 Impact 15.5: Drifting vessel collision with subsea turbine
Orkney Islands Council (OIC)	The proposed area is clear of Orkney Harbour Authority waters but in relative closed proximity the southern approaches to Scapa Flow. It is very unlikely any vessel bound for Scapa Flow would be affected by the proposed development when considering passage planning other than encountering increased vessel traffic in Outer Sound area. The possible displacement of marine traffic from Inner Sound into Outer Sound would have a possible impact safe routing on laden tankers inwards and outwards from Scapa flow.	The potential for traffic to be re-routed from the Inner Sound to the Outer Sound, and the consequent risks in terms of increased collisions, have been considered within the NRA and summarised within Navigation ES section.	Section 15.6 Impacts during Construction and Installation, Section 15.7 Impacts during Operations and Maintenance and Section 15.8 Impacts during Decommissioning
OIC	The Pentland Firth is an exceptionally busy sea lane essential to international navigation. The main shipping channel, however, lies to the north of Stroma, between the island and Orkney. Larger cargo vessels and tankers transit the region using this route and so do not pass through the lease area (except on occasion). However, the recommended route for smaller vessels, when approaching the Firth during the south east-going stream, is through the Inner Sound.	The numbers and sizes of vessels using the Inner Sound have been considered within the NRA.	Section 15.5 Baseline Description
RYA	In summary the RYA's concerns with offshore energy developments and recreational boating relate to: Navigational safety - 1. Collision risk, particularly in adverse weather conditions 2. Risk management and emergency response, for example in response to units breaking free in a storm 3. Marking and lighting 4. Weather		Section 15.6 Impacts during Construction and Installation, Section 15.7 Impacts during Operations and Maintenance and Section 15.8 Impacts during Decommissioning
RYA	Of key importance is the minimum depth over the rotor blades. RYA is opposed to unnecessary exclusion zones and notes that these can only be effective when their existence is fully promulgated and there is enforcement. Although the document states that the rotors not surface piercing, we would wish to be reassured that the rotors are below keel depth at all times even in wave troughs when there is a combination of low water springs, high pressure and strong winds. If they are always below keel depth then there will be no need for vessels to avoid the area.	Further consultation with RYA Scotland during the NRA has confirmed they are satisfied with the planned minimum underwater clearance of 8m (LAT). There are no plans for safety zones during normal operation at the site.	Section 15.6 Impacts during Construction and Installation, Section 15.7 Impacts during Operations and Maintenance
Scottish Canoe Association	Sea kayakers make regular use of the waters in the Pentland Firth. Devices which break the surface of the water will be considered as a major navigational safety issue.	There are no plans to install any structures that break the surface of the water.	Section 5 Project Description
Scottish Canoe Association	If underwater structures are to be put in place by the use of tethered barges then there would be concerns for the safety of boat users in the area during this construction phase.	Consultation has been carried out with the local clubs and appropriate mitigation has been identified during construction work.	Section 15.6 Impacts during Construction and Installation, Section 15.7 Impacts during Operations and Maintenance
Scottish Fisherman's Federation (SFF)	Although the Inner Sound is not a traditional fishing ground for the pelagic fleet, it is a frequented route on passage from east to west and vice versa. The Pentland Firth is a dangerous stretch of water even on a fine day; the sea can be very confused and therefore difficult to keep the ship on a steady heading. One could only imagine that securing 20 quite large turbines on the seabed in the Inner Sound would have an effect on how the water flows through the Pentland Firth, adding to the unpredictable sea state. We need assurances that safe navigation will take priority over energy generation.	Navigational safety risks to fishing vessels are considered in the NRA. The NRA also summarises the findings of the work carried out on the potential effects of the turbines on waves and tidal currents. This indicated no significant concerns.	Section 15.6 Impacts during Construction and Installation, Section 15.7 Impacts during Operations and Maintenance

Table 15.3: Scoping and consultation relevant to shipping and navigation

15.4.1 Desk based study

15.12 The main desk-based data sources used to identify the baseline navigational features and activity in the Pentland Firth were as follows:

- Admiralty Charts;
- Admiralty Sailing Directions, North Coast of Scotland Pilot (NP 52);
- Fishing Vessel Surveillance Patrol Data (2006-10) (Marine Scotland Compliance);
- Fishing VMS Data (2008-10)(Marine Scotland Compliance);
- Clyde Cruising Club Sailing Directions for North Scotland (Clyde Cruising Club, 2010);
- RYA Cruising Atlas;
- Maritime Accident Investigation Branch (MAIB) Incident Data (2001-10); and
- RNLI Incident Response Data (2001-10).

15.4.2 Field survey

15.13 Information on vessel navigation in the area came from a number of sources aimed at covering the full range of vessel activity in the Inner Sound. The primary source of data came from Automatic Information System (AIS) vessel tracking. A total of 16 weeks was analysed, covering the following periods to ensure it was seasonally and tidally weighted:

- 28 days summer 2010 (June to July);
- 28 days winter 2010 (October-December);
- 28 day winter 2011 (February to March); and
- 28 days summer 2011 (July to August).

15.14 AIS is now fitted on the vast majority of commercial ships operating in UK waters including all ships of 300GT and upwards engaged on international voyages, all passenger ships, and fishing vessels of 45m length and over. It is also carried by a proportion of small vessels voluntarily, including a proportion of fishing and recreational vessels.

15.15 The means of covering smaller vessels (non-AIS) was discussed with the MCA, who suggested contacting local ports about their radar coverage. Radar count data was obtained from Scapa Vessel Traffic Services (VTS) operated by OIC Marine Services. The data came from the radar scanner on Sandy Hill, South Ronaldsay. The effective survey period was 42 days during August and September 2011. The fact it is summer only data is considered to be conservative as small vessel activity is likely to be busier during summer. Also smaller vessels, because of their shallower draughts, are only likely to be affected during work on the site. Installation activity will not take place during the winter months.

15.16 Other sources of small vessel activity used in the NRA included visual logs from onshore and vessel-based surveys conducted on behalf of the Project, fishing vessel surveillance data and publications such as the RYA Coastal Atlas and Clyde Cruising Club Sailing Directions. The findings of the analysis were corroborated by local knowledge gained through the extensive local consultation.

15.4.3 Significance criteria

15.17 The shipping and navigation impacts assessment methodology has been carried out in line with the IMO's Formal Safety Assessment (FSA) process and the DECC / MCA Guidelines (see NRA for full details on supporting CD). It does not therefore necessarily follow the significance criteria set out in Section 8. Hazards (impacts) have been categorised using the frequency and consequence categories below.

15.18 The categorisation was carried out based on the discussion at the Hazard Review Workshop involving local stakeholders, together with the baseline data analysis and other consultation.

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

Table 15.4: Frequency bands

Rank	Description	Definition			
		People	Environment	Property	Business
1	Negligible	No injury	<£10k	<£10k	<10k
2	Minor	Slight injury(s)	Tier 1: Local assistance required	£10k-£100k	£10k-£100k
3	Moderate	Multiple moderate or Single serious injury	Tier 2: Limited external assistance required	£100k-£1M	£100k-£1M Local publicity
4	Serious	Serious injury or single fatality	Tier 2: Regional assistance required	£1M-£10M	£1M-£10M National publicity
5	Major	More than 1 fatality	Tier 3: National assistance required	>£10M	>£10M International publicity

Table 15.5: Consequence bands

15.19 The consequence scores are averaged (for a single impact there could be a range of potential consequences) and multiplied by the frequency to obtain an overall ranking (or score) which determined the hazard's position within the risk matrix (Table 15.6).

		Frequency				
		5	4	3	2	1
Consequence	5	High	High	High	Moderate	Moderate
	4	High	High	Moderate	Moderate	Low
	3	High	Moderate	Moderate	Low	Low
	2	Moderate	Moderate	Low	Low	Low
	1	Moderate	Low	Low	Low	Low

Where:

	Broadly Acceptable Region (Low Risk)	Generally regarded as insignificant and adequately controlled. None the less the law still requires further risk reductions if it is reasonably practicable. However, at these levels the opportunity for further risk reduction is much more limited.
	Tolerable Region (Moderate Risk)	Typical of the risks from activities which people are prepared to tolerate to secure benefits. There is however an expectation that such risks are properly assessed, appropriate control measures are in place, residual risks are as low as is reasonably practicable (ALARP) and that risks are periodically reviewed to see if further controls are appropriate.
	Unacceptable Region (High Risk)	Generally regarded as unacceptable whatever the level of benefit associated with the activity.

Table 15.6: Risk matrix

15.20 For the purposes of EIA impact significance ranking, hazards in the Broadly Acceptable (Low Risk) region are not considered to result in significant impacts. Hazards in the Tolerable (Moderate Risk) and Unacceptable (High Risk) regions are considered to result in significant impacts.

15.21 Selected hazards were subject to more detailed collision risk assessment using Anatec's COLLRISK model, which has been widely used for UK energy projects (oil & gas, marine renewables and nuclear), including subsea collision risk assessments in Orkney Waters, the North Sea, Irish Sea and Bristol Channel. Full details on the approach taken are provided in the NRA.

15.4.4 Data gaps and uncertainties

15.22 It is recognised that small vessel activity is variable and dependent on numerous factors including weather conditions, tides, seasonal factors, and in the case of fishing vessels, quotas and the migration of fish species.

15.23 This variability has been taken into account as far as possible by using long-term desk-based research, radar count data and a high level of consultation with local stakeholders to inform an up-to-date baseline. However, over the life of the Project the activity could vary from that identified in the past few years.

15.5 Baseline Description

15.24 The baseline presents an assessment of the existing navigational features, metocean conditions and shipping activity recorded within and adjacent to the Project.

15.5.1 Navigational features

15.25 The Project is located in the Pentland Firth, which separates the Scottish mainland from the Orkney Islands. The Pentland Firth is well known as a challenging environment for mariners, with Admiralty Charts of the firth including general recommendations on navigation and more specific advice for laden tankers, due to strong tidal streams which give rise to eddies and races. The Project area lies outside of the worst of these, such as The Merry Men of Mey and The Swilkie.

15.26 There is a voluntary reporting system in the Pentland Firth. Laden vessels should report to Aberdeen Coastguard on VHF Channel 16 at least 1h before ETA and on final departure of the Pentland Firth. This includes giving details on Name, Course, Speed, Draught and Destination. From discussions with Aberdeen Coastguard, in practice, the majority of commercial vessels, both laden and ballast, tend to report.

15.27 Because of the very strong tidal streams, the eddies and races to which these give rise and the extraordinary violent and confused seas which occur at times, navigation in the firth requires careful preparation. These are such that some mariners may find it advantageous to adjust their arrival at the firth so as to pass through under favourable tidal conditions, or alternatively to use the Fair Isle Channel.

15.28 The Pentland Firth is divided into two passages by the island of Stroma. The principal and usual route through the firth by day and night, recommended for larger vessels, is the 2.5nm wide, deep and well-marked Outer Sound between Stroma and Swona. The Inner Sound between Stroma and the mainland is approximately 1.25nm wide, shallower, poorly marked, and its use by larger vessels is not recommended at any time, particularly in high winds or at night. However, it may be used by slow or smaller vessels with local knowledge in certain weather or in order to avoid proceeding against a stronger contrary stream in the Outer Sound.

15.29 Admiralty Sailing Directions suggest a mid-channel route through the Inner Sound when transiting with the tidal stream. When heading eastbound against the stream, keeping close in to either Stroma or Gills Bay is recommended to take advantage of comparatively slack water either side of mid-channel. For the westbound passage against an east-going tidal stream, the track favours the mainland shore through Inner Sound. However, the directions state that the coast between Ness of Duncansby and Gills Bay should not be approached too closely as it is generally poorly surveyed and in a number of places is fringed by dangerous or drying rocks.

15.5.2 Metocean data

15.30 Wave and tidal data for the Inner Sound was used as input to the under keel clearance (UKC) assessment and risk of collision with the subsea turbines (Section 15.7.1).

15.31 Based on recorded levels during a 30 day Acoustic Wave and Current (AWAC) recorder deployment within the Project area, two years of tidal level data for 2011-12 were predicted using harmonic analysis. Figure 15.1 presents the exceedence probability of tidal height above LAT. This shows that 97% of the time the tidal height is at least 1m above LAT (i.e., minimum UKC of 9m) and 80% of the time it is at least 2m above LAT (minimum UKC of 10m).

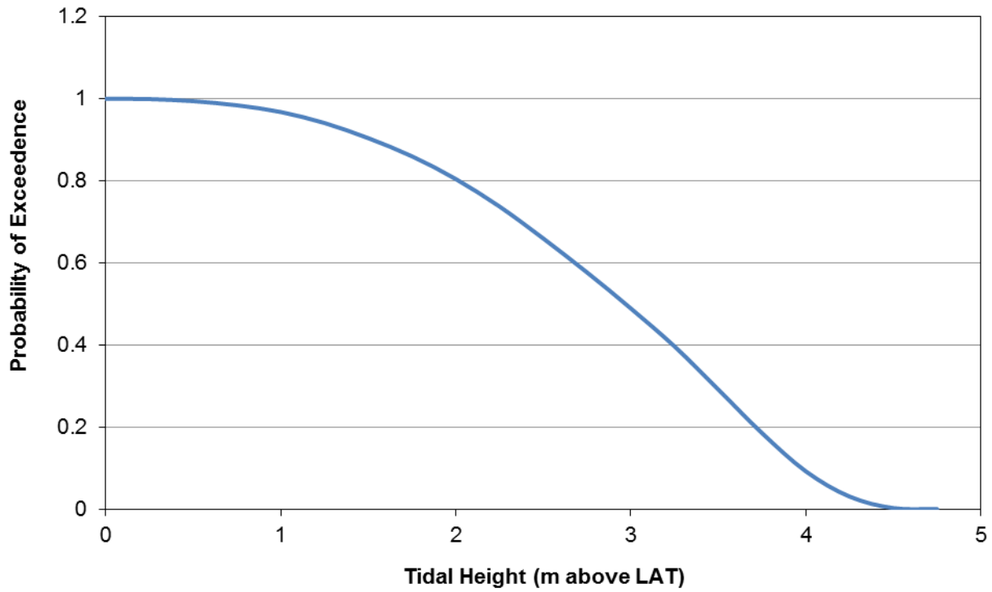

Figure 15.1: Tidal height exceedence probability (2011 to 2012)

15.32 In terms of tidal speeds and directions, the flows recorded exceeded 4.5m/s and analysis of the data indicated that they could exceed 5m/s during an equinoxial tide. The ebb tide runs in a generally westerly direction and the flood tide runs in an easterly direction.

15.33 Wave data were obtained from the DHI/EMEC Mike21 model for a location within the Project area at three-hourly intervals for 1986 to 2005 (EMEC wave data 1986 – 2005). Significant and maximum wave height probability distributions calculated based on this data are presented in Figure 15.2. The average values over the 20 years were 0.9m (significant) and 1.7m (maximum). The highest values were 3.2m (significant) and 6.0m (maximum).

15.34 This data has a relatively coarse resolution at the Project site and comparison with other data sets indicates it may under-predict extreme wave heights in the Inner Sound. Therefore, the maximum wave height data was used in the risk modelling, which is conservative.

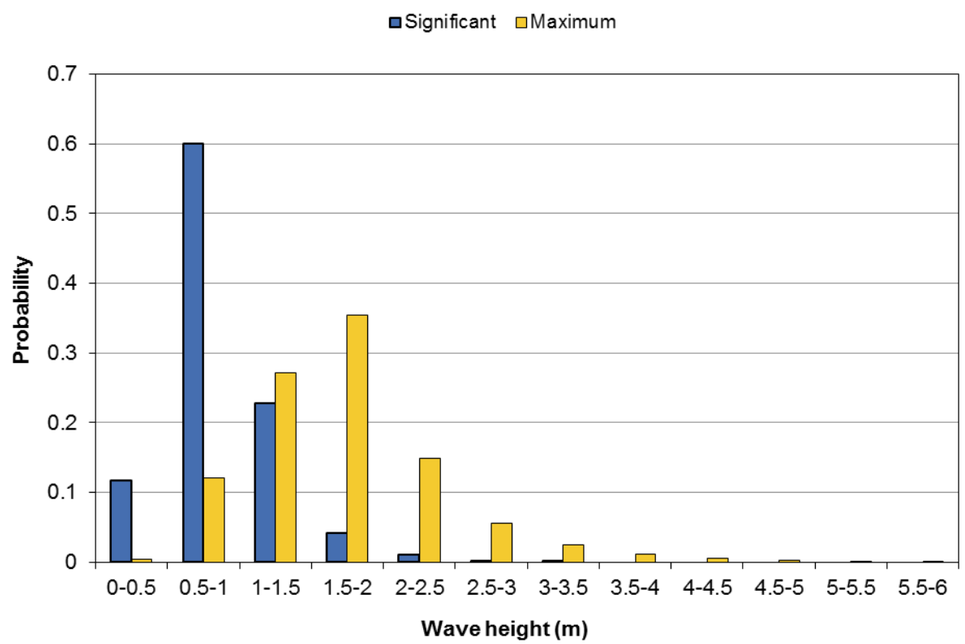

Figure 15.2: Wave height data for the Project

15.5.3 AIS data analysis

15.35 A combined dataset of 16 weeks seasonally and tidally weighted AIS survey data from 2010 -11 was used for the baseline shipping analysis. This exceeded the minimum required by MCA MGN 371 of 4 weeks in order to provide a comprehensive picture of the traffic in the Inner Sound.

15.36 This was analysed for the Project area and its surroundings, covering both the Inner and Outer Sounds. A plot of ship tracks recorded during the survey period, colour-coded by vessel type, is presented in Figure 15.4.

15.37 An illustration of the relative traffic density within the area is presented in Figure 15.5 based on the combined AIS track data.

15.38 Visible during all the periods are the tracks of the *Pentalina* ferry, operated by Pentland Ferries between Gills Bay and Saint Margaret's Hope with three return trips per day. These regular transits are the reason for the higher density in the vicinity of the Project. A combined plot of all the *Pentalina* tracks over the 16 weeks is presented in Figure 15.6. The shortest route is west of Stroma which is seen from the AIS data to be most frequently used with approximately two-thirds of transits. However, from consultation with one of the Masters it was indicated that the choice is also influenced by the wind and tidal conditions. In easterlies the ferry will tend to pass west of Stroma whilst in westerlies the route east of Stroma is preferred. On the one-third of sailings east of Stroma the ferry usually crossed over the Project area.

15.39 All the periods also showed consistently heavy east-west traffic via the Outer Sound between the islands of Stroma and Swona. The number of vessels using the Outer Sound averaged 14 per day, with around 11 per day heading east-west. The east-west traffic transiting the Inner Sound is low-to-moderate by comparison, averaging less than 1 vessel per day (approx. 4% of the Outer Sound traffic). The sizes of vessels in the Inner Sound also tended to be smaller.

15.40 More detailed analysis of the east to west transiting traffic through the Inner Sound over the 16 week survey period was performed. In total, 43 different vessels were recorded using the Inner Sound making a total of 63 transits (average of 1 transit every 2 days). The number of vessels varied slightly between the periods with marginally more traffic in winter.

15.41 A number of these same vessels were also recorded using the Outer Sound during the survey, which suggests vessels can use both channels, although their choice is likely to depend on weather, tides and departure / destination ports.

15.42 The type distribution of east-west transiting vessels (excluding unspecified) is presented in Figure 15.3. The majority were fishing vessels (57%). Figure 15.7 presents all the east-west transiting vessels colour-coded by type.

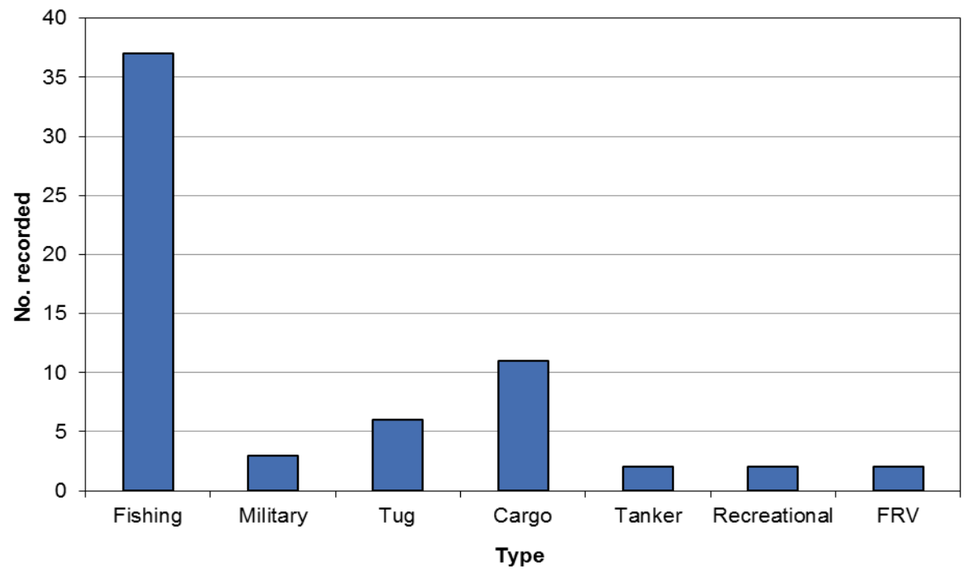

Figure 15.3: Inner Sound East-West Transiting Traffic Vessel Type Distribution – 5nm (2010 to 2011)

15.43 A total of 29 of the 63 vessels were broadcasting their draught on AIS. The draughts of a further 23 vessels were conservatively estimated based on researching their maximum draught or depth. A combined plot of the transiting traffic by draught is presented in Figure 15.8. Draughts for 62 of the 63 vessels have therefore been ascertained.

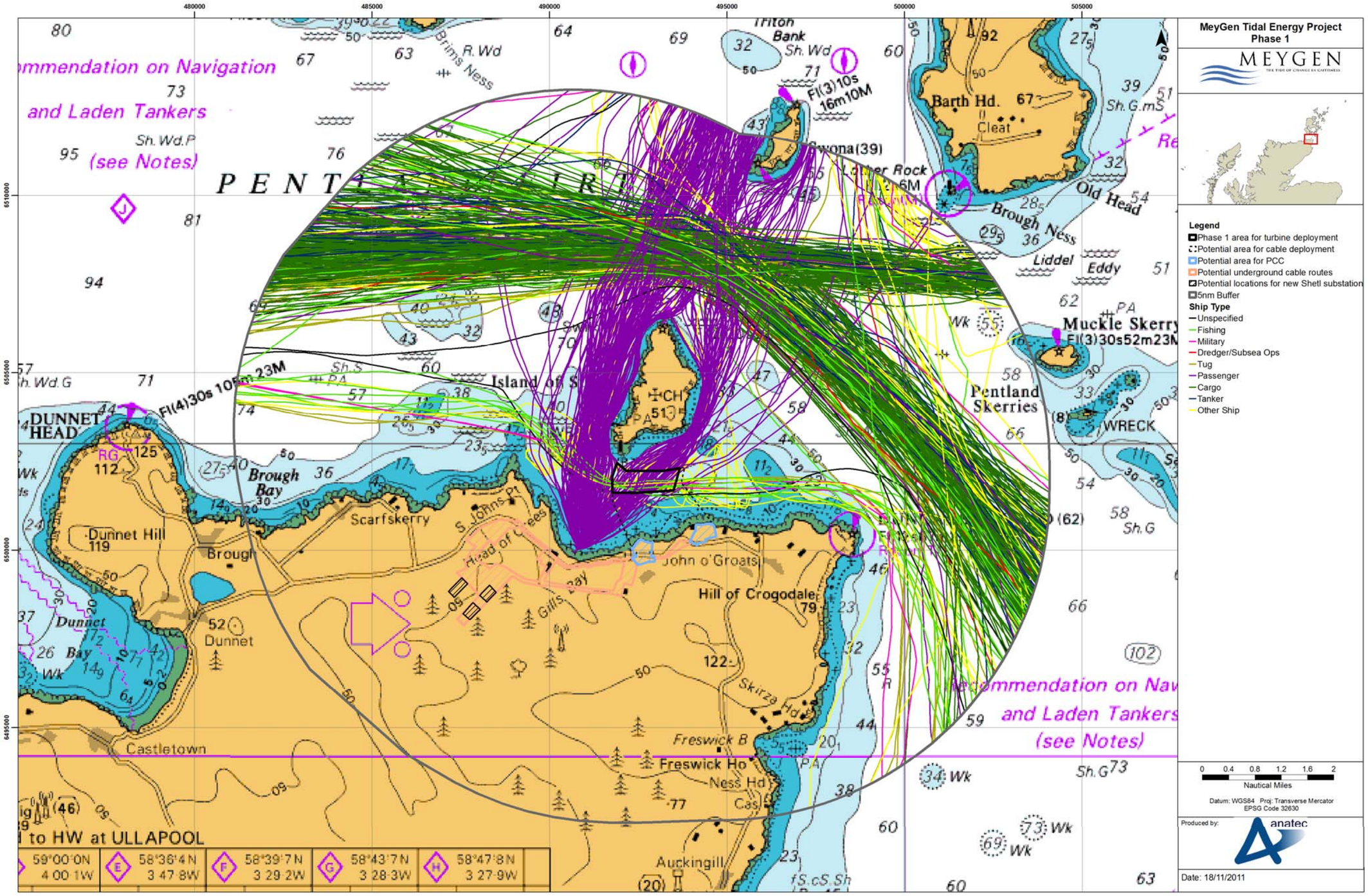

Figure 15.4: AIS tracks by ship type within 5nm of the Project (Summer, 2011)

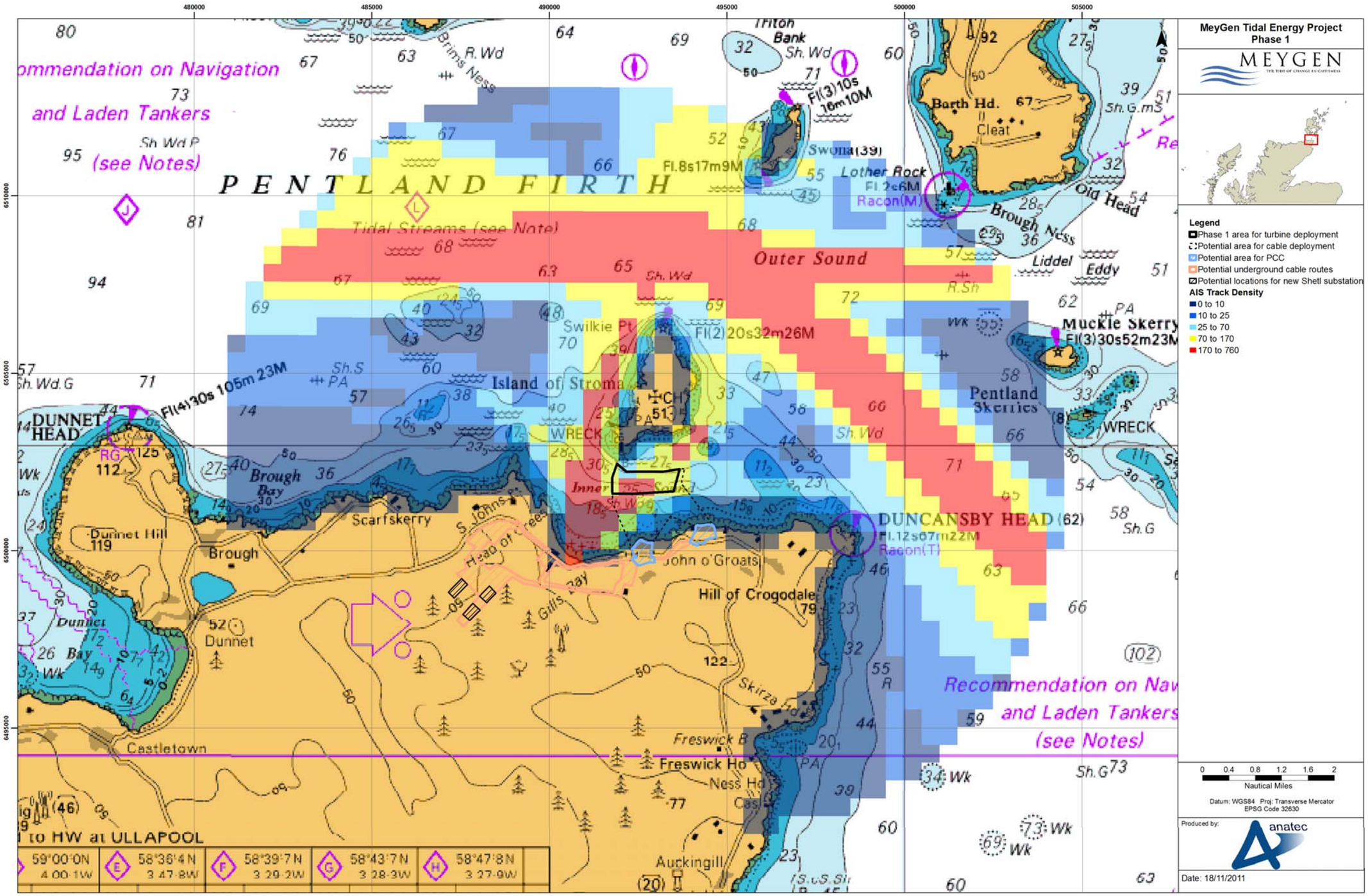

Figure 15.5: AIS density (2010 and 2011)

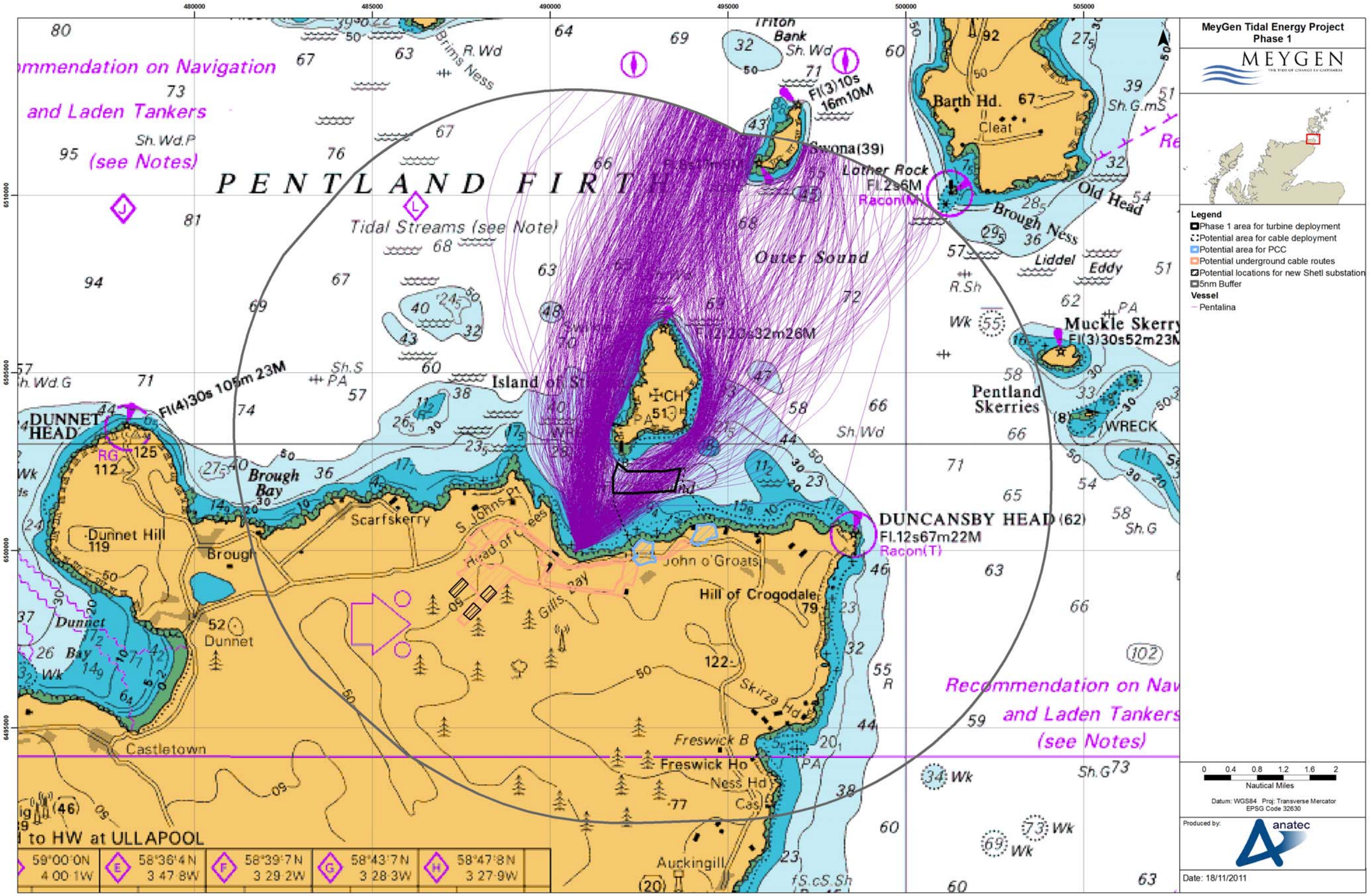

Figure 15.6: AIS tracks of *Pentalina* (2010 and 2011)

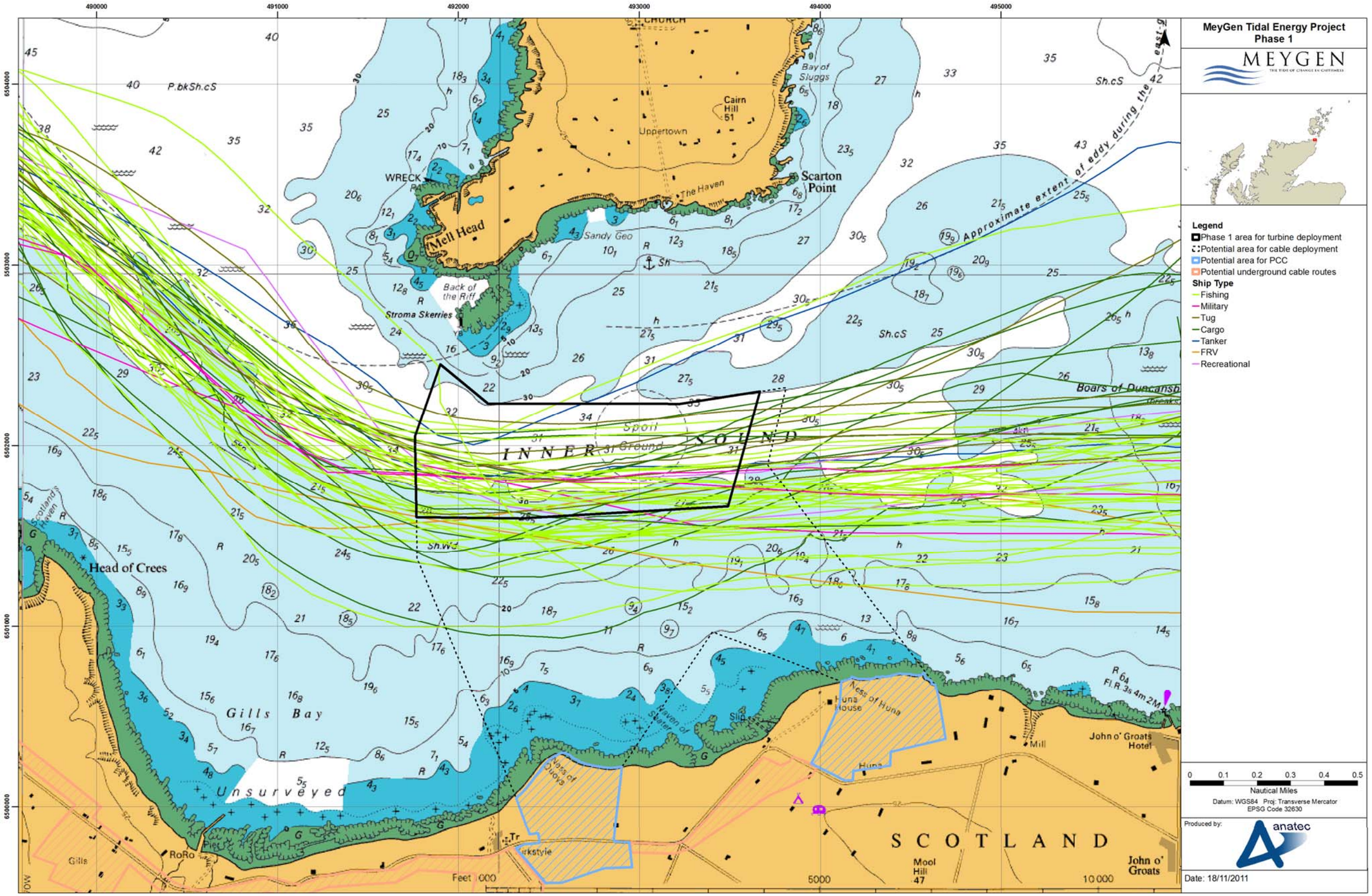

Figure 15.7: AIS tracks by ship type within Inner Sound (2010 and 2011)

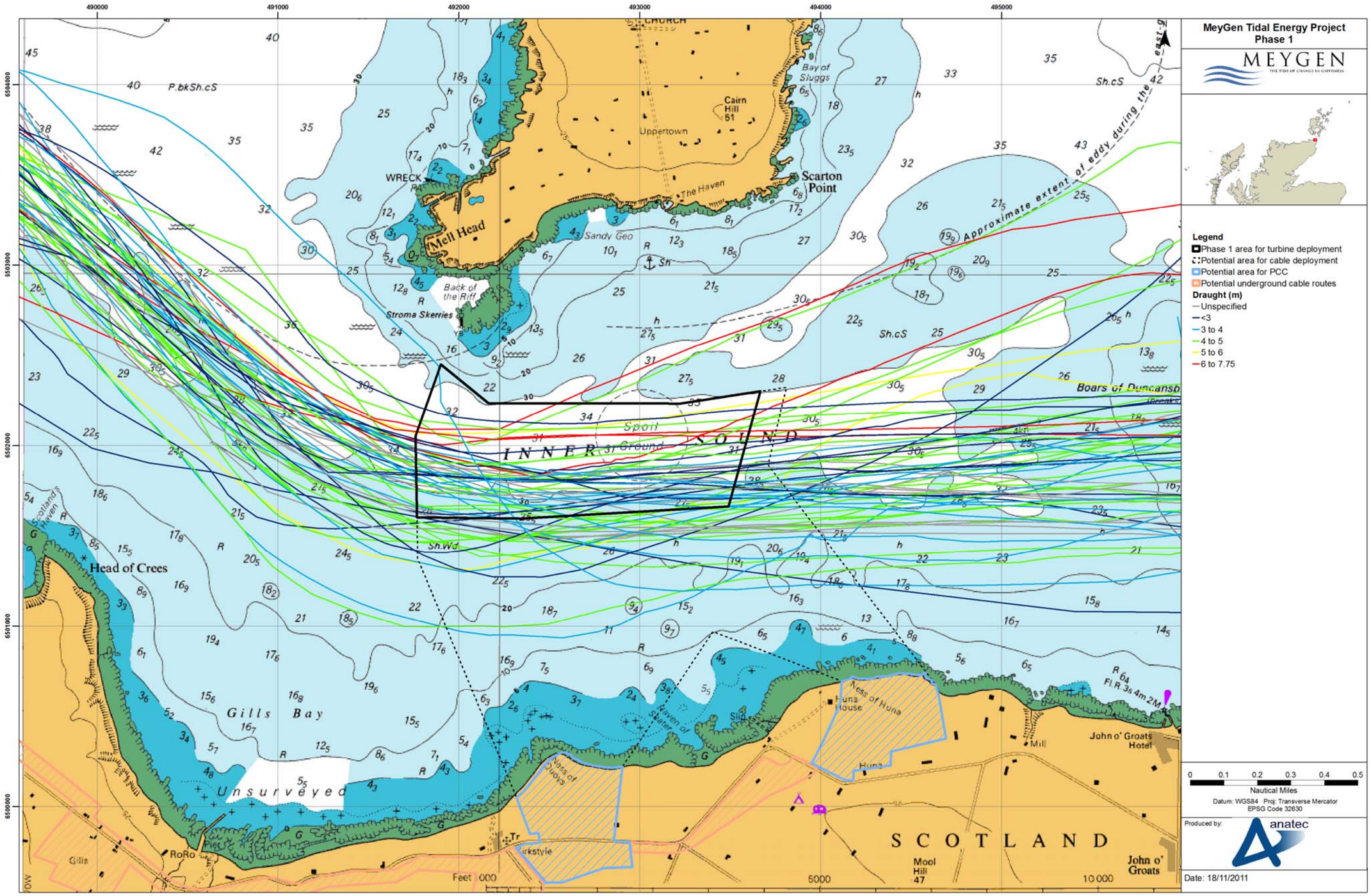

Figure 15.8: AIS tracks by draught within Inner Sound (2010 and 2011)

15.44 The draught distribution of transiting vessels (excluding unspecified) is presented in Figure 15.9.

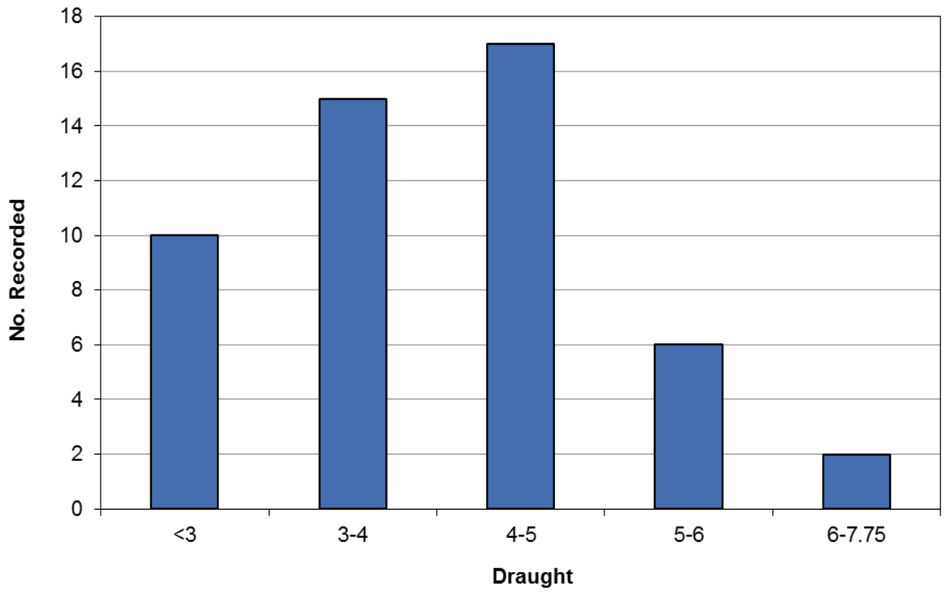

Figure 15.9: Draught Distribution within Inner Sound (AIS 2010 to 2011)

15.45 The average draught was 3.9m and the deepest draught vessel was the pelagic trawler *Pathway PD165* at 7.75m.

15.5.4 Radar data analysis

15.46 Small vessel activity not represented on AIS, such as fishing and recreational vessels, was acquired from Scapa Vessel Traffic Services (VTS) operated by OIC Marine Services for a 42 day period in August-September 2011. This included both AIS and radar (non-AIS traffic) crossing count lines setup crossing the Outer Sound and Inner Sound (refer to supporting studies CD Anatec, 2012).

15.47 Discussion with the VTS Manager indicated that coverage in the Outer Sound is very good in summer for radar targets, as there is generally less sea clutter and spurious tracks. The Inner Sound has a blind spot but by offsetting the count line an estimate of transiting traffic was obtained.

15.48 The numbers of vessels crossing both lines are summarised in Figure 15.10 and Figure 15.11 divided into AIS and Radar (non-AIS).

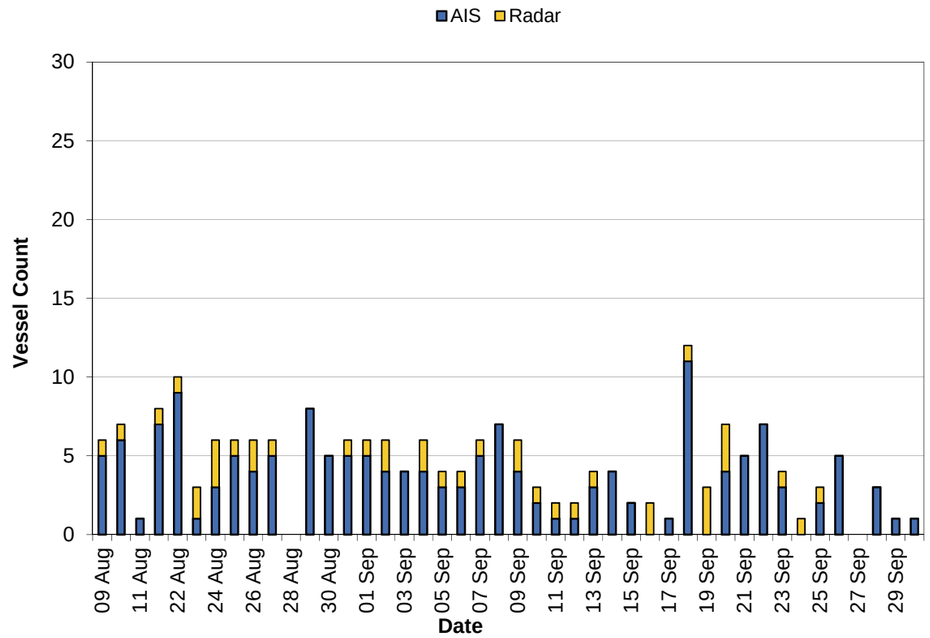

Figure 15.10: Vessels per Day crossing the Inner Sound Count Line

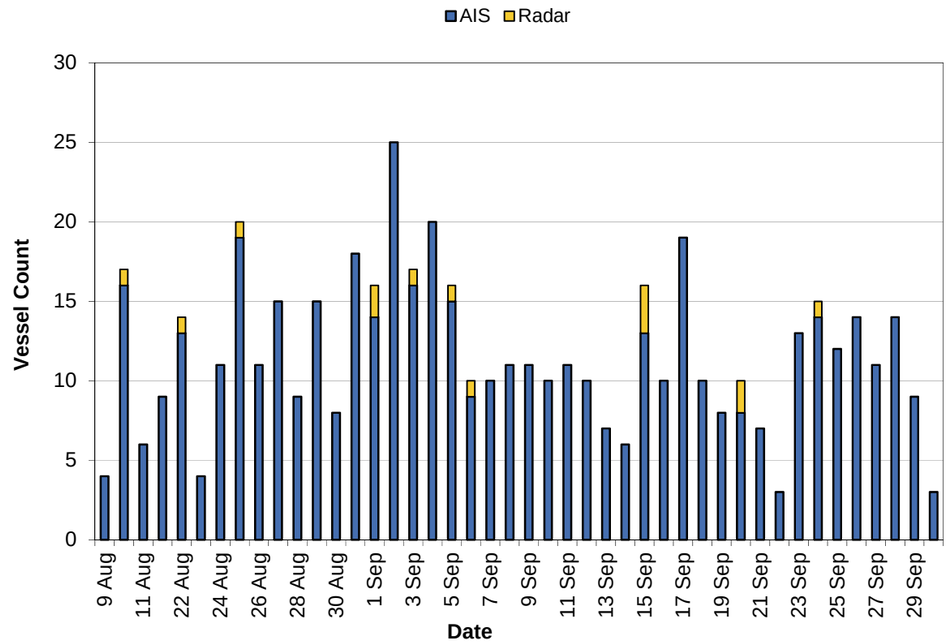

Figure 15.11: Vessels per Day crossing the Outer Sound Count Line

15.49 A total of 515 vessels crossed the Outer Sound line over the effective 42 days survey period, averaging 12.3 per day. There were 501 AIS vessels (around 11.9 per day) and 14 radar targets not broadcasting on AIS (around 0.3 per day). Again, the most regular vessel on AIS crossing the line was the Pentalina with an average of two crossings per day. Excluding the ferry, the daily number of AIS crossings is approximately 10 per day, which shows good agreement with the 16 weeks AIS survey data.

15.50 A total of 199 vessels crossed the Inner Sound line over the effective 42 days survey period, averaging 5 per day. There were 159 AIS vessels (around 4 per day) and 40 radar targets not broadcasting on AIS (around 1 per day). The *Pentalina* was the main AIS target recorded crossing the Inner Sound count line typically 3 times per day when routeing east of Stroma. Excluding this ferry and some working vessels associated with the Project, the number of AIS tracks drops to between 0.5 and 1 per day. This is in-line with the AIS survey data.

15.51 Overall, the Outer Sound had much higher traffic levels than the Inner Sound, which is in agreement with the AIS surveys. However, smaller (non-AIS) vessels tracked on radar tended to favour the Inner Sound, with an average of just under one vessel per day, compared to one every three days through the Outer Sound.

15.52 Combining the AIS and radar (non-AIS) traffic, it was estimated there are 535 vessels per annum transiting the Inner Sound east-west, an average of 1-2 per day.

15.5.5 Ferry vessel activity

15.53 As presented in Figure 15.6, the Pentland Ferries vessel *Pentalina* (draught - 3m) was tracked on AIS crossing the Inner Sound on average six times per day (three return-trips between Gills Bay and Saint Margaret's Hope). The John o' Groats ferry *Pentland Venture* passes in the vicinity of the Project area during summertime wildlife cruises around Stroma. Both ferries are relatively shallow draught and therefore are only likely to be affected by work vessel activity within the site during installation and maintenance. Consultation with both ferry operators indicated no significant problems with the Project. MeyGen plan to continue communications with the operators throughout the Project.

15.5.6 Fishing vessel activity analysis

15.54 All the fishing vessel tracks recorded during the combined AIS survey period (16 weeks from 2010 to 2011) are presented in Figure 15.12. In total, 37 vessels used the Inner Sound and 96 used the Outer Sound, i.e., approximately 1 in 4 via the Inner Sound. All were transiting as opposed to fishing.

15.55 This showed reasonable agreement with analysis of VMS data, which covers fishing vessels of 15m length and over, with position reports received every two hours on average. Analysis of 2009 data indicated around 1 in 3 vessels via the Inner Sound, as shown in Figure 15.13 (2008 and 2010 data of UK vessels also showed a similar pattern).

15.56 It is likely that the majority of radar (non-AIS) vessels counted crossing the Inner Sound by Scapa VTS were also UK fishing vessels.

15.57 Sightings data based on over-flights and Royal Navy patrols were also analysed and tended to corroborate the other data sets. All the sources agreed that vessels tended to transit the Inner Sound as opposed to fishing, and that the vast majority were UK-registered.

15.58 From local consultation, three John o' Groats based skippers (using four vessels) were identified to fish in the Inner Sound. The creel boats they use are less than 12m in length and have draughts up to about 1.5m. They are not equipped with AIS or VMS units. These local vessels use creels to catch lobsters, brown crabs and velvet crabs. They also fish areas to the west, around Stroma and further east. There is no precise fishing pattern and the positioning of pots is variable due to the conditions (tidal and weather) in the Inner Sound being unpredictable. The centre of the Inner Sound where the turbine deployment area is located is infrequently fished. However, fishing is limited as it requires a combination of neap tides and good weather, due to the time it takes to deploy and haul creels between tides (see Section 14).

15.59 From conversations with Marine Scotland Compliance, including the Senior Fisheries Officer in Scrabster, it is understood that Marine Scotland Compliance are performing a research study into the fishing in the area which should be available in early 2012 (this was not available for the NRA).

15.5.7 Recreational vessel activity analysis

15.60 Figure 15.14 presents the recreational vessel tracks recorded during the 16 week shipping survey. There were two transits of the Inner Sound and 5 of the Outer Sound. This indicates a proportion of recreational vessels are carrying AIS voluntarily, although they may not always be broadcasting. The two transits of the Inner Sound were made by *Komale*, a custom-built rowing boat and *Skellig of Sark*, a RIB. Further research indicated both were involved in fund-raising events for charity.

15.61 The latest RYA Coastal Atlas data indicated the Project area does not fall within any Racing or Sailing Areas. In terms of facilities, the nearest harbours / marinas are at Scrabster and Wick. The closest club and training centre is the Pentland Firth Yacht Club in Scrabster.

15.62 No cruising routes are shown through the Inner Sound but there is a medium-use cruising route through the Outer Sound of the Pentland Firth. Medium use cruising routes are defined as "popular routes on which some recreational craft will be seen at most times during summer daylight hours".

15.63 However, a review of the Clyde Cruising Club Sailing Directions, and consultation with RYA (Scotland) and local yachtsmen experienced in sailing through the Pentland Firth identified that the Inner Sound is preferred to the more open Outer Sound when heading east-west. Estimates of the number of transits varied from 1 or 2 yachts per month during summer season and very rarely during winter, to a conservative upper limit of 100 per year.

15.64 The Sailing Directions state that passage should not be undertaken in swell, spring tides, wind against tide, fog and wind force over 4.

15.5.8 Maritime incidents

15.65 Maritime incidents recorded by the MAIB and RNLI in the vicinity of the Project area between 2001 and 2010 have been analysed (some were recorded by both sources).

15.66 The MAIB incident locations are presented in Figure 15.15, colour-coded by type. A total of 14 unique incidents were reported in the area within 5nm of the boundary of the Project, corresponding to an average of 1 to 2 per year.

15.67 No incidents were recorded within the Project area over the 10 years analysed. The closest incident was recorded approximately 0.3nm to the east of the boundary. In April 2004 a fishing vessel suffered machinery failure when its main engine stopped due to dirty fuel oil causing a blockage.

15.68 Figure 15.16 presents the geographical locations of RNLI incidents colour coded by casualty type. A total of 34 launches were carried out in response to 23 unique incidents (excluding hoaxes and false alarms). This equates to an average of 2-3 incidents per year with some incidents being responded to by two or three lifeboats.

15.69 No incidents were recorded within the Project area over the 10 years analysed. The closest incident to the site occurred approximately 0.2nm south of the boundary. This incident occurred on 3rd July 2004 and involved a fishing vessel which became stranded, leading to a person being in danger. This incident was responded to by the Thurso all-weather-lifeboat (ALB).

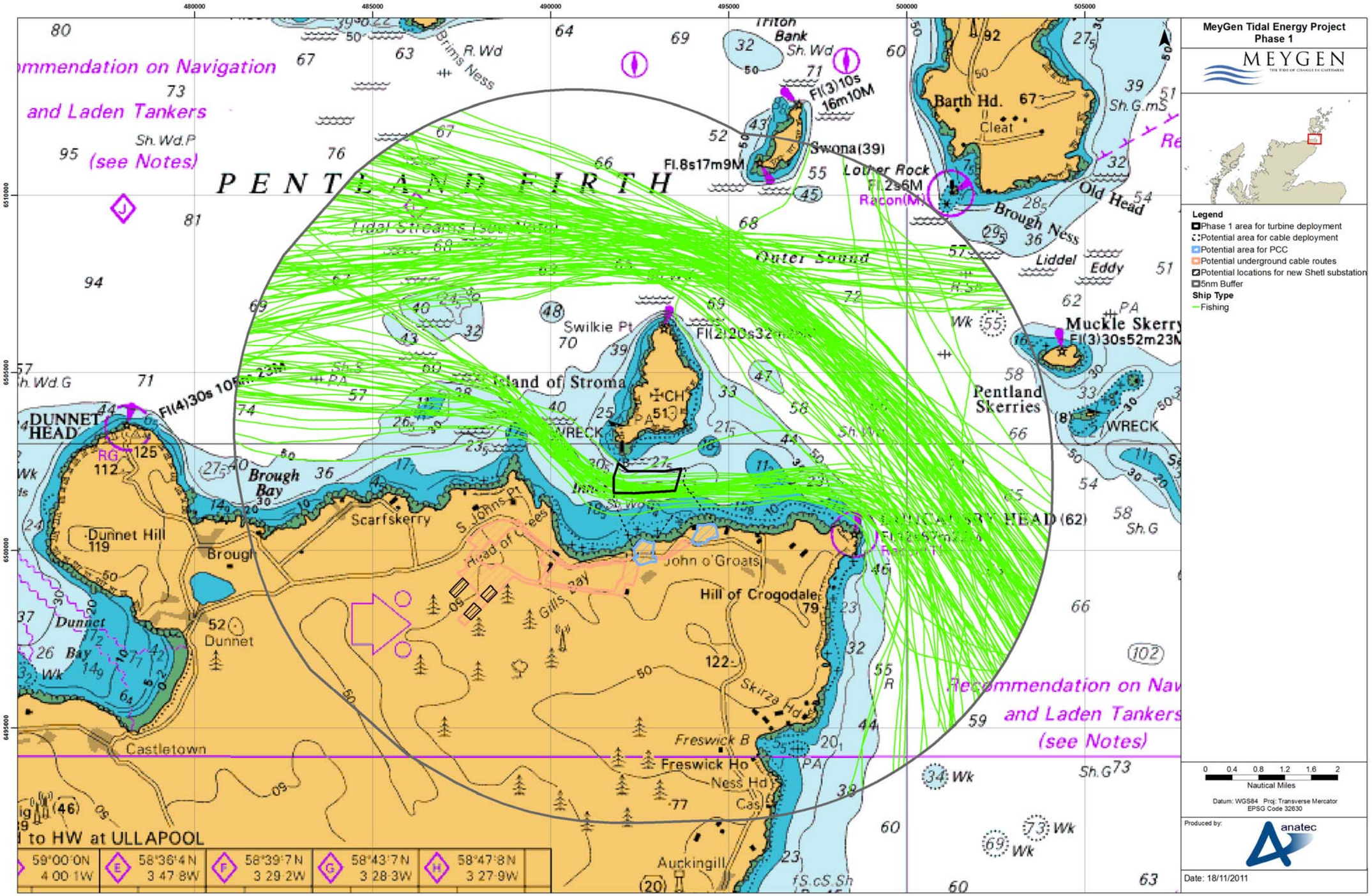

Figure 15.12: Fishing vessels tracked on AIS (2010 and 2011)

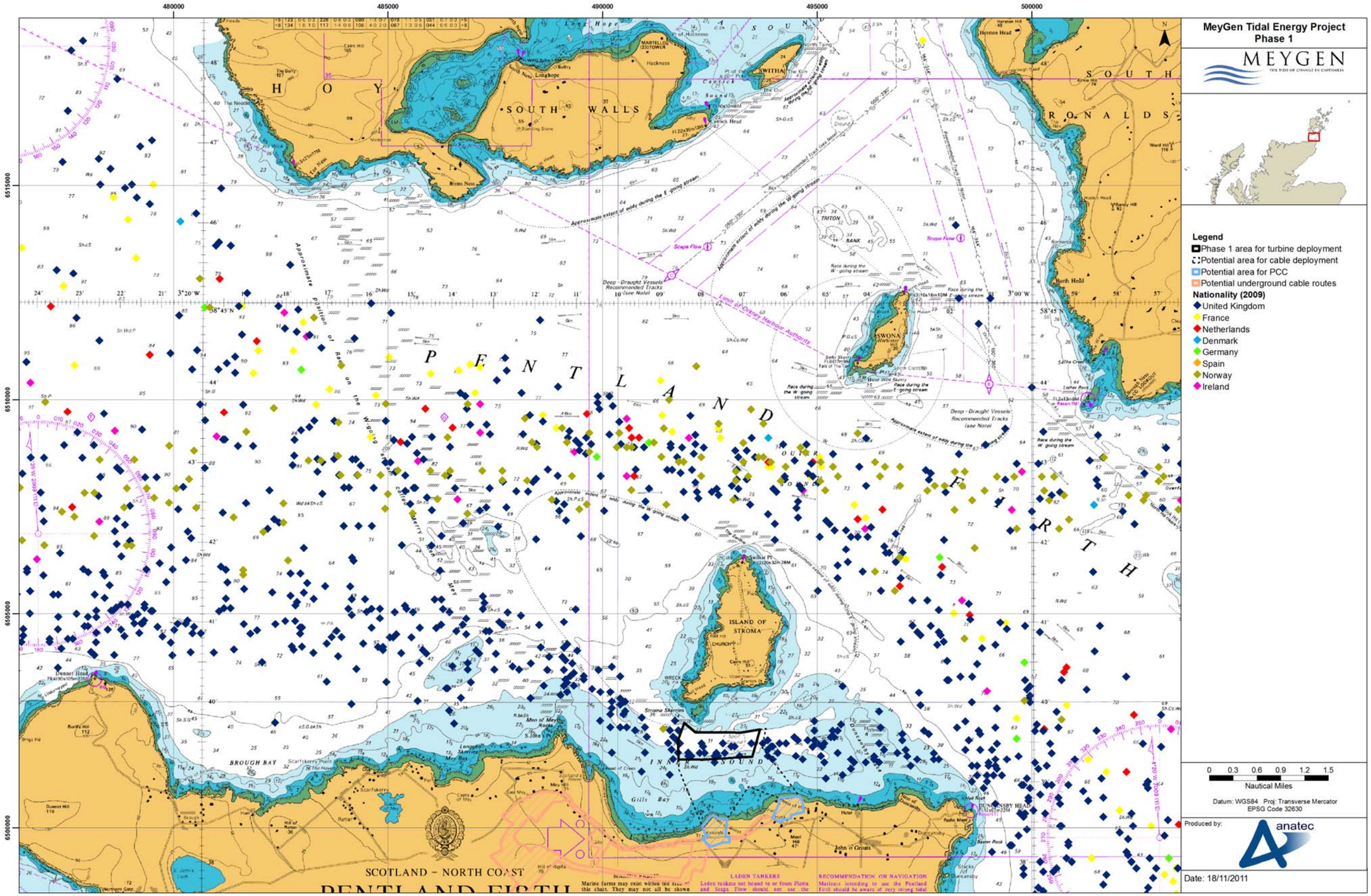

Figure 15.13: Fishing vessel satellite positions relative to the Project (2009)

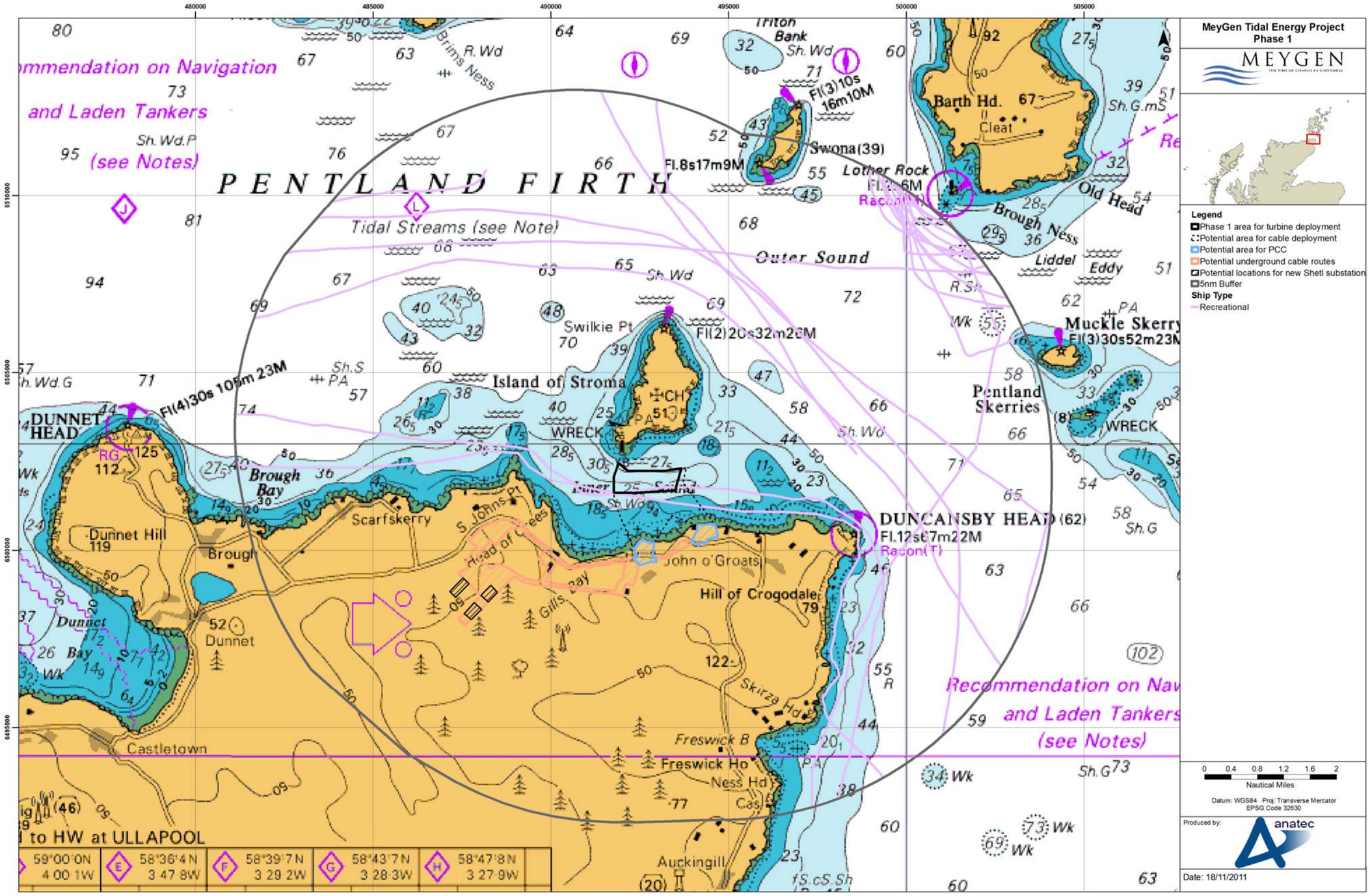

Figure 15.14: Recreational vessels tracked on AIS (2010 and 2011)

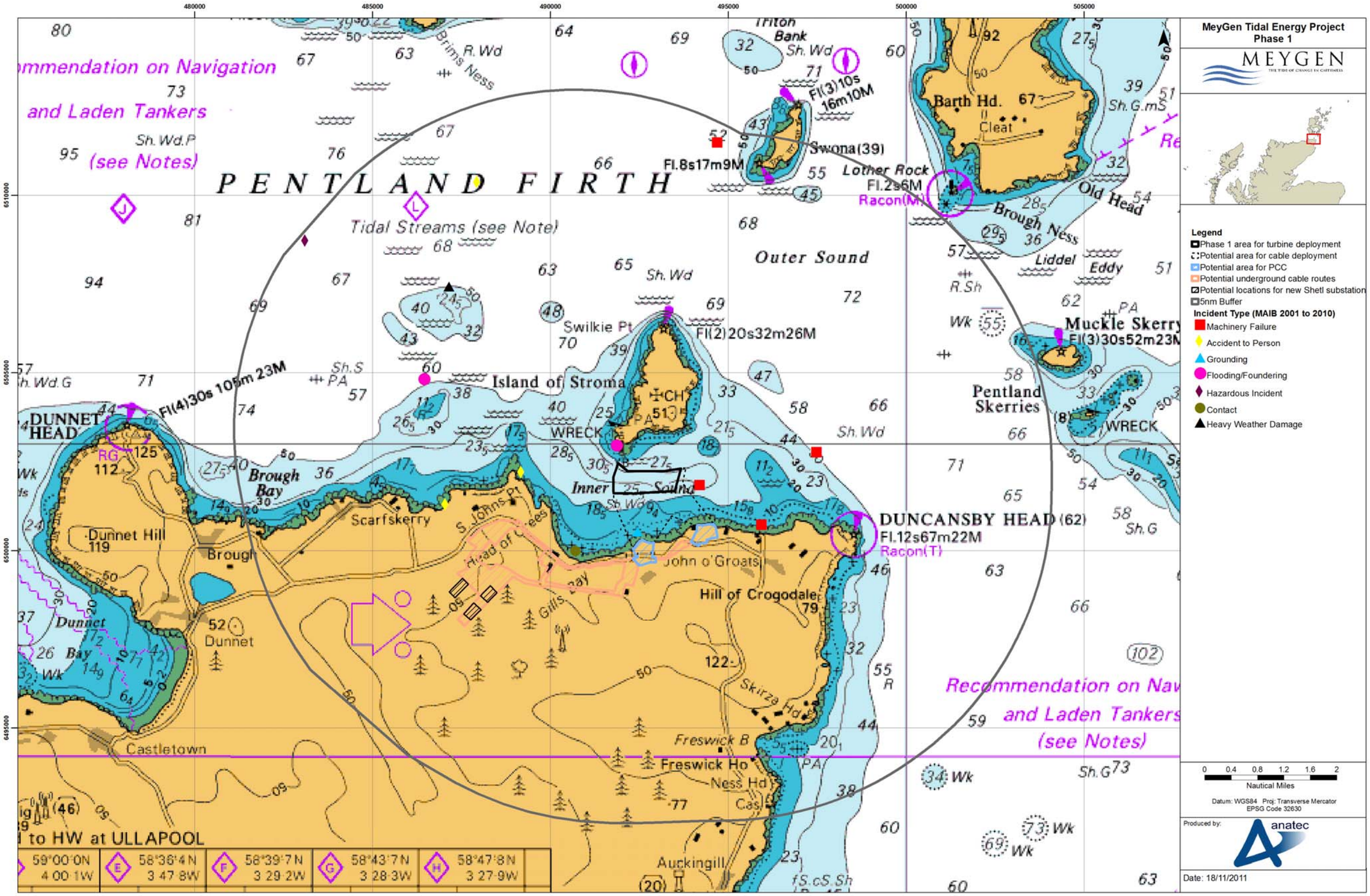

Figure 15.15: MAIB incident locations by type within 5nm of the Project (2001 to 2010)

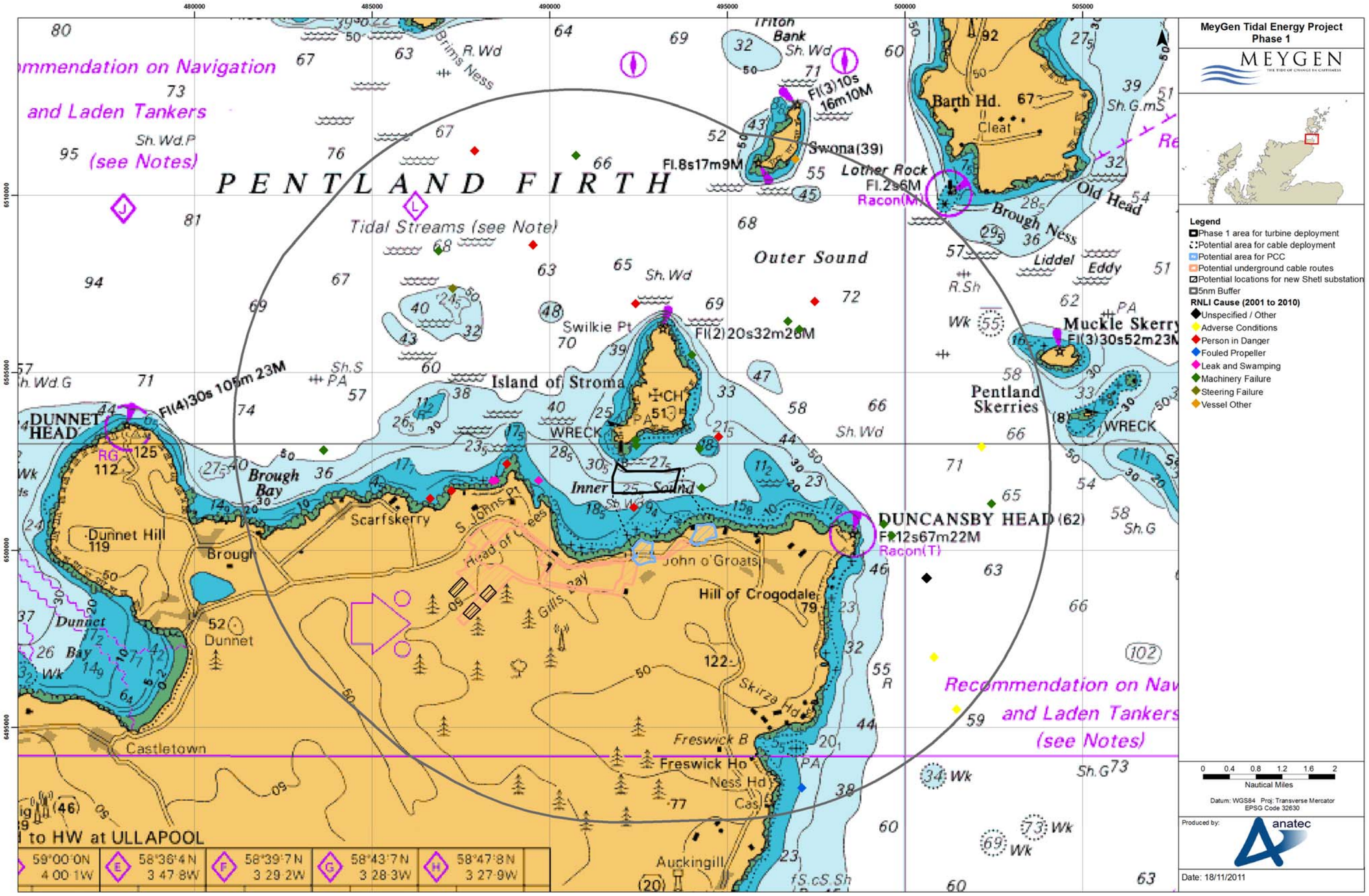

Figure 15.16: RNLI incident locations by casualty type within 5nm of the Project (2001 to 2010)

15.70 There have been two notable maritime incidents responded to by RNLI near Stroma in 2011 (not covered in the above data period):

- On 7th September the Thurso and Longhope RNLI lifeboats responded to a fishing vessel (*Golden Promise*) aground on the west coast of Stroma, which sent a Mayday call to Aberdeen Coastguard; and
- On 27th July the Thurso lifeboat rescued 12 people from rocks after a tour boat (*North Coast Explorer*) got into difficulties while in a sea cave on the island of Stroma. The pleasure boat was not recovered.

15.71 Historical incidents in the Pentland Firth brought up during consultation are described in the NRA and include:

- The chemical tanker Multitank Ascania drifting towards Dunnet Head on fire in 1999;
- The loss of two crew members on the FR8 Venture in 2006 due to severe waves west of Swona after departing Scapa Flow; and
- The loss of fishing gear from the purse seiner Krossfjord in 2008 which fouled the propeller of a passing Scottish trawler.

15.5.9 Search and rescue

15.72 A review of the assets in the area of the Project identified that the closest SAR helicopter base is located at Lossiemouth, operated by the RAF, approximately 57nm to the south of the Project. This base has Sea King HAR3/3A helicopters with a top speed of 125 knots and a radius of action up to 250nm, which is well within the range of the Project area.

15.73 The Royal National Lifeboat Institution (RNLI) maintains a fleet of over 400 lifeboats of various types at 235 stations around the coast of the UK and Ireland. The nearest RNLI stations in the vicinity of the Project, and the ones that responded to the historical incidents in the Inner Sound, are at Wick, Thurso and Longhope. At each of these stations crew and lifeboats are available on a 24 hour basis throughout the year. From conversations with the coxswains, the time for an all-weather lifeboat to reach the Project area would be approximately 45 minutes.

15.6 Impacts during Construction and Installation

15.74 Work vessels will be required during construction and installation of the project. The intention is for a Dynamic Positioning (DP) construction vessel to install foundations and turbines, while a construction vessel or a cable-laying vessel will install the shore-to-array cables and a lightweight vessel with Remotely Operated Vehicle (ROV) will install the short lengths of jumper cable between the turbine bases and the shore-to-array cables. It is anticipated that these activities will not run in parallel.

15.75 The works will be temporary and periodic. All activities will be defined by suitable weather conditions and in some cases by tidal conditions, i.e., periods of slack water. The activities are expected to take place between 2013 and 2015, primarily during spring, summer and autumn.

15.6.1 Impact 15.1: Collision risk with work vessel

15.76 The work vessel(s) could pose a surface collision risk and an obstruction to navigation for all vessels, irrespective of their draught.

15.77 It is noted that much of the work activity will be restricted to windows of time around slack water and the change of the tide. Analysis of tide and current data in the vicinity of the Project indicated that the vessels recorded on AIS transiting the Inner Sound did so at a range of different times and that the peak times did not correspond with slack water. Therefore, only a minority of transiting vessels are likely to encounter working vessels when they are restricted in manoeuvrability in the Project area during these limited tidal windows.

15.78 By pre-warning mariners in advance of the activity, it will allow them the choice of altering their transit to use the Outer Sound rather than the Inner Sound. It is noted the work vessel(s) will monitor passing traffic and have collision risk management procedures in place to help ensure they move out of the way if a vessel is detected on a potential collision course and has not responded to attempts at communication.

Risk significance

15.79 For both local and transiting vessels:

Frequency	Consequence	Risk	Significance
Extremely unlikely	Moderate	Low (Broadly acceptable)	Not Significant

15.80 The above assessment assumes industry good practice will be applied to minimise this impact. Despite the impact being rated as low risk, mitigation is still proposed to ensure that this remains the case. Standard measures and additional mitigation identified during consultation and at the Hazard Review Workshop are presented below:

MITIGATION IN RELATION TO IMPACT 15.1

- Experience and lessons learned from other marine renewables projects will be taken into account.
- Workshops will be held before the activity takes place involving the Construction company and maritime stakeholders to review the hazards and plan how the work can be safely conducted.
- Marine Safety Information broadcasts will be issued by HM Coastguard to inform mariners of the activity at the Project area (8 broadcasts per day covering Fair Isle, Cromarty and Hebrides Areas).
- The Project area will be depicted on Admiralty Charts produced by the UKHO.
- Navtex and Notices to Mariners will be issued including details of the MeyGen work.
- Information on the work activity at the site will be circulated directly to local ports, ferry operators (e.g., Pentland Ferries), fishermen and recreational clubs.
- Details of the Project will be included in updated Kingfisher fishermen's awareness charts and FishSAFE.
- Details of the Project will be included in updated Sailing Directions.
- There will be liaison with local Harbour Masters to ensure they are aware of the activity and can notify visitors to their port.
- A working VHF channel will be provided to local users.
- Safety zone of appropriate dimensions will be applied for to protect working vessels on the site when restricted in manoeuvrability.
- Operating procedures will be established to ensure work vessels do not block the channel when they are not actively working on the site. If it is not practicable for the work vessel to depart from the site they will use AIS and marks to indicate that any safety zone is not operational if they are not restricted in manoeuvrability.
- Collision risk management procedures will be developed to be used by working vessels specifying

traffic monitoring and emergency response procedures.

- An Emergency Response Cooperation Plan (ERCoP) will be prepared for the Project following the template provided by the MCA in MGN 371. This will be submitted to the MCA for comment and approval.
- There will be a dedicated watchkeeper onboard working vessel(s) or onshore.
- Local knowledge will be used during the work whenever possible.
- Local harbours will be used for the work where practicable.
- Radio broadcasts will be given as necessary to warn approaching vessels about the work activity.

15.6.2 Impact 15.2: Traffic re-routeing due to work vessels and associated safety zones

15.81 A major concern raised at the Hazard Review Workshop was the potential for work vessels and their associated safety zones to severely restrict the sea room available to vessels transiting east-west through the Inner Sound.

15.82 Standard safety zone dimensions are 500m but DECC Guidance makes clear that all applications will be assessed on a case-by-case basis taking into account site specific conditions. The NRA has recommended the Developer seeks only to establish the minimum safety zone required to ensure the safety of working vessels, in consultation with Marine Scotland, the MCA, DECC, the appointed contractor and local stakeholders.

15.83 An indicative "maximum case" 500m zone centred on one of the southernmost turbines is presented in Figure 15.17. It can be seen that this could reduce the sea room to the south of the safety zone to 910m from land, and 510m from the 5m water depth contour. In year 3, if there were two work vessels present simultaneously, each with a 500m safety zone, the sea room could be further restricted over a longer stretch of the Inner Sound.

15.84 Hence vessels may be re-routed close to shore or displaced into the Outer Sound. This could lead to increased vessel-to-vessel encounters / collisions as well as a higher risk of grounding. The change in collision risk was modelled assuming two scenarios, firstly, all vessels re-route to the south within the Inner Sound and secondly, all vessels re-route from the Inner Sound to the Outer Sound. (More details on the modelling are provided in Section 15.7.3.)

15.85 Local vessels could also be affected and have to deviate slightly, for example, the *Pentalina*, if routeing to the east of Stroma. By minimising the safety zone radius and providing advanced warning to local users of the activity on the site it is considered that this impact can be minimised and any increase in journey will be of only a few minutes.

Risk significance

Frequency	Consequence	Risk	Significance
Remote	Moderate	Tolerable (moderate risk)	Significant

15.86 The above assessment assumes industry good practice will be applied to minimise this impact. Additional measures identified to those described for Impact 15.1 are listed below:

MITIGATION IN RELATION TO IMPACT 15.2

- Further consultation will be carried out on the safety zone dimensions with Marine Scotland, the MCA, DECC, the appointed contractor and local stakeholders prior to the application being made to DECC.
- Safety zones will be established on a 'rolling' basis, covering only the area of the site in which activity is taking place at a given time. Once that activity has been completed in that specific location, the safety zone will then 'roll on' to cover the next specific location (not the whole Project area).
- Work vessels will indicate their status on AIS and using appropriate marks/lights, e.g., if restricted in manoeuvrability. This will signify to passing traffic whether a Safety Zones is in place or not.

Residual risk

15.87 It is considered that by applying the standard mitigation measures, applying for the minimum size of safety zone required and ensuring as far as possible that both local and transiting vessels are made aware of the work on site prior to their transit of the Inner Sound, the residual impact will be Tolerable (moderate risk). All reasonably practicable steps will have been taken to minimise the risk and obstruction to vessels, i.e., the risks are assessed to have been reduced to ALARP (As Low As Reasonably Practicable).

Frequency	Consequence	Risk	Significance
Remote	Moderate	Tolerable (moderate risk)	Significant

15.6.3 Impact 15.3: Working vessel gets into difficulty

15.88 There is a risk a working vessel gets into difficulty due to adverse conditions, e.g., strong tides and heavy seas, either when working in the Project area of heading to and from the site. This risk is under the management of the developer, and therefore is not a direct 3rd party impact. However, it could lead to more call-outs for the emergency services such as the RNLI.

15.89 The most likely scenario is the working vessel temporarily has difficulty making way and has to suspend operations and seek shelter or return to port (minor consequences). More serious consequences could include vessel damage and, worst case, capsizing of a vessel.

Risk significance

Frequency	Consequence	Risk	Significance
Frequent	Minor	Tolerable (moderate risk)	Significant

15.90 This assumes industry good practice will be applied to minimise this impact. Standard measures and additional mitigation identified during consultation and at the Hazard Review Workshop are presented below:

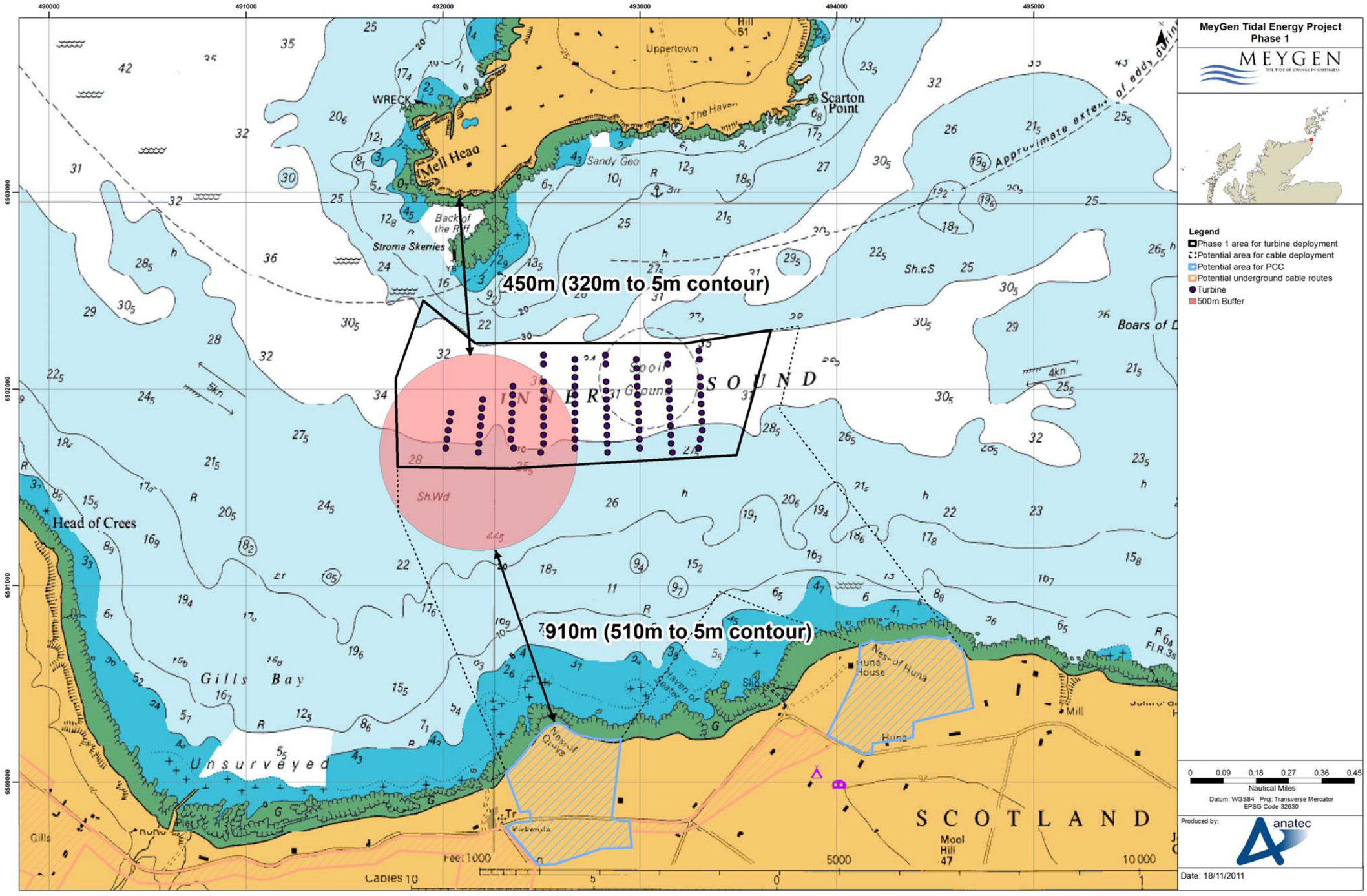

Figure 15.17: Potential area occupied by 500m radius safety zone around working vessel at southern end of the Project

MITIGATION IN RELATION TO IMPACT 15.3
▪ Working vessels are selected and audited based on suitability for the job and the conditions in the Pentland Firth. ▪ Marine operating procedures are developed specifying allowable wave, tide and weather criteria. ▪ Procedures specify that work vessels should seek shelter (or return to base) when not working at the site. ▪ Working personnel are trained in offshore survival and have suitable Personal Protective Equipment (PPE). ▪ The Construction company operates a Safety Management System. ▪ Passage plans are developed for vessels routeing between the Project area and the onshore base. ▪ Work vessel movements are monitored from an onshore control centre, e.g., on AIS and VHF. ▪ An Emergency Response Cooperation Plan (ERCoP) will be prepared for the Project following the template provided by the MCA in MGN 371. This will be submitted to the MCA for comment and approval.

Residual risk

15.91 Based on applying these mitigation measures, and by following industry good practice, it is considered that the residual impact will remain significant. However, the risk is considered tolerable (moderate risk). All reasonably practicable steps will have been taken to minimise the risk, i.e., the risks are assessed to have been reduced to ALARP (As Low As Reasonably Practicable).

Frequency	Consequence	Risk	Significance
Reasonably probable	Minor	Tolerable (moderate risk)	Significant

15.7 Impacts during Operations and Maintenance

15.7.1 Impact 15.4: Powered collision with subsea turbine

15.92 During operation, the turbines will be a minimum of 8m under the level of lowest astronomical tide, although the actual underwater clearance will vary depending on tide and wave conditions. There is a risk of collision with the turbines for vessels of sufficient draught. As well as using the semi-quantitative risk matrix approach, the risk of powered and drifting vessel collision has been modelled using Anatec's COLLRISK software. The NRA discusses the method used which considered the following factors:

- Vessel Draughts (see Figure 15.9) and Squat[1];
- Turbine Elevation relative to Water Depth;
- Tidal Height Variations (see Figure 15.1);
- Wave-induced Vessel Motion (see Figure 15.2);
- Surge; and
- Sounding Accuracy

15.93 An illustration of some of the factors taken into account by the model is presented in Figure 15.18.

15.94 There are also operational impacts associated with vessels re-routeing because they are constrained by their draughts from passing over the turbine array. Other impacts are associated with the subsea cables and potential loss of station of a device.

15.95 The operational impacts are assessed in more detail below

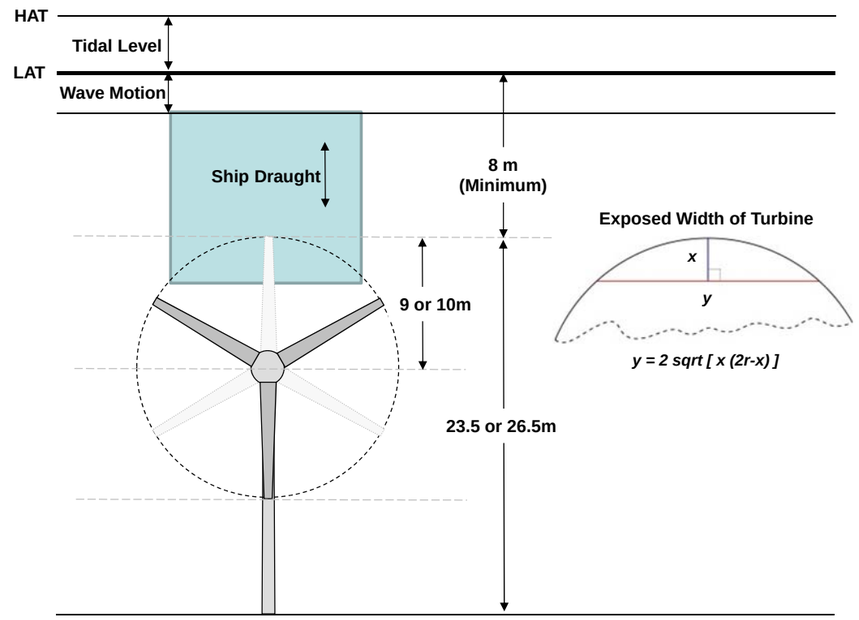

Figure 15.18: Illustration of factors affecting turbine/ship keel interaction[2]

15.96 The risk of vessels under power colliding with the subsea turbines was assessed using COLLRISK.

15.97 The vessel draught distribution assumed in the modelling for the east-west Inner Sound traffic was conservatively based on the AIS draught distribution (larger vessels). Modelling was also performed for the *Pentalina* based on the specific routeing pattern, number of transits and dimensions of this vessel. (Other local vessels such as the John o' Groats creel boats have draughts below 2m and the risk of subsea collision is considered to be minimal.)

15.98 Various scenarios were modelled. Using the most realistic (but still conservative) inputs and including standard mitigation such as chart marking and information circulation, the collision frequency for east-west traffic was estimated to be 1 in 18,400 years. For the Pentalina the collision risk was estimated to be negligible (less than 1 in 1 million years) due mainly to its relatively shallow draught (maximum of 3m).

[1] The squat effect occurs when a vessel travelling at speed in enclosed or shallow waters displaces water from underneath the vessel, thus creating an area of low pressure under the hull, resulting in vertical sinkage.

[2] The factors taken into account by the model represent the 'worst case scenario'. From a navigation perspective the worst case scenario is based on the maximum 86 turbines being a mix of 18m and 20m diameter rotor turbines. The turbine deployment area was selected to ensure that there is always a minimum of 8m clearance from blade tip to Lowest Astronomical Tide (LAT). A 20m diameter rotor turbine is used at turbine locations with the layout where an 8m clearance to LAT can be maintained, the remainder are 18m rotors. Hence the radius of the turbine blades is considered to be between 9 and 10m.

Risk significance

Impact	Frequency	Consequence	Risk	Significance
Collision risk with turbine – local vessel (shallow draught, up to about 3m)	Negligible	Moderate	Low (broadly acceptable)	Not significant
Collision risk with turbine – transiting vessel (a proportion of which are moderate to deep draught, up to approx. 8m)	Extremely unlikely	Moderate	Low (broadly acceptable)	Not significant

15.99 The above assessment assumes industry good practice will be applied to minimise this impact. Standard measures and additional mitigation identified during consultation and at the Hazard Review Workshop are presented below:

MITIGATION IN RELATION TO IMPACT 15.4

- The turbines will have a minimum underwater clearance of 8m relative to LAT.
- The Project area will be depicted on Admiralty Charts produced by UKHO with an associated note on the available underwater clearance.
- Details of the Project will be included in updated fishermen's awareness charts and on FishSAFE.
- Details of the Project will be included in updated Sailing Directions.
- There will be liaison with local Harbour Masters to ensure they are aware of the activity and can notify visitors to their port.
- Marking and lighting of the site will be decided by NLB once they have reviewed the NRA and consulted as appropriate. Discussions to date have indicated that they consider the Project area is effectively marked by the southern part of the island of Stroma and the whole coastline is conspicuous on radar. Therefore, they do not foresee a need for additional marking and lighting. Floating aids to navigation are not considered suitable given the strong tides.
- Survey, Deploy and Monitor strategy, i.e., turbines will be installed over a number of years which allows the effect on vessel navigation to be monitored.
- An Emergency Response Cooperation Plan (ERCoP) will be prepared for the Project following the template provided by the MCA in MGN 371. This will be submitted to the MCA for comment and approval.

15.7.2 Impact 15.5: Drifting vessel collision with subsea turbine

15.100 The risk of a vessel losing power and drifting into a subsea turbine was assessed using Anatec's COLLRISK model. This model is based on the premise that propulsion on a vessel must fail before a vessel will drift. The model takes account of the type and size of the vessel, number of engines and average time to repair in different conditions. Additionally, the factors illustrated in Figure 15.18 must be such that the under keel clearance is insufficient to prevent a collision.

15.101 The exposure times for a drifting scenario are based on the ship-hours spent in proximity to the site estimated based on the traffic levels and speeds. The exposure is divided by vessel type and size to ensure these factors, which based on analysis of historical accident data have been shown to influence accident rates, are taken into account within the modelling.

15.102 Using this information the annual drifting ship collision frequency with the 86 turbines was estimated to be 8.3×10^{-5} per year corresponding to an average of one drifting ship collision in 12,000 years (Anatec, 2012).

15.103 This very low frequency reflects the fact that traffic in the vicinity of the Project area is relatively light, engine breakdown is not a common event, if it were to occur there is a reasonable prospect of recovery before reaching the array and only a proportion of vessels would be capable of interacting with the underwater turbines for a proportion of time (based on the combination of vessel draught, wave and tide).

Risk significance

Impact	Frequency	Consequence	Risk	Is the impact significant or not significant
Collision risk with turbine – local vessel (shallow draught, up to about 3m)	Negligible	Moderate	Low (broadly acceptable)	Not significant
Collision risk with turbine – transiting vessel (a proportion of which are moderate to deep draught, up to approx. 8m)	Negligible	Moderate	Low (broadly acceptable)	Not significant

15.104 Despite no significant risk being identified mitigation is still proposed to ensure this remains the case. The above assessment assumes industry good practice will be applied to minimise this impact. Standard measures and additional mitigation identified during consultation and at the Hazard Review Workshop are presented below:

MITIGATION IN RELATION TO IMPACT 15.5

- The turbines will have a minimum underwater clearance of 8m relative to LAT.
- The Project area will be depicted on Admiralty Charts produced by UKHO with an associated note on the available underwater clearance.
- Marking and lighting is being discussed with NLB (refer to mitigation for Impact 15.4).
- Turbines could be stopped to maximise underwater clearance.
- An Emergency Response Cooperation Plan (ERCoP) will be prepared for the Project following the template provided by the MCA in MGN 371. This will be submitted to the MCA for comment and approval. This will include information on tug availability for potentially recovering a drifting vessel.

15.7.3 Impact 15.6: Increase in vessel-to-vessel collision risk due to re-routeing

15.105 The Project could impact upon vessel-to-vessel collision risk due to reduced sea room in the Inner Sound and / or re-routeing of traffic into the Outer Sound. An assessment of actual vessel-to-vessel encounters was carried out by replaying at high-speed 8 weeks of AIS survey data from summer and winter 2010 and identifying where vessels passed within one nautical mile, which has been assumed as a nominal encounter distance. There were a total of 171 encounters, an average of 3 per day. Most encounters occurred in the Outer Sound where the traffic is much heavier, although the channel is wider, as shown in Figure 15.19. Within the Inner Sound, there were just two occasions when vessels passed within 1nm.

15.106 Anatec's COLLRISK model was used to estimate background (without the Project) and predicted (with the Project) collision risk within 5nm of the Project. The background vessel-to-vessel collision risk level is in the order of 1 major collision in 94.52 years. It is emphasised the model is calibrated based on major

incident data at sea which allows for benchmarking but does not cover all incidents, such as where the consequences were minor.

15.107 When the turbines are installed, it is assumed a proportion of vessels will re-route either within the Inner Sound or via the Outer Sound, as they may be constrained by draught. For the Inner Sound re-routeing scenario, the mean position of the transiting east-west route is assumed to be displaced to the south due to avoidance of the Project area and the route has been narrowed due to the reduction in sea room. The *Pentalina* route is assumed to remain the same. Based on vessel-to-vessel collision risk modelling of the revised routes, the overall collision risk was estimated to be 1 in 94.46 years, i.e., a very small increase of 6×10^{-6} (one additional major collision in 167,000 years). The change is very low as only a small number of vessels are affected and the probability of two vessels transiting the channel at the same time, as seen from the encounter analysis, is relatively low.

15.108 For the Outer Sound scenario, all the east-west transiting traffic through the Inner Sound was re-routed via the Outer Sound. The *Pentalina* route is assumed to remain the same. Based on vessel-to-vessel collision risk modelling of the revised routes, the overall collision risk was estimated to be 1 in 88.3 years, i.e., an increase over the background risk without the Project of 7×10^{-4} (one additional major collision in 1,350 years). This change is higher, which is a combination of the increased voyage distances and the fact that vessel congestion and encounter frequency is already much higher in the Outer Sound.

15.109 In reality, it is expected there will be a combination of the two effects, with some vessels, particularly those with shallower draughts, choosing to remain in the Inner Sound and others, particularly those with deeper draughts, re-routeing via the Outer Sound. It was seen from the survey data analysis that several vessels already use both channels on different occasions. The choice is also likely to be dependent on the weather conditions and tides at the time of the passage.

15.110 In order to assess the risk associated increases in vessel to vessels collisions it is the change in the risk that is the important figure. For the Inner Sound there is one additional major collision in 167,000 years and for the Outer Sound one additional major collision in 1,350 years. Therefore, the frequencies that are considered in the assessment are negligible for the Inner Sound and extremely unlikely for the Outer Sound.

Risk significance

Impact	Frequency	Consequence	Risk	Significance
Re-routeing via Inner Sound	Negligible	Moderate	Low (broadly acceptable)	Not Significant
Re-routeing via Outer Sound	Extremely unlikely	Moderate	Low (broadly acceptable)	Not Significant

15.111 The above assessment assumes industry good practice will be applied to minimise this impact. Standard measures and additional mitigation identified during consultation and at the Hazard Review Workshop are presented below:

MITIGATION IN RELATION TO IMPACT 15.6

- Despite no significant risk being identified mitigation is still proposed to ensure this remains the case.
- Vessels will have increased awareness of the Project area due to the notification measures carried out before and during Installation (described under the mitigation of Impact 15.1).
- The turbines will have a minimum under water clearance of 8m relative to LAT which means a proportion of vessels will not need to re-route as they will have safe under keel clearances when passing over the turbines.
- The Project area will be depicted on Admiralty Charts produced by UKHO with an associated note on the available underwater clearance. This will allow vessels to revise their passage in advance, taking into account information on the Project, before setting off from Port.
- Details of the Project will be included in updated Sailing Directions.
- There will be liaison with local Harbour Masters to ensure they are aware of the Project and can notify visitors to their port.

15.7.4 Impact 15.7: Loss of station

15.112 If part of a device loses station it could pose a risk to other vessels navigating through the Inner Sound. This was raised as a concern during consultation and at the Hazard Review Workshop due to the strong tidal flows through the Inner Sound.

15.113 The incident involving the Norwegian purse seiner *Krossfjord* was highlighted as an example of the hazards that can result from foreign objects within shipping lanes. The nets fouled the propeller of one vessel and were narrowly avoided by a ferry. The only potentially neutrally or positively buoyant parts of the turbine are the turbine nacelle and blades depending on the final manufacturer and design. If these were to become detached they could pose a hazard to vessels navigating in the area, especially during the hours of darkness. Negatively buoyant components will remain on the seabed and will be recovered where possible.

Risk significance

Frequency	Consequence	Risk	Significance
Reasonably probable	Minor	Moderate (tolerable)	Significant

15.114 The above assessment assumes industry good practice will be applied to minimise this impact. Standard measures are presented below:

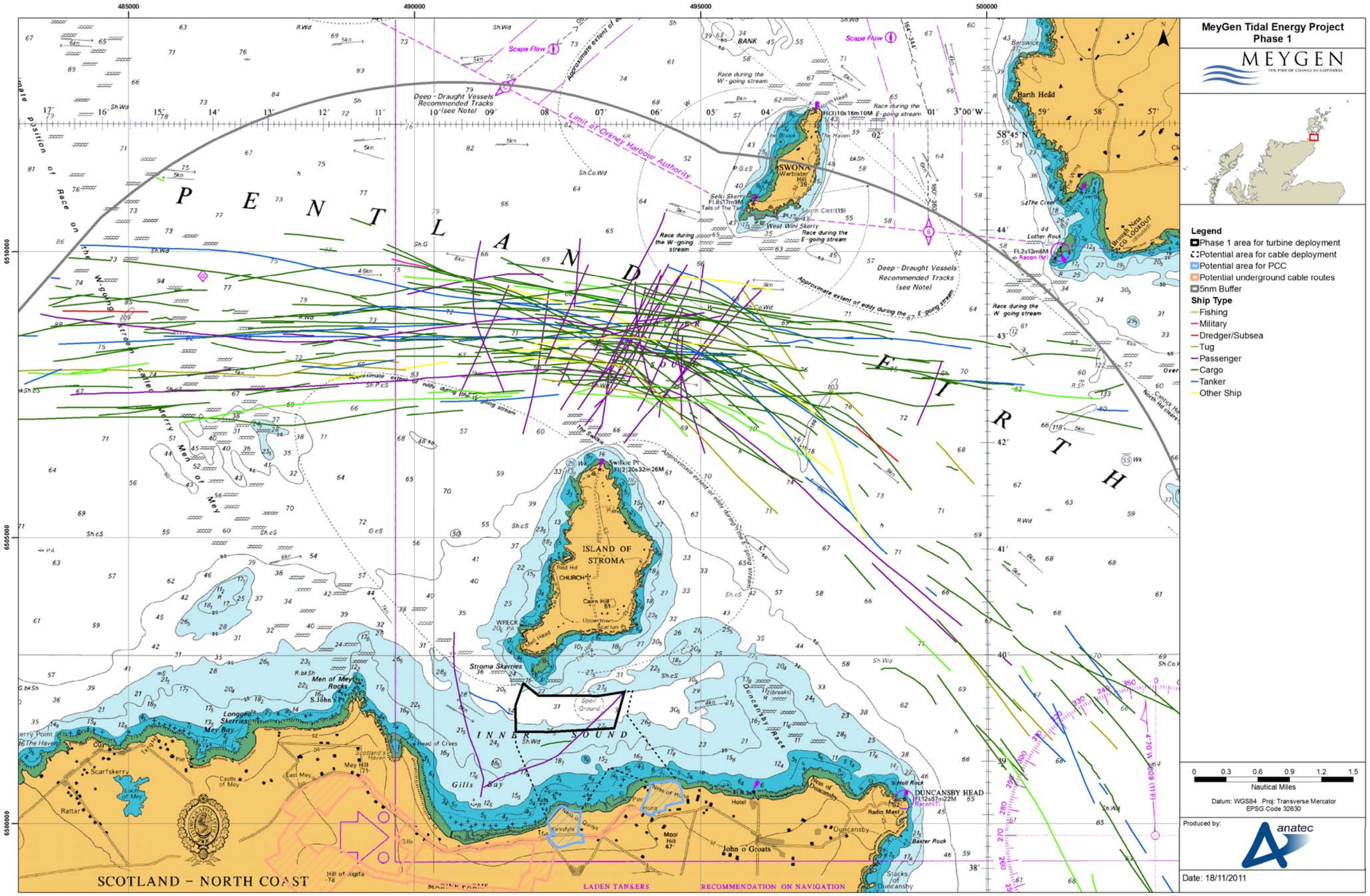

Figure 15.19: AIS tracks of encounters (2010)

MITIGATION IN RELATION TO IMPACT 15.7
▪ The turbines have been subjected to engineering design and third-party verification to ensure they are suitable for deployment in the Inner Sound. ▪ The Survey, Deploy and Monitor strategy will ensure any initial problems are identified and rectified before the full tidal array is in the water. ▪ The Project will be using tried and tested equipment and techniques to minimise the risks associated with the high tidal flow environment. ▪ Most parts will be negatively buoyant. ▪ Turbine nacelle designs that use buoyancy as part of the installation and maintenance strategy have failsafe locking systems for the connection between the nacelle and the TSS to prevent accidental release. ▪ On-site monitoring via SCADA will alert the 24-hour control room operations team of turbine failure or an object hitting the turbine. ▪ Emergency Response Cooperation Plan (ERCoP) to be prepared and agreed with the MCA. Emergency response would include informing HM Coastguard, RNLI, Harbours and local users (e.g., Pentland Ferries) so that vessels in the area are alerted to the potential hazard.

Residual risk

15.115 Based on applying these mitigation measures, and by following industry good practice, it is considered the residual impact will remain significant. However, the risk is considered tolerable. All reasonably practicable steps will have been taken to minimise the risk, i.e., the risks are assessed to have been reduced to ALARP (As Low As Reasonably Practicable).

Frequency	Consequence	Risk	Significance
Reasonably probable	Minor	Moderate (tolerable)	Significant

15.7.5 Impact 15.8: Anchor interaction

15.116 There is a risk of anchor interaction with the turbines, turbine support structures, inter-array cabling and cables to shore.

15.117 No vessels were observed to be anchoring in the Inner Sound during the AIS surveying. Stakeholder consultation and the discussion at the Hazard Review Workshop confirmed that merchant vessels do not anchor in the Pentland Firth. Also the seabed of the Project area is mainly bedrock (Benthic Habitats and Ecology, Section 10), which is not suitable holding ground for anchors.

15.118 The risk of a vessel anchoring over the site in an emergency, or a vessel from east or west of the Pentland Firth dragging anchor towards the site is minimal.

15.119 Anchorage locations for yachts are mentioned as Gills Bay, John o' Groats and south of Stroma (where an anchorage is indicated on Admiralty Charts). Yachts would not anchor mid-channel in water depths of over 30m where the turbines will be located.

Risk significance

Frequency	Consequence	Risk	Significance
Extremely unlikely	Minor	Low (broadly acceptable)	Not Significant

15.120 Despite no significant impact being identified, mitigation is still proposed to ensure this remains the case.

15.121 The above assessment assumes industry good practice will be applied to minimise this impact. Standard measures are presented below:

MITIGATION IN RELATION TO IMPACT 15.8
▪ Project area will be depicted on charts. Turbine and cables areas will be depicted on appropriate scale charts. ▪ Cables will be grouped (where feasible) to minimise the overall footprint area on the seabed. ▪ HDD bores will provide protection for at least part of the cable length from shore. ▪ Natural crevices will be used to avoid exposed cables being on the seabed surface as far as practicable. ▪ Additional material weighting will be used where necessary to ensure cable stability on the seabed.

15.8 Impacts during Decommissioning

15.122 Impacts during decommissioning would be considered to be the same as those experienced during the construction and installation phase of the Project, except that the Project should be well known to all vessels using the area by that time. The mitigation would be the same as that presented in Section 15.6.

15.9 Potential Variances in Environmental Impacts

15.123 Consideration of the maximum potential impact has been undertaken throughout the navigation risk assessment. This has considered the entire footprint of offshore construction and installation activity including a maximum safety zone of 500m radius. It is likely that the safety zone will be reduced to allow navigation of the Inner Sound to be still available to vessels transiting the Pentland Firth.

15.124 The indicative turbine layout used for this assessment is considered to be worst case although changes to layout are likely to be based on further project development. However these are unlikely to be significant and would not alter the outcome of the assessment.

15.125 Future increases in vessel traffic using the Inner Sound and Pentland Firth may vary from those identified in the baseline assessment; however these are unlikely to be significant and would therefore not have a major impact on the assessment.

15.10 Cumulative Impacts

15.126 MeyGen has, in consultation with Marine Scotland and The Highland Council, identified a list of other projects (MeyGen, 2011), which together with the Project may result in potential cumulative impacts. The list of these projects including details of their status at the time of the EIA and a map showing their location is provided in Section 8; Table 8.3 and Figure 8.1 respectively.

15.127 Having considered the information presently available in the public domain on the projects for which there is a potential for cumulative impacts, Table 15.7 below indicates those with the potential to result in cumulative impacts from a Shipping and Navigation perspective. The consideration of which projects could result in potential cumulative impacts is based on the results of the project specific impact assessment together with the expert judgement of the specialist consultant.

Project title	Potential for cumulative impact	Project title	Potential for cumulative impact	Project title	Potential for cumulative impact
MeyGen Limited, MeyGen Tidal Energy Project, Phase 2	✓	SHETL, HVDC cable (onshore to an existing substation near Keith in Moray)	×	OPL, Ocean Power Technologies (OPT) wave power ocean trial	×
ScottishPower Renewables UK Limited, Ness of Duncansby Tidal Energy Project	✓	Brough Head Wave Farm Limited, Brough Head Wave Energy Project	×	MORL, Moray Offshore Renewables Ltd (MORL) offshore windfarm	×
Pelamis Wave Power, Farr Point Wave Energy Project	×	SSE Renewables Developments (UK) Limited, Costa Head Wave Energy Project	×	SSE and Talisman, Beatrice offshore Windfarm Demonstrator Project	×
Sea Generation (Brough Ness) Limited, Brough Ness Tidal Energy Project	✓	EON Climate & Renewables UK Developments Limited, West Orkney North Wave Energy Project	×	BOWL, Beatrice Offshore Windfarm Ltd (BOWL) offshore windfarm	×
Cantick Head Tidal Development Limited, Cantick Head Tidal Energy Project	✓	EON Climate & Renewables UK Developments Limited, West Orkney South Wave Energy Project	×	Northern Isles Salmon, Chalmers Hope salmon cage site	×
SSE, Caithness HVDC Connection - Converter station	×	ScottishPower Renewables UK Limited, Marwick Head Wave Energy Project	×	Northern Isles Salmon, Pegal Bay salmon cage site	×
SSE, Caithness HVDC Connection - Cable	×	SSE Renewables Developments (UK) Limited, Westray South Tidal Energy Project	×	Northern Isles Salmon, Lyrawa salmon cage site	×
RWE npower renewables, Stroupster Windfarm	×	EMEC, Wave Energy test site (Billia Croo, Orkney)	×	Scottish Sea Farms, Bring Head salmon cage site	×
SSE, Gills Bay 132 kV / 33 k V Substation Phase 1: substation and overhead cables (AC)	×	EMEC, Tidal energy test site (Fall of Warness, Orkney)	×	Northern Isles Salmon, Cava South salmon cage site	×
SSE, Gills Bay 132 kV / 33 k V Substation Phase 2: HVDC converter station and new DC buried cable	×	EMEC, Intermediate wave energy test site (St Mary's Bay, Orkney)	×	Scottish Sea Farms, Toyness salmon cage site	×
SHETL, HVDC cable (offshore Moray Firth)	×	EMEC, Intermediate tidal energy test site (Head of Holland, Orkney)	×	Northern Isles Salmon, West Fara salmon cage site	×

Table 15.7: Summary of potential cumulative impacts

15.128 The following sections summarise the nature of the potential cumulative impacts for each potential project phase:

- Construction and installation;
- Operations and maintenance; and
- Decommissioning.

15.10.1 Potential cumulative impacts during construction and installation

15.129 Cumulative impacts arising from installation of multiple marine renewable projects at the same time is only considered to be a potential issue for the Ness of Duncansby site. MeyGen Phase 2 will be after Phase 1, whilst construction traffic associated with the Brough Ness and Cantick Head developments is not expected to use the Inner Sound and any effects should be localised.

15.130 The Ness of Duncansby site is a minimum of 1.6nm east of the Project area. The main cumulative impact would be if the installation activities were to overlap between the two projects. This is likely to be the case given the extended deployment duration of the Project. This could lead to transiting vessels temporarily having to avoid surface vessels (and associated safety zones) at both sites. However, provided the safety zones at both sites are "rolling" zones (i.e., centred on where the work activity is taking place) of maximum 500m radius, the impacts are considered to be manageable. Liaison between the two developers will assist this process.

15.10.2 Potential cumulative impacts during operations and maintenance

15.131 The MeyGen Tidal Energy Project Phase 2 will introduce a further 312MW in the Inner Sound. The exact turbine number, location and layout within the Agreement for Lease (AfL) area is not defined and will incorporate lessons learned from and technology advancements beyond Phase 1 of the Project. These factors will influence the potential for, nature of and significance of any cumulative impacts. The larger overall area will mean that the *Pentalina* will be passing over the turbines when routeing both west and east of Stroma. Other local vessels such as the creel boats will also be crossing the area more frequently, as will the John o' Groats ferry when sailing to and from Stroma. Assuming a consistent minimum clearance depth under Phase 2 as Phase 1, this should not pose a problem for these shallow draught vessels during normal operations.

15.132 In terms of east-west transiting traffic, the width of the Inner Sound channel occupied by Phase 2 is similar to Phase 1 and therefore it is considered to be well-aligned. However, it will increase the duration that east-west passing vessels constrained by draught have restricted sea room.

15.133 The Ness of Duncansby tidal array would have a capacity of 95MW based on 95 x 1MW Hammerfest Strøm HS1000 tidal turbines within the area. Due to the proposed depths of the turbines (40-70m), they are not thought to pose a significant risk to those vessels using the Inner Sound that could be impacted by the Project. Navigational effects are stated as being confined to the activities in which a surface vessel is required on site. During normal operations, the cumulative impact with the Project is considered to be minimal.

15.134 The Open-Centre Turbines planned to be used at Cantick Head Tidal Array Ness are located directly on the seabed, supported by a subsea base structure. Given the water depth of the planned deployment, the under keel clearance should be such that it will not affect surface navigation during normal operations. During work activity at the site, its location is such that it should only have a localised impact on coastal traffic. It is not expected to alter shipping routes to and from Scapa Flow or within the Outer Sound.

15.135 The Brough Ness site is 5.9nm NE of the Project area. Marine Current Turbines Ltd (MCT) is planning to deploy 66 SeaGen tidal turbines off Brough Ness in three phases between 2016 and 2020. The SeaGen turbine rotor blades are mounted on wing-like extensions either side of a tubular steel monopile some 3m in diameter. Given that the turbines have a surface element; this project has the potential to displace traffic during normal operations. However, given its position within 1nm of the South Ronaldsay coast, it will mainly affect small inshore vessels. There could also be some narrowing of the traffic lane between Brough Ness and Muckle Skerry, but this will not affect any traffic re-routeing from the Inner Sound to the Outer Sound because of the Project which will be well to the south.

15.136 Maintenance vessels will also be present on occasion within all the proposed sites but these would not be expected to require safety zones so any effects should be localised to the individual sites.

15.10.3 Potential cumulative impacts during decommissioning

15.137 As with installation, the main cumulative impact would be if the Ness of Duncansby decommissioning work overlaps with the Project. If so, the same issues would apply as described in Section 15.10.1.

15.138 In theory, MeyGen Phase 1 and 2 could be decommissioned at the same. This could lead to additional vessels in the area at the same time which would need further consultation with stakeholders and development of appropriate procedures to minimise any impacts.

15.10.4 Mitigation requirements for potential cumulative impacts

15.139 In addition to the Project-specific mitigation, the following measures have been identified to minimise potential cumulative impacts:

- Liaison with ScottishPower Renewables UK Limited should installation or decommissioning activities overlap at the Ness of Duncansby site; and
- Consultation with stakeholders and development of appropriate procedures should MeyGen Phase 1 and 2 be decommissioned simultaneously resulting in increased work vessel activity in the Inner Sound.

15.11 Proposed Monitoring

15.140 Traffic will be monitored on AIS during construction and operation of the devices to assess the effect the Project has on passing traffic and the proportion of vessels that re route either within the Inner Sound or via the Outer Sound. Any other changes in vessel behaviour compared to the baseline traffic data will be reviewed, e.g. transit times relevant to tide.

15.12 Summary and Conclusions

15.141 There are two channels available for vessels transiting the Pentland Firth. The Outer Sound is the recommended route used by the vast majority of vessels. The Inner Sound, containing the MeyGen Project area, is mainly used by local ferries (regularly by *Pentalina* and occasionally by the seasonal ferry *Pentland Venture*) and creel boats, which are all shallow draught.

15.142 Due to their shallow draughts, the risk of collision with local vessels is assessed to be minimal. A collision would only be possible given a combination of low tide and extreme wave conditions, in which local vessels are unlikely to be out at sea. Pentland Ferries who operate the *Pentalina*, the deepest draught local vessel (approx. 3m), have no issues with the Project.

15.143 East-west transiting traffic levels through the Inner Sound are low, with an average of 1-2 vessels per day, most of which are fishing vessels and too small to be carrying AIS.

15.144 The risk of collision for east-west transiting vessels during normal operations was assessed to be low due to the low traffic levels and 8m minimum clearance.

15.145 During normal operations, any vessels constrained by their draught will have to re-route to the south of the array (reduced sea room) or via the Outer Sound. This will lead to increased encounters and hence collision risk but the overall change from the baseline risk levels was low for both options.

15.146 Installation activities involving surface vessels could further restrict sea room, especially if a standard safety zone of 500m is applied.

15.147 Most work activity, when the DP vessel will be restricted in manoeuvrability and a safety zone may apply, will be around the time of slack water. A review of the times of transiting AIS vessels indicated only a minority of vessels were transited the MeyGen area at these times.

15.148 The most effective mitigation is considered to be circulating information about the development, and installation activities, in order to pre-warn vessels. This will allow vessels to revise their passage plan, or timing of their voyage, in advance of encountering the site.

15.149 Other mitigation measures have been identified and are summarised in the NRA (Anatec 2012). Many of these are standard industry measures but others require to be given further consideration by MeyGen, such as the safety zone radius. Further consultation is planned with Marine Scotland, the MCA and others.

15.13 References

BERR (2007). Applying for Safety Zones around offshore energy installations guidance notes, August 2007.

Clyde Cruising Club (2010). Clyde Cruising Club Sailing Directions and Anchorages – Part 5; N & NE Scotland and Orkney Islands.

EMEC (2006). EMEC Wave Data at 3 hourly intervals from 1 January 1986 to 31st December 2005 for Location 58°39’23.23”N, 003°07’34.19”W.

MAIB (2011). Incident data (2001 – 10).

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16 MARINE CULTURAL HERITAGE

16.1 The table below provides a list of all the supporting studies which relate to the Marine cultural heritage impact assessment. All supporting studies are provided on the accompanying CD.

Details of study	Location on supporting studies CD
Inner Sound, Caithness Marine Cultural Heritage Environmental Impact Assessment (ORCA, 2011a)	OFFSHORE\Marine Cultural Heritage
MeyGen EIA Coastal Processes Modelling – Modelling setup, calibration and results (DHI, 2012)	OFFSHORE\Seabed interactions
Benthic survey for Phase 1 of the MeyGen Tidal Stream Energy Project, Inner Sound, Pentland Firth – Report (ASML, 2011)	OFFSHORE\Seabed interactions

16.1 Introduction

16.2 This section of the Environmental Statement (ES) addresses the potential impacts of the proposed Project on the marine cultural heritage. The assessment was undertaken by Orkney Research Centre for Archaeology (ORCA). A detailed technical Environmental Impact Assessment (EIA) report on marine cultural heritage is provided on the accompanying supporting studies CD (ORCA, 2011a).

16.3 As part of this assessment, Scientific Underwater Logistics And Diving (SULA Diving) was commissioned by ORCA to carry out a Desk Based Assessment (DBA) of relevant data sources. ORCA reviewed and interpreted remote sensing survey data obtained by IX Survey (2009), Environmental Research Institute (ERI) and Marine Scotland. Further seabed data was available from the benthic survey undertaken by Aquatic Survey and Monitoring Ltd (ASML, 2011).

16.4 Marine cultural heritage is considered to encompass man-made structures on the seabed including shipwrecks, piers, fish traps and anchor sites as well as submerged landscapes. The latter is where human beings and early hominids previously lived or hunted on terrain which was at that time dry land, or where they exploited fish and shellfish on the coast or in rivers, which are now submerged.

16.2 Assessment Parameters

16.2.1 Rochdale Envelope

16.5 In line with the Rochdale Envelope approach, this assessment considers the maximum ('worst case') project parameters. Identification of the worst case scenario for each receptor (i.e. Environmental Impact Assessment (EIA) topic) ensures that impacts of greater adverse significance would not arise should any other development scenario be taken forward in the final scheme design. Table 16.1 describes the detail of the project parameters that have been used in this assessment and explains why these are considered to be worst case. The potential impacts from alternative Project parameters have been considered in Section 16.9.

Project Parameter relevant to the assessment		'Maximum' Project parameter for impact assessment	Explanation of maximum Project parameter
Turbines	-	N/A	Turbine parameters do not directly influence marine cultural heritage, however potential effects on water flow from the presence of the turbines is considered under the physical processes and sediment dynamics impact assessment and the results of this impact assessment are used to inform the impact assessment.
Turbine support structure	Maximum amount of drill cuttings released into the marine environment	86 monopile Turbine Support Structure (TSS)	The drilled monopile TSS will result in the maximum release of drill cuttings to the marine environment. Assuming the maximum number of 86 TSSs, the maximum amount of drill cuttings that can be generated from turbine support installations is 17,200m^2 (total for 86 TSSs).
	Maximum seabed footprint	86 Gravity Based Structure (GBS) TSS	Each GBS TSS has a maximum footprint of 40m x 30m. The total footprint for 86 turbines is 0.103km^2.
	Operations and Maintenance	No removal of TSSs required for routine operations and maintenance	It is assumed that no replacement or major TSS overhaul involving removal is required during the operational life of the Project.
	Decommissioning	86 monopile	86 monopile TSSs will be cut at the seabed. The bottom on the piles below the seabed will remain in-situ.
Cable connection to shore	Maximum cable footprint on seabed	86, 120mm unbundled cables each 1,300m in length	The maximum physical area of the seabed occupied by the cables has been calculated as 0.027km^2. Based on a maximum 1.3km of cable from Horizontally Directionally Drilled (HDD) bore exit to turbine, and maximum cable diameter of 120mm (x2 to account for any armouring or weighting) for 86 turbines.
	Decommissioning	86, 250mm unbundled cables, each 1,300m in length	All cables laid on the seabed will be fully removed at decommissioning.
Cable landfall	Maximum drill cuttings released into marine environment	29, 0.6m HDD bores, drilled from either Ness of Quoys or Ness of Huna	The majority of drill cuttings generated from the drilling of the HDD bores will be returned to shore and not discharged to sea; however it is estimated that the contents of the last 10m of each bore could be discharged to sea and the seabed breakthrough. Of the two potential HDD scenarios, the greatest potential volume of cuttings discharged to sea at breakthrough will result from last 10m of 29 boreholes of 0.6m diameter 82m^2.
Onshore Project components	-	N/A	As there are no proposed works in the intertidal area along the coast the onshore aspects of the Project do not influence the benthic habitats and ecology impact assessment.

Table 16.1: Rochdale Envelope parameters for the marine cultural heritage assessment

16.2.2 Area of assessment

16.6 It is also important to define the geographical extent of the assessment area. The focus of the marine cultural heritage assessment is potential impacts on seabed of the offshore the Project area and adjacent seabed (Figure 16.1).

16.7 It should be noted that at the time of undertaking the assessment the exact distance from shore at which the HDD bores would emerge was considered to be between 700 and 2,000m, although the exact distance was unknown. The assessment here is based on the worst case where the cables emerge from shore at 700m.

16.3 Legislative Framework and Regulatory Context

16.3.1 Legislation

16.8 The United Nations Convention of the Law of the Sea (UNCLOS) was ratified by the UK in 1997. Article 303 stipulates that 'states have the duty to protect objects of an archaeological and historical nature found at sea and shall co-operate for this purpose'.

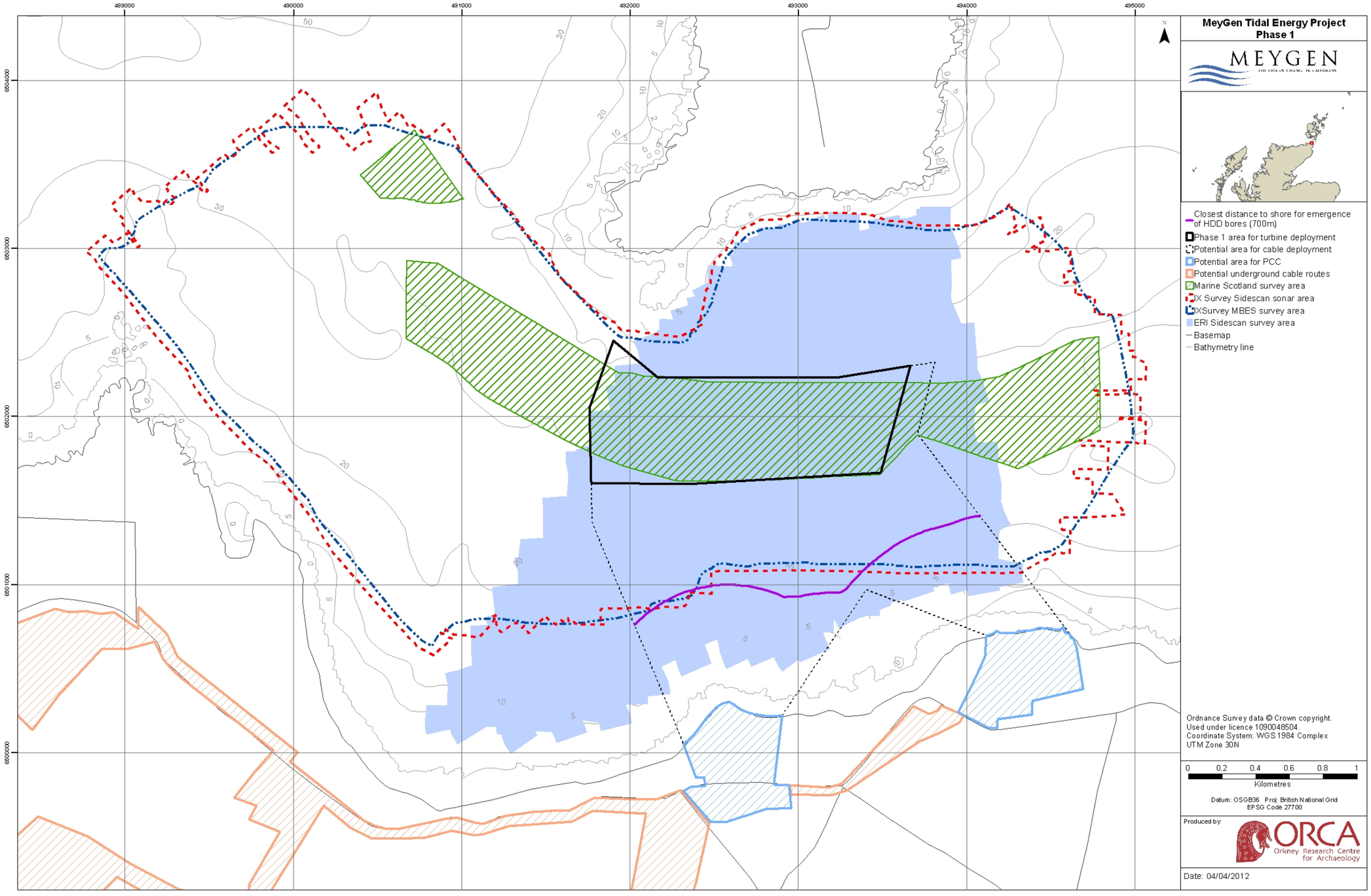

Figure 16.1: Map showing the coverage of the marine geophysical data sets

16.9 The European Convention on the Protection of the Archaeological Heritage (revised), known as the Valletta Convention, was ratified by the UK government in 2000. This contains provisions for the protection of archaeological heritage both under water and on land, preferably in situ, but with provisions for appropriate recording and recovery if disturbance is unavoidable.

16.10 Such definitions are included in national policy, such as Historic Scotland's Scottish Historic Environment Policy (SHEP) 2009, as well as international agreements such as the European Convention on the Protection of the Archaeological Heritage, ratified by the UK government in 2000, and guidance such as Wessex Archaeology's (2007) Historic Environment Guidance for the Offshore Renewable Energy Sector produced for COWRIE.

16.11 The Ancient Monuments and Archaeological Areas Act 1979 (AMAAA) Section 61(12) defines sites that warrant protection due to their being of national importance as 'ancient monuments'. A monument is defined as any building, structure or work above or below the surface of the land, any cave or excavation; any site comprising the remains of any such building, structure or work or any cave or excavation; and any site comprising or comprising the remains of any vehicle, vessel or aircraft or other movable structure or part thereof (Section 61 (7)).

16.12 Although primarily designed for land based structures the legislation was used in 2001 to designate the seven remaining wrecks of the scuttled German High Seas Fleet in Scapa Flow as Scheduled Ancient Monuments. Access to a marine scheduled monument is not restricted, but it is a criminal offence to demolish, destroy, damage alter or repair any part of a Scheduled Ancient Monument.

16.13 The Merchant Shipping Act 1995 requires that all recovered wreck landed in the United Kingdom is reported to the Receiver of Wreck, whether recovered from within or outside UK waters and even if the finder is the owner. The Receiver of Wreck will investigate ownership.

16.14 The Protection of Wrecks Act 1973 provides protection for designated wrecks which are deemed to be important by virtue of their historical, archaeological or artistic value. Approximately 56 wrecks around the coast of the UK have been designated under this section of the Act. Each wreck has an exclusion zone around it and it is an offence to tamper with, damage or remove any objects or part of the vessel or to carry out any diving or salvage operation within this exclusion zone.

16.15 The Protection of Military Remains Act 1986 has the principal concern to protect the sanctity of vessels and aircraft that are military maritime graves. In 2001 the Secretary of State for Defence announced that 16 vessels within UK jurisdiction would be designated as Controlled Sites, and 5 vessels in international waters would be designated as Protected Places. Any aircraft lost while in military service is automatically protected under this Act.

16.16 The Marine (Scotland) Act 2010, Section 73, concerns Historic Marine Protected Areas (HMPA). The Act defines a marine historic asset as any of the following:

- A vessel, vehicle or aircraft (or a part of a vessel, vehicle or aircraft);
- The remains of a vessel, vehicle or aircraft (or a part of such remains);
- An object contained in, or formerly contained in, a vessel, vehicle or aircraft;
- A building or other structure (or a part of a building or structure);
- A cave or excavation; and
- A deposit or artefact (whether or not formerly part of a cargo of a ship) or any other thing which evidences, or groups of things which evidence, previous human activity.

16.17 Historic Scotland recently consulted (consultation closed on 27th January 2012) on the proposed process for the selection, designation and management of HMPAs. It is expected that the final guidelines on selection, designation and management of HMPAs will be published in March 2012. Initial candidate sites are likely to be sites already protected under the Protection of Wrecks Act 1973 and Ancient Monuments and Archaeological Areas Act 1979. There are no sites protected under this legislation in the Inner Sound.

16.18 Scotland's National Marine Plan, which closed for consultation in 2011, recognises that there are environmental and economic impacts along with spatial constraints caused by the existence of marine cultural heritage. Environmental impacts include shipwrecks, which provide habitats for wildlife as well as being a pollution risk. There is an economic value from tourists visiting coastal and underwater heritage sites. It is recommended that Historic Marine Planning Partnerships (HMPP) and licensing authorities should seek to identify significant historic environment resources at the earliest stages of the planning or development process and preserve them in situ wherever feasible. Where this is not possible licensing authorities should require developers to archaeologically record the asset before it is lost, which can result in significant financial and time constraints on development. The sea and coast also help to define the setting of many important historic buildings and monuments, aiding their understanding and appreciation. In accordance with Scottish Planning Policy, proposals should also seek to avoid or mitigate detrimental impacts on the setting of these assets. Due to cultural material in this marine report being submerged the setting issues are not visual but involve indirect impacts such as scouring on the seabed caused by the development construction.

16.3.2 Policy and guidance

- The Joint Nautical Archaeology Policy Committee and The Crown Estate's (2006) *Maritime Cultural Heritage & Seabed development: JNAPC Code of Practice;*
- Wessex Archaeology Ltd's (2009) UKCS Offshore Oil and Gas and Wind Energy Strategic Environmental Assessment: Archaeological Baseline Ref: 68860.03;
- Wessex Archaeology Ltd's Historic Environment Guidance for the Offshore Renewable Energy Sector (2007), commissioned by COWRIE Ltd;
- COWRIE Ltd's (2008) Guidance for Assessment of Cumulative Impacts on the Historic Environment from Offshore Renewable Energy by Oxford Archaeology & George Lambrick Archaeology and Heritage;
- Gribble, J. and Leather, S. for EMU Ltd. (2011) Offshore Geotechnical Investigations and Historic Environment Analysis: Guidance for the Renewable Energy Sector. Commissioned by COWRIE Ltd (project reference GEOARCH-09); and
- DTI (2003) Strategic Environmental Assessment Area North and West of Orkney and Shetland. Report to the Department of Trade and Industry.

16.4 Assessment Methodology

16.4.1 Scoping and consultation

16.19 Since the commencement of the Project, consultation on marine cultural heritage issues has been ongoing. Table 16.2 summarises all consultation relevant to marine cultural heritage. In addition, relevant comments from the EIA Scoping Opinion are summarised in Table 16.3, together with responses to the comments and reference to the ES sections relevant to the specific comment.

Date	Stakeholders	Consultation	Topic/specific issue
7th April 2011	Marine Scotland and Scottish Natural Heritage (SNH)	Pre-Scoping meeting	EIA surveys and studies required and the data needs for each EIA study.
27th May 2011	Marine Scotland, statutory consultees and non statutory consultees	Submission of EIA Scoping Report	Request for EIA Scoping Opinion from Marine Scotland and statutory consultees and request for comment from non-statutory consultees.
30th June – 2nd July 2011	Local stakeholders	Public Event - EIA Scoping	Public event to collate information/opinions on proposed EIA scope.
26th August 2011	Historic Scotland	Submission of document for	Copy of marine cultural heritage baseline report provided for comment.

Date	Stakeholders	Consultation	Topic/specific issue
		comment	
14th September 2011	Historic Scotland	E-mail	Confirmed proposals do not appear to raise significant issues for HS statutory historic environment interests.
31st September 2011	Marine Scotland, The Highland Council (THC), statutory consultees and non statutory consultees	Receipt of EIA Scoping Opinion	Receipt of response to EIA Scoping Report and other comments from non statutory consultees.
3rd October 2011	Marine Scotland	Project update meeting	Report on EIA progress and presentation of key findings of the impact assessment.
6th – 7th December 2011	Local stakeholders	Public Event – pre-application consultation	Public event to communicate the findings of the EIA to local stakeholders.

Table 16.2: Consultation undertaken in relation to marine cultural heritage

Name of organisation	Key concerns	Response	ES section within which the specific issue is addressed
Historic Scotland	Without prejudice and on the basis of the information supplied, we can indicate at this stage that we consider that it may be possible to locate such a development in this location without it raising significant issues for our historic environment interests.	Comment noted.	Section 16 Marine Cultural Heritage
Historic Scotland	We would however expect certain aspects of the proposal to be assessed and we provide further details about this below. Notwithstanding this, please note that our comments here are provisional and we would need to see any Environmental Statement (ES) to give our final view on the proposals.	This section of the ES presents the results of the marine cultural heritage impact assessment.	Section 16 Marine Cultural Heritage
Historic Scotland	We generally advise for such developments that the following issues are taken into account in the assessment of potential impacts: • on-shore effects • off-shore effects (including potential effects outside the development site).	This section of the ES presents the results of the marine cultural heritage impact assessment. The impact assessment has included consideration of a buffer around the Project area in order to ensure inclusion of potential effects outside the development site.	Section 16 Marine Cultural Heritage
Historic Scotland	Impacts are assessed with the appropriate involvement of archaeological expertise and in consultation with The Highland Council's conservation and archaeological service.	This assessment has been undertaken by Orkney Research Centre for Archaeology (ORCA) and has included consultation with The Highland Council's conservation and archaeological service.	Section 16.4.1 Scoping and Consultation
Historic Scotland	The potential for the discovery of unknown sites and artefacts be assessed.	Mitigation measures address the potential for discovery of unknown artefacts.	Sections 16.6, 16.7 and 16.8 Impact Assessment sections
Historic Scotland	Assessment should consider the significance of potential direct impacts by the development on any archaeological features, such as direct impacts to marine historic features within the proposed development site which could result from the construction, operation and decommissioning of the tidal array and associated operations, such as the laying of power and control cables.	Direct and indirect impacts have been considered.	Sections 16.6, 16.7 and 16.8 Impact Assessment sections
Historic Scotland	Assessment should consider the significance of indirect impacts to historic features on the seabed or at the coast edge within the proposed development area, and possibly beyond, which may be caused by alteration to tidal currents and sedimentary regimes, and by changes to the chemical balance of the water and seabed sediments.	Indirect impacts have been considered.	Section 16.7 Impacts during Operations and Maintenence
Historic Scotland	The cumulative impacts of this development proposal in combination with other proposed and consented schemes.	Potential cumulative impacts have been assessed.	Section 16.10 Cumulative Impacts
Historic Scotland	Specific advice on the treatment of cultural heritage in the marine environment can be found in The Joint Nautical Archaeology Policy Committee (JNAPC) Code of Practice for Seabed Development. This can be found at: http://www.thecrownestate.co.uk/jnapc_code_of_practice_2	This guidance has been referenced.	Section 16.3.2 Policy and Guidance
Historic Scotland	The developer may also find the following sector-specific guidance useful, particularly in respect of approaches to mitigation where the ES identifies effects to a marine historic features within the development area: Historic Guidance for the Offshore Renewable Energy Sector: http://www.offshorewindfarms.co.uk/Assets/archaeo_guidance.pdf	This guidance has been referenced.	Section 16.3.2 Policy and Guidance
Historic Scotland	In addition, the Royal Commission of Ancient and Historical Monument's (RCAHMS) Canmore database provides an extra source of data to PASTMAP for the marine historic environment in addition to the SEA study for the area undertaken by Wessex Archaeology. Just look at the map provided on this page and click on the relevant SEA area: http://www.offshore-sea.org.uk/site/scripts/sea_archive.php	SEA studies by the Department of Trade and Industry on the area north and west of Orkney, Wessex Archaeology on the UKCS Offshore Oil and Gas and Wind Energy and Dr N. Flemming on the potential for prehistoric archaeological remains have been considered.	Section 16.3.2 Policy and Guidance
Historic Scotland	The developer may also wish to refer to the relevant industry guidance on cumulative impacts on cultural heritage features matter in the Guidance for Assessment of Cumulative Impacts on the Historic Environment from Offshore Renewable Energy: http://www.offshorewindfarms.co.uk/Pages/Publications/Archive/ Cultural_Heritage/Guidance_for_Assessmen642afc68/	This guidance has been referenced.	Section 16.3.2 Policy and Guidance

Name of organisation	Key concerns	Response	ES section within which the specific issue is addressed
Historic Scotland	I wish to draw the developer's attention to some new guidance produced by COWRIE entitled Offshore Geotechnical investigations and Historic Environment Analysis: Guidance for the Renewable Energy Sector (January 2011). This is mainly for offshore wind farms in respect of geotechnical surveys and archaeology, but is of interest for EIA work and something we are encouraging developers to consider. It is particularly relevant in relation to prehistoric submerged landscapes: http://www.offshorewind.co.uk/Pages/Publications/Latest_Reports/Cultural_Heritage/Offshore_Geotechnical_b6715e61/	This guidance has been referenced.	Section 16.3.2 Policy and Guidance
Historic Scotland	Enquired about the longevity of marine geophysical survey data in terms of cultural heritage analysis.	HS responded that the baseline information was not expected to have changed much in relation to cultural heritage.	NA
Marine Scotland	The ES should address the predicted impacts on the historic environment and describe the mitigation proposed to avoid or reduce impacts to a level where they are not significant. Historic environment issues should be taken into consideration from the start of the site selection process and as part of the alternatives considered.	Potential impacts have been assessed.	Sections 16.6, 16.7 and 16.8 Impact Assessment sections

Table 16.3: Scoping comments relevant to marine cultural heritage

16.4.2 Desk based assessment

16.20 The DBA covered the Project area. Any items identified outside but close to the Project have been included in this report. This was to identify any sites that might be directly affected by the proposed development and their immediate context.

16.21 The principal reference sources examined for this assessment were:

- The National Monuments Record of Scotland (NMRS), using the Canmore database website; http://www.rcahms.gov.uk/;
- The local Sites and Monuments Record using The Highland Council website; http://her.highland.gov.uk/;
- Statutory lists, registers and designated areas, including List of Scheduled Ancient Monuments, Designated Wrecks and Historic Marine Protected Areas;
- UK Hydrographic Office (UKHO) wreck register and relevant nautical charts;
- Marine Scotland Science includes data from marine surveys and laboratory work;
- DEFRA (Department of Environment, Food and Rural Affairs) funds, commissions and manages research relating to the marine environment;
- Heath/Ferguson private wreck database, which contains material not published by Ferguson (see Ferguson, 1991) and has been added to by Heath and Ferguson as new discoveries of wreck sites have been made;
- Larn, R. & Larn, B. (1998) *The Ship Wreck Index of Great Britain & Ireland* Vol.4 Scotland (SIBI);
- Whittaker I.G. (1998) Off Scotland: a comprehensive record of maritime and aviation losses in Scottish waters, Edinburgh;
- Flemming, N.C. (2003). The scope of Strategic Environmental Assessment of Continental Shelf Area SEA 4 in regard to prehistoric archaeological remains. Available at http://www.offshore-sea.org.uk/site/scripts/sea_archive.php;
- The Bulletins of the Caithness Field Club, available at http://www.caithness.org/caithnessfieldclub/bulletins/linkindex.htm; and
- Other readily available archaeological and historical reports, databases and publications (such as Houston, 1996; Omand, 1989) and, where used, will be cited in the report.

16.4.3 Subsea survey methods and resolution limitations

16.22 Coverage of geophysical surveys is shown in Figure 16.1. Although, not every data set covers the entire offshore footprint, the combined datasets cover the area of impact. IXSurvey were contracted in 2009 to undertake a geophysical site survey in the Inner Sound in the Pentland Firth using a multi-beam echosounder, a hull mounted sub-bottom profiler, and a side-scan sonar interfaced with a magnetometer. The objective of the surveys was to provide geophysical data to determine geological conditions and hazards affecting the planning, design and installation of an offshore marine tidal energy project in the Inner Sound.

16.23 Multi-beam echosounder data collected by Marine Scotland in the Pentland Firth was also viewed. This data included areas to the east and west of the Island of Stroma and part of the Inner Sound. It was collected with a Reson 7125 (http://www.scotland.gov.uk/Topics/marine/science/MSInteractive).

16.24 Further side-scan sonar data was collected by the Environmental Research Institute (ERI) in Thurso in October and November 2010. This covered part of the potential cable deployment area linking the tidal array with the mainland. The data provided adequate survey coverage, so it will not be necessary to carry out any further survey work between the Agreement for Lease (AfL) area and the cable landfall.

16.25 All geophysical data was inspected systematically by an experienced marine archaeologist. Points of interest or anomalies where marked on the mapping software and assigned high, medium and low potential.

16.26 A coastal processes modelling study investigated how sediments would be affected by the introduction of turbines in calm and storm conditions (Section 9). The model resolution did not allow investigation of the effect of individual turbines on turbidity in the water column and the surrounding seabed. It discussed the larger-scale affect of the turbine array on the Inner Sound.

16.27 Reports on the seabed sediment types in the Inner Sound (AMSL, 2011) were made available for the assessment.

16.28 IX Survey (2009) exported sounding data to ESRI ArcGIS Mapping software in which a Terrain was created and used as the modelling surface for production of Contours, Slope and Aspect, Hill-Shade, Shaded Relief and 3D modelling (IX Survey, 2009).

16.29 IX Survey (2009) provided the side-scan sonar in .xtf format and as a Mosaic which could be imported into GIS ArcMap. Locations of all contacts were verified against the MBES data, which was also imported into ArcMap as a geotiff and placed as a background to the side-scan sonar image.

16.30 ERI data was provided as a georeferenced mosaic and as individual georeferenced survey tracks. These were viewed on GIS ArcMap. Overlaps with the IX Survey data (IX Survey, 2009) were used to verify the existence of anomalies.

16.31 The sub-bottom profiler data was provided as raw Coda files and was viewed on Coda GeoSurvey software. The tracks of the sub-bottom profiler were the same as that covered by the side-scan sonar.

16.32 IXSurvey (2009) state that ground truthing would be required to positively identify and classify sub-seabed sediments. It is also possible that sub-seabed features between survey lines may not have been detected.

16.33 The magnetometer data was gridded using Surfer10 software and compared with the anomalies identified by IX Survey. Each line was analysed for spikes and anomalies and these were referenced against multi-beam echosounder, side scan sonar and sub-bottom profiler data sets for confirmation and interpretation of anomalies.

16.4.4 Significance criteria

16.34 The assessment of impact significance approach used for this impact assessment varies slightly from the core methodology in Section 8; specific details are provided in the following sections.

Importance of cultural heritage assets

16.35 The impact assessment of the potential of the Project on the marine cultural heritage will be assessed taking into account the importance attributed to each identified marine cultural area, site or feature and the magnitude of the impact. The importance of an asset or feature will be determined using the criteria in Table 16.4, which incorporate general guidelines used by statutory agencies such as Historic Scotland, outlined in Scottish Historic Environment Policy (SHEP) 2009, Scottish Planning Policy (February 2010), with the companion Planning Advice Note (PAN 2/2011): Planning and Archaeology, the Marine (Scotland) Act 2010, Historic Scotland's Managing Change in the Historic Environment Guidance Notes and Wessex Archaeology's (February 2011) Assessing Boats and Ships.

16.36 The importance given to historic environment considerations will depend on a number of factors[1], including:

- the relative rarity of the feature concerned;
- the completeness of the feature / whether it is a particularly good example of its type;
- the historical or cultural associations of the feature;
- the value given to the feature by the local community;
- the potential value of the feature as an in situ educational or research resource; and
- the potential value of retaining the feature for tourism or place-making.

16.37 It should be noted that a site that has not been statutorily designated can still be of high significance. Features that would require considerable further work to interpret them are recorded as of uncertain importance.

16.38 Anomalies recorded in the analysis of geophysical data were initially assigned an 'uncertain' importance because very little is known about them without further investigation. They have also been assigned a rank of importance in Table 16.5. This additional ranking was used to place the geophysical anomalies within the criteria in Table 16.4. Geophysical anomalies of the first and second ranking were considered to be of uncertain importance in Table 16.4. Geophysical anomalies of the third ranking were considered to be of negligible importance in Table 16.4. The criteria acts as an additional qualification on what risk could be associated with an uncertain geophysical anomaly, which is discussed in Section 16.5.2.

Level of importance	Criteria
Very High	▪ Archaeological and historical sites or areas of international importance such as World Heritage Sites, and may also include some Scheduled Ancient Monuments, Historic Naval Battles, Designated Wrecks or Historic Marine Protected Areas (MPA).
High	▪ Archaeological and historical sites or areas of national importance such as Scheduled Ancient Monuments, Historic Naval Battles, Designated Wrecks and Historic MPAs.
Medium	▪ Sites, wrecks and areas of regional importance.
Low	▪ Locally important sites, wrecks or areas.
Negligible	▪ Features that have been recorded but assessed as of no archaeological or historical interest, such as modern clearance cairns or recent wrecks, or have been so damaged they no longer have any historic merit.
Uncertain	▪ Features that cannot be identified without detailed work, but potentially may be of some interest. Also, for example, if the date of construction and rarity of a vessel is not known, but potentially may be of some interest. Findspots, which may represent an isolated find, or could represent the location of a hitherto unknown site. Unidentified geophysical anomalies are also of uncertain importance and have been divided up further in Table 16.5.

Table 16.4: Definitions of importance of cultural heritage assets

Level of geophysical anomaly ranking	Criteria
1	▪ Geophysical anomaly: if the feature is shaped like a shipwreck; or there is identifiable cultural material; or it is in the area of a known archaeological site, or another anomaly identified to be of a high ranking.
2	▪ Geophysical anomaly: If there is an uncertain determination that could be anthropogenic. It would be considered for where an anomaly lies in an area of intensive human activity such as near ports. It could also be used for submerged terrestrial deposits such as peat on the seabed due to possibility of cultural material relating to submerged landscapes.
3	▪ Geophysical anomaly: If the feature is probably a rock or bedrock formation such as sand dune.

Table 16.5: Definitions of importance for geophysical anomalies

Criteria for assessing magnitude of impact

16.39 The magnitude of any potential adverse direct and indirect impacts on submerged cultural heritage caused by the development proposals will be determined using the criteria in Table 16.6.

16.40 Direct impacts predominately occur during the construction phase of a project, but may to a lesser extent occur during maintenance or decommissioning, e.g. a maintenance vessel dropping anchor on a site.

16.41 Indirect impacts predominately occur during the operational phase of a project, but may to a lesser extent occur during construction, maintenance or decommissioning, e.g. propeller wash on seabed sediments. Potential indirect impacts include the disturbance and redeposition of sediments around and forming the context of a site, dispersal of the debris field around a site, or further erosion of a site, perhaps caused by scouring, propeller wash, vibration and the changing of water flow. It should be noted that the categories are guideline criteria only, since assessments of magnitude are matters of professional judgement.

Magnitude of impact	Direct impact criteria	Indirect impact criteria
Severe	Works would result in the complete loss of a site.	An irreversible and radical change to the context of a highly sensitive or valued underwater cultural heritage asset or environment, which removes or prevents appreciation of key characteristics of the asset, or permanent change to or removal of surroundings of a less sensitive or valued asset.
Major	Works would result in the loss of an area, features or evidence fundamental to the historic character and integrity of the site. Severance would result in the complete loss of physical integrity.	A fundamental or key change to the context of a highly sensitive or valued underwater cultural heritage asset or environment, or intensive change to less sensitive or valued asset.
Moderate	Works would result in the loss of an important part of the site or some important features and evidence, but not areas or features fundamental to its historic character and integrity. Severance would affect the integrity of the site, but key physical relationships would not be lost.	A material but non-fundamental change to the context of an underwater cultural heritage asset or environment, but not key or highly valued, and tolerant of moderate levels of change.
Minor	Works or the severance of the site would not affect the	A detectable but non-material change to the

[1] PAN 2/2011, paragraph 6

Magnitude of impact	Direct impact criteria	Indirect impact criteria
	main features of the site. The historic integrity of the site would not be significantly affected.	context of an underwater cultural heritage asset or environment, resulting in minor changes to an underwater asset or environment considered tolerant of change.
Negligible	Works or the severance of the site would be confined to a relatively small, peripheral and/or unimportant part of the site. The integrity of the site, or the quality of the surviving evidence would not be affected.	N/A
Uncertain	Works over features that have not been fully interpreted would reduce the chance of interpretation in the future. In the event of significant features this would constitute impact of high magnitude; for sites of lesser significance it is less problematical. Nevertheless, it remains an issue where features have not been or could not be interpreted.	N/A
None	N/A	No detectable change.

Table 16.6: Definitions of magnitude of direct and indirect impact

Significance of impacts

16.42 The importance of the marine cultural heritage asset or geophysical anomalies are combines with the magnitude of impact to define the significance of impact (Table 16.7).

16.43 The significance of any potential adverse direct impacts from the development proposals on archaeological and historic sites will be determined by comparing the magnitude of the impact with the importance of each area, site or monument.

16.44 In order to evaluate how important the indirect impact really is, the importance of the site with which the effect is associated must be related to the impact, otherwise a major impact on the surroundings of a site of low or negligible importance would take on more significance than it merits

Magnitude of impact	Asset importance					
	Very High	High	Medium	Low	Negligible	Uncertain
Very High	Severe	Severe	Major	Moderate	Minor	Uncertain/ Severe
High	Severe	Major	Moderate	Minor	Negligible	Uncertain/ Major
Moderate	Major	Moderate	Moderate	Minor	Negligible	Uncertain/ Moderate
Minor	Moderate	Minor	Minor	Negligible	Negligible	Uncertain/ Minor
Negligible / none	Minor	Negligible	Negligible	Negligible	Negligible	Uncertain/ Negligible
Uncertain	Uncertain/ Severe	Uncertain/ Major	Uncertain/ Moderate	Uncertain/ Minor	Uncertain/ Negligible	Uncertain/ Negligible

Table 16.7: Determination of impact significance

Impact significance (with regards to EIA Regulations)

16.45 The significance of impacts in relation to the EIA Regulations are defined in Table 8.2.

16.46 Significance of moderate or higher are considered to be significant effects under the EIA Regulations that may require consideration by the regulatory authorities and will require control, management and mitigation. However, it should be noted that significance of minor may still require some management or mitigation to remain within acceptable levels.

16.47 Where the significance of an impact on a geophysical anomaly includes the ranking 'uncertain', if it cannot be avoided, further survey work is proposed as mitigation to investigate the anomaly.

16.4.5 Data gaps and uncertainties

16.48 The limitations to the subsea surveys in terms of methods and the identification and interpretation of items of potential cultural heritage interest are included in Section 16.4.3. The DBA sources reviewed for this report were extensive but not exhaustive, and there remains the possibility that there may be sites or features of archaeological or historical significance that have not been recorded in this report.

16.49 RCAHMS, the Royal Commission for Ancient and Historical Monuments for Scotland, runs a Maritime Project of the National Monuments Record of Scotland (NMRS), which seeks to document maritime sites, defined as ships, boats, and crashed aircraft, but not built structures or prehistoric sites. The information in the archive record is largely drawn from Whittaker (1998) and Larn and Larn (1998). These books contain some inaccuracies in locations of wreck sites that have been duplicated into the NMRS. If any of these are relevant to this report, they are noted and are corrected as far as possible.

16.50 There are 32 wrecks listed in the reference sources where they are categorised as PA (Position Approximate). Their location, or if they survive at all, is not known.

16.5 Cultural Heritage Baseline Description

16.5.1 Historic landscape and setting

Potential for submerged landscapes and prehistoric sites

16.51 Hominids and humans have occupied the UK Continental Shelf at various times for more than 700,000 years. The recovery of Palaeolithic stone artefacts and Pleistocene faunal remains in the North Sea has a long history predominantly associated with the fishing and dredging industries. Although a number of apparently isolated artefacts, without stratigraphic context, have been retrieved in the North Sea, there are relatively few examples of known submerged Palaeolithic and Mesolithic sites (Tizzard *et al*., 2011). However, evidence of the glaciations and interglacials over this period, of the palaeo-environment, of relative sea level changes, and of palaeo-landscapes and -seascapes, all indicate that in general terms, the potential for submerged prehistoric archaeology and landscapes across wide areas of the UK continental shelf is high (Wessex Archaeology, 2009). Our knowledge and understanding is changing rapidly as a result of new discoveries and research. Many of the new discoveries have been made as a (positive impact) result of seabed development, and more will be made through archaeological assessment and analysis of geophysical, geotechnical and other survey data (ibid., 74).

16.52 At 22000BP (before present) Scotland was covered by the ice sheet, with Caithness and Orkney just on the edge (Woodcock and Strachan, 2000). By 18000BP Caithness to Shetland was dry land, with a glacial sea area linking that shelf to the main North Sea exposed shelf. This sea would have been covered in floating ice. By 14000BP the ice cap retreated almost completely to the modern coastline of Scotland, and by 12000BP the ice has entirely melted, although there is a brief period of renewed ice cover, the Loch Lomond stadial, around 10000BP. The sea level was about 40-50m lower relative to the land around the Western Isles and Shetland when the first documented sites were occupied about 9000BP (Flemming 2003).

16.53 There is evidence for early humans living in Arctic polar conditions, such as the environment around the Pentland Firth prior to 9000BP, as excavations at the Mamontovaya Kurya site on the Usa River, inside the Arctic circle, revealed stone tools and carved mammoth tusks nearly 40000BP (Pavlov *et al*., 2001). Orkney was separated from Caithness by about 13000 years BP (Ritchie 1995), and several small mammals already lived on the islands. Fish, shellfish, seals, and whales were abundant. The exploitation of marine mammals, especially seals, walruses, and cetaceans must be considered for peoples living in circum-polar conditions. Walruses would have been easy and attractive prey, lying on the beach, for any peoples who chose to live on the northern or north-west margins of Europe during glaciations 12-14000BP (Flemming 2003).

16.54 In the submerged environment Dutch fishermen have recovered walrus bones showing signs of cut-marks and butchery from 56°N in the central North Sea strongly suggests this possibility (Flemming 2003). This type of culture may correlate with the retrieval of a lithic artefact off the Viking Bank from a depth of 145m (Long *et al*., 1986).

16.55 Where relative sea level was constant for hundreds or thousands of years, rivers and the sea would erode stable river valleys, estuaries, barrier bars, and lagoons. Waves would erode rock terraces, cliffs, and caves. At the present time with sea level now risen, one would expect to find submerged caves off the coasts (Flemming 2003, 14-15).

16.56 The earliest inhabitants of the Scottish continental shelf may have been living in a culture similar to that of the Inuit peoples of Greenland and northern Canada and Alaska. Therefore, environments where marine mammals would have prospered such as submerged sheltered sea bays and gulfs, which may have been covered by sea ice, would be areas of human activity (Flemming 2003). In near Arctic conditions settlements would have been in the lee or shelter of ridges and headlands. The ice caps had melted completely by 9000BP, but even as the climate ameliorated and vegetation and forests covered the land, the attraction of the coast would persist into the Mesolithic (Flemming 2003).

16.57 The sill of the Pentland Firth is at a depth of 70m, and the channel is 25km wide. Currents through the Firth are 1.0-1.5m/sec. The bottom of the Firth is bare rock. Areas of bare rock with gently sloping or horizontal surfaces swept by waves and currents would have a minimal chance of preserving bones or artefacts. However, where such surfaces have been exposed after the erosion and removal of late Quaternary deposits or post-Devensian material it is possible that artefacts may have been trapped in cracks and gullies. Artefacts from shipwrecks have frequently been found in such locations (Flemming 2003). Low gradients within the Pentland Firth mean that wave action during transgression will have been heavily attenuated, and depressions in the shelf could have acted as traps for slowly moving large particles (Flemming 2003).

16.58 There are sands and gravels recorded on the IX Survey (2009) data at the northeast and northwest sides of the Inner Sound within which there is the possibility of embedded stone tools and bones. The ASML survey (ASML, 2011) conducted in the MeyGen AfL area collected sediment samples. The results of the particle size analysis (PSA) suggest that the sediment at the sites is largely composed of very coarse sand or very fine gravel, with three of the four sites showing a predominance of gravel over sand. From observations made during sampling, the sediment collected for this analysis was made up completely of shell material (carbonate) and appeared devoid of organic matter (ASML, 2011). These marine sediments are different to the Quaternary deposits recorded by Flemming (2003) to the east and west of the Pentland Firth, consisting of pebbly clays, glacial till, and patches of sandy gravel, which date to just after deglaciation (*c*. 12400BP). The modern marine sediments recorded in the ASML survey are generally less than 1.5m thick and have a low potential for the survival of submerged landscapes and prehistoric sites. It should be noted that the majority of the turbine deployment area is scoured bedrock and turbines will not be installed in areas of sediment.

Shipwreck sites

16.59 The Pentland Firth lies between the northern Scottish mainland and the islands of Orkney and has a well-deserved reputation among the world's mariners as a channel to be navigated with great care. Tides surges through the Firth from the Atlantic to the North Sea and back again, and can reach up to 12 knots (22km/h). In the past many captains and ship owners preferred to make long detours north of Orkney or south by the English Channel to avoid the tides and eddies in the Firth. However, through history it has been the primary passage between the North Sea and the Atlantic. Consequently losses are recorded for the area.

16.60 The strong tides and severe storms in winter significantly impacts on the survival of wreck sites in the area, particularly in shallow waters.

16.61 UKHO have only two wrecks and one obstruction in the Inner Sound area (Table 16.8):

- The MV Bettina Danica, 1354 gross tonnage, was stranded in 1990 and is just outside the area, being on the west side of Stroma. A portion of this vessel shows at all states of the tide;

- SS Malin Head (UKHO wreck number 1117), 3467 gross tonnage, struck on the reef at Quoy Ness on 21 October 1910. The vessel was then reportedly refloated and towed into Gills Bay where she was beached (Whittaker, 1998). The UKHO put the wreck in very shallow water in Gills Bay but position quality is classed as ''unreliable''. Crawford (2002) in her book ''Deep Water'' mentions salvage attempts by her husband on the wreck so the wreck must be in water deep enough to get a salvage boat over the top. It is recorded that divers were employed to recover the cargo after the SS Malin Head had sunk, and also that a boat put marker buoys on the wreck which vanished after a while (Houston 1996: 357). UKHO has no information relating to the buoys; and

- A submerged obstruction (UKHO wreck number 930) was located in 1949 by the MV Actuality and charted, but then removed and classed as ''dead' when not mentioned in a subsequent survey by BUE Subsea in 1983. This obstruction is listed as possibly SS Malin Head in ''Off Scotland'' (Whittaker, 1998). However, it is unlikely to be SS Malin Head as this was refloated and put into Gill's Bay. Therefore, this obstruction is unknown and until identified has been listed as of high potential significance.

16.62 In addition to the charted wrecks the sources list 32 wrecks where the position is only approximate (PA). These are listed in Table 16.9. Ships that were wrecked pre-1914, involved a loss of life or have evidence of international activity have been assigned higher significance.

Aircraft crash sites

16.63 Whittaker (1998) cites a Spitfire (*R6974)* lost on 18/07/1941 400 yards off Mell Point, the south-western head of Stroma (Table 16.9). Both Air Britain & the Spitfire Production List (http://www.spitfires.ukf.net/p010.htm) show it as lost off Duncansby Head. 124 Squadron lost no pilots that day so he must have survived. It is not known if the aircraft ditched or crashed into the sea. However, due to the strong tides and severe storms in winter it is unlikely that such a fragile structure would remain intact. Irrespective, the site would be protected under the *Protection of Military Remains Act 1986.*

16.64 An A.M. Form 1180 (accident report) was obtained for this aircraft, showing that the incident happened in the sea off Duncansby Head. The report says *'insufficient height to make land might have turned back sooner (co) Inexperience'*. The pilot's name was Dabrowsri. As the incident was off Duncansby Head it is outside of the development area.

Other marine cultural features

16.65 There is a charted spoil ground on the east side of the turbine deployment area (Figure 16.2). The UKHO have no information relating to the spoil ground. The area around Orkney and the Pentland Firth is regulated by Marine Scotland (MS), who have indicated the previously licenced spoil ground is used by dredgers as a dumping ground for spoil from the Gills Bay Harbour. It is however no longer licenced. It is regarded as of low significance. The site has not been used for at least seven years and is listed as ''closed'' by MSS, although. DEFRA have the site still listed as ''open'' (DEFRA and MS, personal communication).

Name	Description	Circumstance of loss	Date lost	Importance of cultural heritage asset	Reason
Malin Head	Steamship registered in Belfast. Built 1892. Length 105m, beam 13m. Cargo 2500 pig iron.	Stranded on an outlying reef at Ness of Quoy then refloated and beached at Gills Bay.	21/10/1910	High	Pre-1914
MV Bettina Danica	Motor vessel, Danish cargo vessel, 1354 grt, 69.8x11x4.3m, builder Sakskobing Mast, Skibsvaerft, Sakskobing.	Went aground on rocks on W side Stroma Island in good weather conditions, while on passage Greenore to Oslo. Salvage attempts proved unsuccessful.	13/02/1993	Low	Post-1913
Obstruction	Reported in 1949 at depth 18m. Not reported in 1985 survey, amended to ''dead''.	-	-	Low	SSS shows rise in bedrock at this location

Table 16.8: UKHO listed shipwrecks designated as within the Inner Sound area

Name	Description	Circumstance of loss	Date lost	Importance of cultural heritage asset	Reason
Thetis	Captain: Robinson, Registration: Hull.	Sailing from Hull to Quebec. Stranded south end of Stroma.	09/04/1830	High	Pre-1914, international trade
Blue Bonnet	Wooden schooner of Leith, Grandison, in ballast.	Route: from Lerwick to Scrabster, Stranded SE corner of Stroma, got off and sunk in deep water.	25/05/1857	High	Pre-1914, national trade
Clarence G Sinclair	19 years old, of Wick. Wooden schooner. 78 ton. 5 men. Master J. Sutherland. Owner G. Stark, Edinburgh. Cargo of paving stones.	Route: Castlehill, near Thurso to S. Shields. Stranded at Mell Head, Stroma.	15/06/1897	High	Pre-1914, national trade
Golden Eagle	Brigantine? Capt. Gordon, Registration: Belfast. 174 tons.	Stranded near the beacon, Stroma, crew saved and materials secured.	24/11/1859	High	Pre-1914, national trade
Eagle	Possibly same vessel as Eagle above.	Swilkie Point; Stroma.	19th century	High	Pre-1914
Andrew Longmore	Schooner. 26 years, of Banff. Built 1874. 143 grt. Length: 28m. Beam: 7m. 125 ton. 5 men, master W. Angus, owner J.W. Simpson, Banff. Cargo of salt.	Route: Weston Point to Banff. Stranded on rocks near the beacon, Stroma.	29/06/1899	High	Pre-1914, national trade
Lord Suffield	Of Carlill, sailing from Hull to Quebec.	Ran on shore near Huna and became a complete wreck.	10/04/1832	High	Pre-1914, international route
Percy	9 yrs old, of Newcastle-on-Tyne, wooden schooner, cargo of salt, 58 tons, 4 crew, Master A. Miles, Owner M. Pearson, South Shields.	Departed Runcorn for Fraserburgh, wind N. to NW 8, stranded with total loss at Huna, Caithness.	10/08/1883	High	Pre-1914, national trade
Pheasant	Brig of Sunderland, sailing from Shields to Barbadoes, cargo of coal.	Went on shore at Duncansbey [Duncansby] and became a total wreck: three of the crew drowned, materials and part of cargo expected to be saved.	10/01/1849	Very High	Pre-1914, international trade, loss of life
Brothers	Brigantine of Milford, captain Evans, sailing from Westport to Hartlepool, cargo of oats.	Came ashore at Ness of Hun, drifted off and sank in deep water. Part of materials and a small portion of cargo saved.	17/10/1856	High	Pre-1914, national trade
Science	Snow (type of brig), cargo of timber, Captain Whitfield. Registration: Sunderland. Built 1819. 160grt. Length: 22m. Beam: 7m.	Wrecked at Huna.	22/08/1833	High	Pre-1914
St Martin	Whaler with cargo of fish and whale oil. Registration: Bayonne.	Stranded near Huna, Caithness.	Dec 1674	High	Pre-1914, international fishing
Hector	Brig with cargo of iron. Captain: Prentiss, Registration: Providence (Rhode Island, USA).	Route: Stockholm to Providence. Wrecked near Huna.	10/07/1822	High	Pre-1914, international trade
Abiding (BCK449)	Iron steam trawler, Registration: Buckie.	Stranded at Ness of Quoys.	15/07/1927	Low	Post 1913
Hudson	Barque. Built 1825. 380 tons Length: 34m. Beam: 9m. Captain Donaldson, from Dundee, bound to Quebec.	Stranded at Ness of Quoys.: driven on shore in the Pentland Frith [Firth], during a severe gale: crew saved, totally wrecked.	23/09/1829	High	Pre-1914, international trade
Bittern	Brig, Captain Wall, sailing from Yarmouth NS to Sunderland, cargo of timber, registration Yarmouth NS.	Stranded at Quoys, near Gill Bay, and was expected to become a wreck.	1/12/1825	High	Pre-1914, international trade
Scotia	Schooner, of Inverness, Captain Campbell, from Liverpool to Arbroath, cargo of salt, Built 1842. 112 grt. Length: 22m. Beam: 6m.	Stranded at Gills Bay and is a wreck, crew saved.	18/12/1866	High	Pre-1914, national trade
Glasgow packet	Schooner of Wick, Captain Leith, from Stromness to Scrabster, in ballast, Built 1831. 78 nrt.	Stranded at Gills Bay near Dunnet [?Duncansby] Head during a gale, and was thrown on her beam ends, and will probably become a total wreck.	13/12/1859	High	Pre-1914, regional importance
Margaret Gunn	Lugger, 5 yrs old, not registered, wooden lugger, 25 tons, 7	Wind S. by E.10, stranded, total loss, Gills Bay, near Duncansby Head, crew	19/01/1883	High	Pre-1914, regional importance

Name	Description	Circumstance of loss	Date lost	Importance of cultural heritage asset	Reason
	crew, Captain J. McLean, Owner G. Doull, Wick, departed Wick for fishing, in ballast, Built 1878. 25 tons.	saved.			
Northumbrian	Barque, cargo of coal, Capt. Tait. Registration: Glasgow. Built 1832. 351 tons burthern. Length: 32m. Beam: 8m.	This vessel stranded on Quoys Ness [Ness of Quoys], and was expected to become a total loss.	13/04/1836	High	Pre-1914
Minna	Iron steamship with a cargo of coke. 438 ton. 16 men. Built 1875. 811grt. Length: 73m. Beam: 9m. Master T.J. Snelling. Owner R. Grandidge, Chester.	Stranded at Quoy Ledge, Gills Bay.	20/11/1889	High	Pre-1914
Elizabeth	Of Montrose, Captain Morgan, sailing from Alloa to Oban, cargo of coal.	Struck on the Skerry of Stroma, Pentland Frith [Firth], considerably damaged, with her keel broken, and likely to become a wreck. Not cited by I G Whittaker (1998), possibly suggesting her successful recovery.	15/06/1854	High	Pre-1914, national trade
Louisa	Capt. Saadman, wooden schooner, with cargo of coal. Registration: Barth. Built 1861. 117 tons.	Stranded on the SE side of Stroma.	23/12/1876	High	Pre-1914
Anna Maria	Wooden schooner, cargo of coal for Stromness.	South end of Stroma.	20th century	Uncertain	Needs further investigation to identify
Mary	Wooden schooner. 110 ton. 5 men. Master J. Christie. Owner J. Mitchell, Montrose. Cargo of coal. 110grt. Length: 26m. Beam: 7m.	Route: Shields to Stornoway. Wind SW8. Stromacan's Bay, Stroma Skerries, Caithness.	16/12/1892	High	Pre-1914, national trade
Unknown				Uncertain	Needs further investigation to identify
Unknown		Off Stroma.	31/09/1868	High	Pre-1914
R6974	Supermarine Spitfire aircraft of 124 sqdn [RAF]. Registration: British.	Crashed 400 yrds off Mell Head.	18/07/ 1941	High	Protected under Military Remains Act
Edwin and Lizzie	Registered N. Shields, wooden barquentine, 372 tons, 9 crew, Master R. Cowell, Owner H. Campbell. Departed the Tyne for Bona carrying coal.	Wind SSE2, stranded Stroma Island, Caithness.	05/07/1884	High	Pre-1914
Victor and Louis	French lugger, laden with fishing materials, Captain Claeysen, bound to Iceland.	Got ashore at Huna, Pentland Firth: the crew landed in safety: the cargo is being saved, but the vessel will probably break up. The loss of this vessel is not cited by I G Whittaker (1998), possibly suggesting that she was successfully recovered.	14/03/1874	High	Pre-1914, international fishing
North Sea	15 years old, of Dundee. Iron steamship. 96 ton. 17 men. Master J. Craig. Owner J.P. Bruce, Dundee. Cargo of coal.	Route: Glasgow to Copenhagen. Wind SE3. SW end of Stroma Island, Caithness.	08/05/1896	High	Pre-1914, international trade
Cairn Glen	Steamer, 5119 ton, of Newcastle, Captain Miller. No loss of life, 48 persons on board. General cargo.	4 miles from Duncansby Head Lighthouse. Daylight. SW light breeze, sea calm, cloudy.	23/03/1904	High	Pre-1914

Table 16.9: List of recorded shipwrecks and aircraft wrecks in the Inner Sound area

16.5.2 Marine geophysical data analysis

16.66 The survey data was studied in detail. The interpretation is based upon all available data and is illustrated with location maps of features. The interpretation combines data from the remote sensing surveys and the IX Survey (2009) report. In the technical report (Inner Sound, Caithness Marine Cultural Heritage Environmental Impact Assessment (ORCA 2011a)) provided on the accompanying CD, the results of the analysis are presented as images of anomalies followed by summaries of anomalies.

16.67 Whilst the following sections provide an interpretation of the geophysical anomalies, it should be noted that the impact assessment is based on the asset importance not the geophysical importance; in most cased this is considered 'uncertain' without further investigation.

Multi-beam echosounder (MBES) anomalies

16.68 In total there are 13 MBES anomalies in the proposed turbine deployment area and potential cable deployment area (Figure 16.2). Five are of rank 3 (MB16, MB24, MB25, MB30 and MB45). The rest are rank 2 (MB19, MB20, MB22, MB23, MB28, MB41, MB44 and MB47). Rank 2 anomalies have been summarised in Table 16.10.

16.69 The MBES data shows bedrock exposed on the seabed over most of the survey area with the exception of sand waves and gravel ridges to the SE and W of the Island of Stroma. The extent of the exposed bedrock indicates a high-energy environment causing scouring. This leaves low potential for the survival of in situ cultural material apart from heavy materials such as large iron shipwrecks, cannons or anchors. This explains the relatively low amount of anomalies in the tidal turbine deployment area. However, there are many gullies present which could act as sediment traps into which cultural material could have accumulated. IX Survey (2009: 22) records these fissures as up to 18 metres deep and they are at their most extensive towards the centre of the survey area south of Mell Head, Stroma (i.e. within the Project area).

Anomaly ID	Description	Geophysical rank	Easting	Northing	Proximity
MB19	6.5m x 3m rectangular feature amongst bedrock.	2	493541.829935	6502233.48931	Within turbine deployment area.
MB20	21m wide circular feature on edge of gully amongst bedrock.	2	492501.221604	6501933.84808	Within turbine deployment area.
MB22	10m x 4m rectangular feature amongst bedrock.	2	492289.28993	6501335.75626	63mS of cable corridor to Ness of Huna.
MB23	8m long triangular feature amongst bedrock, up to 6m wide.	2	492333.343143	6501465.93152	78mN of cable corridor to Ness of Huna.
MB28	16m x 0.5m curved feature higher than surrounding bedrock.	2	493505.317362	6501320.67498	10mE of cable corridor to Ness of Quoys.
MB41	3m x 2.5m circular feature raised above sand and boulders.	2	494176.666579	6501149.32887	82mW of cable corridor to Ness of Huna.
MB44	12m x 2.5m rectangular feature amongst sand and boulders (same as SS20).	2	494166.040891	6501425.82166	89mE of cable corridor to Ness of Huna.
MB47	5m diameter circular feature amongst bedrock.	2	491793.195188	6502419.75635	87mW of turbine deployment area.

Table 16.10: Rank 2 MBES anomalies within 100m of the Project

16.70 Anomaly MB19 is located within the sand wave area bordering the Project. It has the potential to be better preserved that the anomalies in the high-energy environment and to still be *in situ*. It is possible it may be intermittently uncovered and re-buried by mobile sediments on the seafloor. However, IX Survey (2009: 31) compared their data with a previous data set completed in 2008 that indicated the large sand body in the north east of the site had not migrated to any significant degree. Furthermore, the morphology modelling study predicted that there will be no significant impacts to the sediment dynamics and bedforms following the installation of the tidal array. Under calm conditions and with no turbines, the bedforms show evidence of movement, but not in a way which is significant. The addition of the array is predicted to make little or no difference to the existing bedform structures with small (±0.2-0.5 m) differences in bed height (DHI, 2011).

Side-scan sonar (SSS) anomalies

16.71 In total there are seven SSS anomalies within the Project (Figure 16.2). One is of rank 1 associated with a magnetic anomaly (SS36). None are of Rank 3. The rest are Rank 2 (SS14-15, SS18, SS20, SS24 and SS39). High and medium potential anomalies have been summarised in Table 16.11.

16.72 The area of the obstruction listed as UKHO reference number 930 (Table 16.8) was examined on the ERI SSS data. It was found to be an area of rising bedrock on the seabed. Therefore, its significance is low.

Magnetometer anomalies

16.73 Seven magnetometer anomalies were recorded by IX Survey in the turbine deployment and cable corridor area. On examination of the data this was narrowed down to two areas or clusters of anomalies (Table 16.12). These clusters may represent a single shipwreck with a large enough iron content to be picked up on successive transects, different shipwrecks collecting in the gullies (acting as sediment traps), or parts of a shipwreck breaking up and being dispersed on the seabed.

16.74 The cluster M/001-M/005 is within the turbine deployment area. It is probably associated with SSS anomaly SS36 (Figure 16.2). It is in the area of a deep, 30m wide gully at a water depth of up to 48m. It is an area where sediment and other material on the seabed would have accumulated. It is possible that some of this anomaly is buried within the gully sediment. IX Survey (2009: 41) record M/001 and M/005 as relatively small and perhaps constituting separate items.

Anomaly ID	Description	Geophysical rank	Easting	Northing	Proximity
SS14	Double mound feature on gully edge, 18 x 10m aligned SW-NE, 1m high, possible indication of features within the feature.	2	491836.089514	6502386.83095	45mW of turbine deployment area.
SS15	2m x 3m circular feature higher than surrounding sand and boulders (Same as MB41).	2	494169.877357	6501151.84507	70mSW of cable corridor to Ness of Huna.
SS18	6 x 6m circular area on bedrock.	2	493387.106	6501220.50458	105mW of cable corridor to Ness of Quoys.
SS20	35 x 6m rectangular feature amongst sand and boulders (same as MB44).	2	494160.220046	6501423.57269	80mN of cable corridor to Ness of Huna.
SS24	5 x 4m with shadow about 1.5m high circular feature amongst sand waves.	2	492751.883141	6502340.12096	103mN of turbine deployment area.
SS36	Rectangular block 2 x 2.5m, on bedrock 20m from M/001 to M/005.	1	492092.479246	6501792.19447	Within turbine deployment area.

Anomaly ID	Description	Geophysical rank	Easting	Northing	Proximity
SS39	22 x 8m boat-shaped feature on bedrock, sand area to SW.	2	492975.555038	6501139.20556	7mN of cable corridor to Ness of Huna.

Table 16.11: Rank 1 and 2 SSS anomalies within 100m of the Project

16.75 The cluster M/007-M/008 is within the turbine deployment area. The surrounding area is bedrock and there is little evidence of deep and wide gullies in this location, though the presence of bedding planes in the bedrock could allow for some sediment accumulation between them. IX Survey (2009) believes this to be a single small target though the double peak on the magnetometer trace suggested two sources.

Anomaly cluster	Anomaly ID	nT (Anomaly)	Easting	Northing	nT (Total field)	Proximity
1	M/001	nT=34	492082.15	6501839.74	50480.43	Within turbine deployment area.
	M/002	nT= 73	492098.02	6501813.72	50510.73	
	M/003	nT=100	492106.86	6501817.66	50560.92	
	M/004	nT=37	492111.70	6501808.66	50471.26	
	M/005	nT=12	492174.27	6501810.46	50437.27	
3	M/007	nT=7	492919.99	6501786.60	50479.93	Within turbine deployment area.
	M/008	nT=20	492933.20	6501793.89	50454.50	

Table 16.12: Magnetometer anomalies within 100m of the Project

16.76 The spoil ground contains material dredged from Gills Bay harbour. Some of this may contain anthropogenic material and could explain some of the magnetic anomalies caught in gullies in the turbine deployment area.

16.77 The magnetometer anomalies cluster in two locations and each of these clusters are probably the same anomaly, or associated anomalies, picked up on different transects. IX Survey concludes that these contacts were anthropogenic *'most probably debris from broken up wrecks or discarded fishing equipment'* that have become embedded in the bedrock features (IX Survey, 2009). It is concluded that the anomalies are unlikely to be igneous due to their concentration around gullies and no evidence of the magnetic anomalies forming a linear feature (which would indicate an igneous dyke or a sill). Therefore, these anomalies are anthropogenic and of geophysical Rank 1.

Sub-bottom profiler anomalies

16.78 The Project area was devoid of sediments with the exception of northern margin. The turbines and cables will not be placed in the areas of sand and gravel. The sediments include a coarse gravel veneer, gravel ridges and larger mobile accumulations of sand. There is no evidence of cultural material on analysis of the sub-bottom data. Large areas of the seafloor are uneven bedrock containing depressions and gullies. Gravel and sand deposits can be observed within these features. There is a high potential for these deposits to contain within them disturbed or redeposited cultural material from shipwrecks. Areas of deeper sediment above bedrock are located to the NW, E and N of the Project. These sediments of sand and gravel contained no evidence of a terrestrial deposit such as peat beds. There are depressions in the bedrock. However, no layering of sediments could be ascertained within these depressions to identify these features as palaeo-channels. Therefore, no evidence of submerged landscapes could be identified from the data. No geophysical anomalies were recorded in the sub-bottom profiler data.

16.5.3 Summary

16.79 Figure 16.2 shows the distribution of multi-beam echo sounder (MBES) anomalies in the whole of the MeyGen AfL area. Twelve anomalies have been identified from MBES data to be within the turbine deployment area and the cable deployment area or within 100m of these areas. 100m has been chosen as the cut off distance away from the development areas, due to issues of size of anomaly, accuracy in underwater location recording, and scouring on the seabed due to the strong tidal currents moving cultural material. Of the 12 anomalies, four are of Rank 3 importance, eight of Rank 2 and none of Rank 1 importance.

16.80 Figure 16.2 shows the distribution of side-scan sonar (SSS) anomalies. Seven SSS anomalies are in, or within 100m of the turbine deployment area and the cable deployment area. Six are of Rank 2 and one is Rank 1 importance.

16.81 Two of the magnetometer anomaly clusters are within the turbine deployment area (Figure 16.2). These are M/001-M/005 and M/007-M/008. M/001-M/005 is in the same area as SS36. Both of these magnetometer anomalies are Rank 1 importance because of the high probability of cultural material.

16.82 The Project area contains the former spoil ground (no longer licenced). This was used by dredgers as a dumping ground for spoil from the Gills Bay Harbour. Harbours have high potential for cultural material. No evidence of the dumping ground could be seen on the MBES or SSS data and it is probable that the high-energy environment dispersed this sediment. It is possible that the anomalies within the Project area may have originated from dredging in Gills Bay Harbour.

16.6 Impacts during Construction and Installation

16.6.1 Impact 16.1: Damage caused by placing turbine and cable over marine cultural material

16.83 During construction the direct impacts to cultural material on the seabed will be from the potential to place the turbines and cable over cultural material. The weight of the turbine and cable could have a damaging effect on cultural material exposed at the surface. A drilled Turbine Support Structure (TSS) pin pile or mono pile will not cause further damage to cultural material below the seabed surface as TSS are to be placed on a bedrock seabed and not areas of sand and gravel.

16.84 The direct impacts for each site have been shown in Table 16.13. The magnitude of direct impact is high for sites within the Project, and within 100m. The magnitude of direct impact was considered to be high rather than severe because although placing turbines and cables would result in the loss of some of the surrounding area and features at the site, it is unlikely to remove all evidence of cultural material. Twenty-three sites have been assigned a high magnitude of direct impact. Outside of that area the magnitude of direct impact is negligible.

16.85 Table 16.13 shows that there is a major significance of impact on sites with a magnitude of direct impact of major and if they have a Rank 1 or 2 geophysical potential importance ('uncertain' importance of site). If the sites have a Rank 3 geophysical importance ('negligible' importance of site) the impacts are of minor significance if the direct impact is minor. There are 20 sites with 'major' significance of direct impact. Outside of 100m of the Project area, the significance of direct impact is either negligible or uncertain/negligible.

16.86 The following sites, recorded in the Project area or within 100m of the area, are recommended to be either avoided or investigated by Remote Operated Vehicle (ROV):

- Three MBES anomalies (MB19, MB20 and MB47). These anomalies are possibly wreckage, lost cargo, or ballast;
- Two clusters of magnetic anomalies (M/001-M/005 and M/007-M/008). These anomalies may be anthropogenic: iron wreckage, lost marine equipment or iron material from spoil ground; and
- Three side-scan sonar anomalies (SS14, SS24 and SS36). These anomalies are possibly wreckage or lost cargo.

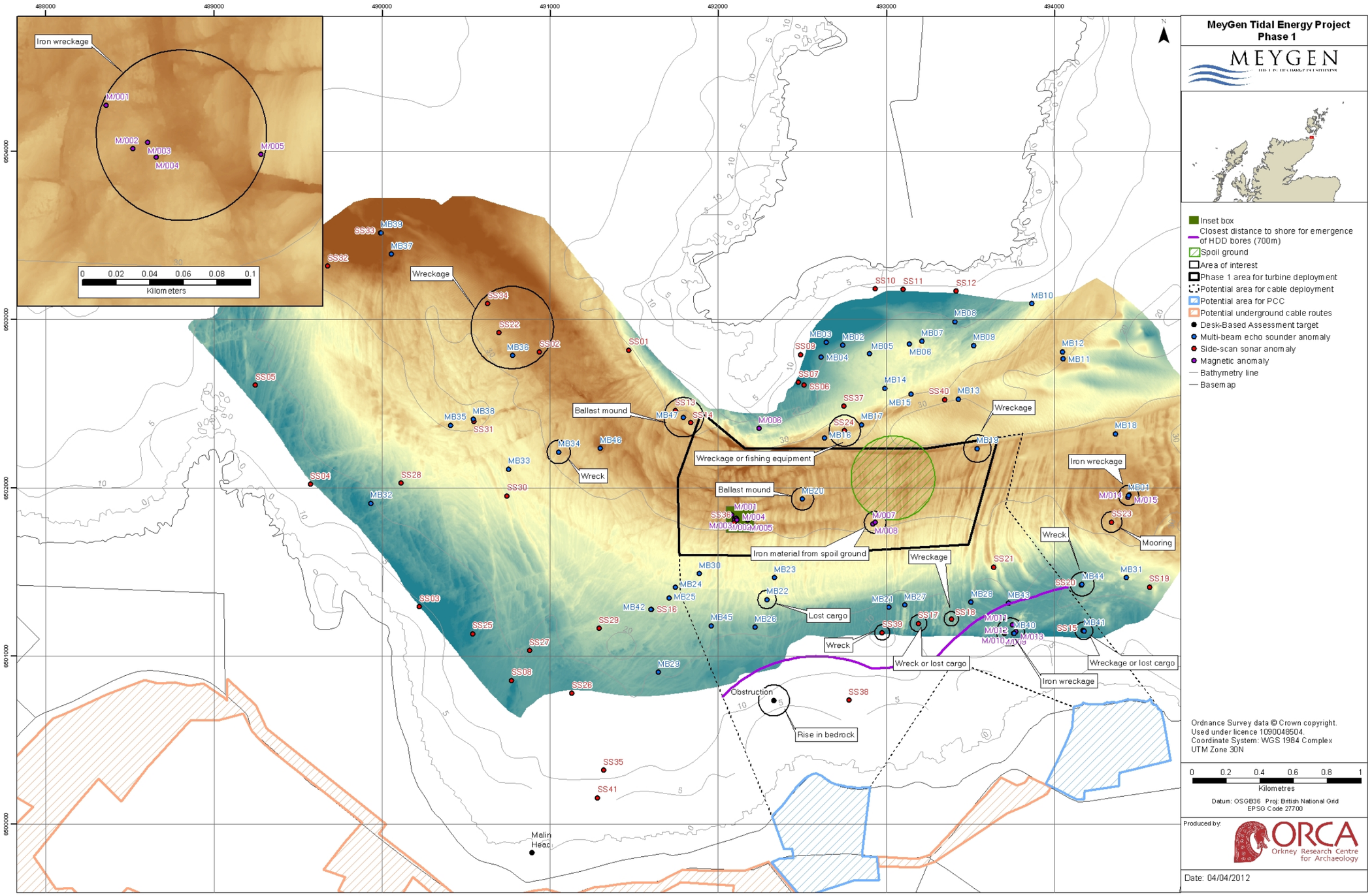

Figure 16.2: Overall map of survey anomalies over bathymetry survey data showing multi-beam bathymetry on top. Possible interpretations of geophysical anomalies included.

Site_No	Proximity	Importance of site	Magnitude of direct impact	Significance of direct impact	Mitigation for direct impacts	Residual direct impact[1]	Residual direct impact significance	Magnitude of indirect Impact	Significance of indirect impact	Mitigation for indirect impacts	Residual indirect impact	Residual indirect impact significance
MB13	260mN of turbine deployment area.	Uncertain	Negligible	Uncertain/ Negligible	No further rec.			Moderate	Uncertain/ Moderate	(1) avoidance (2) dive or ROV survey	Minor	Not Significant
MB19	Within turbine deployment area.	Uncertain	High	Uncertain/ Major	(1) avoidance (2) dive or ROV survey	Minor	Not Significant	Major	Uncertain/ Major	(1) avoidance (2) dive or ROV survey	Minor	Not Significant
MB20	Within turbine deployment area.	Uncertain	High	Uncertain/ Major	(1) avoidance (2) dive or ROV survey	Minor	Not Significant	Minor	Uncertain/ Minor	No further rec.		
MB22	63mS of cable corridor to Ness of Huna.	Uncertain	High	Uncertain/ Major	(1) avoidance (2) dive or ROV survey	Minor	Not Significant	Minor	Uncertain/ Minor	No further rec.		
MB23	78mN of cable corridor to Ness of Huna.	Uncertain	High	Uncertain/ Major	(1) avoidance (2) dive or ROV survey	Minor	Not Significant	Minor	Uncertain/ Minor	No further rec.		
MB24	29mW of cable corridor to Ness of Quoys.	Negligible	High	Minor	No further rec.			Minor	Negligible	No further rec.		
MB25	69mW of cable corridor to Ness of Quoys.	Negligible	High	Minor	No further rec.			Minor	Negligible	No further rec.		
MB28	10mE of cable corridor to Ness of Quoys.	Uncertain	High	Uncertain/ Major	(1) avoidance (2) dive or ROV survey	Minor	Not Significant	Minor	Uncertain/ Minor	No further rec.		
MB30	65mS of cable corridor to Ness of Huna.	Negligible	High	Minor	No further rec.			Minor	Negligible	No further rec.		
MB44	89mE of cable corridor to Ness of Huna.	Uncertain	High	Uncertain/ Major	(1) avoidance (2) dive or ROV survey	Minor	Not Significant	Minor	Uncertain/ Minor	No further rec.		
MB45	105mE of cable corridor to Ness of Quoys.	Negligible	Negligible	Negligible	No further rec.			Minor	Negligible	No further rec.		
MB47	87mW of turbine deployment area.	Uncertain	High	Uncertain/ Major	(1) avoidance (2) dive or ROV survey	Minor	Not Significant	Minor	Uncertain/ Minor	No further rec.		
SS14	45mW of turbine deployment area.	Uncertain	High	Uncertain/ Major	(1) avoidance (2) dive or ROV survey	Minor	Not Significant	Minor	Uncertain/ Minor	No further rec.		
SS18	105mW of cable corridor to Ness of Quoys.	Uncertain	High	Uncertain/ Major	(1) avoidance (2) dive or ROV survey	Minor	Not Significant	Minor	Uncertain/ Minor	No further rec.		
SS20	80mN of cable corridor to Ness of Huna.	Uncertain	High	Uncertain/ Major	(1) avoidance (2) dive or ROV survey	Minor	Not Significant	Minor	Uncertain/ Minor	No further rec.		
SS24	103mN of turbine deployment area.	Uncertain	High	Uncertain/ Major	(1) avoidance (2) dive or ROV survey	Minor	Not Significant	Moderate	Uncertain/ Moderate	(1) avoidance (2) dive or ROV survey	Minor	Not Significant
SS36	Within turbine deployment area.	Uncertain	High	Uncertain/ Major	(1) avoidance (2) dive or ROV survey	Minor	Not Significant	Minor	Uncertain/ Minor	No further rec.		
SS39	7mN of cable corridor to Ness of Huna.	Uncertain	High	Uncertain/ Major	(1) avoidance (2) dive or ROV survey	Minor	Not Significant	Minor	Uncertain/ Minor	No further rec.		
SS40	269mN of turbine deployment area.	Uncertain	Negligible	Uncertain/	No further rec.			Moderate	Uncertain/	(1) avoidance	Minor	Not Significant

Site_No	Proximity	Importance of site	Magnitude of direct impact	Significance of direct impact	Mitigation for direct impacts	Residual direct impact[1]	Residual direct impact significance	Magnitude of indirect Impact	Significance of indirect impact	Mitigation for indirect impacts	Residual indirect impact	Residual indirect impact significance
				Negligible					Moderate	(2) dive or ROV survey		
M/001	Within turbine deployment area.	Uncertain	High	Uncertain/ Major	(1) avoidance (2) dive or ROV survey	Minor	Not Significant	Minor	Uncertain/ Minor	No further rec.		
M/002	Within turbine deployment area.	Uncertain	High	Uncertain/ Major	(1) avoidance (2) dive or ROV survey	Minor	Not Significant	Minor	Uncertain/ Minor	No further rec.		
M/003	Within turbine deployment area.	Uncertain	High	Uncertain/ Major	(1) avoidance (2) dive or ROV survey	Minor	Not Significant	Minor	Uncertain/ Minor	No further rec.		
M/004	Within turbine deployment area.	Uncertain	High	Uncertain/ Major	(1) avoidance (2) dive or ROV survey	Minor	Not Significant	Minor	Uncertain/ Minor	No further rec.		
M/005	Within turbine deployment area.	Uncertain	High	Uncertain/ Major	(1) avoidance (2) dive or ROV survey	Minor	Not Significant	Minor	Uncertain/ Minor	No further rec.		
M/007	Within turbine deployment area.	Uncertain	High	Uncertain/ Major	(1) avoidance (2) dive or ROV survey	Minor	Not Significant	Minor	Uncertain/ Minor	No further rec.		
M/008	Within turbine deployment area.	Uncertain	High	Uncertain/ Major	(1) avoidance (2) dive or ROV survey	Minor	Not Significant	Minor	Uncertain/ Minor	No further rec.		

Note:
[1]If a potential impact was deemed to be not significant then no residual impact ranking has been applied

Table 16.13: Summary of geophysical anomalies; impact significance with and without mitigation

	Proximity	Importance of site	Magnitude of direct impact	Significance of direct impact	Significant	Magnitude of indirect Impact	Significance of indirect impact	Significant
Thetis	Unknown	High	Negligible	Negligible	Not Significant	None	Negligible	Not Significant
Blue Bonnet	Unknown	High	Negligible	Negligible	Not Significant	None	Negligible	Not Significant
Clarence G Sinclair	Unknown	High	Negligible	Negligible	Not Significant	None	Negligible	Not Significant
Golden Eagle	Unknown	High	Negligible	Negligible	Not Significant	None	Negligible	Not Significant
Eagle	Unknown	High	Negligible	Negligible	Not Significant	None	Negligible	Not Significant
Andrew Longmore	Unknown	High	Negligible	Negligible	Not Significant	None	Negligible	Not Significant
Lord Suffield	Unknown	High	Negligible	Negligible	Not Significant	None	Negligible	Not Significant
Percy	Unknown	High	Negligible	Negligible	Not Significant	None	Negligible	Not Significant
Pheasant	Unknown	Very high	Negligible	Minor	Not Significant	None	Minor	Not Significant
Brothers	Unknown	High	Negligible	Negligible	Not Significant	None	Negligible	Not Significant
Science	Unknown	High	Negligible	Negligible	Not Significant	None	Negligible	Not Significant
St Martin	Unknown	High	Negligible	Negligible	Not Significant	None	Negligible	Not Significant
Hector	Unknown	High	Negligible	Negligible	Not Significant	None	Negligible	Not Significant
Abiding (BCK449)	Unknown	Low	Negligible	Negligible	Not Significant	None	Negligible	Not Significant
Hudson	Unknown	High	Negligible	Negligible	Not Significant	None	Negligible	Not Significant
Bittern	Unknown	High	Negligible	Negligible	Not Significant	None	Negligible	Not Significant

	Proximity	Importance of site	Magnitude of direct impact	Significance of direct impact	Significant	Magnitude of indirect Impact	Significance of indirect impact	Significant
Scotia	Unknown	High	Negligible	Negligible	Not Significant	None	Negligible	Not Significant
Glasgow packet	Unknown	High	Negligible	Negligible	Not Significant	None	Negligible	Not Significant
Margaret Gunn	Unknown	High	Negligible	Negligible	Not Significant	None	Negligible	Not Significant
Northumbrian	Unknown	High	Negligible	Negligible	Not Significant	None	Negligible	Not Significant
Minna	Unknown	High	Negligible	Negligible	Not Significant	None	Negligible	Not Significant
Elizabeth	Unknown	High	Negligible	Negligible	Not Significant	None	Negligible	Not Significant
Louisa	Unknown	High	Negligible	Negligible	Not Significant	None	Negligible	Not Significant
Anna Maria	Unknown	Uncertain	Negligible	Uncertain/ Negligible	Not Significant	None	Negligible	Not Significant
Mary	Unknown	High	Negligible	Negligible	Not Significant	None	Negligible	Not Significant
Unknown	Unknown	Uncertain	Negligible	Uncertain/ Negligible	Not Significant	None	Negligible	Not Significant
Unknown	Unknown	High	Negligible	Negligible	Not Significant	None	Negligible	Not Significant
Edwin and Lizzie	Unknown	High	Negligible	Negligible	Not Significant	None	Negligible	Not Significant
Victor and Louis	Unknown	High	Negligible	Negligible	Not Significant	None	Negligible	Not Significant
North Sea	Unknown	High	Negligible	Negligible	Not Significant	None	Negligible	Not Significant
Cairn Glen	Unknown	High	Negligible	Negligible	Not Significant	None	Negligible	Not Significant

Table 16.14: Summary of known wrecks that might be present in the area; impact significance with and without mitigation

16.87 The cable routes are in another high-energy environment area with exposed bedrock and gullies. The following sites, recorded in the cable deployment area or within vicinity (100-300m) of the area, are recommended to be either avoided or investigated by Remote Operated Vehicle (ROV):

- Four MBES anomalies (MB22, MB23, MB28 and MB44). These anomalies could be lost cargo, fishing equipment or wreckage; and
- Three SSS anomalies (SS18, SS20 and SS39) of uncertain potential were recorded or within 100m of the cable deployment area. These anomalies could be parts of a wreck or lost cargo and fishing equipment.

MITIGATION IN RELATION TO IMPACT 16.1

The following mitigations are proposed if practicable for sites of moderate and major impact significance within 100m of the development.

- Avoidance.
- ROV survey of the geophysical anomalies by Remote Operated Vehicle (ROV) in an appropriate manner by specialists in marine archaeology so they can be positively identified.
- Detailed wreck survey and salvage. If the ROV survey reveals cultural heritage, plans/elevations will be made with a full photographic record prior to impact. Wrecks should be recorded in an appropriate manner by specialists in marine archaeology. Attempts will be made to retrieve and conserve representative examples of the fabric. If the feature is of high archaeological potential the strategies below may be implemented.
- Intrusive archaeological assessment. This response will be implemented for all sites and wrecks with high archaeological potential and where there will be intrusive works. Intrusive assessments would groundtruth geophysical survey results and assess the nature, extent and preservation of identified remains.
- Full archaeological excavation. This level of mitigation may be deemed necessary as a result of evidence gathered by other levels and should be conducted by specialists in marine archaeology. Provision should be made for the examination and possible conservation of any artefacts recovered. Provision should be made for post-excavation work bringing the results together in a report of publication standard.
- Further documentary research and archiving. This response includes further detailed examination of unusual archival sources that would not routinely be consulted.
- No recommendations are made for anomalies of low potential. This is due to them being interpreted as natural features.

Residual impact

16.88 If the geophysical anomalies are identified by ROV survey and found to be either natural formations or recent anthropogenic debris, and are considered to have no or negligible significance, no further actions will be necessary. If a geophysical anomaly is identified as cultural material of low to very high importance it is proposed to avoid the site or implement further recording strategies. The residual significance of direct impact from both these scenarios is minor.

16.6.2 Impact 16.2: Damage to discovered marine cultural material Impact

16.89 The high-energy environment does not allow for much cultural material to remain except in the gullies in the bedrock. Therefore, recorded shipwrecks that only have an approximate position have been given a negligible allocation (Table 16.14). The shipwrecks of unknown location also have an impact significance of 'minor' with the exception of the Pheasant, which is internationally important and highly significant, thus having an impact of 'moderate' significance.

16.90 No known shipwreck locations are within 100m of the development. No known evidence of submerged prehistoric sites is located within 100m of the development. However, although the potential is low, there remains the possibility that unknown marine cultural material could be discovered during construction and installation.

16.91 There is low potential for significant prehistoric cultural material to have survived in areas sheltered from the current such as in gullies or any submerged caves, or in the western and eastern extents of the development area where gravel and sand seabed deposits could overlie submerged terrestrial deposits. Such areas are unsuitable for turbine deployment and therefore will not be directly impacted by the proposed Project.

16.92 Although there are no significant impacts, if marine cultural heritage material was discovered pre-construction or during construction, it would be recommended to avoid the site or the following procedures would be put in place.

MITIGATION IN RELATION TO IMPACT 16.2

- A reporting protocol will be instigated for the accidental discovery of marine cultural material during development, maintenance and monitoring.
- Avoidance. Should cultural material be accidentally discovered, it is proposed that the site be avoided.
- If it is not practicable to avoid the material a detailed wreck survey will be undertaken. If the ROV survey reveals cultural heritage, plans/elevations will be made with a full photographic record prior to impact. Wrecks will be recorded in an appropriate manner by specialists in marine archaeology. Attempts will be made to retrieve and conserve representative examples of the fabric. If the feature is of high archaeological potential the strategies below may be implemented.
- Intrusive archaeological assessment. This response will be implemented for all sites and wrecks with high archaeological potential and where there will be intrusive works. Intrusive assessments would groundtruth geophysical survey results and assess the nature, extent and preservation of identified remains.
- Full archaeological excavation. This level of mitigation may be deemed necessary as a result of evidence gathered by other levels and should be conducted by specialists in marine archaeology. Provision should be made for the examination and possible conservation of any artefacts recovered. Provision should be made for post-excavation work bringing the results together in a report of publication standard.
- Further documentary research and archiving. This response includes further detailed examination of unusual archival sources that would not routinely be consulted.
- No recommendations are made for anomalies of low potential. This is due to them being interpreted as natural features.

16.7 Impacts during Operations and Maintenance

16.7.1 Impact 16.3: Damage to marine cultural material from scouring caused by alteration of currents from placing turbine and cable on seafloor

16.93 There is the possibility of indirect impacts on marine cultural heritage assets and their associated environment caused by the development causing scour on the seabed. Scour occurs on the seafloor when sediment is eroded from an area in response to forcing by waves and currents (Quinn, 2006). It can be initiated by the introduction of an object to the seafloor such as a tidal turbine. Marine features such as shipwrecks and submerged landscape deposits are therefore vulnerable to erosion due to scouring by tidal currents, and scour processes can ultimately lead to the complete failure and collapse of structures on the seafloor.

16.94 The coastal processes modelling review revealed how current speeds through the Inner Sound, could be changed by the introduction of the tidal array (DHI, 2011). Current speeds are expected to increase to the north and south of the array, and decrease through the array itself. During calm conditions, the addition of 86, 1MW turbines is expected to reduce current speed through the array by up to 0.8m/s, and increase the current speeds by up to 0.8m/s to the north and south of the array. There are loose sediments on the seabed to the north east of the array. During storm conditions the current speed is predicted to change by between ±0.1 to ±1.2m/s in a similar pattern to that described for the calm scenario. These figures are based on an extreme scenario with a 14 day storm.

16.95 The modelling study predicted there would be no significant impacts to the sediment dynamics and bedforms near the site following the installation of the array. There is a natural movement of sediments as would be expected in a tidal flow receiving wave action, but the array is not predicted to affect these processes significantly. As the change in currents and seabed sediment is relatively minor there is expected to be no impact on any cultural material.

16.96 Table 16.13 and Table 16.14 summarise the potential indirect impacts. For the survey area it was considered that in areas of bedrock and subrock the development would have 'minor' magnitude of indirect impact on any cultural material due to the small amount of sediment that would be affected by scour. Any sediment that is present in gullies, in the areas of bedrock and subrock, is not expected to be affected by any changes in the currents. Beyond 100m of the Project in areas of bedrock and subrock the indirect impact is considered to be 'none'.

16.97 Where the cultural material is in an area of sand and gravel the magnitude of indirect impact would be 'major' within the development area, 'moderate' outside the development (up to 300m from the development limit) and 'minor' beyond 300m from the development. 300m, rather than the usual 100m buffer zone, has been chosen as a buffer zone for indirect impacts in sand and gravel areas. This is due to recognition of the indirect effect scouring caused by underwater structures could have on the seafloor sediments. The magnitude of indirect impact is higher due to the unconsolidated sediments being susceptible to scouring or other disturbance, which would affect the location and preservation of cultural material within and on top of the sediment.

16.98 The assessment has resulted in a 'major' magnitude of indirect impact on one site (MB19), 'moderate' magnitude of indirect impact on three sites (MB13, SS24 and SS40) and 'minor' indirect impact on 22 sites (Table 16.13). The significance of indirect impact is the same or less than that for the direct impacts (with the exception of MB13) and so they have been assessed in terms of impact together.

16.99 It is assumed that sites with a high and medium geophysical potential within 300m of the development in sand and gravel areas have the potential to be affected by scouring caused by the development.

16.100 The following sites, recorded in the turbine deployment area or within 300m of that area, are recommended to be either avoided or investigated by ROV:

- One MBES anomalies (MB19). This anomalies is a possibly wreckage, lost cargo, or ballast; and
- Two side-scan sonar anomalies (SS24 and SS40). These anomalies are possibly wreckage or lost cargo.

16.101 Both MB19 and SS24 are previously recorded in mitigation for impact 16.1. A 100m buffer has been allowed around the development areas due to issues of size of anomaly, accuracy in underwater location recording, and scouring on the seabed due to the strong tidal currents moving cultural material.

16.102 The potential cable deployment area is in another high-energy environment area with exposed bedrock and gullies. There were no sites recorded within 300m of this area.

MITIGATION IN RELATION TO IMPACT 16.3
▪ Although no significant impact have been identified, mitigation measures have been provided as a precautionary approach to ensure this remains the case. ▪ Avoid placing the turbines on the sandy substrate on the northeast corner of the proposed turbine deployment area.

Residual impact

16.103 After implementation of the mitigation measures to address the significance of indirect impact on the geophysical anomalies that is currently assessed as major or moderate, the mitigated impact significant will be brought down to minor or negligible.

16.8 Impacts during Decommissioning

16.8.1 Impact 16.4: Damage caused by removal of turbine and cable to marine cultural material

16.104 The removal or cutting of the drilled piles, or the release of weight, from the TSS will impact the seabed affecting surrounding sediment or cultural material. The cables will be recovered to a vessel as the cables are moved over the seabed and the Horizontal Directional Drilling (HDD) bores filled at the breakthrough location. The TSS are to be installed on bedrock, therefore, this will not cause any damage to marine cultural material, which would have been examined prior to construction.

MITIGATION IN RELATION TO IMPACT 16.4
▪ No mitigation required.

16.9 Potential Variances in Environmental Impacts

16.105 This assessment has addressed the potential impacts associated with all potential offshore development areas; however, in reality it will only be certain areas within this footprint that will be developed. Therefore the actual impacts (both direct and indirect) will be less than those predicted here.

16.106 The majority of geophysical anomalies with uncertain/major significance of direct impact were located in the potential cable deployment area to the Ness of Huna. This involved five sites within 100m of this area (MB22, MB23, MB44, SS20 and SS39). The alternative cable route area to the Ness of Quoys involved two sites of uncertain/major significance of direct impact (MB28 and SS18) within 100m of the cable route.

16.10 Cumulative Impacts

16.10.1 Introduction

16.107 MeyGen has in consultation with Marine Scotland and The Highland Council identified a list of other projects (MeyGen, 2011) which together with the Project may result in potential cumulative impacts. The list of these projects including details of their status at the time of the EIA and a map showing their location is provided in Section 8; Table 8.3 and Figure 8.1 respectively.

16.108 Having considered the information presently available in the public domain on the projects for which there is a potential for cumulative impacts, Table 16.15 below indicates those with the potential to result in cumulative impacts from a marine cultural heritage perspective. The consideration of which projects could result in potential cumulative impacts is based on the results of the project specific impact assessment together with the expert judgement of the specialist consultant.

Project title	Potential for cumulative impact	Project title	Potential for cumulative impact	Project title	Potential for cumulative impact
MeyGen Limited, MeyGen Tidal Energy Project, Phase 2	✓	SHETL, HVDC cable (onshore to an existing substation near Keith in Moray)	×	OPL, Ocean Power Technologies (OPT) wave power ocean trial	×
ScottishPower Renewables UK Limited, Ness of Duncansby Tidal Energy Project	✓	Brough Head Wave Farm Limited, Brough Head Wave Energy Project	×	MORL, Moray Offshore Renewables Ltd (MORL) offshore windfarm	×
Pelamis Wave Power, Farr Point Wave Energy Project	×	SSE Renewables Developments (UK) Limited, Costa Head Wave Energy Project	×	SSE and Talisman, Beatrice offshore Windfarm Demonstrator Project	×
Sea Generation (Brough Ness) Limited, Brough Ness Tidal Energy Project	×	EON Climate & Renewables UK Developments Limited, West Orkney North Wave Energy Project	×	BOWL, Beatrice Offshore Windfarm Ltd (BOWL) offshore windfarm	×
Cantick Head Tidal Development Limited, Cantick Head Tidal Energy Project	×	EON Climate & Renewables UK Developments Limited, West Orkney South Wave Energy Project	×	Northern Isles Salmon, Chalmers Hope salmon cage site	×
SSE, Caithness HVDC Connection - Converter station	×	ScottishPower Renewables UK Limited, Marwick Head Wave Energy Project	×	Northern Isles Salmon, Pegal Bay salmon cage site	×
SSE, Caithness HVDC Connection - Cable	×	SSE Renewables Developments (UK) Limited, Westray South Tidal Energy Project	×	Northern Isles Salmon, Lyrawa salmon cage site	×
RWE npower renewables, Stroupster Windfarm	×	EMEC, Wave Energy test site (Billia Croo, Orkney)	×	Scottish Sea Farms, Bring Head salmon cage site	×
SSE, Gills Bay 132 kV / 33 k V Substation Phase 1: substation and overhead cables (AC)	×	EMEC, Tidal energy test site (Fall of Warness, Orkney)	×	Northern Isles Salmon, Cava South salmon cage site	×
SSE, Gills Bay 132 kV / 33 k V Substation Phase 2: HVDC converter station and new DC buried cable	×	EMEC, Intermediate wave energy test site (St Mary's Bay, Orkney)	×	Scottish Sea Farms, Toyness salmon cage site	×
SHETL, HVDC cable (offshore Moray Firth)	×	EMEC, Intermediate tidal energy test site (Head of Holland, Orkney)	×	Northern Isles Salmon, West Fara salmon cage site	×

Table 16.15: Summary of potential cumulative impacts

16.109 The following sections summarise the nature of the potential cumulative impacts for each potential project phase:

- Construction and installation;
- Operations and maintenance; and
- Decommissioning.

16.10.2 Potential cumulative impacts during construction and installation

16.110 Cumulative impacts arising from installation of multiple marine renewable projects at the same time as the proposed installation are not anticipated as the majority of impacts are expected to be localised. The Ness of Duncansby Tidal Energy project is the only project that may potentially be constructed at the same time as the MeyGen Tidal Energy Project, Phase 1 and would not act in combination to cause significant impacts.

16.111 The MeyGen Project, Phase 2 will require additional seabed within the AfL with the potential to increase the direct impacts (damage to cultural heritage assets exposed on the surface), although wherever possible cultural heritage assets will be avoided.

16.10.3 Potential cumulative impacts during operations and maintenance

16.112 The operation of both Phase 1 and Phase 2 of the MeyGen Project are likely to increase the likelihood of indirect impacts (by changes in bedload transport or erosion and deposition) on cultural heritage assets and geophysical anomalies. However the magnitude of impact is likely to be low as no turbines will be places on areas of sediment.

16.113 The operation of the Ness of Duncansby project is considered not to have cumulative impacts on the marine heritage as none of the modelling results for the Project show any changes that extend to the Ness of Duncansby site.

16.10.4 Potential cumulative impacts during decommissioning

16.114 Cumulative impacts arising from the decommissioning of multiple marine renewable projects at the same time as the Project are not anticipated as the majority of impacts are expected to be localised. There is limited scope for cumulative decommissioning impacts, since it is highly unlikely that the Ness of Duncansby development would be decommissioned at the same time as this development.

16.115 The MeyGen Phase 2 development (which would likely be decommissioned at the same time as the proposed development) may increase the likelihood of impacts from decommissioning as it will cover a greater area of the seabed. However the removal of turbines, TSS's and cables is not likely to cause any damage to marine cultural material, which would have been examined prior to construction.

16.10.5 Mitigation requirements for potential cumulative impacts

16.116 No mitigation is required over and above the Project specific mitigation.

16.11 Proposed Monitoring

16.117 A reporting protocol will be put in place in the event of discovery of previously unknown marine cultural heritage material. Depending on the significance of the find there may be a requirement for further investigation and recording in line with the mitigation proposed in this section.

16.12 Summary and Conclusions

16.118 There is no evidence of and low potential for, submerged landscapes, prehistoric cultural materials and wrecks, as large areas of the seabed have been scoured down to bare rock. There are 35 recorded wrecks (shipwrecks, aircraft and obstructions) in the general area. The position of 32 shipwrecks is approximate and none has been identified in the geophysical survey data. Therefore, it is assessed that the development may have direct and indirect impacts of negligible significance on this potential resource. The two shipwrecks with known locations, MV Bettina Danica and SS Malin Head, are outside of the offshore Project area (760m and 1450m away respectively). It is assessed that they may sustain direct and indirect impacts of negligible significance at most. A Spitfire lost in the general area in 1941 has been shown to have been lost in the sea off Duncansby Head, so is outside of the development area. There are no other areas, sites or wrecks protected, designated or controlled under the *Ancient Monuments and Archaeological Areas Act* 1979, the *Protection of Wrecks Act* 1973, the *Protection of Military Remains Act* 1986 or the *Marine (Scotland) Act* 2010, or potential Historic Marine Protected Area, within the proposed lease area.

16.119 Geophysical anomalies were identified in the overall survey area. Geophysical anomalies with Ranks 1 and 2 have uncertain potential of being cultural remains (those of Rank 3 are interpreted as natural). They could be wreckage, fishing material, anchors, or cargo lost overboard. There may be direct impacts of 'major' significance on 20 geophysical anomalies within 100m of the turbine deployment area and cable deployment area. There may be indirect impacts of 'major' significance on three geophysical anomalies within 100m of the development and indirect impacts of uncertain/moderate significance on three geophysical anomalies within 100 to 300m of the development, all in a sand or gravel sediment area.

16.120 If avoidance of potential cultural heritage features is not possible, it is recommended that geophysical anomalies of high and medium potential within 100m of the development are investigated by ROV methods in an appropriate manner by specialists in marine archaeology so they can be positively identified. This will be done before offshore construction commences. If the anomalies are identified and found to be either natural formations or recent anthropogenic debris they would have no or negligible significance and no further actions will be necessary. If a geophysical anomaly is identified as cultural material of low or higher significance it is proposed that they are avoided. If this is not practicable, mitigation or managements strategies such as wreck survey, salvage or intrusive archaeological evaluation will be undertaken. A reporting protocol will be instigated for the accidental discovery of marine cultural material during development, maintenance and monitoring. The implementation of the recommended mitigation strategies will result in the development having a minor or negligible residual impact on marine cultural heritage.

16.13 References

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17 GEOLOGY, HYDROGEOLOGY & HYDROLOGY

17.1 There were no supporting studies which directly relate to the Geology, Hydrogeology and Hydrology impact assessment.

17.1 Introduction

17.2 This section assesses the effects of the proposed Project on geology, hydrogeology and hydrology. The assessment was undertaken by Mouchel, water and environmental consultants.

17.3 Geology, hydrogeology and hydrology are closely linked resources with the possibility of common effects. For the purposes of this assessment, 'hydrology' is considered to include all fresh surface waters, 'hydrogeology' covers groundwater including water held within superficial drift or soils, and 'geology' includes bedrock and superficial deposits.

17.4 Effects on the geology, hydrogeology and hydrology may result in secondary ecological effects on habitats (e.g. wetland areas) or species (e.g. fish). Any such effects have not been discussed here, but are addressed in Section 18 (Terrestrial Habitats and Ecology).

17.5 During construction there will be physical disturbance and removal of soil and superficial deposits by mobile plant. The onshore infrastructure and cable route will introduce physical changes which may alter the hydrological and hydrogeological characteristics of the site. During the construction and decommissioning phases, and to a lesser extent during operation, potential sources of pollution will be present on site.

17.2 Assessment Parameters

17.2.1 Rochdale Envelope

17.6 In line with the Rochdale Envelope approach, this assessment considers the maximum ('worst case') Project parameters. Identification of the worst case scenario for each receptor (i.e. Environmental Impact Assessment (EIA) topic) ensures that impacts of greater adverse significance would not arise should any other development scenario be taken forward in the final scheme design. Table 17.1 describes the detail of the Project parameters that have been used in this assessment and explains why these are considered to be worst case.

17.7 In terms of the assessment of alternative Project parameters, this assessment has addressed the potential; impacts associated withal potential onshore development areas. However it will only be certain areas of within this footprint that will be developed. Therefore the actual impacts of the Project will be less than those predicted here.

Project parameter relevant to the assessment		'Maximum' Project parameter for impact assessment	Explanation of maximum Project parameter
Onshore Power Conversion Centre (PCC)	Construction, operation/maintenance and decommissioning	Maximum potential footprint at both Ness of Quoys and Ness of Huna (at EIA commencement)	Assessment of potential impacts associated with the construction, operation and maintenance activities and decommissioning of the Power Conversion Centre (PCC) at both the Ness of Huna and Ness of Quoys maximum potential footprint.
Onshore cable routes between PCC and SHETL substation	Construction, operation/maintenance and decommissioning	All potential cable corridors between PCC locations and SHETL substation proposed at Phillips Mains (see Figure 2.1) (at EIA commencement)	Assessment of potential impacts associated with all potential cable corridors identified between PCC locations and SHETL substation proposed at Phillips Mains.
Cable landfall	HDD site	Maximum potential footprint at both Ness of Quoys and Ness of Huna (at EIA commencement)	Assessment of potential impacts associated with the construction, operation and reinstatement of the temporary Horizontal Directional Drill (HDD) site at both the Ness of Huna and Ness of Quoys maximum potential footprint.
Offshore Project parameters	Maximum drill cuttings released into marine environment	29, 0.6m HDD bores, drilled from either Ness of Quoys or Ness of Huna	The majority of drill cuttings generated from the drilling of the HDD bores will be returned to shore and not discharged to sea; however, it is estimated that the contents of the last 10m of each bore could be discharged to sea and the seabed upon breakthrough. Of the two potential HDD scenarios, the greatest potential volume of cuttings discharged to sea will result from 29 boreholes of 0.6m diameter and 700m in length (82m^2). Drill cuttings produced at breakthrough from drilling 86 individual boreholes of 0.3m diameter and 2,000m in length will be less (61m^2).
	Maximum amount of drill cuttings released into the marine environment	86 monopile Turbine Support Structure (TSS)	The drilled monopile TSS will result in the maximum release of drill cuttings to the marine environment. Assuming the maximum number of 86 TSSs, the maximum amount of drill cuttings that can be generated from turbine support installations is 17,200m^2 (total for 86 TSSs).
	Maximum seabed footprint	86 Gravity Base Structure (GBS) TSS	Each GBS TSS has a maximum footprint of 40m x 30m. The total footprint for 86 turbines is 0.103km^2.
	Maximum cable footprint on seabed	86, 250mm unbundled cables each 1,300m in length	The maximum physical area of the seabed occupied by the cables has been calculated as 0.056km^2. Based on a maximum 1.3km of cable from HDD bore exit to turbine, and maximum cable diameter of 250mm (x2 to account for any armouring or weighting) for 86 turbines.

Table 17.1: Rochdale Envelope parameters for the geology, hydrogeology and hydrology assessment

17.2.2 Area of assessment

17.8 It is also important to define the geographical extent of the assessment area. The focus of the geology, hydrogeology and hydrology assessment is potential impacts on:

- The geology of the on- and offshore areas that could be directly impacted by Project infrastructure at Ness of Quoys, Ness of Huna and along the cable corridor to the SHETL substation;
- The hydrology of the Project site has been considered using a surface water catchment based system. As the Project activities may influence watercourses and locations beyond the proposed infrastructure area, relevant areas within catchments have been considered; and
- From a hydrogeological perspective, owing to the nature of the groundwater resources in the area, potential impacts will generally be restricted to the areas directly impacted by, adjacent to and down-catchment of Project infrastructure.

17.9 It should be noted that this assessment was completed on a more extensive Project area; this has since been refined to a smaller footprint at both the Ness of Quoys and Ness of Huna PCC sites and a single

cable corridor to the SHETL substation option areas. The final Project is described in Section 5 and shown in Figure 5.2; the selection process for these is discussed in Section 4.

17.10 **Following the completion of the EIA, landowner consultation has identified potential issues with small areas of the proposed cable route. It has therefore been necessary to include areas outside that surveyed for the onshore impact assessments. The area is 0.50km^2 and is shown in Figure 2.1. Unfortunately this issue was not identified at the time of ES compilation and therefore is not addresses in this document. Work to survey and assessment of any changes required to the original impact assessment as a result of the altered cable route is ongoing and will be provided in an ES addendum.**

17.3 Legislative Framework and Regulatory Context

17.3.1 Legislation

17.11 In addition to the EIA Regulations the following are also relevant to this assessment:

- Water Environment and Water Services (Scotland) Act 2003;
- Water Environment (Controlled Activities) (Scotland) Regulations 2011; and
- Private Water Supplies (Scotland) Regulations 2006.

17.3.2 Policy and guidance

17.12 In addition to the EIA guidance published by Marine Scotland and Scottish Natural Heritage (SNH), the following guidance has been taken into consideration during this assessment:

- CIRIA (Construction Industry Research and Information Association) Report C532, Control of water pollution from construction sites: Guidance for consultants and contractors;
- CIRIA Report C648, Control of water pollution from linear construction projects: Technical guidance;
- CIRIA Report C649, Control of water pollution from linear construction sites: Site guide;
- BSI Code of Practice for Earthworks, BS 6031: 2009;
- Forestry Commission (2003), Forests & water guidelines, 4th Edition;
- Scottish Executive (2000), River crossings & migratory fish: Design guidance;
- SNH (2005), A handbook on environmental impact assessment;
- Scottish Planning Policy, 2010;
- Scottish Environmental Protection Agency (SEPA) Policy No. 19, Groundwater protection policy for Scotland;
- SEPA Position Statement WAT-PS-06-02, Culverting of watercourses;
- SEPA WAT-SG-25, Good practice guide – river crossings;
- SEPA WAT-SG-26, Good practice guide – sediment management;
- SEPA WAT-SG-29, Good practice guide – temporary construction works;
- SEPA WAT-SG-31, Special requirements for civil engineering contracts for the prevention of pollution;
- SEAP/CIRIA (2006), Small environmental guide for construction workers; and
- The Highland Council's Caithness Local Plan (2002) and The Highland Councils Structure Plan (2001)[1]. These will be supplemented and eventually superseded by the Highland-wide Local Development Plan (HWLDP)[2].

17.13 SEPA (jointly with the Environment Agency and the Northern Ireland Environment Agency (NIEA)) Pollution Prevention Guidelines:

- PPG1: General guide to the prevention of pollution;
- PPG2: Above ground oil storage tanks;
- PPG3: Use and design of oil separators in surface water drainage systems;
- PPG4: Treatment and disposal of sewage where no foul sewer is available;
- PPG5: Works and maintenance in or near water;
- PPG6: Working at construction and demolition sites;
- PPG7: Safe storage – The safe operation of refuelling facilities;
- PPG8: Safe storage and disposal of used oils;
- PPG13: Vehicle washing and cleaning;
- PPG18: Managing fire water and major spillages;
- PPG21: Pollution incident response planning; and
- PPG26: Safe storage - drums and intermediate bulk containers.

17.4 Assessment Methodology

17.4.1 Scoping and consultation

17.14 Since the commencement of the Project, consultation on geology, hydrology and hydrogeology issues has been ongoing. Table 17.2 summarises all consultation relevant to geology, hydrogeology and hydrology. In addition, relevant comments from the EIA Scoping Opinion are summarised in Table 17.3, together with responses to the comments and reference to the Environmental Statement (ES) sections relevant to the specific comment.

Date	Stakeholder	Consultation	Topic/specific issue
7th April 2011	Marine Scotland and SNH	Pre-Scoping meeting	EIA surveys and studies required and the data needs for each EIA study.
27th May 2011	Marine Scotland, statutory consultees and non statutory consultees	Submission of EIA Scoping Report	Request for EIA Scoping Opinion from Marine Scotland and statutory consultees and request for comment from non-statutory consultees.

[1] Still in force at the time of the EIA and ES compilation.

[2] Not adopted at the time of the EIA and ES compilation.

Date	Stakeholder	Consultation	Topic/specific issue
30th June – 2nd July 2011	Local stakeholders	Public Event - EIA Scoping	Public event to collate information/opinions on proposed EIA scope.
24th August 2011	SEPA	Meeting	Project update.
30th August 2011	SEPA	Submission of draft ES sections	Copy of draft Geology, Hydrogeology & Hydrology and Terrestrial Habitats ES sections provided for comment.
12th September 2011	SEPA	Letter	Comments received on draft Geology, Hydrogeology & Hydrology and Terrestrial Habitats ES sections.
14th September 2011	The Highland Council	Meeting	Planning pre application meeting. Presentation on overall Project and results of EIA studies to date.
31st September 2011	Marine Scotland, The Highland Council, statutory consultees and non statutory consultees	Receipt of EIA Scoping Opinion	Receipt of response to EIA Scoping Report and other comments from non statutory consultees.
10th October 2011	The Highland Council	Receipt of pre application advice	Receipt of pre application advice from The Highland Council.
6th – 7th December 2011	Local stakeholders	Public Event – pre application consultation	Public event to communicate the findings of the EIA to local stakeholders.

Table 17.2: Consultation undertaken in relation to geology, hydrogeology ad hydrology

Name of organisation	Key concerns	Response	ES section within which the specific issue is addressed
The Highland Council	Provided private water supply information for the study area. No formal consultation response received to date.	None required.	Section 17.5 Baseline description
Marine Scotland	Developers are advised to consult with SEPA at an early stage. SEPA's Pollution Prevention Guidelines should be used in ES preparation and during Project development. Prevention and clean-up measures for all stages of the development should be considered. Impacts on the water environment such as increase in sediment load, pollution incidents, watercourse obstruction and drainage issues should all be considered. The ES should identify the locations of, and protective/mitigation measures relating to, all private water supplies within affected catchments. Developers should be aware of CIRIA guidance on control of water pollution and environmental good practice.	Consultations with SEPA were undertaken. All applicable PPGs were consulted and are referenced. Prevention and mitigation measures have been identified. Full assessment has been made in the EIA. Private water supply locations were identified. None lie within affected catchments. Relevant CIRIA guidance documents were consulted and are referenced.	Table 17.2 Consultation Section 17.3 Legislative Framework and Regulatory Context Section 17.5 Baseline Description Sections 17.6.1, 17.7.1 and 17.8.1 Pollution, Sections 17.6, 17.7 and 17.8 Impact Assessment sections
Scottish Environment Protection Agency	ES should identify if the impacts are likely to lead to deterioration of, or provide opportunities to improve, the water environment. Onshore components should be designed where possible to avoid engineering activities in the water environment. Watercourse crossings that do not affect the bed and banks of watercourses are preferred and culverting is not encouraged. Onshore elements of the Project should be assessed for flood risk from all sources. If water abstraction is proposed, details should be provided in the ES. If borrow pits are required, details should be contained in the ES. The ES should systematically identify all aspects of site work that might impact upon the environment and potential pollution risks, and should identify the principles of preventive measures and mitigation. Works should be planned to avoid construction and other potentially polluting activities during periods of high rainfall. Potential impacts on Groundwater Dependent Terrestrial Ecosystems should be assessed.	Full assessment has been made in the EIA. All onshore infrastructure has been sited well away from watercourses as far as possible. No permanent watercourse crossings are proposed. Flood risk has been considered. Water abstraction is not proposed. No borrow pits are required. Full assessment has been made in the EIA. This has been identified as a key control measure and is considered to be good construction practice. Full assessment has been made in the EIA, following discussion with SEPA about the GWDTEs present on site.	Section 17.5 Baseline Description Sections 17.6, 17.7 and 17.8 Impact Assessment
Scottish Water	Provided information on public water supply infrastructure for the study area. No formal consultation response received to date.	None required.	Section 17.5 Baseline Description
Scottish Natural Heritage	Coastal geomorphology should be considered when identifying directional drilling, cable routes and land-based infrastructure. It is recommended that potential decommissioning impacts are assessed in the ES. Potential impacts on designated areas should be considered in the ES. SEPA should be contacted for advice on hydrological and hydrogeological aspects.	Coastal geomorphology has been included as a receptor in the assessment. Decommissioning has been included in the assessment. Full assessment has been included in the EIA. SEPA has been consulted at various stages of the Project for discussion and advice.	Section 17.5 Baseline Description, Sections 17.6, 17.7 and 17.8 Impact Assessment Table 17.6 Designations, Table 17.2 Consultation

Table 17.3: Scoping comments relevant to geology, hydrogeology and hydrology

17.4.2 Desk based study

17.15 The desk based study involved:

- Identification of hydrological catchments, watercourses, springs and boreholes within the study area;
- Estimation of low and peak stream flows;
- Collation of data on public and private abstractions;

- Collation of historical hydrological and flooding information for the immediate area and the main downstream watercourses; and
- Collation of geological and hydrogeological information, including information on offshore geology.

17.16 Data was collated from the following sources:

- Ordnance Survey Landranger 12 (Thurso & Wick; John o' Groats), 1:50,000 scale;
- Ordnance Survey Explorer 451 (Thurso & John o' Groats; Dunnet Head), 1:25,000 scale;
- Ordnance Survey digital raster mapping, 1:50,000 scale and OS OpenData;
- Ordnance Survey digital vector mapping, 1:10,000 scale;
- British Geological Survey DiGMapGB-50 digital geological mapping: Bedrock, superficial and linear geology, 1:50,000 scale;
- British Geological Survey hydrogeological map of Scotland, 1:625,000 scale;
- SNIFFER map of vulnerability of groundwater in the uppermost aquifer, Scotland, 2004;
- Macaulay Land Use Research Institute, Soil Survey of Scotland Sheet 3 soil types and land capability for agriculture, 1:250,000 scale;
- Centre for Ecology & Hydrology flood estimation handbook CD-ROM v3;
- ISIS hydrological software; and
- Wallingford HydroSolutions LowFlows 2 software.

17.4.3 Field survey

17.17 A site visit was undertaken on 19th and 20th July 2011. The visit focused on gaining a good overall understanding of the hydrological and geological regime of the area.

17.18 The site visit consisted of a walkover survey covering all identified potential infrastructure options. The main surface waters were described and assessed visually in the area of all potential crossing locations and additional minor watercourses and site drainage noted as appropriate. Bedrock exposures were assessed where visible, with particular focus along the coastline sections. Sample peat probing was carried out in areas identified as having peat deposits, to inform routing decisions and to give an indication of existing ground conditions.

17.4.4 Significance criteria

17.19 The significance criteria used in this section are based on the methodology described in Section 8. Each assessment section is, however, required to develop its own criteria for the 'sensitivity of receptor' and 'magnitude of impact' aspects since the definition of these will vary between different topics. For geology, hydrogeology and hydrology, the sensitivity of the receptor and magnitude of impact are defined in Table 17.4 and Table 17.5 respectively.

17.20 The consequences of impacts are then considered by reference to the relevant criteria in the EIA Regulations. The significance of impacts in relation to the EIA Regulations is defined in Section 8, Table 8.2.

Sensitivity of receptor	Definition
Very High	The receptor has very little ability to absorb change without fundamentally altering its present character, is of very high environmental value or of international importance.
High	The receptor has little ability to absorb change without significantly altering its present character, is of high environmental value or of national importance.
Medium	The receptor has moderate capacity to absorb change without significantly altering its present character, is of moderate environmental value or of regional importance.
Low	The receptor is tolerant of change with only minor detriment to its present character, is of low environmental value or of local importance.
Negligible	The receptor is tolerant of change without perceptible detriment to its present character or is of negligible environmental value.

Table 17.4: Definitions for sensitivity of receptor

17.21 The magnitude of the various impacts are evaluated taking into account the scale or size of the change, the duration, frequency and likelihood of the impact. Typical criteria used in determining the magnitude of the impacts are shown in Table 17.5.

Magnitude of impact	Definition
Severe	▪ Very high risk of pollution/sediment release during construction, operation or decommissioning, substantial long-term or permanent change in water quality resulting in a permanent reduction in WFD status. ▪ Widespread major change in geomorphological conditions i.e. major change in sediment deposition or erosion patterns, major reduction in morphological diversity, major interruption to fluvial processes such as channel platform evolution, all with major consequences for ecological quality. ▪ Widespread permanent alteration to groundwater level and/or flow pathways with consequent permanent effects on groundwater dependent habitats. ▪ Widespread damage to designated geological sites.
Major	▪ High risk of pollution/sediment release during construction, operation or decommissioning, substantial temporary or long-term change in water quality resulting in a temporary but long-term change in WFD status. ▪ Major change in geomorphological conditions i.e. major change in sediment deposition or erosion patterns, major reduction in morphological diversity, major interruption to fluvial processes such as channel platform evolution, all with major consequences for ecological quality but localised to one section of the watercourse. ▪ Widespread long-term alteration to groundwater level and/or flow pathways with consequent long-term but reversible effects on groundwater dependent habitats. ▪ Widespread change to qualifying interest in designated geological sites.
Moderate	▪ Moderate risk of pollution/sediment release during construction, operation or decommissioning, moderate temporary change in water quality resulting in a temporary reduction in WFD status. ▪ Moderate change in geomorphological conditions i.e. moderate change in sediment deposition or erosion patterns, moderate reduction in morphological diversity, moderate interruption to fluvial processes such as channel platform evolution, all with moderate consequences for ecological quality. ▪ Localised long-term or widespread temporary alteration to groundwater level and/or flow pathways with consequent temporary effects on groundwater dependent habitats. ▪ Localised damage to qualifying interest in designated geological sites.
Minor	▪ Minor risk of pollution/sediment release during construction, operation or decommissioning, relatively minor temporary change in water quality resulting in a temporary, but measurable, reduction in WFD status. ▪ Minor change in geomorphological conditions i.e. minor change in sediment deposition or erosion patterns, minor reduction in morphological diversity, minor interruption to fluvial processes such as channel platform evolution, all with minor and localised consequences for ecological quality.

	▪ Localised temporary alteration to groundwater level and/or flow pathways with consequent temporary effects on groundwater dependent habitats. ▪ Localised damage to geological features of local importance but non-designated.
Negligible	▪ Negligible risk of pollution/sediment release during construction, operation or decommissioning, negligible or minor transient change in water quality with no discernible effect on watercourse ecology or WFD status. ▪ Negligible change in geomorphological conditions i.e. no discernible change in sediment patterns or fluvial processes, negligible change in morphological diversity. Any changes are likely to be highly localised. ▪ There would be no perceptible changes to the groundwater flow or levels, no perceptible changes to groundwater dependent terrestrial ecosystems. ▪ Impacts on geology highly localised.
Positive	▪ An enhancement of the availability or quality of a resource.

Table 17.5: Definitions for magnitude of impact

17.4.5 Data gaps and uncertainties

17.22 The fieldwork followed standard 'reconnaissance level' field methods in which watercourses were visited close to planned development work, bedrock exposures were assessed where visible and sample peat probing was undertaken in locations identified as likely to include peat deposits. The information gathered was then extrapolated for areas where such data were not available, including areas where access was restricted or visibility poor. This extrapolation was informed by other visible characteristics such as vegetation type and landform, use of available satellite imagery and also by professional judgment.

17.23 The Project area is located on the coast, set back from the shore area. Bedrock exposure is extensive along parts of the shore, although in some areas is obscured by beach deposits, high watermarks and intertidal vegetation. Additional bedrock was visible occasionally in burn channels. The area further inland has no bedrock exposure.

17.24 Field surveys were undertaken on 19th and 20th July 2011. Flows observed may not have represented peak flows, although an indication of high flows could be interpreted from channel morphology and debris abandoned by previous high flow levels.

17.25 Private water supply information was provided by The Highland Council. It is recognised that council information may be incomplete and that supplies serving abandoned properties and for the purposes of livestock welfare may not have been identified.

17.5 Baseline Description

17.5.1 Context

17.26 The site of the Project is within the Inner Sound of the Pentland Firth, with the associated onshore infrastructure situated on the coastal section of Caithness immediately south of the offshore area. Details are provided in Figure 5.2.

17.27 The onshore infrastructure is proposed to lie within a section extending to a maximum of 4km inland from the coast. The area is dominated by agricultural land, mainly grazing land with some arable land, areas of rough moorland and commercial forestry. Most of the watercourses in the area are small and many have been extensively modified for drainage purposes.

17.5.2 Designations

17.28 Sites designated for geological, geomorphological, hydrogeological or hydrological reasons that lie within 5km of the study area have been identified and considered within the assessment. One designated site lies partly within the study area. A number of additional designated sites lie within 5km of the study area (SNH, 2011). The 5km study area buffer ensures that all designated sites that may be affected by the development are included for consideration, as hydrological effects in particular have the ability to travel considerable distances. Details of the identified sites with statutory and non-statutory designations are provided in Table 17.6. These include Sites of Special Scientific Interest (SSSIs), Special Areas of Conservation (SACs), Special Protection Areas (SPAs), Ramsar sites and Geological Conservation Review (GCR) sites.

Site name	Designation	Category	Distance & direction	Linkage
Stroupster Peatlands; Caithness & Sutherland Peatlands	SSSI, SAC, SPA	Blanket bog, oligotrophic loch, depressions on peat substrates, wet heathland, quaking bog, otter, acid peat-stained lochs, clear-water lochs, marsh saxifrage, aggregations of breeding birds.	Partly within study area, extending south	None, site lies up-catchment of project.
Phillips Mains Mire	SSSI	Blanket bog.	0.2km, south	None, site lies up-catchment of project.
North Caithness Cliffs	SPA	Aggregations of breeding birds.	0.6km, north 1.2km, east	None, site not cited for hydrological features.
John o' Groats	SSSI, GCR[i]	Palaeontology.	1.0km, east	Site lies along coast from proposed Project work.
Loch of Mey; Caithness Lochs	SSSI, Ramsar site, SPA	Aggregations of breeding and non-breeding birds, transition grassland.	1.9km, west	Site lies downstream of proposed Project work.
Duncansby to Skirza Head	GCR	Coastal geomorphology.	2.9km, east	Site lies along coast from proposed Project work.
Stroma	SSSI	Aggregations of breeding birds.	3.1km, north	None, site not cited for hydrological features.
Duncansby Head	SSSI	Aggregations of breeding birds, coastal geomorphology, maritime cliff.	3.2km, east	Site lies along coast from proposed Project work.
Loch Heilen	SSSI	Aggregations of non-breeding birds, mesotrophic loch.	4.1km, south-west	None, site lies within an unaffected catchment area.
Dunnet Links	SSSI	Coastal geomorphology, sand dunes.	4.6km, south-west	None, site is protected by intervening coastline from any changes to coastal processes.

Note:
[i]GCR: Geological Conservation Review site, a non-statutory designation for geological and geomorphological sites of national or international importance for earth science conservation (JNCC, 2011).

Table 17.6: Designated sites within 5km of the study area

17.5.3 Climate

17.29 The Meteorological (Met.) Office regional climate information (Met. Office, 2011) locates the Project within the Northern Scotland regional climatic area. Whilst much of Northern Scotland is exposed to rain-bearing westerly winds originating from the Atlantic Ocean, the study area which lies on the north coast is relatively sheltered from prevailing winds by the intervening landmass of the Northern Highlands. It is,

however, exposed to heavy seas from the North Atlantic and North Sea. Rainfall across Northern Scotland varies from over 4000mm near Fort William to less than 700mm along the Moray Firth coast.

17.30 The standard annual average rainfall (SAAR) for the site has been estimated from the Flood Estimation Handbook (FEH) CD-ROM as varying from 868mm to 894mm.

17.31 There is one weather monitoring station in the area near the site with a reliable dataset covering more than one year. This is located near Scrabster, at NGR ND 0931 7063, and is approximately 28 km west of the site. The station has been in operation since October 2007 (Weather Underground, 2011). Daily rainfall data have been collated to give monthly totals, with calculated averages where more than one year's data are available. The data are shown graphically in Figure 17.1.

17.32 As the station has been in operation for a relatively short time with occasional missed readings, there is the possibility that the data could be skewed by missing records or unusual rainfall patterns in one or more months. To overcome this problem, long-term historical data from the Met. Office monitoring station at Wick Airport, at NGR ND 3650 5220, has been included in Figure 17.1 for comparison. The Wick Airport station lies approximately 32km to the south-east of the site and has been in operation since 1914.

17.33 Both Scrabster and Wick Airport monitoring stations lie near sea level, with Scrabster at 73m AOD (above Ordnance Datum) and Wick Airport at 36m AOD. The annual average rainfall for the Wick station is 783mm. The Scrabster station reported a total annual rainfall of 783mm for 2008 and 779mm for 2010. The study area is located at a similar elevation to the monitoring stations and is expected to experience similar rainfall values to those shown in Figure 17.1.

17.34 The UK Climate Projections Report (UKCP, 2009) probabilistic projections of climate change would suggest that Northern Scotland will experience slightly increased temperatures in both summer and winter. This may result in a reduction in summer precipitation and an increase during winter. If climate change leads to drier summers, low flows and water shortages may occur in prolonged periods of dry weather. Increase in winter precipitation could increase the risk and extent of flooding.

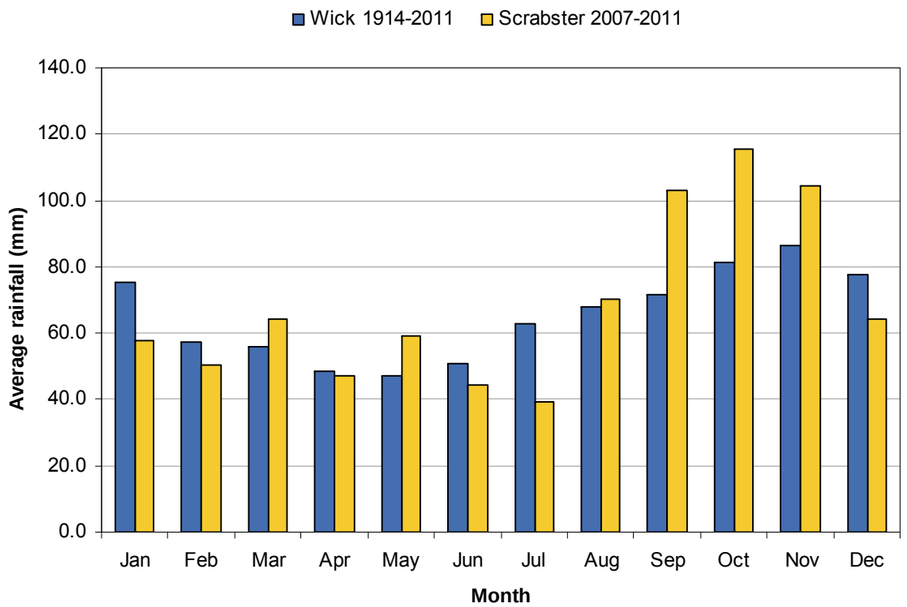

Figure 17.1: Monthly rainfall data for Scrabster and Wick monitoring stations

17.5.4 Geomorphology

17.35 The onshore infrastructure is proposed to occupy an area of agricultural and rough grazing land situated between the coastline and a maximum distance of 4km inland.

17.36 Much of the coastal section is marked by cliff exposures, typically 5 to 10m high, with a wave-cut platform of nearly flat-lying slabs exposed in the littoral zone at the cliff foot. The cliff sections are usually vertical to sub-vertical, with a sloping vegetated bank section at the top, and include good exposure of the local bedrock (Figure 17.2a).

17.37 In areas where cliff exposures are absent, the back wall of the beach is formed by a usually steep, vegetated bank of between 2 and 15m in height. These areas tend to have more beach development, composed largely of cobbles and boulders up to 2m in length. Storm beach development is present in some areas, marked by a steep shore profile of large blocky boulders; a particularly good example is present at Ness of Quoys (Figure 17.2b).

17.38 Inland, the topography is smooth and rolling, sloping gently down towards the coast. Slopes are generally shallow, rising to broad and indistinct hills a short distance inland. The site is cut by a series of watercourses, mainly marked by shallow and indistinct valleys. Some watercourses have more pronounced channels and two, the East and West Burns of Gills, are notable for their deeply incised character in the lower reaches. Most site watercourses have been heavily modified for land drainage.

Figure 17.2: Coastal geomorphology. (a) Cliff section and wave-cut platform, Ness of Huna, view north-west from NGR ND 3767 7155; (b) Storm beach, Ness of Quoys, view east from NGR ND 3458 7335

17.5.5 Onshore geology

17.39 Geological information is summarised from Johnstone & Mykura (1989), Trewin (2002) and BGS (2011a) with reference to information gathered on site.

17.40 The Project area underlain by rocks belonging to the Caithness Flagstone and Eday Groups of the Middle Old Red Sandstone, which are Devonian in age. The Caithness Flagstones (including the Spittal, Mey and Upper Stromness Flagstone Formations), which underlie the majority of the site including Stroma, consist of cycles of laminated, carbonate-rich siltstones and shales with subordinate fine-grained thinly bedded sandstones. These cycles are generally 5 to 10m thick but cycles up to 60m in thickness have been recorded in some locations. The younger Eday Group (including the John o' Groats Sandstone), a dominantly fluvial sequence consisting of medium-grained red sandstones with pebbly lenses, occurs in the area from John o' Groats southwards and in the coastal section around Gills Bay.

17.41 Northern Scotland has been significantly affected by major faultlines, such as the Great Glen Fault. However, the faults in the study area are minor in comparison. These faults traverse the site with either a

north-west to south-east or east-north-east to west-south-west orientation, bringing the younger John o' Groats Sandstone (Eday Group) into contact with the older Mey Flagstone (Caithness Flagstone Group).

17.42 Superficial geology within the area is dominated by glacial till and peat. The glacial till forms a blanket across approximately half of the site with peat covering the remaining portion. Ground investigation undertaken in the area identified that the glacial till typically includes an overlying layer of weathered till (e.g. Ian Farmer Associates, 2007). The weathered till is described as a brown sandy to gravelly clay, including some cobbles and occasional bands of silt, sand and gravel, with a soft to firm texture. The underlying till is described as a grey sandy to gravelly clay with occasional cobbles with a very stiff texture. Along the coastal sections the till is visible forming the steep banks that mark the backwall of the beach area and in some areas is also visible forming a cap at the top of cliff sections (Figure 17.2a).

17.43 Minor hummocky moraine deposits are present in the area around Phillips Mains. Alluvial deposits with minor river terrace deposits are present alongside the Burn of Rattar in the western part of the site. Marine beach deposits can be found along much of the coastal section and blown sand is present at the Ness of Duncansby.

17.44 Maps of the bedrock and superficial geology are provided in Figure 17.3 and Figure 17.4 respectively.

17.5.6 Offshore geology

17.45 The Middle Old Red Sandstone, which dominates the Caithness onshore area, continues offshore under Inner Sound and onto the Island of Stroma. The strata around Gills Bay and Stroma dip variably between 3° and 40°, owing to folding in the area, with dip directions generally to the east or west. The significant dip variations recorded may be due to faulting (RPS Energy, 2009). To the west of Stroma, dykes have intruded the sandstones with orientations of east and east-north-east. It has been suggested that these dykes may also occur within Inner Sound (RPS Energy, 2009).

17.46 The high velocity tidal currents within the sound have scoured the Quaternary deposits and seabed soils from the study area. In consequence, seabed sediments are largely restricted to cobble and boulder grade sediments, which are too heavy to transport far, including glacial erratics (RPS Energy, 2009).

17.47 BGS (1990) indicates that the sea floor between Helmsdale (NGR ND 0250 1550) and Dunnet Head (NGR ND 2010 7730) slopes away from the coast to a depth of approximately 60m in a distance between 5km and 10km. Within the study area RPS Energy (2009) indicates that the seabed depth ranges from 30m to 40m with a shallower slope angle on the Caithness shore than the Stroma shore. Depths greater than 30m are found within 500m of the Stroma shoreline.

17.48 Marine Scotland collected a number of video transects and still images within the Inner Sound in 2009 and 2010. Analysis of the footage indicates that the seabed in the northern part of the Sound is heterogeneous, composed mainly of shell gravel and including small outcrops of scour-polished rock. In contrast, the more southerly transects show a complex, uneven and fissured bedrock seafloor with boulders present in gullys and low areas. The fissures include occasional pockets of sediment.

17.49 iXSurvey (2009) reported that the seabed is largely formed from current-scoured bedrock demonstrating a 'saw tooth' profile. This is considered to form from differential erosion of the different rock types present within the Old Red Sandstone bedrock. Some parts of the offshore study area were mapped as subrock, where rock is at or near the seabed surface. These sections were concentrated mainly to the south and south-west of Stroma, providing additional confirmation to the Marine Scotland data. The remaining areas were characterised by megarippled sand, sandbanks and areas of coarse gravel. Further details of the Marine Scotland surveys and iXSurvey are included in Section 9.

17.50 Sediment samples were collected within the MeyGen Agreement for Lease (AfL) area (ASML, 2011). Analysis of the samples indicated that the loose seabed sediment is dominated by very coarse sand or very fine gravel consisting entirely of carbonate shell fragments. The bedload (particles transported along the seabed by water movement) consists almost entirely of very fine sand and finer, with a near absence of silt and clay material. Details of the sediment analyses are included in Section 10.

17.5.7 Soils

17.51 The following information is summarised from Macaulay Land Use Research Institute mapping (MLURI, 1981a) with reference to MLURI (1982, 2011) and information gathered on site.

17.52 The distribution of soils within the study area is dependent on the geology, topography and drainage regime of the area. The site soils consist of various soil units belonging to the Canisbay and Thurso soil associations, derived largely from the flagstones and sandstones of Middle Old Red Sandstone age. In addition, there are Organic Soils, derived from organic materials, and Alluvial Soils, derived from alluvial materials. The main soil types within the study area are:

- **Blanket peat**: accumulations of partly or completely decomposed organic material that have remained wet to the surface; typically dominated by *Sphagnum* mosses. Organic soils have greater than 60% organic matter and are considered to be 'deep' if the deposits are more than 1m thick;
- **Gleys**: naturally poorly drained soils that develop under conditions of intermittent or permanent waterlogging. Soils are typically greyish or blue-grey with orange mottling. **Peaty gleys** have a peat-rich surface horizon; **noncalcareous gleys** have a low lime content;
- **Brown forest soils**: fertile, usually free draining, often deep soils that are favoured for agriculture. Soils typically have a good crumb structure, mild acidity and are brown in colour, becoming gradually lighter as organic content decreases with depth. They are characteristic of areas originally covered with deciduous woodland, mostly now cleared for agriculture;
- **Rankers**: thin, immature soils usually with bedrock occurring between 10 and 30cm below land surface. Soils generally lack a subsoil horizon and predominate in mountain or hilly terrain, on steep slopes in association with rock outcrops or on glacially eroded rocky terrain. **Brown rankers** are fertile and free draining like brown forest soils; and
- **Alluvial soils**: derived from alluvial material, these soils have a very variable morphology, texture and drainage depending on the age and characteristics of the parent material. They are typically confined to principal river valleys and stream channels.

17.53 Four soil units are found within the environs of the study area and are summarised in order of dominance in Table 17.7. Each soil unit consists of varying proportions of the soil types discussed above, with the proportion of each soil type within a soil unit dictated by the local climatic, topographical and drainage conditions.

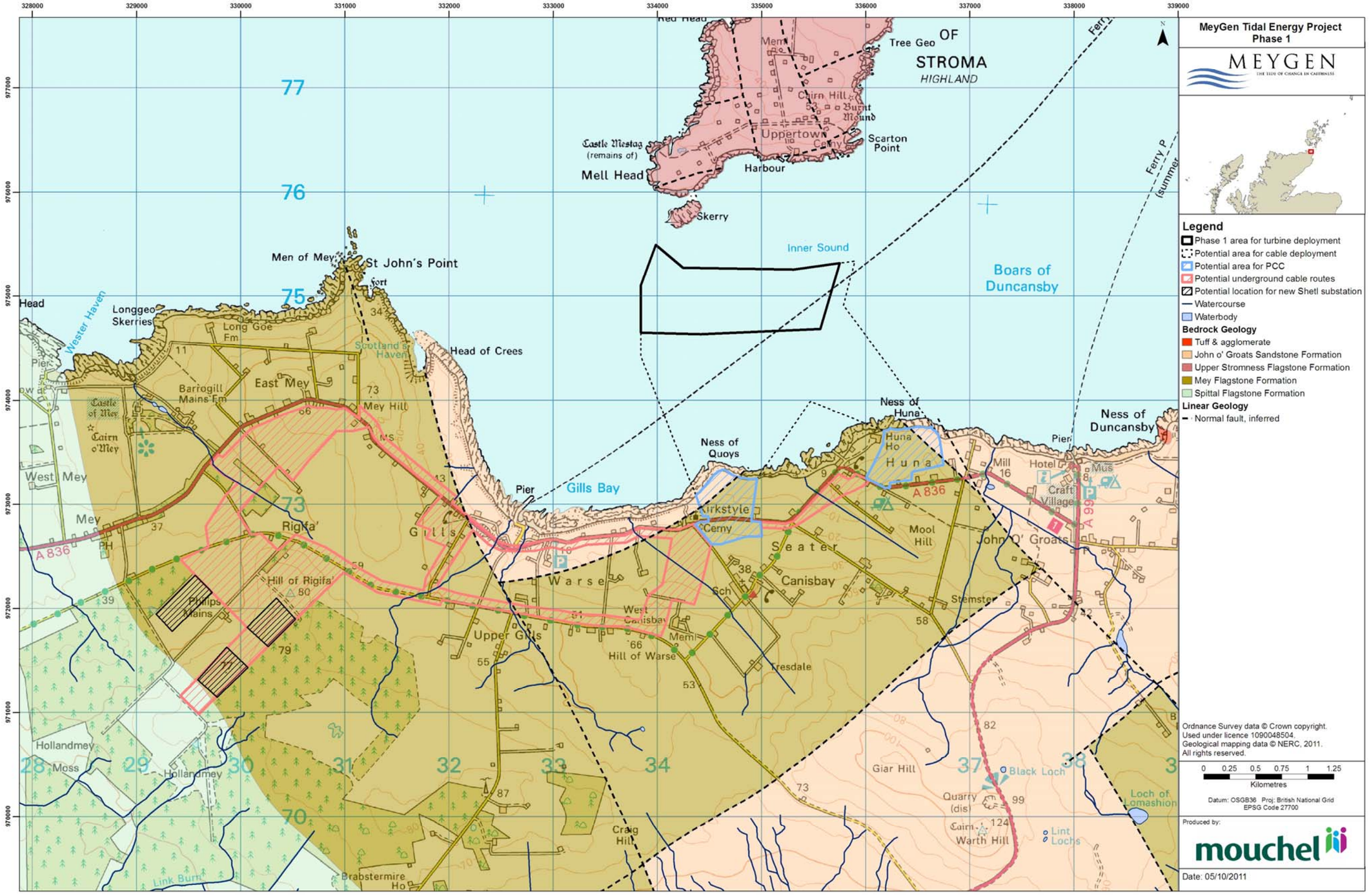

Figure 17.3: Onshore bedrock geology mapping

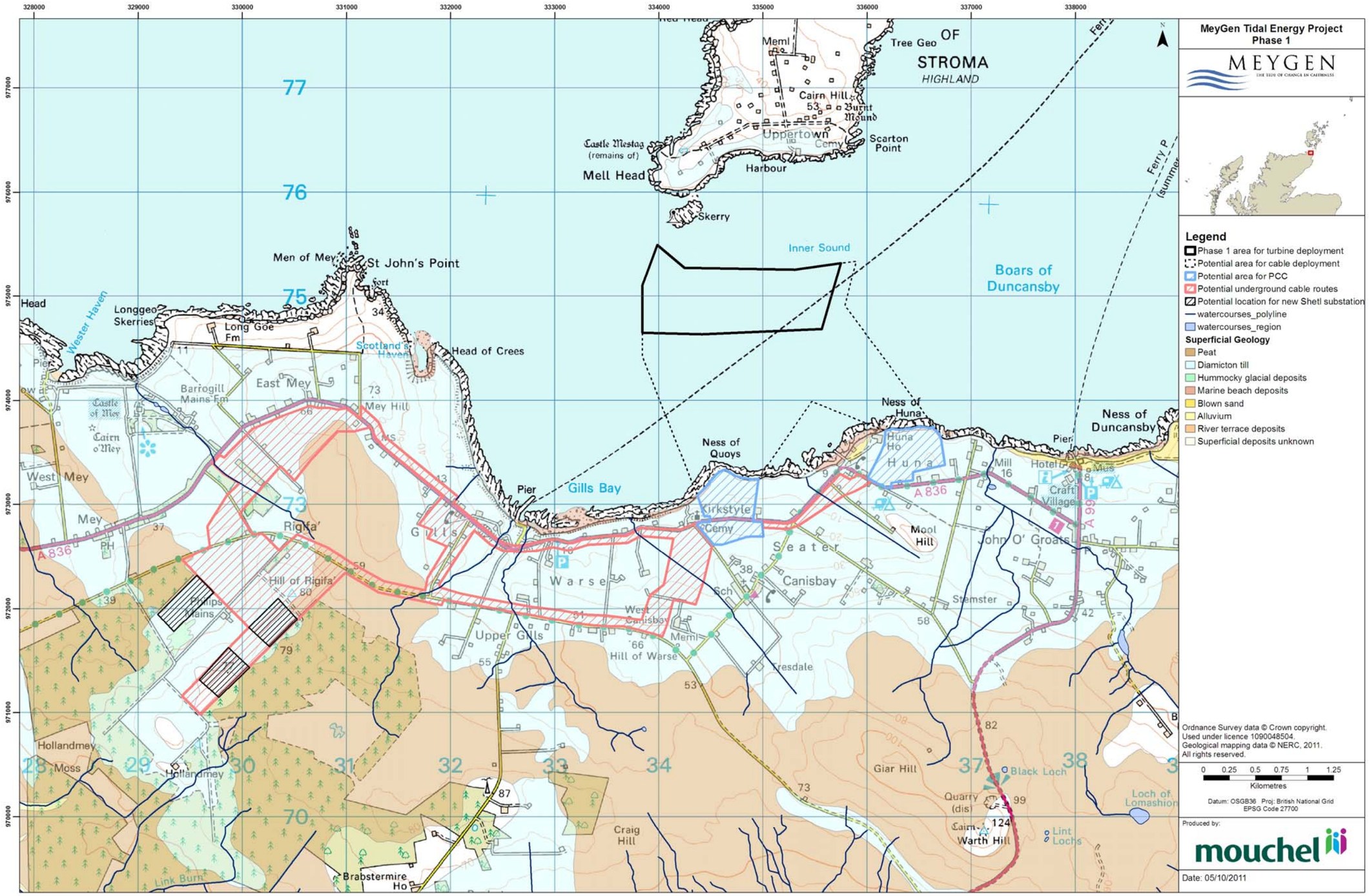

Figure 17.4: Onshore superficial geology mapping

Soil unit	Soil association	Parent materials	Component soils	Landforms	Vegetation
4	Organic Soils	Organic deposits.	Blanket peat (d - deep).	Uplands and northern lowlands with gentle and strong slopes.	Blanket and northern blanket bog; upland and flying bent bog; deer-grass bog; sedge mires.
79	Canisbay	Reddish brown drifts derived from Middle Old Red Sandstone sandstones and flagstones.	Noncalcareous gleys, peaty gleys.	Undulating lowlands with gentle slopes.	Arable and permanent pastures; rush pastures and sedge mires.
537	Thurso	Greyish brown drifts derived from Middle Old Red Sandstone flagstones and sandstones.	Noncalcareous gleys; some peaty gleys, brown forest soils and brown rankers.	Undulating lowlands with gentle slopes.	Arable and permanent pastures; rush pastures and sedge mires; acid bent-fescue grassland.
1	Alluvial Soils	Recent riverine and lacustrine alluvial deposits.	Alluvial soils.	Flood plains, river terraces and former lake beds.	Arable and permanent pastures; white bent grassland; swamp rush pastures and sedge mires.

Table 17.7: Soil units with associated landforms and vegetation land capability for agriculture

17.54 The following information is summarised from MLURI (1981b) with reference to information gathered on site.

17.55 The site is classified largely as land capable of use only as rough grazing. The vegetation is dominated by plant communities with low grazing values, particularly heather moor, bog heather moor and blanket bog (land capability class 6_3). Located mainly to the south of Upper Gills and round to Mey Hill, this land is used mainly for low density rough grazing.

17.56 The coastal section is mainly classified as land capable of producing a narrow range of crops (land capability class 4_2), primarily grassland with some limited potential for other crops. Grass yields can be high and some forage cropping is possible, with occasional cereal crops. This land is used mainly as improved or semi-improved grassland for stock grazing, with hay or silage crops taken from some fields. Arable crops are uncommon but are grown in some areas.

17.57 The western part of the site, around Mey, is situated on land capable of producing a moderate range of crops (land capability class 3_2), with high yields of barley, oats and grass often obtained. Other crops are usually limited to potatoes and forage crops. This area includes some areas of cereal crop, including wheat and oats.

17.58 A small area near the south-west corner of the site is classed as land capable of use as improved grassland (land capability class 5_2). Some parts of the site, around Phillips Mains, have been planted with commercial forestry.

17.5.8 Hydrogeology

17.59 Hydrogeological information is summarised from BGS (1988, 2011a) with reference to SNIFFER (2004a) and information gathered on site.

17.60 The Project site is underlain by the Middle Old Red Sandstone, which is classified as a locally important aquifer in which flow through the bedding planes and joints makes an important contribution to groundwater transport (Robins, 1990). Groundwater flow is generally limited to the upper weathered portion of the flagstones and is largely restricted to cracks and open joints. The bedrock generally consists of fine- to medium-grained sandstones with subordinate siltstones, mudstones and conglomerates. Borehole yields are typically low, usually less than 1 ls^{-1} in the Caithness area. Groundwater infiltration in this part of the study area, based on geology, topography and baseflow data, is estimated to be between 100 and 300$mmyr^{-1}$. The presence of faults within the area may influence groundwater flow and productivity, depending on the nature of the fault planes.

17.61 The glacial till is highly variable in composition and may contain lenses of sand and gravel which can support perched water tables. These are likely to be discontinuous and limited in extent and as such can have limited groundwater potential. The variable composition of the till indicates that it may act as a confining layer to the underlying Middle Old Red Sandstone in some areas and the presence of springs in some parts of Caithness supports this.

17.62 Peat deposits within the study area are discontinuous and occur mainly in the southern part of the study area. Most peat encountered was shallow, typically less than 0.7m in thickness and often dry in character. An area with peat generally deeper than 1m was encountered along the north-east slopes of the Hill of Rigifa'. The discontinuous and generally thin nature of the peat indicates it is unlikely to contribute substantially to groundwater potential. Watercourse catchments with peatland deposits may benefit from lateral seepage through the peat, contributing to baseflow in these areas. Peat deposits are unlikely to provide much additional storage for rainfall as the water table is typically close to or at the surface for much of the year.

17.63 The groundwater in this area has been assigned Class 4c with some areas of Class 4d (vulnerable to pollutants not readily adsorbed or transformed) (SNIFFER, 2004a, b) where peat is present. This reflects the dominantly fracture flow of groundwater within the bedrock, the low productivity which indicates low flow rates, and the variable composition and thickness of the overlying glacial tills. These factors mean that any contaminant would have limited opportunity to be removed or modified before reaching the groundwater. In the areas with significant peat thickness, the peat would act as a barrier to the entry of contaminants into the groundwater, although it would also serve to restrict access of water into the bedrock for dilution purposes.

17.64 Ground investigation results from the surrounding area indicate that water strikes occur variably between 1 and 8m below ground level although some boreholes and trial pits recorded no water strike (BGS, 2011b). Boreholes near the shoreline sometimes demonstrate a tidal influence (Iain Farmer Associates, 2007)

Groundwater dependent terrestrial ecosystems

17.65 Some habitat types identified on or near the potential onshore development areas fall under the description of groundwater dependent terrestrial ecosystems (GWDTE) as identified by SEPA (2010).

17.66 Two areas of potential GWDTE were identified within or near the site:

- Stroupster Peatlands SSSI/Caithness & Sutherland Peatlands SAC and Ramsar site, which includes groundwater dependent habitats within its citation, and
- A small area of habitat E1.7, wet modified bog, is located east of the Hill of Rigifa' along the margin of, and partially within, one of the cable route options. This is shown in Figure 18.3 (Section 18)

17.67 The Stroupster Peatlands SSSI/Caithness & Sutherland Peatlands SAC designated site lies approximately 230m from the nearest proposed infrastructure corridor. The area identified as habitat E1.7 lies immediately adjacent to, and partly within, the proposed infrastructure corridor.

17.5.9 Hydrology

17.68 The hydrology of the Project site has been considered using a surface water catchment-based system. It is recognised that Project activities may influence watercourses and locations beyond the proposed infrastructure area, therefore the baseline description includes areas downstream of any proposed activity.

17.69 The study area is drained by a number of small watercourses rising within the higher land situated to the south of the site. These watercourses mainly follow natural channels although it is apparent from their outline and from field observations that they have been modified by widening, deepening or straightening in order to improve land drainage (Figure 17.5a).

17.70 In addition to the natural watercourses, a large number of artificial drainage channels are present within the area principally for either land or roadside drainage. Land or field drains largely follow field

boundaries. Road drainage is typically located along both sides of public roads and links into the land drainage or natural watercourse network. Some of the observed artificial drains carry water regularly whereas others remain dry for much of the time (Figure 17.5b). Evidence was found on site of buried field drainage; this is likely to be extensive across the agricultural sections of the study area. Constructed drainage channels frequently cross catchment boundaries and may, in consequence, conduct water into or out of the natural catchments. Watercourse catchments are shown in Figure 17.7.

Burn of Rattar

17.71 The westernmost catchment, the Burn of Rattar or Link Burn drains the southern side of the Hill of Rigifa' before turning north to pass west of Loch of Mey. It enters the sea near Kirk o' Tang, at NGR ND 2519 7390. The catchment covers an area of 20.2km^2.

17.72 The upper part of the catchment is largely commercial forestry with the lower part mainly as agricultural land for grazing and crop production. Phillips Mains Mire SSSI lies across the watershed between the Burn of Rattar and the West Burn of Gills and forms an 'island' within forested land. The burn and its tributaries have been modified in some areas, notably in the agricultural area lower in the catchment but also associated with the forestry in the catchment headwaters, and artificial drainage within the catchment is extensive.

17.73 Very little of the potential onshore infrastructure is proposed to lie within this catchment (Figure 17.7).

Figure 17.5: Examples of modified and artificial drainage: (a) Burn of Mey, view south-east from NGR ND 3014 7310; (b) dry drainage ditch, Rigifa', view south-west from NGR ND 3059 7260

Burn of Horsegrow

17.74 Located immediately west of the Burn of Rattar, the Burn of Horsegrow forms the main inflow to the Loch of Mey. It drains the north-western side of the Hill of Rigifa' and flows generally north-west to the Loch of Mey. There is no clear outflow from the loch, although a network of drainage ditches continues north to the coastline from the loch to discharge at NGR ND 2732 7458. The catchment has an area of 7.7km^2.

17.75 As with the Burn of Rattar, the upper part of the catchment includes areas of commercial forestry although the area around Phillips Mains is largely agricultural land. The lower catchment is partly grazing and cropland and partly rough grazing, with the section around the Loch of Mey being dominated by marshy ground. The agricultural and forestry areas have been extensively drained and include a network of ditches and channels.

17.76 Two of the cable route options to potential grid connection points lie within this catchment (Figure 17.7).

Burn of Mey

17.77 Lying north-east of the Burn of Horsegrow catchment, the Burn of Mey is a small watercourse that rises in the marshy ground north of the Hill of Rigifa'. It flows north-west, past the Castle of Mey, to enter the sea at NGR ND 2893 7419. The catchment area is 3.2km^2 in size.

17.78 Although the headwaters rise in an area of peatland, this catchment is dominated by agricultural land with small areas of forestry in the upper section. In consequence, the burn and its tributaries have been straightened for much of their length.

17.79 Sections of the potential cable routes lie within the Burn of Mey catchment (Figure 17.7). .

West Burn of Gills

17.80 The West Burn of Gills flows north and east from the Hill of Rigifa', draining the northern half of Phillips Mains Mire SSSI, and meets the sea at Gills Bay at NGR ND 3259 7285. It has a catchment covering an area of 3.1km^2.

17.81 Much of the upper catchment is peat moorland with some commercial forestry around Phillips Mains Mire. In its lower reaches, the burn flows through agricultural land. In this section the burn channel becomes increasingly incised until, just inland of the coast, the burn flows through a pronounced valley approximately 10 to 15 m deep with a steep bank particularly on the eastern side (Figure 17.6a).

17.82 One potential grid connection point and sections of the potential cable routes pass through the catchment area (Figure 17.7).

East Burn of Gills

17.83 The East Burn of Gills drains the northern side of Craig Hill and the western side of Hill of Warse. The burn runs northwards to enter the sea at Gills Bay at NGR ND 3276 7278. Part of Stroupster Peatlands SSSI and the Caithness and Sutherland Peatland SAC and SPA lie within this catchment and across the watersheds into the adjacent Tresdale Burn and Burn of Freswick catchments. The East Burn of Gills catchment is 4.4km^2 in size.

17.84 The lower catchment and mid-section of the upper catchment are mainly agricultural land with extensive field drainage systems. The remainder of the upper catchment is largely rough grazing and peat moorland, some sections of which have historically been used for peat cutting. Similar to the West Burn of Gills, the burn channel is markedly incised in its lower reaches to a depth of approximately 10 to 15m with a steep bank on the eastern side (Figure 17.6b).

17.85 Parts of the potential cable routes lie within the catchment area (Figure 17.7).

Figure 17.6: Incised watercourse valleys beside the A836: (a) West Burn of Gills, view south from NGR ND 3243 7261; (b) East Burn of Gills, view south from NGR ND 3267 7255

Tresdale Burn

17.86 The Tresdale Burn flows from the lower slopes of Giar Hill, past Canisbay to Gills Bay where it discharges into the sea at NGR ND 3372 7287. A small part of the Stroupster Peatlands SSSI/Caithness and Sutherland Peatland SAC and SPA lies within the south-western corner of the catchment. The catchment covers a total area of 3.3km^2.

17.87 The southernmost part of the catchment, including the burn headwaters, is largely peat moorland and rough grazing. The lower section is agricultural land used for grazing and arable crops. The main burn channel and its tributaries have been modified for most of their length for drainage purposes.

17.88 Parts of the potential cable routes pass through the lower section of this catchment (Figure 17.7).

Burn of Huna

17.89 The Burn of Huna has the smallest catchment of all identified site watercourses, at 1.8km^2. It enters the sea between Ness of Quoys and Ness of Huna at NGR ND 3541 7326.

17.90 The majority of the catchment is occupied by agricultural land, so the Burn of Huna has been straightened and the drainage pattern modified by a network of ditches across much of the catchment. The southernmost part of the catchment is peat moorland.

17.91 Part of the proposed cable route from the potential Ness of Huna landfall / PCC location passes through the Burn of Huna catchment.

Burn of Duncansby

17.92 The Burn of Duncansby forms the easternmost catchment, entering the sea at NGR ND 3724 7354 just west of John o' Groats. The catchment area covers 8.9km^2 and the main watercourses (Burn of Duncansby and Burn of Stemster) flow generally northwards.

17.93 As with the other hydrological catchments, the lower section is agricultural in character with a network of drainage ditches and straightened watercourse channels. Most of the catchment, however, is characterised by peat moorland used for rough grazing and, in some areas, for peat cutting. A number of small lochs are present in the peatland area near the southern catchment boundary.

17.94 There is no proposed infrastructure within this catchment area.

Burn of Freswick

17.95 Lying immediately south of the study area, the Burn of Freswick or Gill Burn has the largest catchment at 26.3km^2. The dominant flow direction is eastwards as the Burn of Freswick enters the sea at Freswick Bay at NGR ND 3783 6714, with tributaries joining the main channel from the north and south.

17.96 The catchment is dominated by peat moorland. Some areas show signs of artificial drainage although much of the moorland remains in good condition. The coastal section is largely agricultural and there are blocks of commercial forestry inland.

17.97 There is no proposed infrastructure within this catchment.

17.5.10 Waterbody status

17.98 The Water Framework Directive (WFD) came into force in December 2003 and is implemented in Scotland through the *Water Environment and Water Services (Scotland) Act 2003*. A key objective of this Directive is the achievement of 'good ecological status' (as a minimum) of all natural waterbodies by 2015. This involves a move towards a risk-based classification system (SEPA, 2005). This risk-based system highlights such issues as stream morphology and existing artificial structures in addition to chemical water quality and ecological diversity. Heavily modified waterbodies, which can no longer be considered to be natural, are classified on the basis of 'ecological potential'.

17.99 Under the terms of the Water Framework Directive, all river basin districts are required to be characterised. This process requires SEPA to produce an initial assessment of the impact of all significant pressures acting on the water environment. Surface water bodies are defined as being whole or parts of rivers, canals, lochs, estuaries or coastal waters. The main purpose of identifying waterbodies is so that their status can be described accurately and compared with environmental objectives.

17.100 The WFD applies to all surface waters, but for practical purposes SEPA has defined a size threshold above which a river or loch qualifies automatically for characterisation. For lochs, the threshold is a surface area of 0.5km^2; rivers must have a catchment area of 10km^2 or more. In addition to these larger waterbodies, smaller waters have been characterised where there is justification by environmental concerns and to meet the requirements of regulatory legislation such as for drinking water supplies

17.101 Coastal water bodies have been classified based on latitude, longitude, tidal range and salinity, with additional information from mixing characteristics, substratum composition and wave exposure used to define the ecology of coastal waters.

17.102 Groundwater bodies have been identified to reflect the main aquifer types. For areas above low productivity aquifers, groundwater bodies have been defined using surface water subcatchments as a surrogate. Areas above high productivity aquifers have been defined using geological and major catchment boundaries.

17.103 Two local rivers have been classified under this system (SEPA, 2011a). In addition, the coastal section lies within one coastal waterbody and the entire onshore study area falls within one groundwater body. The classification results are presented in Table 17.8. The identified rivers are also indicated in Figure 17.8.

17.104 The Link Burn (Burn of Rattar) and Gill Burn (Burn of Freswick) are both regarded as having pass grades for chemical status and a good rating for hydromorphology. The Dunnet Head to Duncansby Head coastal waterbody is regarded has having a pass grade for chemical status and a high rating for hydromorphology. The Wick bedrock and sand and gravel aquifers waterbody is regarded as having a good rating for quality and quantity with no trend for pollutants. The current status of all waterbodies meets WFD requirements and should not be allowed to deteriorate. All site watercourses are considered to be of at least good status.

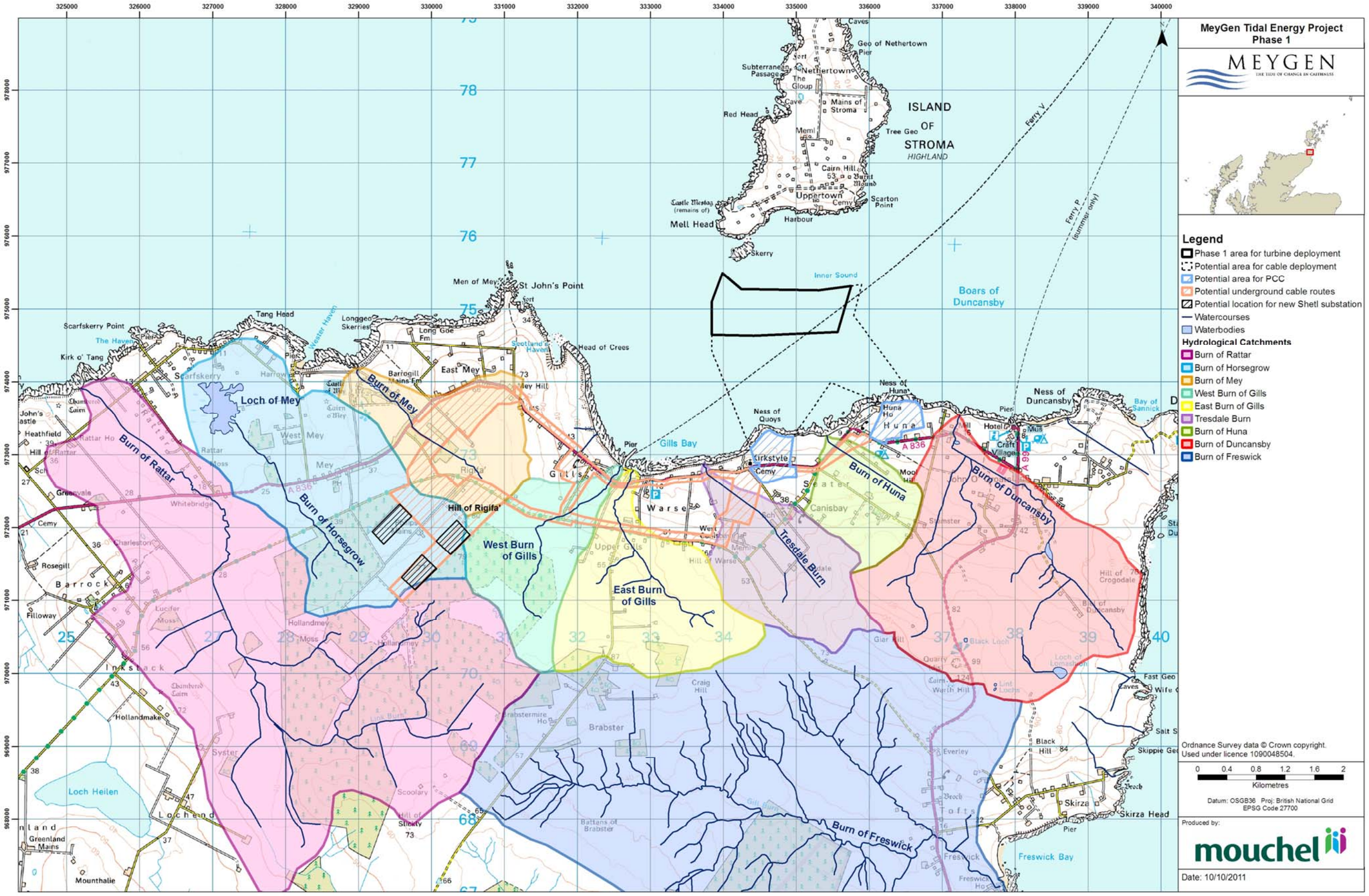

Figure 17.7: Hydrological catchment areas for site watercourses

Waterbody name	Waterbody ID	Waterbody category	Overall classification	Confidence of classification	Summary of pressures
Link Burn (Burn of Rattar)	20632	River	Good	Medium	No identified pressures
Gill Burn (Burn of Freswick)	20000	River	Good	Medium	No identified pressures
Dunnet Head to Duncansby Head	200225	Coastal	High	High	No identified pressures
Wick bedrock and localised sand and gravel aquifers	150361	Groundwater	Good	High	No identified pressures

Table 17.8: Waterbody classification and identified pressures

17.5.11 Flow levels

17.105 Peak runoff rates have been estimated for the full extent of each catchment using the Flood Estimation Handbook (CEH, 2009) catchment characteristics with the ISIS method used to derive a range of peak flow return periods (Halcrow/HR Wallingford, 2004). Low flow measurements have been determined by the Low Flow method (WHS, 2010) and are quoted as $Q_{95}(10)$. These data are shown in Table 17.9.

Catchment	Area (km^2)	Mean daily flow (m^3s^{-1})	$Q_{95}(10)$ (m^3s^{-1})	Estimated peak runoff (m^3s^{-1}) for each return period (years)						
				2	5	10	25	50	100	200
Burn of Rattar	20.2	0.31	0.03	6.11	8.36	9.79	12.1	14.1	16.0	18.5
Burn of Horsegrow	7.7	0.12	0.02	1.59	2.20	2.59	3.20	3.73	4.23	4.91
Burn of Mey	3.2	0.05	0.01	1.42	2.00	2.36	2.87	3.39	3.89	4.56
West Burn of Gills	3.1	0.05	0.01	1.38	1.94	2.28	2.79	3.29	3.75	4.38
East Burn of Gills	4.4	0.07	0.01	1.91	2.67	3.13	3.85	4.52	5.15	5.99
Tresdale Burn	3.3	0.05	0.01	1.56	2.20	2.60	3.16	3.73	4.27	5.00
Burn of Huna	1.8	0.03	0.004	1.08	1.54	1.82	2.23	2.58	3.00	3.55
Burn of Duncansby	8.9	0.13	0.02	1.57	2.18	2.55	3.15	3.68	4.19	4.88
Burn of Freswick	26.3	0.40	0.07	10.1	13.9	16.3	20.2	23.5	26.6	30.9

Table 17.9: Estimated flow statistics for local catchments

17.106 The Hydrology of Soil Types (HOST) is a hydrologically-based classification of soils on the basis of their physical properties and their effects on the storage and transmission of water (IH, 1995). It makes use of the fact that the physical properties of soils have a major influence on the hydrological response of a catchment. Other parameters can then be derived from the HOST classification. For the purposes of hydrological assessment, the Standard Percentage Runoff (SPR) and Baseflow Index (BFI) are the most useful parameters.

17.107 SPR is the average percentage of rainfall that causes the short-term increase in flow seen at a catchment outflow following a storm event (NSRI, 2008).

17.108 BFI is the long-term ratio of baseflow to total stream flow, where a baseflow represents the contribution to total flow from groundwater (SCEG, 2008). BFI values range from 0.1 in relatively impermeable clay catchments to 0.99 in highly permeable chalk catchments. A very low BFI of 0.15 represents a flashy catchment with minimal storage, low BFI values (e.g. 0.3) indicate a catchment with little storage and active runoff, a BFI of 0.7 (or greater) indicates a significant contribution to flow from a major aquifer.

17.109 For the Project area catchments, BFI-HOST values range from 0.24 to 0.29, indicating a low contribution from stored water sources, and SPR-HOST values range from 45-57%, indicating a flashy response to rainfall.

17.5.12 Flooding

17.110 SEPA provides a Scottish Flood Map (SEPA, 2011b) to give a Scotland-wide picture of the areas estimated to be at risk of flooding from rivers and/or the sea, in order to raise awareness of flood risk. The map shows the areas estimated to have a 0.5% or greater chance of flooding each year.

17.111 The map has been reviewed to establish the likelihood of river and/or coastal flooding within the potential development areas. River flooding has not been identified as a concern, with most site watercourses showing only minor flood risk confined to the immediate channel, or no flood risk. Site watercourses indicated as having minor flood risk are the Tresdale Burn, from NGR ND 3389 7264 to the sea, the East Burn of Gills, from Upper Gills (ND 3277 7173) to the sea, and the Burn of Mey, from Barrogill Mains Farm (ND 2932 7387) to the sea.

17.112 Potential flood risk within the Burn of Rattar catchment is slightly more extensive, from ND 2925 6931 to the sea and affecting small areas outwith the immediate watercourse channel. This is particularly notable around the village of Rattar and in the flat-lying area between Hollandmey and Lucifer Mosses around ND 2733 7045.

17.113 The Loch of Mey is indicated to have a flood risk affecting the adjacent low-lying marshy ground mainly to the west and south of the loch, with some flood risk potentially affecting the village of Scarfskerry between the loch and the sea.

17.114 Coastal flooding is indicated to have a limited effect along the coastal strip but is unlikely to reach further than the high water mark as identified on the OS 1:50,000 mapping. This should not affect the proposed onshore infrastructure, as this is planned to be located no less than 5m AOD and will be set back from the immediate coastline.

17.5.13 Water resources

Public water supplies

17.115 There are no Scottish Water supply sources or service reservoirs within the study area. A network of distribution mains is present throughout the study area, largely following the road network. In some areas, notably around Rigifa', Upper Gills/Warse and Canisbay, distribution mains follow cross-country routes. Pipes are variably constructed of iron, asbestos cement and plastic.

17.116 Once a final preferred route has been identified, consultation with Scottish Water to identify the location of distribution mains within the route corridor will be required to avoid inadvertent damage to the distribution network during necessary excavation work.

Private water supplies

17.117 Private water supply information has been provided by The Highland Council. There are no identified private water supply sources within the study area. Two private water supplies have been identified within 5km of the study area, one on Stroma and one at the Biel of Duncansby. As both are located within catchment areas with no proposed infrastructure they have been scoped out of any further assessment.

17.118 SEPA has noted that there are a number of properties using septic tanks present within the study area. Locations of these tanks and their associated pipework are currently unknown. It will be necessary to identify the tank locations and connecting pipe routes prior to undertaking any intrusive ground work to avoid causing damage to this infrastructure.

Figure 17.8: Surface waterbodies classified under the Water Framework Directive

17.5.14 Summary of baseline description

17.119 The proposed MeyGen Project area is located within the Inner Sound of the Pentland Firth, between Stroma and north Caithness. Associated onshore infrastructure is proposed to lie within the adjacent coastal section in the Gills Bay area. The area is dominated by agricultural land, mainly grazing and arable fields, with some areas of rough grazing and peat moorland. The littoral zone is characterised by mixed boulder and cobble beaches and wave-cut platform slabs, backed by steep cliffs or banks.

17.120 The underlying geology consists of cyclic sedimentary strata, dominated by fine- to medium-grained sandstones, siltstones and mudstones. Superficial deposits are characterised by glacial tills and peat with marine beach deposits along the coastline section. Site soils are mainly peat, peaty or noncalcareous gleys with minor contributions from other soil types.

17.121 A number of fairly small watercourses are present within or adjacent to the study area. The watercourses flow directly into the sea at various points along the north and east coast. Most watercourses have been modified for drainage purposes. Some public water supply distribution mains are present within the study area, mainly following the road network. No private water supplies were identified within the study area although two are located within 5km of the potential development areas.

17.122 One designated site lies partly within the study area. A watercourse draining part of the study area flows through the Loch of Mey SSSI and Ramsar site.

17.6 Impacts during Construction and Installation

17.123 The impact assessment is based on cable landfall at either Ness of Huna or Ness of Quoys, with a PCC located adjacent to temporary HDD site and cable landfall. The cable routes between the PCC and the grid connection point will be buried and follow one of the identified cable route corridors.

17.6.1 Impact 17.1: Pollution event

17.124 During construction activity, potential pollutants will be present in the site area. These will include fuel, lubrication oils, chemicals, unset concrete, grout and drilling fluid as well as waste and waste water from staff facilities. Any pollution incident occurring on the site may adversely affect the quality of nearby surface waters, groundwater or site soils.

Impact significance

Impact title	Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Pollution event (surface water)	High	Moderate	Major	Significant
Pollution event (groundwater)	High	Moderate	Major	Significant
Pollution event (soils)	Medium	Moderate	Moderate	Significant

MITIGATION IN RELATION TO IMPACT 17.1

- All infrastructure will be located 50m or more from surface watercourses or waterbodies where possible.
- Concrete will not be batched on site.
- Use of wet concrete near watercourses will be minimised and carefully controlled.
- Water-based lubricants and drill fluid will be used where possible and drill fluid will be recycled throughout the drilling process to minimise total volume required. Any surplus drill fluid will be disposed of as controlled waste at the end of construction.
- Waste water and sewage will be disposed of in accordance with PPG4. Where ground conditions permit, disposal to ground will be considered as the preferred option. Locations of existing private septic tanks and associated pipework will be identified prior to undertaking any ground moving activity and will be avoided as far as possible to minimise the risk of damaging this infrastructure.
- Waste materials including drill cuttings generated during HDD (apart from the final 5-10m which will be discharged to sea), will be reused or recycled, and where this is not possible will be disposed of appropriately. A Construction Waste Management Plan will be produced by the appointed principal contractors and will follow guidelines similar to the ones set out in SEPA (2006).
- All equipment, materials and chemicals will be stored well away from watercourses, with at least a 50m separation. Chemical, fuel and oil stores will be stored safely in accordance with PPG2.
- Machinery standing for several days or longer will have drip trays placed underneath to prevent oil and fuel leaks causing pollution.
- Where practicable, refuelling of vehicles and machinery will be carried out in a designated area, on an impermeable surface and well away from any watercourse.
- Only emergency maintenance will be carried out within the Project area, on an impermeable surface and well away from watercourses. If vehicles have broken down, necessitating maintenance at the point of breakdown, special precautions will be taken.
- Construction traffic movements will be limited as far as practicable, to reduce the risk of accidental spillage.
- Washing-out of vehicles used to transport concrete, grout or drilling fluid will not be undertaken on site.
- Contingency plans will be in place to ensure that emergency equipment, such as spill kits and absorbent materials, is available on site and will include advice on actions to be taken and personnel to be informed in the event of a pollution incident.
- All relevant staff and site personnel will be trained in normal operating and emergency procedures and will be made aware of highly sensitive areas on site.
- All activity occurring within the Burn of Horsegrow catchment will be undertaken with particular care to minimise pollution risk to the Loch of Mey SSSI/Ramsar site and its tributary watercourses. Additional protection measures will be installed if necessary to ensure the site is adequately safeguarded.
- A suitably qualified Environmental Clerk of Works will be appointed who will have responsibility for ensuring mitigation measures are in place and are operating effectively.

Residual impact

Impact title	Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Pollution event (surface water)	High	Negligible	Minor	Not Significant
Pollution event (groundwater)	High	Negligible	Minor	Not Significant
Pollution event (soils)	Medium	Negligible	Negligible	Not Significant

17.6.2 Impact 17.2: Erosion and sedimentation

17.125 Soil erosion and sediment generation may occur in areas where the ground has been disturbed. This will include preparation of the working width, excavation of cable trenches and building foundations, construction of open-cut watercourse crossings (where these are proposed), construction of temporary or permanent watercourse crossing structures for vehicle and plant access as required, from plant and machinery movements, construction of new track and hardstanding areas, drilling of cable boreholes, erosion of stockpiled soils, bare ground and new drainage ditches.

17.126 If this sediment reaches natural watercourses in the area it could cause high turbidity in the water, thus reducing light and oxygen levels with consequent effects upon the water quality and aquatic ecology of affected watercourses. The deposition of material could also reduce the flood storage capacity of watercourse channels, introducing a flood risk to the site or nearby area.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
High	Moderate	Major	Significant

MITIGATION IN RELATION TO IMPACT 17.2

- All earth-moving operations will be undertaken in compliance with BSI Code of Practice for Earthworks, BS 6031:2009. This will include halting of all earthworks during and immediately after heavy rainfall events.
- All heavily sediment-laden discharges will be routed through balancing tanks and one or more suitable filters or silt-busters in series as necessary, to reduce the sediment load.
- Water with light sediment load and supernatant water following treatment to remove heavy sediment load will be discharged onto vegetated surfaces and directed away from surface watercourses and ditches to avoid direct entry into the surface water system.
- In areas where it is necessary to run cable trenches and working width parallel to and within 20m of roadside or field drainage ditches, additional sediment control measures may be required to ensure the existing drainage network continues to operate at its current level. Additional control measures may take the form of silt fences, bunds, straw bales or other suitable barrier as appropriate to local conditions.
- Measures to control surface water runoff will be instigated prior to topsoil stripping. These may include retention of vegetation cover on watercourse banks, installation of straw bales or alternative barrier to intercept runoff or the installation of new land drains.
- Sediment control measures and temporary drainage will remain in place until vegetation cover has been re-established on the working width, to prevent reinstated soils being carried into nearby watercourses.
- Where open-cut cable crossings of watercourses are proposed, preference will be given to isolated open-cut techniques to minimise any potential release of sediment to the watercourse. Watercourse bed and bank material will be fully reinstated prior to the restoration of flow in the channel.
- All activity occurring within the Burn of Horsegrow catchment will be undertaken with particular care to minimise the risk of sediment release to the Loch of Mey SSSI/Ramsar site and its tributary watercourses. Additional protection measures will be installed if necessary to ensure the site is adequately safeguarded.
- A suitably qualified Environmental Clerk of Works will be appointed who will have responsibility for ensuring mitigation measures are in place and are operating effectively.

Residual impact

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
High	Negligible	Minor	Not Significant

17.6.3 Impact 17.3: Soil compaction and loss of quality

17.127 Vehicle movements on site will result in localised compaction of soils under temporary running surfaces. Reinstatement of working width and cable trenches could also result in soil compaction and in mixing of different soil horizons. Poor storage of soil in stockpiles can result in loss of soil structure and erosion of soil particles, causing a reduction in soil quality.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Medium	Moderate	Moderate	Significant

MITIGATION IN RELATION TO IMPACT 17.3

- Vehicle movements on site will be restricted as far as practicable, especially on temporary tracks and within the working width, to restrict soil compaction.
- Specialist low ground pressure vehicles will be considered for construction work, to minimise the requirement for temporary tracks.
- For the working width and cable trenches, topsoil will be stripped on a field-by-field basis and stored in a mound running alongside the working width on unstripped land. Where possible, topsoil will be stripped in reasonably dry conditions and stored in a mound no more than 2m high.
- Stored topsoil will be kept free from the passage of vehicles and will be prevented from intermixing with other materials. Erosion protection will be placed around stockpiles if required to minimise soil loss to surface runoff.
- Subsoils removed from the cable trenches will be stored on the opposite side of the working width from stored topsoil and will be laid on undisturbed subsoil.
- Topsoil reinstatement will be carried out under suitably dry conditions in order to limit compaction. Soil loosening may be required in areas where compaction is a problem, such as under the running track or under temporary track routes.
- A suitably qualified Environmental Clerk of Works will be appointed who will have responsibility for ensuring mitigation measures are in place and are operating effectively.

Residual impact

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Medium	Negligible	Negligible	Not Significant

17.6.4 Impact 17.4: Increase in surface runoff

17.128 Constructed impermeable or poorly permeable surfaces, such as new buildings, temporary or permanent tracks and hardstanding areas restrict infiltration of rainfall and surface water into the soil and underlying superficial deposits. This results in increased volumes of surface runoff and increased surface flow velocities. This impact is largely incremental during construction and the full effect is unlikely to be seen until the works have been completed and the scheme is operational.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
High	Negligible	Minor	Not Significant

MITIGATION IN RELATION TO IMPACT 17.4

- Although no significant impact has been identified, mitigation measures have been provided as a precautionary approach to ensure this remains the case.
- All temporary tracks and hardstanding areas will be removed and fully reinstated upon completion of the construction work.

17.6.5 Impact 17.5: Modification of drainage patterns

17.129 Interception of diffuse overland flow by temporary drainage alongside foundation and cable trench excavations will disrupt the natural drainage regime of the site by concentrating flows and changing soil drainage. Permanent drainage will be required around the PCC and substation and alongside permanent access tracks.

17.130 The natural drainage regime has already undergone extensive modification relating to land drainage, as a network of surface ditches and buried field drains, and road drainage, alongside the public road network.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Medium	Minor	Minor	Not Significant

MITIGATION IN RELATION TO IMPACT 17.5

- Although no significant impact has been identified, mitigation measures have been provided as a precautionary approach to ensure this remains the case.
- All temporary excavations associated with excavations will be fully reinstated upon completion of the construction work once vegetation has been re-established on previously stripped ground.
- Where permanent modifications to land drainage are required, such as around the PCC site, alternative drainage will be installed prior to construction to provide continuity of flow capacity in the affected area.

17.6.6 Impact 17.6: Impediments to surface flows

17.131 Surface flows can be impeded by construction activity in or adjacent to watercourse channels, poor selection of watercourse crossing locations, inadequate design of temporary or permanent watercourse crossing structures or crossing of watercourses by plant in locations with no crossing structure. These activities can also result in permanent bank damage, leading to potential future instability and further restrictions to flow.

17.132 Blockages can be caused by inadequate control of earth-moving plant, increased sedimentation and poor waste management. These can lead to an increase in flooding upstream and could have long term effects on the dynamics of the watercourse.

17.133 Where surface watercourses are used for livestock watering, flow restrictions or changes of this nature can impact upon the long term availability and quality of the water supply.

17.134 A number of watercourse crossings will be required on the identified cable route options. The total number of crossings will depend on the final route selected but is likely to be between four and six. Details of all possible watercourse crossing locations are provided in Table 17.10 with their locations indicated in Figure 17.9; in each case the grid reference indicates the approximate midpoint of the potential cable corridor. Additional crossings of drainage ditches, whether roadside or land drainage, will be also be required although the total number will depend on the final cable routing required.

Watercourse crossing details		Watercourse photograph
Crossing	SC01, Burn of Huna (Figure 17.9)	 SC01, looking upstream (south-east) from A836 crossing
Grid reference	NGR ND 3562 7305	
Description	Modified & straightened burn 0.5m wide by up to 1.5m deep. Bed is stony with gravel & sand. Channel very overgrown for most of its length. Used for cattle watering just upstream of A836.	
Suggested construction	Isolated open-cut with temporary bridge for construction traffic	
Crossing	SC02, Tresdale Burn (Figure 17.9)	 SC02, looking downstream (north-west)
Grid reference	NGR ND 3427 7236	
Description	Modified & straightened burn 1.0-2.0m wide by up to 1.5m deep. Channel very overgrown and water appears nearly stagnant.	
Suggested construction	Isolated open-cut with temporary bridge for construction traffic	
Crossing	SC03, Tresdale Burn (Figure 17.9)	 SC03, looking upstream (south-east) from A836 crossing
Grid reference	NGR ND 3379 7271	
Description	Small burn, modified & straightened, 1.5-2.0m wide by up to 2.0m deep. Gravel & cobble bed with overgrown channel.	
Suggested construction	Isolated open-cut with temporary bridge for construction traffic	

Watercourse crossing details		Watercourse photograph
Crossing	SC04, East Burn of Gills (Figure 17.9)	 SC04, looking downstream (north-north-west) from minor road crossing
Grid reference	NGR ND 3258 7200	
Description	Moderate burn 2.0-3.0m wide by up to 1.5m deep. Bedrock, cobble and gravel bed with well vegetated banks. Becomes incised towards northern edge of cable route.	
Suggested construction	Isolated open-cut with temporary bridge for construction traffic	
Crossing	SC05, East Burn of Gills (Figure 17.9)	 SC05, looking south-east from A836 crossing towards steep slope
Grid reference	NGR ND 3267 7256	
Description	Moderate burn 2.0-4.0m wide by 1.0-2.0m deep. Deeply incised by approximately 15m especially on steep eastern side. Boulder, cobble & gravel bed with very well vegetated banks.	
Suggested construction	Directional drilling or similar non-open-cut method	
Crossing	SC06, West Burn of Gills (Figure 17.9)	 SC06, looking upstream (south-west)
Grid reference	NGR ND 3178 7215	
Description	Moderate burn 1.0-3.0m wide by 1.0m deep with headwaters in peaty ground. Bed is largely gravel with cobbles and channel is very overgrown. Incised in places to 2-3m, although this is less pronounced both up- and downstream.	
Suggested construction	Isolated open-cut with temporary bridge for construction traffic	

Watercourse crossing details		Watercourse photograph
Crossing Grid reference Description Suggested construction	SC07, West Burn of Gills (Figure 17.9) NGR ND 3244 7263 Moderate burn 2.0-4.0m wide by 1.0-2.0m deep. Deeply incised by approximately 15m especially on steep eastern side with undercutting on east bank. Boulder, cobble & gravel bed with very well vegetated banks. Directional drilling or similar non-open-cut method	 SC07, looking upstream (south-west) from A836 crossing
Crossing Grid reference Description Suggested construction	SC08, unnamed burn (Figure 17.9) NGR ND 3204 7307 Marshy & overgrown ditch approximately 2.0m wide by 0.5m deep. No flow apparent, channel is entirely filled with rushes. Microsite to avoid crossing	 SC08, looking downstream (north-east)
Crossing Grid reference Description Suggested construction	SC09, Burn of Mey (Figure 17.9) NGR ND 3004 7315 Modified & straightened burn variably 1.0-1.5m wide by up to 1.5m deep. Bed is mainly gravel & sand with flagstones & cobbles in places. Channel has recently been cleared as it crosses the field (July 2011). Isolated open-cut with temporary bridge for construction traffic	 SC09, looking downstream (north-west)

Table 17.10: Watercourse crossing details

17.135 A number of temporary crossings are likely to be required to facilitate vehicle access to the cable route during the construction work. Regulations relating to the construction of underground crossings and permanent or temporary bridges or fords and the levels of authorisation required are summarised in Table 17.11, extracted from SEPA's CAR Practical Guide v5.

17.136 General advice regarding river crossing techniques includes:

- Ground levels around any watercourse crossing must not be raised, to maintain floodplain storage and conveyance capacity; and
- Any excess spoil arising from the works should be disposed of outwith the flood risk area to avoid loss of floodplain volume.

17.137 It is anticipated that cable crossings of watercourses will be achieved by isolated open-cut as all site watercourses are small in width and typically carry fairly low flow volumes. If crossings in the lower reaches of the West and East Burns of Gills are proposed, directional drilling may be required owing to the incised nature of the watercourse channels in the lower sections. Where possible, multiple crossings of a single watercourse will be avoided to minimise the total effect on the watercourse. In addition, the total number of watercourse crossings will be kept to a minimum to restrict impacts on the water environment as far as practicable.

General Binding Rule	Registration	Simple Licence	Complex Licence
Bridges and other types of crossing structures			
Minor bridges with no construction on bed or banks [General Binding Rule 6]	Bridges with no construction on bed and ≤20m of total bank affected	All other bridges, fords and causeways	N/A
Temporary bridges in rivers <5m wide [General Binding Rule 6]	Pipe or box culvert used for footpaths, cycle route or single track road in rivers ≤2m wide	All other pipe or box culverts used for crossings	N/A
Pipelines or cable crossings by boring beneath the bed of inland surface waters [General Binding Rule 7]	Pipeline or cable crossings beneath bed by isolated open-cut	All other pipeline or cable crossings, e.g. by direct open-cut or laid on channel bed	N/A

Table 17.11: Engineering levels of authorisation from CAR

17.138 No watercourse crossings on permanent tracks are anticipated. Track crossings of roadside and land drainage ditches are likely to take the form of culverts, sized appropriately for the flow capacity of the ditches to ensure their continued operation and prevent increase in flood risk.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
High	Minor	Moderate	Significant

MITIGATION IN RELATION TO IMPACT 17.6
▪ All crossings will be constructed taking account of guidance and good practice detailed in SEPA's Engineering in the Water Environment Good Practice Guide: River Crossings (2010) and Scottish Executive's River crossings & migratory fish: Design guidance (2000).

Residual impact

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
High	Negligible	Minor	Not Significant

17.6.7 Impact 17.7: Increase in fluvial flood risk

17.139 Installation of the underground cable will require excavation of a continuous trench from the selected PCC to the substation location. As the cable will have to cross several watercourses and existing drainage ditches, engineering work will be required in or near watercourses and across potential floodplain areas. The existing natural and artificial drainage network across the site area is extensive.

17.140 Engineering work in or near watercourses and in floodplain areas can adversely affect the watercourse flow dynamics and cause loss of flood storage capacity.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Medium	Moderate	Moderate	Significant

MITIGATION IN RELATION TO IMPACT 17.7

- Ground levels around temporary and permanent watercourse crossings and along the line of the cable trench will not be raised and care will be taken to ensure that bed reinstatement above cable trench crossings does not impede water flow within the channel.
- Permanent infrastructure will be located outwith the 1-in-200 year flood risk area and at least 5 m AOD to minimise risk from coastal flooding.
- Where possible, siting of the PCC and associated infrastructure will avoid the existing field drainage network. If this is not possible, alternative field drainage will be installed prior to construction work to provide continuity of flow capacity in the affected area.
- Track crossings of watercourses, including field and roadside drainage ditches, will be sized appropriately to ensure flow is not restricted. A programme of inspection and maintenance will be put in place to ensure their continued effective operation throughout the lifetime of the project.
- Should excess spoil arise from engineering works, this will be disposed of outwith the floodplain area to avoid loss of flood storage capacity.

Residual impact

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Medium	Negligible	Minor	Not Significant

17.6.8 Impact 17.8: Modification of groundwater levels and flows

17.141 Excavation work, such as that required for cable trenching and for building foundations, can disrupt shallow groundwater systems. Groundwater controls, such as physical cut-offs or dewatering, will be used as necessary to prevent excavations filling with water. This may result in a lowering of groundwater levels in the vicinity of the excavations. The effects of dewatering are likely to be localised and temporary. No groundwater discharges were identified in the area during the site visit.

17.142 The cable trenches would be likely to provide preferential flow paths for groundwater. This is particularly likely where trenches are backfilled with more permeable material than the surrounding soil or in areas where the cable requires to be seated on sand. This can have a permanent effect on the groundwater flow regime in the area.

17.143 Potential groundwater dependent terrestrial ecosystems have been identified in two areas. The Stroupster Peatlands SSSI/Caithness & Sutherland Peatlands SAC designated site lies approximately 230m from potential cable route options. The designated site is located uphill and across an existing minor road from the proposed cable routes. The minor road has roadside drainage ditches along both sides. It is therefore very unlikely that additional impacts on the designated site will result from cable trench excavation.

17.144 A small area of wet modified bog, habitat type E1.7, is located partly within a potential cable route. The habitat in this area is already degraded owing to previous use of the area for peat cutting. In addition, a minor road with roadside drainage ditches runs along the north-eastern boundary of the habitat area. The cable route corridor lies along the downhill edge of the habitat area. Excavation of cable trenches through the north-eastern edge of this area would cause some disruption to groundwater flow but the effects would be limited as most of the habitat area is uphill from the cable route and the habitat is already degraded from optimal condition.

Impact significance

Impact	Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Modification of groundwater levels & flows (groundwater)	High	Minor	Moderate	Significant
Modification of groundwater levels & flows (GWDTE)	High	Negligible	Minor	Not Significant

Figure 17.9: Watercourse crossing locations

MITIGATION IN RELATION TO IMPACT 17.8
▪ Cable trench backfill will be compacted to an appropriate degree to minimise along-trench groundwater flow without compromising the required technical performance. ▪ Where the cables are required to be seated on sand, use of cement-bound sand or appropriate alternative impermeable barrier will be considered to divert groundwater from the trench. ▪ If groundwater discharges are identified during construction, cable trenches and infrastructure will be microsited where possible to avoid the identified discharge location. ▪ In the event that the cable route running from Upper Gills to the Hill of Rigifa' is selected as the preferred option, cables will be located as close to the road as possible in order to minimise disruption to the identified groundwater dependent terrestrial ecosystem in this corridor. Consideration will be given to locating the cable trenches across the road from the identified habitat area to avoid further disruption to groundwater flow.

Residual impact

Impact	Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Modification of groundwater levels & flows (groundwater)	High	Negligible	Minor	Not Significant
Modification of groundwater levels & flows (GWDTE)	High	Negligible	Minor	Not Significant

17.6.9 Impact 17.9: Damage to geological or geomorphological features

17.145 Much of the trench is likely to require cutting through bedrock, to a depth of 1.2m below ground level. For trench crossings of watercourses this will be to at least 1.2m below the natural watercourse bed level. Breaking to facilitate trench excavation through bedrock will cause localised damage to the bedrock geology and may result in additional fracturing within nearby sections of the bedrock.

17.146 Excavation of the cable trench through superficial geology deposits will result in disturbance to the horizons present within the material, including loss of natural structure and sediment mixing during excavation work and storage.

17.147 Surface features of geomorphological interest may be damaged during trench excavation. This is particularly relevant to watercourse morphology. No open trenching is planned within the coastal or littoral area so no damage to coastal geomorphological features is anticipated.

17.148 Coastal processes modelling indicates that no additional erosion or sediment deposition is anticipated along the coastal section near the development area. In consequence, the local sites designated for geological and geomorphological characteristics are not expected to be affected by the development.

Impact significance

Impact	Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Damage to geological/ geomorphological features	Low	Minor	Minor	Not Significant
Damage to geological/ geomorphological features (designated sites)	High	Negligible	Minor	Not Significant

MITIGATION IN RELATION TO IMPACT 17.9
▪ No mitigation measures proposed as no significant impact predicted.

17.6.10 Impact 17.10: Mobilisation of contaminants

17.149 A number of road crossings will be required on the final cable route, varying between nine and 16 depending on the route selected. Road crossings are likely to be constructed by open-cut trenching, although crossings of the A836 may be better achieved by auger boring or other non-open-cut technique. Construction of road crossings could provide a preferential pathway for fluid flow, providing a direct link into ground and surface water systems and potentially allowing mobilisation of contaminated soil particles as dust or other sediment.

17.150 Road surface and sub-base material may be contaminated with a variety of metals, hydrocarbons and other materials which may be hazardous to the water environment.

Impact significance

Impact	Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Mobilisation of contaminants (surface water)	High	Negligible	Minor	Not Significant
Mobilisation of contaminants (groundwater)	High	Negligible	Minor	Not Significant
Mobilisation of contaminants (soils)	Medium	Minor	Minor	Not Significant

MITIGATION IN RELATION TO IMPACT 17.10
▪ Although no significant impact has been identified, mitigation measures have been provided as a precautionary approach to ensure this remains the case. ▪ Excavated material from road surface and sub-base may need appropriate disposal as hazardous waste. Testing will be required to determine if this is required. Disposal would be subject to agreement and licensing by The Highland Council and SEPA. ▪ Water ingress to the excavation may contain contaminants and would require collection and appropriate treatment to remove contaminant prior to discharge. This may be subject to agreement and licensing by SEPA.

17.7 Impacts during Operations and Maintenance

17.7.1 Impact 17.11: Pollution event

17.151 During operations and maintenance, potential pollutants will be present in the site area. These will be restricted to the power conversion centre, substations and access routes to these locations. Potential pollutants will include fuel, lubrication oils, chemicals and waste water from staff facilities. Any pollution incident occurring on the site may adversely affect the quality of nearby surface waters, groundwater or site soils.

Impact significance

Impact	Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Pollution event (surface water)	High	Negligible	Minor	Not Significant
Pollution event (groundwater)	High	Negligible	Minor	Not Significant
Pollution event contaminants (soils)	Medium	Negligible	Negligible	Not Significant

MITIGATION IN RELATION TO IMPACT 17.11

- Although no significant impact has been identified, mitigation measures have been provided as a precautionary approach to ensure this remains the case.
- It has been assumed that all operations and maintenance activity will be undertaken in accordance with the good practice and mitigation measures set out above with relation to Impact 17.1.

17.7.2 Impact 17.12: Erosion and sedimentation

17.152 Potential levels of erosion and sedimentation will be very much lower than during construction as there will be no excavations or exposed ground, unless required for emergency repair or replacement work. Some erosion could still occur on site access tracks and drainage ditches as a result of scouring during extreme rainfall events, particularly if poorly maintained. The permanent drainage network for the onshore infrastructure is not expected to be large or extensive.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
High	Negligible	Minor	Not Significant

MITIGATION IN RELATION TO IMPACT 17.12

- Although no significant impact has been identified, mitigation measures have been provided as a precautionary approach to ensure this remains the case.
- A programme of regular inspection and maintenance for all permanent drainage features will be put in place and carried out regularly.

17.7.3 Impact 17.13: Impediments to surface flows

17.153 During operation, impediments to surface flows relate largely to the constriction of drainage channels through poor maintenance.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
High	Negligible	Minor	Not Significant

MITIGATION IN RELATION TO IMPACT 17.13

- Although no significant impact has been identified, mitigation measures have been provided as a precautionary approach to ensure this remains the case.
- A programme of regular inspection and maintenance will be implemented to prevent constriction of drainage channels and to ensure continued efficient operation of the drainage network.

17.8 Impacts during Decommissioning

17.154 It has been assumed that all above ground onshore infrastructure and associated PCC foundations, will be removed during decommissioning.

17.8.1 Impact 17.14: Pollution event

17.155 During decommissioning activity, potential pollutants will also be present in the site area. These will include fuel, lubrication oils and chemicals as well as waste and waste water from staff facilities. Any pollution incident occurring on the site may adversely affect the quality of nearby surface waters, groundwater or site soils.

Impact significance

Impact	Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Pollution event (surface water)	High	Minor	Moderate	Significant
Pollution event (groundwater)	High	Minor	Moderate	Significant
Pollution event (soils)	Medium	Minor	Minor	Not Significant

MITIGATION IN RELATION TO IMPACT 17.14

- Mitigation relating to Pollution Events is set out above, with relation to Impact 17.1. These good practice and mitigation measures will be implemented during decommissioning. No additional mitigation specific to decommissioning is required.

Residual impact

Impact	Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Pollution event (surface water)	High	Negligible	Minor	Not Significant
Pollution event (groundwater)	High	Negligible	Minor	Not Significant
Pollution event contaminants (soils)	Medium	Negligible	Negligible	Not Significant

17.8.2 Impact 17.15: Erosion and sedimentation

17.156 During decommissioning, activity relating to removal of above ground onshore infrastructure and associated PCC foundations will necessitate ground disturbance. Any activity requiring ground disturbance can lead to soil erosion and the generation of loose sediment. However, this is likely to be contained with the footprint of the PCCs resulting in a lower potential impact.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Medium	Minor	Minor	Not Significance

MITIGATION IN RELATION TO IMPACT 17.15

- Although no significant impact has been identified, mitigation measures have been provided as a precautionary approach to ensure this remains the case.
- Mitigation relating to Erosion and Sedimentation is set out above, with relation to Impact 17.2. These good practice and mitigation measures will be implemented during decommissioning.
- Excavation and ground-disturbing work will be kept to a minimum as far as practicable, to minimise the potential for mobilising sediment.

17.8.3 Impact 17.16: Soil compaction and loss of quality

17.157 As for construction, the movement of vehicles and plant on site during decommissioning activity will result in localised compaction of soils under temporary running surfaces. Reinstatement of any excavations could also result in soil compaction and mixing. Poor storage of excavated soils could result in a reduction of soil quality through loss of soil structure and erosion of soil particles.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Medium	Minor	Minor	Not Significant

MITIGATION IN RELATION TO IMPACT 17.16

- Although no significant impact has been identified, mitigation measures have been provided as a precautionary approach to ensure this remains the case.
- It has been assumed that all decommissioning activity will be undertaken in accordance with the good practice and mitigation measures set out above with relation to Impact 17.3.

17.8.4 Impact 17.17: Impediments to surface flows

17.158 Impediments to surface flows as a result of decommissioning could be caused by the same site activities as during construction. The level of activity would be considerably reduced from the construction phase as these would be contained within the footprint of the PCC.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
High	Negligible	Minor	Not Significant

MITIGATION IN RELATION TO IMPACT 17.17

- Although no significant impact has been identified, mitigation measures have been provided as a precautionary approach to ensure this remains the case.
- It has been assumed that all decommissioning activity will be undertaken in accordance with the good practice and mitigation measures set out above with relation to Impact 17.6.

17.8.5 Impact 17.18: Increase in fluvial flood risk

17.159 Ground disturbance and excavations associated with engineering work to remove buried infrastructure (PCC foundations) could affect watercourse flow dynamics and flood storage. However, most activities will be contained within the footprint of the PCC, therefore the level of activity would be reduced from the construction phase.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Medium	Minor	Minor	Not Significant

MITIGATION IN RELATION TO IMPACT 17.18

- Although no significant impact has been identified, mitigation measures have been provided as a precautionary approach to ensure this remains the case.
- It has been assumed that all repowering/decommissioning activity in the area of the PCC and associated above ground infrastructure will be undertaken in accordance with the good practice and mitigation measures set out above with relation to Impact 17.7.

17.8.6 Impact 17.19: Modification of groundwater levels and flows

17.160 Groundwater controls may be required to prevent any decommissioning-related excavations from filling with water, resulting in a lowering of groundwater levels around the excavation area. As all excavations will be backfilled and fully reinstated upon completion of the decommissioning activity, any effects are likely to be localised and temporary.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Medium	Negligible	Negligible	Not Significant

MITIGATION IN RELATION TO IMPACT 17.19
▪ Although no significant impact has been identified, mitigation measures have been provided as a precautionary approach to ensure this remains the case. ▪ It has been assumed that all decommissioning activity will be undertaken in accordance with the good practice and mitigation measures set out above with relation to Impact 17.8.

17.8.7 Impact 17.20: Damage to geological or geomorphological features

17.161 Removal of buried infrastructure for decommissioning would result in increased loss of structure of superficial geology deposits and in increased mixing of sediment layers. No impact on the identified sites designated for geology or geomorphology is anticipated from decommissioning.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Low	Negligible	Negligible	Not Significant

MITIGATION IN RELATION TO IMPACT 17.20
▪ Although no significant impact has been identified, mitigation measures have been provided as a precautionary approach to ensure this remains the case. ▪ It has been assumed that all repowering/decommissioning activity will be undertaken in accordance with the good practice and mitigation measures set out above with relation to Impact 17.9.

17.8.8 Impact 17.21: Mobilisation of contaminants

17.162 Removal of buried infrastructure for decommissioning is unlikely to lead to any contaminant mobilisation.

Impact significance

Impact	Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Mobilisation of contaminants (surface water)	High	Negligible	Minor	Not Significant
Mobilisation of contaminants (groundwater)	High	Negligible	Minor	Not Significant
Mobilisation of contaminants (soils)	Medium	Negligible	Negligible	Not Significant

MITIGATION IN RELATION TO IMPACT 17.21
▪ No mitigation proposed as no significant impact predicted.

17.9 Cumulative Impacts

17.9.1 Introduction

17.163 MeyGen has, in consultation with Marine Scotland and The Highland Council, identified a list of other projects (MeyGen, 2011) which together with the Project may result in potential cumulative impacts. The list of these projects, including details of their status at the time of the EIA, and a map showing their location is provided in Section 8; Table 8.3 and Figure 8.1 respectively.

17.164 Having considered the information presently available in the public domain on the projects for which there is a potential for cumulative impacts, Table 17.12 below indicates those with the potential to result in cumulative impacts from a geology, hydrogeology and hydrology perspective. The consideration of which projects could result in potential cumulative impacts is based on the results of the project specific impact assessment together with the professional judgment of the specialist consultant.

Project title	Potential for cumulative impact	Project title	Potential for cumulative impact	Project title	Potential for cumulative impact
MeyGen Limited, MeyGen Tidal Energy Project, Phase 2	✓	SHETL, HVDC cable (onshore to an existing substation near Keith in Moray)	✗	OPL, Ocean Power Technologies (OPT) wave power ocean trial	✗
ScottishPower Renewables UK Limited, Ness of Duncansby Tidal Energy Project	✗	Brough Head Wave Farm Limited, Brough Head Wave Energy Project	✗	MORL, Moray Offshore Renewables Ltd (MORL) offshore windfarm	✗
Pelamis Wave Power, Farr Point Wave Energy Project	✗	SSE Renewables Developments (UK) Limited, Costa Head Wave Energy Project	✗	SSE and Talisman, Beatrice offshore Windfarm Demonstrator Project	✗
Sea Generation (Brough Ness) Limited, Brough Ness Tidal Energy Project	✗	EON Climate & Renewables UK Developments Limited, West Orkney North Wave Energy Project	✗	BOWL, Beatrice Offshore Windfarm Ltd (BOWL) offshore windfarm	✗

Project title	Potential for cumulative impact	Project title	Potential for cumulative impact	Project title	Potential for cumulative impact
Cantick Head Tidal Development Limited, Cantick Head Tidal Energy Project	✗	EON Climate & Renewables UK Developments Limited, West Orkney South Wave Energy Project	✗	Northern Isles Salmon, Chalmers Hope salmon cage site	✗
SSE, Caithness HVDC Connection - Converter station	✗	ScottishPower Renewables UK Limited, Marwick Head Wave Energy Project	✗	Northern Isles Salmon, Pegal Bay salmon cage site	✗
SSE, Caithness HVDC Connection - Cable	✗	SSE Renewables Developments (UK) Limited, Westray South Tidal Energy Project	✗	Northern Isles Salmon, Lyrawa salmon cage site	✗
RWE npower renewables, Stroupster Windfarm	✓	EMEC, Wave Energy test site (Billia Croo, Orkney)	✗	Scottish Sea Farms, Bring Head salmon cage site	✗
SSE, Gills Bay 132 kV / 33 k V Substation Phase 1: substation and overhead cables (AC)	✓	EMEC, Tidal energy test site (Fall of Warness, Orkney)	✗	Northern Isles Salmon, Cava South salmon cage site	✗
SSE, Gills Bay 132 kV / 33 k V Substation Phase 2: HVDC converter station and new DC buried cable	✓	EMEC, Intermediate wave energy test site (St Mary's Bay, Orkney)	✗	Scottish Sea Farms, Toyness salmon cage site	✗
SHETL, HVDC cable (offshore Moray Firth)	✗	EMEC, Intermediate tidal energy test site (Head of Holland, Orkney)	✗	Northern Isles Salmon, West Fara salmon cage site	✗

Table 17.12: Summary of potential cumulative impacts

17.165 The following sections summarise the nature of the potential cumulative impacts for each potential project phase:

- Construction and installation;
- Operations and maintenance; and
- Decommissioning.

17.9.2 Potential cumulative impacts during construction and installation

17.166 The following projects have potential for cumulative impacts during construction and installation:

- Gills Bay Substation Phase 1; and
- Gills Bay Substation Phase 2.

17.167 The SSE Power Distribution Gills Bay Substation Phase 1 works are proposed to lie within one or more of the East Burn of Gills, West Burn of Gills, Burn of Mey, Burn of Horsegrow or Burn of Rattar catchments. The final substation location has yet to be identified although the three currently preferred sites lie within the upper Burn of Horsegrow catchment. The final substation location will dictate the start of the proposed overhead line routes, which are likely to run roughly south from the substation, through the upper Burn of Rattar and Burn of Freswick catchments, and roughly south-west, through the middle Burn of Rattar catchment.

17.168 As the cables from the MeyGen Project will, during the later stages of Phase 1 of the Inner Sound project, need to link into the substation, there will be cumulative impacts as the infrastructure will, of necessity, be adjacent. Assuming that all substation construction work follows recognised good practice and mitigation similar to that set out for this Project, cumulative impacts on the geology, hydrogeology and hydrology will be minor and not significant. Although the specific details of the construction schedule are not yet known, it is unlikely that MeyGen cable installation works will be undertaken at the same time as the substation construction works, thereby minimising the potential for cumulative impacts during the construction phases of these projects.

17.169 The SSE Power Distribution Phase 2 works include the construction of an HVDC converter station adjacent to the above mentioned Phase 1 substation and installation of an underground cable to run south from the substation towards Wick. Again, there will be cumulative impacts on hydrology, hydrogeology and geology as work from the substation/HVDC cable proposal will be immediately adjacent to elements of the MeyGen project. Assuming that all converter station construction work and cable trench excavation and installation work are undertaken to recognised good practice standards and make use of mitigation similar to that set out for this Project, cumulative impacts on the hydrology, hydrogeology and geology will be minor and not significant. Although the specific details of the construction schedule are not yet known, it is unlikely that MeyGen cable installation works could be undertaken at the same time as the substation construction works, thereby minimising the potential for cumulative impacts during the construction phases of these projects.

17.9.3 Potential cumulative impacts during operations and maintenance

17.170 The following projects have potential for cumulative impacts during their operational phases:

- MeyGen Tidal Energy Project Phase 2; and
- RWE npower renewables Stroupster Windfarm.

17.171 Phase 2 of the MeyGen Tidal Energy Project will comprise the deployment of a further 312 MW offshore and associated cables to shore and onshore infrastructure. The exact geographical location, extent and nature of the onshore facilities required for Phase 2 are not yet defined and will incorporate lessons learned from and technology advancements beyond, Phase 1 of the Project. These factors will influence the potential for, nature of and significance of any cumulative impacts. From a geology, hydrology and hydrogeology perspective the requirement for additional land for onshore infrastructure has the potential for cumulative impacts.

17.172 Stroupster Windfarm lies approximately 3.5km south of the proposed Project area. It is situated largely within the southern part of the Burn of Freswick catchment and the adjacent catchment to the south. All proposed infrastructure for the MeyGen Project is located north of the Burn of Freswick catchment (Figure 17.7). There will, in consequence, be no cumulative impacts on hydrology, hydrogeology or geology from the MeyGen Project in combination with Stroupster Windfarm.

17.9.4 Potential cumulative impacts during decommissioning

17.173 At present it cannot be determined what concurrent works will be ongoing in the area of the Project at the time of decommissioning and therefore is not possible to determine potential cumulative impacts. However, if any other works ongoing at the time are undertaken to recognised good practice standards and make use of mitigation similar to that set out for this Project, cumulative impacts on the hydrology, hydrogeology and geology will be minor and not significant.

17.9.5 Mitigation requirements for potential cumulative impacts

17.174 No mitigation in required over and above the Project specific mitigation.

17.10 Proposed Monitoring

17.175 Monitoring is proposed of any surface watercourses that could be affected by the Project, to provide baseline water quality prior to any construction and to provide reassurance that mitigation measures are effective.

17.176 Surface water monitoring will include regular visual inspections of identified locations, plus regular but less frequent water quality sampling.

17.177 The monitoring will include control sites outwith affected watercourse catchments and/or upstream of all proposed activity as well as areas within the MeyGen Project area and downstream of the proposed activity.

17.178 The construction contractors' Environmental Clerk of Works (or equivalent) will monitor the construction team to avoid any accidental damage to surface watercourses.

17.11 Summary and Conclusions

17.179 An assessment has been carried out of the likely effects of the Project on the geology, hydrogeology and hydrology. The assessment has considered construction and installation, operations and maintenance, and decommissioning/repowering of the project. The predicted impacts are summarised in Section17.6, Section 17.7 and Section 17.8.

17.180 The potential effects on surface water, groundwater, soils, geology and geomorphology that have been considered are:

- Pollution event;
- Erosion and sedimentation;
- Soil compaction and loss of quality;
- Increase in surface runoff;
- Modification of drainage patterns;
- Impediments to surface flows;
- Increase of fluvial flood risk;
- Modification of groundwater levels and flows;
- Damage to geological and geomorphological features; and
- Mobilisation of contaminants.

17.181 A number of layout, design and construction proposals have been identified that will minimise, mitigate or offset these effects. An Environmental Clerk of Works should be appointed to oversee the effective operation of the identified mitigation measures.

17.182 It is concluded that, with the proposed mitigation in place, the identified effects on the geology, hydrogeology and hydrology environments will not be significant.

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18 TERRESTRIAL HABITATS AND ECOLOGY

18.1 The table below provides a list of all the supporting studies which relate to terrestrial habitats and ecology. All supporting studies are provided on the accompanying CD.

Details of study	Location on supporting studies CD
Extended Phase 1 Habitat Survey Report – MeyGen (Xodus, 2011a)	ONSHORE\Phase 1 Habitat Survey

18.1 Introduction

18.2 This section addresses impacts of the onshore component of the Project specific to terrestrial ecology, focusing on impacts to terrestrial habitats and protected species. This assessment was undertaken by Xodus.

18.3 This section deals solely with terrestrial ecology impacts, focusing on terrestrial habitats and protected terrestrial species (bat species, otter, Scottish wildcat, badger, water vole, red squirrel, amphibian and reptile species) with consideration of nature conservation issues. Impacts on bird species are considered and assessed separately in the ornithology section, Section 12. Additionally, impacts on marine mammals and fish species, including anadromous salmonid species and commercial marine fish species are assessed in Sections 13, and 14, respectively.

18.4 Statutorily protected sites are also considered in this section and in the separate Habitats Regulations Appraisal (HRA) report, the results of which have been reported separately to the Environmental Statement (ES) (MeyGen, 2012).

18.2 Assessment Parameters

18.2.1 Rochdale Envelope

18.5 In line with the Rochdale Envelope approach, this assessment considers the maximum ('worst case') project parameters. Identification of the worst case scenario for each receptor (i.e. Environmental Impact Assessment (EIA) topic) ensures that impacts of greater adverse significance would not arise should any other development scenario be taken forward in the final scheme design. Table 18.1 describes the detail of the project parameters that have been used in this assessment and explains why these are considered to be worst case. The potential impacts from alternative Project parameters have been considered in Section 18.9.

Project parameter relevant to the assessment		'Maximum' Project parameter for impact assessment	Explanation of maximum Project parameter
Onshore Power Conversion Centre (PCC)	Construction, operation / maintenance and decommissioning	Maximum potential footprint at both Ness of Quoys and Ness of Huna (at EIA commencement)	Assessment of potential impacts associated with the construction, operation and maintenance activities and decommissioning of the Power Conversion Centre (PCC) at both the Ness of Huna and Ness of Quoys maximum potential footprint.
Onshore cable routes between PCC and SHETL substation	Construction, operation / maintenance and decommissioning	All potential cable corridors between PCC locations and SHETL substation proposed at Phillips Mains (at EIA commencement)	Assessment of potential impacts associated with all potential cable corridors identified between PCC locations and SHETL substation proposed at Phillips Mains.
Cable landfall	Horizontal Directional Drill (HDD) site	Maximum potential footprint at both Ness of Quoys and Ness of Huna (at EIA commencement)	Assessment of potential impacts associated with the construction, operation and reinstatement of the temporary HDD site at both the Ness of Huna and Ness of Quoys maximum potential footprint.
Offshore Project components		N/A	The offshore Project parameters do not influence the terrestrial habitats and ecology impact assessment.

Table 18.1: Rochdale Envelope parameters for the terrestrial habitats and ecology assessment

18.2.2 Area of assessment

18.6 It is also important to define the geographical extent of the assessment area. The focus of the terrestrial habitats and ecology assessment is on the potential for impacts on areas that could be directly impacted by the onshore the Project infrastructure and adjacent areas.

18.7 It should be noted that since this assessment was completed on a more extensive Project area (Figure 18.2), this has since been refined to a smaller footprint at both the Ness of Quoys and Ness of Huna PCC sites and a single cable corridor to the SHETL substation option areas. The final Project is described in Section 5 and shown in Figure 5.2; the selection process for these is discussed in Section 4. The potential mitigation measures proposed in this ES section should be considered as the maximum list of required mitigation relevant to terrestrial ecology impacts. The definition of final required mitigation measures will be addressed as part of the European Protected Species (EPS) licence regime and any scheme of mitigation will be included in the Environmental Management Plan (EMP).

18.8 **Following the completion of the EIA, landowner consultation has identified potential issues with small areas of the proposed cable route. It has therefore been necessary to include areas outside that surveyed for the onshore impact assessments. The area is 0.50km^2 and is shown in Figure 2.1. Unfortunately this issue was not identified at the time of ES compilation and therefore is not addresses in this document. Work to survey and assessment of any changes required to the original impact assessment as a result of the altered cable route is ongoing and will be provided in an ES addendum.**

18.3 Legislative Framework and Regulatory Context

18.3.1 Legislation

18.9 In addition to the EIA Regulations the following legislation relevant to the assessment of terrestrial ecology includes the following:

- Statutorily protected sites: 'Habitats Directive' (Directive 92/43/EEC) and the 'Birds Directive' (Directive 79/409/EEC). The Habitats Directive is implemented by the Conservation (Natural Habitats, &c) Regulations 1994 (as amended);
- The Habitats Regulations 1994 (as amended in Scotland) implements species protection requirements of the Habitats Directive in Scotland, on land and in inshore waters;
- Wildlife and Countryside Act 1981, as amended by the Nature Conservation (Scotland) Act 2004;
- Wildlife and Natural Environment (Scotland) Act 2011;
- UK Biodiversity Action Plan (UK BAP); UK Government's response to the Convention on Biological Diversity (CBD), which the UK signed up to in 1992 in Rio de Janeiro; and
- Scottish Biodiversity List.

18.3.2 Policy and guidance

18.10 In addition to EIA guidance published by Marine Scotland and Scottish Natural Heritage (SNH), the following guidance has been taken into account during this assessment:

- The Scottish Planning Policy (SPP) (paragraphs [37, 77, 93,102,126,129,134,137, 39, 142, 143, 144, 145, 146 and 147]);
- PAN 60 Planning for Natural Heritage;
- Scottish Government Interim Guidance on European Protected Species, Development Sites and the Planning System;
- The Scottish Biodiversity Strategy;
- Institute of Ecology and Environmental Management (IEEM) Guidelines for Ecological Impact Assessment in the United Kingdom (2006); and
- The Highland Council's Caithness Local Plan (2002) and the Highland Council's Structure Plan (2001)[1]. These will be supplemented and eventually superseded by the Highland-wide Local Development Plan (HwLDP)[2].

18.4 Assessment Methodology

18.11 The impact assessment considers the likely effects of the Project on terrestrial ecology receptors (i.e. terrestrial habitats and species) which may occur during the following phases of development; construction and installation, operation (including maintenance activities) and decommissioning. Consideration of variance in impacts (accounting for different Project options) will also be given due consideration; in addition to potential for cumulative impacts arising from other proposed developments occurring in the vicinity of the Project. The sections below outline the assessment methodology including results of the scoping and consultation process, baseline data collection (i.e. desk based study and field survey) and the criteria employed to assess significance of impacts within the impact assessment.

18.4.1 Scoping and consultation

18.12 Since commencement of the Project, consultation on terrestrial habitat and ecology issues has been ongoing. Table 18.2 summarises all consultation relevant to terrestrial habitats and ecology. In addition, relevant comments from the EIA Scoping Opinion are summarised in Table 18.3, together with responses to the comments and reference to the ES sections relevant to the specific comment.

Date	Stakeholder	Consultation	Topic / specific issue
7th April 2011	Marine Scotland and SNH	Pre-scoping meeting	EIA surveys and studies required and the data requirements for each EIA study.
27th May 2011	Marine Scotland, statutory consultees and non statutory consultees	Submission of EIA Scoping Report	Request for EIA Scoping Opinion from Marine Scotland and statutory consultees, and request for comment from non statutory consultees.
30th June – 2nd July 2011	Local stakeholders	Public event - EIA Scoping Report	Public event to collate information / opinions on proposed EIA scope.
8h August 2011	Marine Scotland and SNH	Submission of document for comment	Submission of HRA Screening Report.
9th August 2011	SNH	Submission of document for comment	Submission of the report of the extended Phase 1 habitat survey.
22nd August 2011	SNH	Letter	Comments on extended Phase 1 habitat survey report.
30th August 2011	Scottish Environment Protection Agency (SEPA)	Submission of draft ES sections	Copy of draft Geology, Hydrology & Hydrogeology and Terrestrial Habitats ES sections provided for comment.
12th September 2011	SEPA	Letter	Comments received on draft Geology, Hydrology & Hydrogeology and Terrestrial Habitats ES sections.
14th September 2011	The Highland Council (THC)	Meeting	Planning pre-application meeting. Presentation on overall Project and results of EIA studies to date.
30th September 2011	Marine Scotland and SNH	Letter	Response to HRA Screening Report.
31st September 2011	Marine Scotland, The Highland Council, statutory consultees and non statutory consultees	Receipt of EIA Scoping Opinion	Receipt of response to EIA Scoping Report and other comments from non statutory consultees.
10th October 2011	THC	Receipt of pre application advice	Receipt of pre application advice from TCH
2nd November 2011	Marine Scotland and SNH	Meeting	EIA progress and HRA discussion.
6th – 7th December 2011	Local stakeholders	Public event – pre application consultation	Public event to communicate the findings of the EIA to local stakeholders.
2nd March 2012	Marine Scotland and SNH	Meeting	Final meeting to close out HRA approach to the Project.

Table 18.2: Consultation undertaken in relation to terrestrial habitats and ecology

Name of organisation	Key concerns	Response	ES section within which the specific issue is addressed
SNH Response to extended Phase 1 habitat survey report	On the basis of information available to date, it appears unlikely that Stroupster Peatlands SSSI (the most northerly component of the Peatlands of Caithness and Sutherland Special Area of Conservation (SAC), Special Protection Area (SPA) and Ramsar site) will be affected. The potential for indirect effects due to disturbance of birds may need further assessment as the design, and more specifically, construction methods become clearer.	Potential for disturbance to bird species during the construction phase is considered within the impact assessment.	Indirect disturbance to bird species is considered in the ornithology section, Section 12. HRA Report (MeyGen, 2012).
SNH Response to extended Phase 1 habitat survey report	The presence of otters, particularly in coastal habitats adjacent to the Project footprint requires further investigation once the cable landfall location is confirmed and when proposals for horizontally directionally drilling have been developed. Assessment should consider impacts on otter as a European Protected Species (EPS) and establish if there could be connectivity with Caithness and Sutherland Peatlands SAC, for which otter is a qualifying interest. Information should be sufficient to allow SNH and the competent authority to determine if there could be a	An otter survey will be commissioned once the onshore cable landfall location is confirmed and proposals for horizontal directional drilling developed. This will include assessment for potential connectivity with Caithness and Sutherland Peatlands SAC.	For consideration of impacts to otters, refer to Section 18.6.4 Impact 18.4: Disturbance to otters, Section 18.7.1 Impact 18.6: Temporary disturbance to otters during maintenance operations and Section 18.8.2 Impact 18.8: Temporary disturbance to otters during decommissioning operations. HRA Report (MeyGen,

[1] Still in force at time of EIA and ES compilation.

[2] Not adopted at the time of EIA and ES compilation.

Name of organisation	Key concerns	Response	ES section within which the specific issue is addressed
	significant effect and thus whether an appropriate assessment would be required.		2012).
SNH Response to extended Phase 1 habitat survey report	SNH support the extended Phase 1 habitat survey report findings on bats, breeding bird habitat and water voles and support proposals for future assessment of these species.	Further, targeted protected species surveys where relevant, will be undertaken in future as the Project develops.	Refer to extended Phase 1 habitats survey report which is available on the accompanying supporting studies CD (Xodus, 2011a.
SNH Scoping Advice	Caithness and Sutherland Peatlands SAC: advice on otters The potential options for cabling and onshore works are within the home range (10-20km) of otters from this designated site. Boat movements, cable laying, directional drilling and other construction activity may also give rise to disturbance of otters. Additionally, there may be impacts to their prey species (particularly marine fish species), either from placement of infrastructure or due to noise. SNH advise that there is potential for the proposal to have likely significant effect on otters, a designatory feature of Caithness and Sutherland Peatlands SAC.	Impacts to otters will be considered within the EIA; including potential for disturbance during the construction, operation and decommissioning Project phases, with consideration of potential for likely significant effect on the otter qualifying interest of the Caithness and Sutherland Peatlands SAC.	For consideration of impacts to otters, refer to Section 18.6.4 Impact 18.4: Disturbance to otters, Section 18.7.1 Impact 18.6: Temporary disturbance to otters during maintenance operations and Section 18.8.2 Impact 18.8: Temporary disturbance to otters during decommissioning operations HRA Report (MeyGen, 2012).
SNH Scoping Advice	Based on the conservation objectives of Caithness and Sutherland Peatlands SAC, the following questions need to be addressed in an appropriate assessment, focussing on the potential impacts of the proposal on the otter population of the Caithness and Sutherland Peatlands SAC: Will the proposal cause significant disturbance to otters while they are outwith the SAC, such that the viability of this SAC population will be affected? Will the proposal affect the viability of the SAC population of otters in any way? Further information on cabling and on-shore infrastructure is required to assess whether there will be any direct disturbance to otters, including their potential displacement from foraging grounds and other supporting habitats.	Potential impacts of disturbance to otters are given due consideration within the EIA and within the separate HRA process. The status and distribution of otters within the Project footprint and surrounding environment is not currently known. Further ecological investigation will be undertaken to ascertain otter presence, to enable accurate assessment of potential impacts to this protected species and to inform mitigation. Mitigation against disturbance to otters (throughout the Project duration) has been proposed. Where disturbance cannot be avoided, application for a European Protected Species Licence will be undertaken.	For consideration of impacts to otters, refer to Section 18.6.4 Impact 18.4: Disturbance to otters, Section 18.7.1 Impact 18.6: Temporary disturbance to otters during maintenance operations and Section 18.8.2 Impact 18.8: Temporary disturbance to otters during decommissioning operations. HRA Report (MeyGen, 2012)
Royal Society for the Protection of Birds (RSPB)	Special Protection Areas (SPAs) considered in subsequent ornithological studies should not be limited to those on or adjoining the coast.	All SPA's occurring in the surrounding environment (and not limited to those occurring on the coast) have been given due consideration (refer to Figure 18.1).	Consideration has also been given to potential for impact on relevant SPAs within the Habitat Regulations Appraisal. HRA Report (MeyGen, 2012). Ornithological issues are considered separately in Section 12.
Mary Legg, local ecologist	Indicated there are records of *Colletes succinctus* (bee) in Scotland's Haven and also the small white orchid (*Psuedorchis albida*) which is rare in Caithness.	Data available from the local biological records centre and further consultation with Mary Legg concluded these records were out with the assessment area / potential onshore footprint for the Project. These species were not recorded during the extended Phase 1 habitats survey.	N/A

Table 18.3: Scoping comments relevant to terrestrial habitats and ecology

18.4.2 Desk based assessment

18.13 A desk based assessment (DBA) identified the following statutorily protected sites in the vicinity of the Project footprint; Caithness and Sutherland Peatlands SAC, SPA and Ramsar site, located 0.16km from the southern boundary of the Project footprint and Philips Main Mire Site of Special Scientific Interest (SSSI), located approximately 0.55km to the south-east of the Project footprint. Notably, these protected sites are classified by SEPA as Water Dependant Conservation Areas. Caithness and Sutherland Peatlands SAC, SPA and Ramsar site (including Stroupster Peatlands SSSI) and Phillips Main SSSI are considered sufficiently remote as not to be affected by the proposed development (Figure 18.1).

18.14 A detailed DBA was undertaken for the provision of comprehensive background information to inform and guide the field survey. Data sources consulted as part of the desk-based assessment included the following:

- Multi Agency Geographic Information for the Countryside (MAGIC) (http://magic.defra.gov.uk/default.htm);
- National Biodiversity Network website (http://www.nbn.org.uk/);
- UK Biodiversity Action Plan and Local Biodiversity Action Plan (http://www.ukbap.org.uk/);
- Scottish Natural Heritage Information Service (http://www.snh.org.uk/snhi/);
- SEPA water quality classification and salmonid watercourse maps;
- Data from the Highlands Biological Recording Group (provided in the form of an excel spreadsheet);
- Local Government Agency Biodiversity Officer; and
- Aerial photography (using widely available aerial mapping for initial assessment of habitat types).

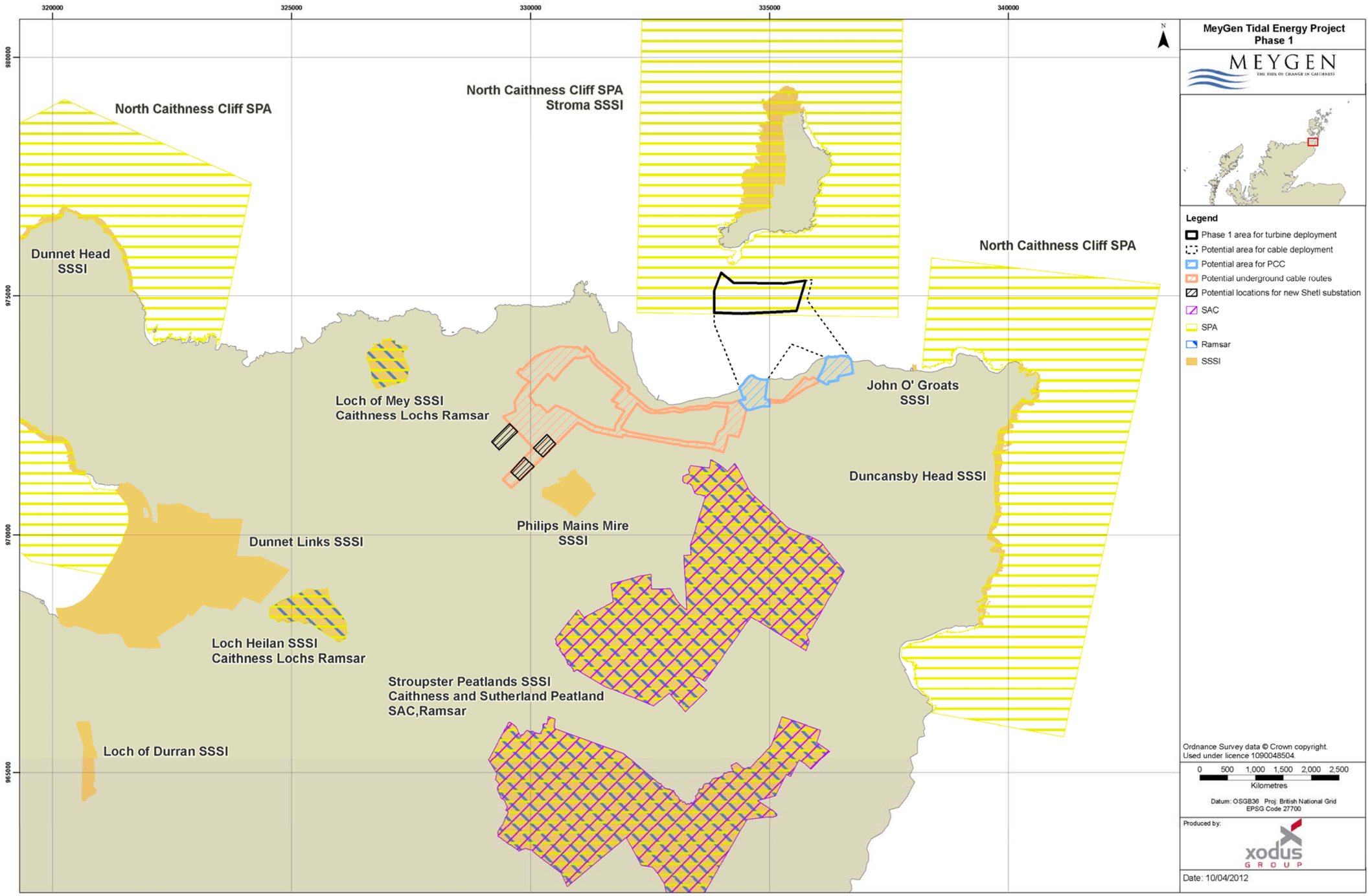

Figure 18.1: Statutorily protected sites located in the vicinity of the Project

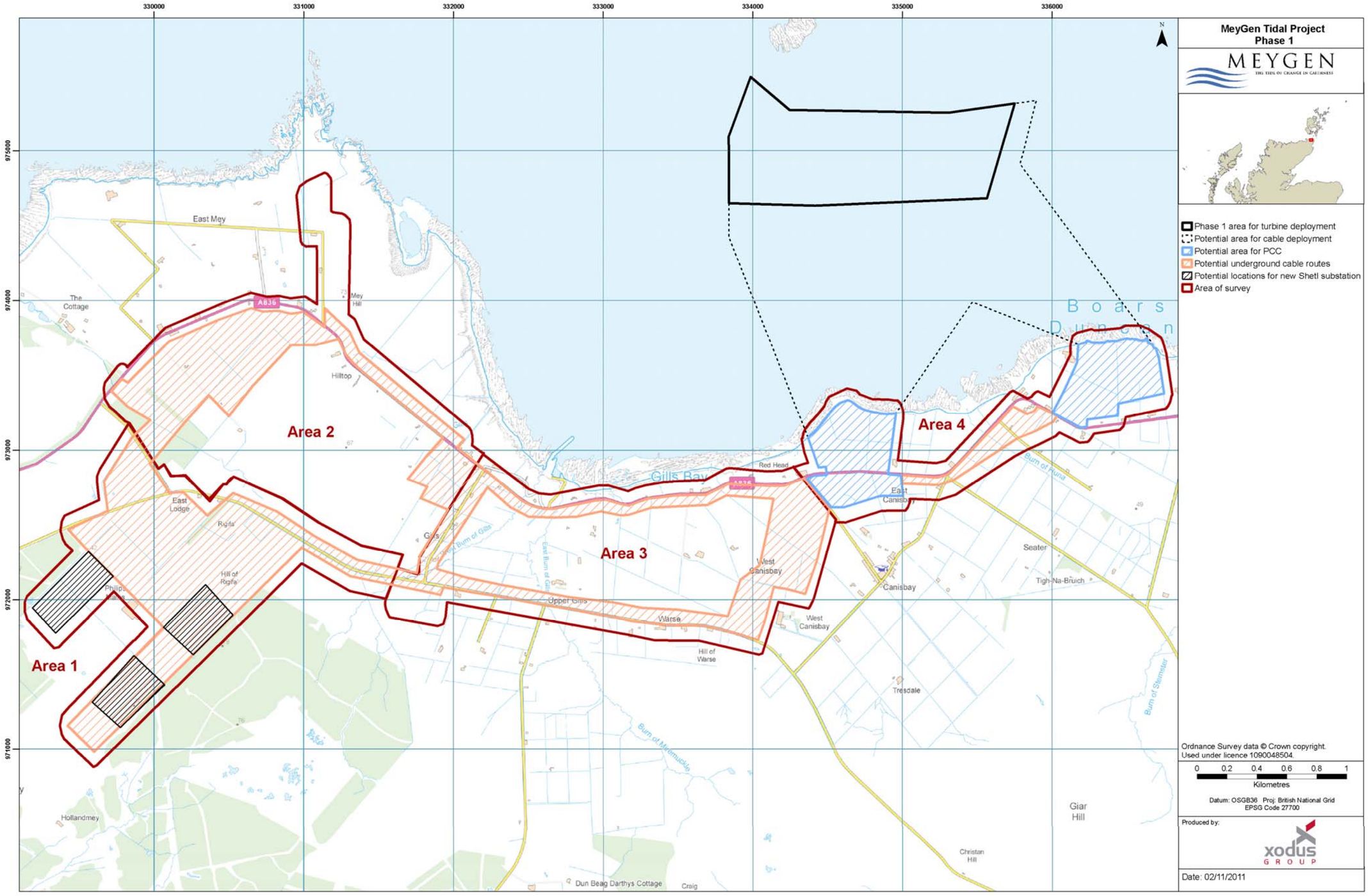

Figure 18.2: Details of extended Phase 1 habitat survey extent

18.4.3 Field survey

18.15 An extended Phase 1 habitat survey was carried out to characterise the terrestrial ecology baseline. It provides comprehensive baseline information for the assessment of impacts regarding terrestrial habitats and species. The extended Phase 1 habitat survey followed the Joint Nature Conservation Committee (JNCC) Guidelines (JNCC, 2010), to map and describe habitats within the Project footprint. Dominant botanical species were recorded for each habitat type observed, with evidence of protected species and areas of ecological interest recorded using target notes. Habitats within the Project footprint were also assessed for potential to support protected species; therefore a 100m buffer zone around the Project footprint was included in the survey extent (Figure 18.2) to ensure all potential environmental licensing requirements (particularly in relation to protected species) were given due consideration.

18.16 The extended Phase 1 habitat survey was undertaken at an optimal time of year (27th June to 1st July 2011), by suitably qualified and experienced environmental consultants from Xodus Environment (Leona Graves (MIEEM) and Anne-Marie Hodgson (AIEEM)).

18.17 The survey area covered 1339.31ha including 1004.44ha within the potential Project footprint, with an additional survey area of 100m (334.87ha) surrounding the potential Project footprint. The survey was constrained by limited access to several fields throughout the site, predominantly due to the frequent occurrence of livestock, particularly in Areas 3 and 4. Where livestock occurred within the site boundary, habitats were surveyed from field boundaries and survey results checked against aerial photography.

18.4.4 Significance criteria

18.18 In concurrence with IEEM guidance (IEEM, 2006) an ecologically significant impact within this assessment is defined as an impact (positive or negative) on the integrity of an ecological receptor (e.g. a defined site or ecosystem and/or the conservation status of habitats or species within a given geographical area). To determine if an impact on an ecological receptor is significant, it is necessary to determine if changes arising from the Project are likely to affect baseline conditions or the integrity of ecological receptors. The value of an ecological receptor will be used to identify the geographical scale at which the impact is significant. Notably, the value of an ecological receptor also relates to the consequences of Project development at an appropriate level (in terms of legislation, policy and/or development control). To determine whether there is likely to be an effect on the integrity of an ecological receptor from a Project impact, the following factors will be taken into consideration;

- Occurrence of alteration or removal of an ecosystem process;
- Effects on the nature, extent, structure and function of component habitats;
- Effects on the average population size and viability of component species; and
- Condition of the ecosystem / site being assessed.

18.19 Adherence to the EIA Regulations requires consideration of the significance of environmental effects as part of the EIA; within this section consideration of significance of Project effects is undertaken in relation to terrestrial ecology, specifically habitats and species. Assessment criteria regarding the significance of Project effects has been developed in accordance with standard principals and guidance; adapted from SNH (SNH, 2009) and IEEM guidance (IEEM, 2006).

18.20 The EIA process and methodology are described in detail in Section 8. Each assessment section is, however, required to develop its own criteria for the 'sensitivity of receptor' and 'magnitude of impact' aspects since the definition of these will vary between different topics. For terrestrial habitats and ecology, the significance criteria used in this section is based on the methodology described in Section 8 but the sensitivity of the receptor and magnitude of impact are defined in Table 18.4 and Table 18.5 respectively.

18.21 The environmental consequences of impacts are then considered by reference to the relevant criteria in the EIA Regulations. The significance of impacts in relation to the EIA Regulations is defined in Section 8, Table 8.2.

Sensitivity of receptor	Definition
Very High	▪ Sites of international designation (e.g. SAC, SPA) or species / assemblages which form qualifying interests of internationally designated sites. ▪ Globally threatened species or habitats (e.g. IUCN list). ▪ Species which are considered to be present in internationally important numbers or habitats, comprising an internationally important proportion of that habitat type.
High	▪ Nationally important sites (e.g. SSSI) or species / assemblages which form qualifying interests of nationally designated sites. ▪ Species / assemblages which contribute to an international site but which are not listed as qualifying interests. ▪ Ecologically sensitive species/habitats (e.g. rare) or present in nationally important numbers / area.
Medium	▪ Sites of local value. ▪ Habitats on Annex I or species on Annex II of the EC Habitats Directive. ▪ Species listed in Schedule 1 of the Wildlife and Countryside Act 1981 (as amended). ▪ Species present in regionally important numbers. ▪ Species / assemblages which contribute to a national site but which are not listed as qualifying interests. ▪ Species occurring within international/national sites but are not crucial to the integrity of the site. ▪ Species listed as priority species in the UK Biodiversity Action Plan (BAP).
Low	▪ Sites not containing features that would meet the criteria for sites of local value, but nevertheless having some biodiversity value. ▪ Any other species of conservation interest (e.g. Local BAP species, Scottish Priority Marine Features).
Negligible	▪ Habitats / species of undesignated Importance (e.g. a widespread species). ▪ Habitat / species of no conservation concern.

Table 18.4: Definitions for sensitivity of terrestrial ecology receptors

Magnitude of impact	Definition
Severe	▪ Widespread total loss or very major alteration to species and habitats such that the condition of features of qualifying interest (of internationally designated sites) will be fundamentally altered. ▪ Little or no recovery anticipated, with a high likelihood of impact occurrence.
Major	▪ Widespread change to characterising species or lasting change to habitat leading to medium-term damage with a medium likelihood of occurrence. ▪ Recovery (to original condition) anticipated taking several years following decommissioning.
Moderate	▪ Change to terrestrial species in a localised area (confined to Project footprint and immediate locality) for Project duration, with a moderate likelihood of occurrence, but with no lasting change to habitats. ▪ Good recovery potential following decommissioning (approximately 2 years).
Minor	▪ No significant effect. ▪ Change from baseline conditions measurable but within scale of natural variability, and confined to Project footprint, with a minor likelihood of occurrence. ▪ Temporary alteration or effects confined to a small percentage of available habitat, with rapid recovery likely.
Negligible	▪ No effect or not measurable effect. ▪ Effects unlikely to be discernable or measurable, with a negligible or no likelihood of occurrence.

Magnitude of impact	Definition
Positive	▪ An enhancement of an ecosystem or population parameter.

Table 18.5: Definitions for magnitude of impact on terrestrial ecology receptors

18.4.5 Data gaps and uncertainties

18.22 The extended Phase 1 habitat survey was undertaken at an optimal time of year (27th June to 1st July 2011) by suitably qualified and experienced consultants. It is therefore likely that the majority of flowering plants were visible and where dominant (or of conservation concern) were recorded; however, the survey was constrained by limited access to several fields throughout the site. This was primarily due to the presence of livestock, frequently occurring around the site and most abundantly in central areas within the footprint of proposed onshore cable routes.

18.23 Where livestock occurred within the site boundary, habitats were surveyed from field boundaries and survey results checked against aerial photography. This constraint may have contributed to some limitations in the recording of habitats and botanical species, with some field margins potentially surveyed in more detail than the mainstay of habitats in fields grazed by livestock at the time of survey. Additionally, several field drains and minor watercourses occurring in fields grazed by livestock were also not surveyed in detail due to constraining access.

18.5 Baseline Description

18.24 The terrestrial ecology baseline description presents the results of the desk-based ecological assessment, followed by consideration of data obtained from the extended Phase 1 habitat survey. Existing terrestrial ecology conditions, specifically habitat type, habitat extent and occurrence / distribution of relevant and protected species, are outlined and discussed in this section.

18.5.1 Statutorily protected sites

18.25 The Project footprint and survey extent does not lie within a statutorily protected site for nature conservation (Figure 18.1). However a number of sites with statutory protection do occur in the vicinity of the Project footprint; these are detailed below in Table 18.6. Statutorily protected sites within the vicinity of the Project include the following; Caithness and Sutherland Peatlands SAC, SPA and SSSI, located approximately 0.16km south of Area 3, North Caithness Cliffs SPA located 0.7km from Area 4, Caithness Lochs SPA and Ramsar site located 0.15km from Area 3 and Philips Main Mire SSSI, located approximately 0.55km to the south-east of one of the potential cable routes.

Site name	Qualifying feature(s) / interest(s) / Ramsar criteria	Approximate distance to potential Project footprint, with reference to area number shown in Figure 18.2 (km)			
		1	2	3	4
Caithness and Sutherland Peatlands SPA, SAC and Ramsar	SPA *Under Article 4.1* Regularly supporting populations of European importance of: ▪ Black throated diver (*Gavia arctica*); ▪ Golden eagle (*Aquila chrysaetos*); ▪ Golden plover (*Pluvialis apricaria*); ▪ Hen harrier (*Circus cyaneus*); ▪ Merlin (*Falco columbarius*); ▪ Red throated diver (*Gavia stellata*); ▪ Short eared owl (*Asio flammeus*); and ▪ Wood sandpiper (*Tringa glareola*). *Under Article 4.2* During the breeding season, supporting populations of European importance of migratory: ▪ Common scoter (*Melanitta nigra*); ▪ Dunlin (*Caldris alpine schinzii*); and ▪ Wigeon (*Anas Penelope*). SAC *Under Article 3* ▪ Blanket bogs ▪ Depression on peat substrates of the *Rhynchosporion*; ▪ Otter (Lutra lutra); ▪ Natural dystrophic lakes and ponds; ▪ Northern Atlantic wet heaths with *Erica tetralix*; ▪ Oligotrophic to mesotrophic standing waters with vegetation of the *Littorelletea uniflorae* and / or of the *Isoeto-Nanojun*cetea; and ▪ Transition mires and quaking bogs. Ramsar *Criterion 1* The site supports one of the largest and most intact areas of blanket bog in the world. *Criterion 2* The site supports a number of rare species of wetland plants and animals, including 3 species of nationally rare moss, 8 internationally scarce vascular plants and 4 nationally scarce mosses, 1 internationally rare species of insect and 10 nationally important species of breeding waterfowl. *Criterion 6* Regularly supporting species of dunlin and alpine (*schinzii*).	1.82	1.7	0.16	1.07
North Caithness Cliffs SPA	SAC *Under Article 4.1* ▪ Regularly supporting populations of European importance of peregrine (Falco peregrinus). *Under Article 4.2* Regularly supporting populations of European importance of migratory common guillemot (*Uria alge*). Regularly supporting in excess of 20,000 individual seabirds.	6.5	0.9	1.7	0.7
Caithness Lochs SPA and Ramsar	SPA *Under Article 4.1* ▪ Winter populations of whooper swan (*Cygnus Cygnus*) and Greenland white fronted goose (*Anser albifrons*). *Under Article 4.2* ▪ Winter populations of migratory greylag goose (*Anser anser*). Ramsar *Criterion 6* ▪ Supporting internationally important populations of	1.87	1.75	0.15	1.06

Site name	Qualifying feature(s) / interest(s) / Ramsar criteria	Approximate distance to potential Project footprint, with reference to area number shown in Figure 18.2 (km)			
		1	2	3	4
	whooper swan, Greenland white-fronted goose and greylag goose.				
Philips Main Mire SSSI	SSSI ▪ Bogs (upland); blanket bog habitat.	0.55	1.4	1.0	3.7

Table 18.6: Details of statutorily protected sites located within the surrounding environment

18.26 Notably, there are no local nature conservation designations in the Caithness area (Bromham, pers. com. The Highland Council, Highland Biodiversity Officer, 2011). In addition to sites which have statutory protection, there are a number of species and habitats which are considered important at either an international, national or local level. A number of these species and habitats have been recorded in the vicinity of the Project footprint or have the potential to occur there, refer to Table 18.8 for further details.

18.5.2 Terrestrial habitats

The UK Biodiversity Action Plan

18.27 The UK Biodiversity Action Plan (UK BAP) was published in 1994 and is the UK Government's response to the Convention on Biological Diversity (CBD), which the UK signed up to in 1992 in Rio de Janeiro.

18.28 The UK BAP describes the biological resources of the UK and provides detailed plans for conservation of these resources, at both national and local levels. Action plans for the most threatened species and habitats have been set out to aid recovery, and with reporting rounds every three to five years showing how the UK BAP has contributed to the UK's progress towards the significant reduction of biodiversity loss. The UK BAP encompasses over 160 Local Biodiversity Action Plans (LBAPs), which highlight local priorities for biodiversity and conservation, in addition to delivering agreed actions and targets for priority habitats and species including locally important wildlife and nature conservation sites.

18.29 Priority species and habitats are those that have been identified as being the most threatened and requiring conservation action under the UK Biodiversity Action Plan (UK BAP). Following review in August 2007 the UK BAP priority list now contains 1,150 species and 65 habitats. The UK BAP list is an important reference source and is used to inform statutory lists.

18.30 The objectives of the Caithness LBAP are outlined below in Table 18.7 and priority habitats specific to the Caithness Area plan are detailed in Table 18.8; some of these habitats have potential to occur within the potential Project footprint.

Objectives of the Caithness Local Biodiversity Action Plan (LBAP)
▪ To ensure that all habitats are managed in a way that takes account of their wildlife interests; ▪ To ensure that future development plans and proposals take account of local biodiversity; ▪ To promote projects and initiatives that help maintain or restore biodiversity towards natural levels; ▪ To develop quality education at all levels, to raise awareness of the biodiversity of Caithness amongst local people, visitors, funding organisations and policy makers; ▪ To reduce perceived or real conflicts between biodiversity and people, by increasing community involvement and local action for biodiversity; ▪ To improve access to information about important habitats and species, and their management requirements, and enable interested residents to improve their specialist knowledge and understanding; ▪ To secure additional support for biodiversity and related projects, and help publicise existing sources of funding and advice; and ▪ To establish a mechanism to help individuals, community groups and partners deliver the Caithness Biodiversity Action Plan, monitor progress and share information on biodiversity matters.

Table 18.7: Details of statutorily protected sites located within the surrounding environment

Habitat type		Potential to be found in the vicinity of the study area
Sea and coast	sublittoral sands and gravels	Y
	deep water mud habitats	N
	maerl beds	N
	horse mussel beds	N
	tidal rapids	N
	machair	Y
	coastal saltmarsh	Y
	coastal sand dunes	N
	coastal vegetated shingle	Y
	mudflats	N
	saline lagoons	N
	seagrass beds	Y
	sheltered muddy gravels	Y
	maritime cliff and slope	Y
River, loch and wetland	mesotrophic lochs	N
	eutrophic standing waters	Y
	fens	Y
	reedbanks	Y
Farm and croft land	native pine woodland	Y
	upland mixed ash woodland	N
	wet woodland	N
	lowland wood pasture and parkland	Y
Blanket bog and woodland	blanket bog	Y
	lowland heathland	Y
	upland heathland	N

Table 18.8: UK priority habitat types (UK BAP, 2011)

Aerial photography

18.31 Aerial photography (obtained online using Bing maps) was consulted to gain an initial insight into the possible habitats found within the four study areas. The level of image resolution was sufficient to identify areas of woodland and to indicate the presence of slightly larger watercourses such as burns; however image resolution was not good enough to detect smaller water bodies such as field drains and streams, or to enable identification of woodland type.

18.32 **Area 1 – cable routes close to proposed substation (see Figure 18.2):** Aerial photography from this area indicates habitats are dominated by agriculture. The area is divided into a number of fields of varying sizes, consisting of grassland displaying various levels of improvement. A strip of forestry occurs along the eastern boundary of the site, in addition to a small area along the western boundary. The north-east of the area is dissected by a minor road, to the north of which there is an area of heathland.

18.33 Based on aerial photography, it was predicted that the habitats with the most potential to support important or rare species would be found in the woodland strips and heathland areas. The field survey concentrated on these habitats within the area to assess potential for locally important habitats and / or species.

18.34 **Area 2 - cable routes (northern approach) to proposed substation (see Figure 18.2):** Aerial photography shows a large area of heathland which appears uniform in nature. This is surrounded by agricultural land of varying uses. The A836 road runs close to the northern boundary of the area; north of this road (to the east of the area) there appears to be a further heathland habitat in addition to a very small area of woodland, occurring to the north of the road (to the west of the area).

18.35 Based on aerial photography, it was predicted that the habitats with the most potential to support important or rare species would be found in the woodland strips and the heathland area. The field survey examined in detail the nature of all the habitats within this area and assessed the potential for the presence of key species.

18.36 **Area 3 - cable routes (eastern approach) to proposed substation (see Figure 18.2):** Aerial photography indicated that this area is largely dominated by agriculture and predominantly consists of fields divided by fences and walls. A small area of heathland can be seen in the south-west of the area, with two potential watercourses to the west of the area.

18.37 Based on aerial photography, it was predicted that the habitats with the most potential to support important or rare species would be found in heathland areas and along potential watercourses. The field survey concentrated on these habitats within the area and identified the potential for key species to occur in heathland and riparian zones.

18.38 **Area 4 – Ness of Quoys and Ness of Huna cable landfall / PCC sites and interconnecting cable routes (see Figure 18.2):** Aerial photography indicated that this area is largely dominated by agriculture and consists largely of fields divided by fences and walls. The area is dissected by the A836 road along an almost central line. This area also includes some intertidal habitats.

18.39 Based on aerial photography, it was predicted that habitats which have the most potential to support important or rare / protected species would comprise littoral areas located along the coastline.

Extended Phase 1 Habitat Survey results: Habitats within the Project footprint

18.40 Habitats within the Project footprint are dominated by grasslands of various levels of improvement and grazing pressure. Both semi-improved neutral and acidic grassland habitat types are present throughout the site, in addition to improved grassland, occurring where grazing and nutrient enrichment by livestock has been more intense. Dominant grasses include species typical of such habitats, including; rough meadow grass, Yorkshire fog, cocksfoot, perennial ryegrass, meadow foxtail and crested dogs tail. Broad-leaved dock, common nettle, sorrel and thistle species were present around field margins, with meadow buttercup, daisy and clover species occurring throughout.

18.41 *Juncus spp.* (soft rush) species were frequently observed in areas of acidic grassland, which were commonly located adjacent to heathland; often producing acid grassland / heathland mosaic habitats (both wet and dry heathland mosaics were recorded). Species observed in these habitats included common heather, cross-leaved heather, bog cotton, heath rush and matt grass species, with frequently observed tormentil, heath bedstraw, milkwort and occasional orchids. Sphagnum moss was present throughout these areas in varying abundance. Notably, land markings suggest previous peat extraction throughout the site in heathland habitats; therefore it is possible (and likely) that existing heathland may be comprised of historically degraded blanket bog.

18.42 Woodland, where present, is largely limited to coniferous plantation, with only a small area of semi-natural broad-leaved woodland present to the west of Area 2. Within Area 2, some scattered and immature rowan trees are present along field boundaries; however the most frequently observed habitat present along field boundaries was gorse scrub, commonly observed in Area 3 lining several field drains.

18.43 Watercourses occurring within the Project footprint are restricted to burns and shallow field drains, with the two principal watercourses (comprising the East and West Burn of Gills) located in Area 3. The Burn of Huna, located in Area 4, also provides some freshwater habitat; elsewhere in the site small watercourses have been culverted with likely re-profiling of burns to promote field drainage. Small pools are present in wet heathland habitats to the south of Area 3 (within the survey buffer), where terrestrial habitats support more areas of sphagnum moss than present elsewhere around the site.

18.44 Several farm steadings and residential properties are located across the site, with the majority of buildings occurring along roads and in peripheral areas of the site. In addition to livestock, several fields of arable crop are present, particularly in Areas 2 and 4, with areas of bare ground recorded where fields had been recently ploughed. In general, habitats occurring within the site can be described as semi-natural and frequently were considered as degraded, due to previous and current land uses.

Phase 1 habitat classification

18.45 Details of habitat types and dominant botanical species recorded within the Project footprint are presented in the extended Phase 1 habitat survey report which is provided on the accompanying supporting studies CD (Xodus, 2011a). An overview of recorded habitat types and dominant species observed within the Project footprint are listed below in Table 18.9; a summary of the Phase 1 habitat survey results is presented in Figure 18.3.

Habitat code	Habitat type	Details specific to habitats occurring within the Project footprint
A.1.1.1	Semi-natural Broadleaved Woodland	Broadleaved woodland is very limited throughout the site, with only a small area located to the west of Area 2. Trees species in this habitat included sycamore, alder and ash with understory scrub dominated by grasses, ferns and marsh thistle.
A.1.2.2	Coniferous Plantation	Coniferous plantation is present in solid blocks throughout the site, particularly in Area 1 and Area 2 where is it located adjacent to grassland used for grazing livestock. Additionally, a small area of plantation in Area 3 may provide a wind breaking function to an adjacent residential property.
A.1.3	Mixed Woodland	A small area of mixed woodland is present adjacent to residential properties in Area 3. Tree species include sycamore, ash, hawthorn, rowan and planted spruce species.
B.1.2	Semi-improved Acid Grassland	Several fields of acid grassland exists where grazing occurs and where the habitat grades into dwarf shrub heath. Within these habitats, soft rush (*Juncus spp.*) is abundant, with heath rush, sorrel and thistle species present throughout.
B.2.2	Semi-improved Neutral Grassland (SING)	This is the most abundant habitat type occurring within the Project footprint and is comprised of grassland modified by grazing; therefore the diversity of species in this habitat is lower than would be expected in similar unimproved grasslands. Cocksfoot, Yorkshire fog and fescue species were present in the majority of SING, with meadow buttercup also frequently observed.
B.4	Improved Grassland	Improved grassland was frequently observed throughout the site, occurring where grazing had taken place and the resultant sward was short, even and nutrient enriched. Within fields of improved grassland, marsh thistle, broad-leaved dock and spear thistle were recorded around field margins, with white clover and occasional meadow buttercup located throughout this habitat.
B.6	Poor Semi-improved Grassland	This habitat was evident where grazing by livestock was very intensive and where species diversity was lower than observed in fields of improved grassland.
C.3.1	Tall Ruderal	Tall ruderal vegetation was occasionally recorded at field margins, where common nettles, broad-leaved dock and thistle species comprised tall stands of vegetation.
D.1.1	Dry Dwarf Shrub Heath (acid)	This habitat was recorded where heather species were dominant (greater than 25% cover), with occasional bilberry and cowberry.
D.5	Dry heath / acid grassland mosaic	This habitat was recorded where a mixture of acid grassland and dry heath was present. Where present, this habitat was often grazed.
D.6	Wet heath / acid grassland mosaic	This habitat was recorded where a mixture of acid grassland and wet heath was present. Small pools were recorded in this habitat, particularly in Area 1.
E.1.7	Wet Modified Bog	This habitat was very localised and where present appeared to have markings suggestive of previous peat extraction. This habitat supported little or no sphagnum vegetation.
G.2	Running Water	Small water courses were present within the Project footprint, including; the East Burn of Gills, the West Burn of Gills and the Burn of Huna. Field drains were present throughout the site and occasionally supported shallow water courses.
H.4	Boulders / rocks above the high tide mark	This habitat type was present in Area 4, where the site boundary is located adjacent to the coast.

Habitat code	Habitat type	Details specific to habitats occurring within the Project footprint
H.5	Strandline Vegetation	This was present in coastal areas immediately adjacent to Area 4. Common orache was recorded in this habitat, with a large pebble substrate.
J.1	Arable	Several fields within the site boundary were used to grow arable crops.
J.2	Amenity	Small areas of amenity grassland were present around buildings, such as around the church at Canisbay.
J.3.6	Buildings	Residential and agricultural buildings were located throughout the site, with the majority of buildings located along the main roads of the area.
J.4	Bare Ground	Bare ground was present and noted where fields had been recently ploughed and additionally where bare ground occurred around buildings.

Table 18.9: Habitat types recorded within the Project footprint and surrounding environment during the extended Phase 1 habitat survey (June 2011)

18.5.3 Protected and relevant terrestrial species

Caithness Biodiversity Action Plan Priority Species

18.46 The terrestrial species detailed in Table 18.10 have been identified as priority species in the UKBAP and are known to occur in Caithness, with potential to occur within the Project footprint.

Terrestrial species		Potential to be found in the vicinity of the study area
Bees	great yellow bumble bee (*Bombus distinguendus)*	Y
Fungi	pink meadow cap (*Hygrocybe calyptriformis)*	Y
Mammals	water vole (*Arvicola terrestris)*	Y
	brown hare (*Lepus europaeus)*	Y
	otter (*Lutra lutra)*	Y
	pipistrelle bat (*Pipistrellus pipistrellus)*	Y
Mosses	long-leaved threadmoss (*Bryum neodamense)*	Y
Vascular plants	Scottish small reed (*Calamagrostis scotica)*	Y
	an eyebright *(Euphrasia rotundifolia)*	Y
	yellow marsh saxifrage (*Saxifraga hirculus)*	Y
	Killarney fern (*Trichomanes speciosum)*	Y

Table 18.10: Caithness BAP priority species (UK BAP, 2011)

Scottish Biodiversity List

18.47 The Scottish Biodiversity List (SBL) is a list of plants and habitats that Scottish Ministers consider to be of principal importance for biodiversity conservation in Scotland. The purpose of the list is to help public bodies carry out their Biodiversity Duty by identifying the species and habitats which are the highest priority for biodiversity conservation in Scotland. It is also a useful source of information on nature conservation in Scotland (SNH, 2010). Of the species and habitats listed, a number have the potential to occur in the vicinity of the study area.

18.5.4 Extended Phase 1 Habitat Survey results: Protected species with potential to occur within the Project footprint

18.48 Table 18.11 details historical species records within the Project footprint and surrounding environment. This data includes species which have statutory protection, are listed as a priority UK BAP species or LBAP species, or additionally if a species is featured on the SBL and is relevant to the study area.

Species	Status	Record description	Source
AMPHIBIAN AND REPTILE SPECIES			
Common toad (*Bufo bufo)*	UK BAP Priority species	Reptiles and Amphibians Dataset, provided by Biological Records Centre. Recorded before 1995 NGR ND3472	NBN Gateway
Adder (*Vipera berus*)	UK BAP Priority species	Atlas of amphibians and reptiles in Britain 1995. Field observation recorder unknown. Recorded circa 1994 NGR ND37 (10km grid square)	NBN Gateway
MAMMAL SPECIES			
European water vole (*Arvicola terrestris)*	UK BAP Priority species SBL	Field record by Mary Legg (03/05/2008) NGR ND313718	HBRG
Wild cat (*Felis silvestris)*	UK BAP Priority species SBL	Mammal records from Britain from the Atlas of Mammals (1993). Recorded by Caithness Records Centre in 1985 (Dataset resolution of 100m)	NBN Gateway
European otter (*Lutra lutra)*	European Protected Species UK BAP Priority species SBL	Field record of one live otter by Mary Legg (21/01/2011) NGR ND 360732	HBRG
Roe deer (*Capreolus capreolus)*	SBL	Field record by Dave Jones for three Roe deer (24/10/2008) NGR ND3770	NBN Gateway
Harbour Seal *(Phoca vitulina)*	Annex II UK BAP Priority species	Field record by Dave Jones for one live harbour seal (10/05/2009) NGR ND328730	NBN Gateway
Common pipistrelle (*Pipistrellus pipistrellus)*	European Protected Species UK BAP Priority species SBL	Field record by Les Hatton (06/08/2010) NGR ND379735	NBN Gateway
INVERTEBRATE SPECIES			
Great yellow bumble bee (*Bombus distguendus)*	UK BAP Priority species SBL	Field record by Bob Dawson (06/09/2009) NGR ND327727	HBRG
VASCULAR PLANT SPECIES			
Narrow fruited water stalwort (*Callitiche palustris)*	SBL	Vascular Plants Database, provided by Botanical Society of the British Isles (08/08/2011) (10km resolution in grid square ND37)	NBN Gateway
Heather *(Calluna vulgaris)*	SBL	Vascular Plants Database, provided by Botanical Society of the British Isles (08/08/2011) (10km resolution in grid square ND37)	NBN Gateway
Harebell (*Campanula rotundifolia)*	SBL	Vascular Plants Database, provided by Botanical Society of the British Isles (Between 1970-1986) (10km resolution in grid square ND37)	NBN Gateway

Table 18.11: Records of protected and relevant species occurring in the vicinity of the Project footprint (obtained from NBN Gateway, 2011, HBRG records, 2011)

Bat

18.49 Several outbuildings and residential properties located within the Project footprint were identified as having potential to support roosting bats. A derelict house located adjacent to a potential underground cable route in the centre of the Project footprint, in addition to agricultural buildings and a farmhouse to the west of the Project footprint near the Ness of Huna (occurring within a potential cable route) were assessed as having numerous structural features which may support roosting bats. These features include large undisturbed and south-facing roof spaces, with unobstructed roof voids and entrances which may enable bats to fly through. Additionally, the use of traditional stone and pre 20th century/early 20th century building construction may provide roosting opportunities for crevice dwelling species such as pipistrelles. The aforementioned buildings are located in close proximity to good bat foraging habitat, including woodland edges and wet heath/acid grassland mosaic, also enhancing their potential as suitable roosting sites for bat species. Bat species (*Pipistrelle spp*.) have been recorded in the wider environment, however their status within the Project footprint is unknown. Refer to Figure 18.4 for locations of buildings occurring within the Project footprint identified as having potential to support roosting bats.

18.50 Notably, no large mature deciduous trees (with features that may support roosting bats) were identified within the Project footprint; semi-mature woodland present within the potential cable route (occurring in the central area of the Project footprint) was generally comprised of coniferous plantation, assessed as having generally limited opportunities to support roosting bats. However, woodland habitats within the site boundary may provide bat species with suitable foraging habitat, particularly where woodland edges occur in close proximity to watercourses, wet heathland and pools.

18.51 Currently there are no plans to undertake works affecting potential roosting sites in residential and / or agricultural buildings, therefore further consideration of bat species is not required.

Otter

18.52 Field evidence of otter (predominantly otter spraint) was identified inland along the Burn of Huna and in coastal habitats adjacent to the east of the Project footprint, including around the Ness of Quoys and adjacent to the Ness of Huna. In coastal habitats otter spraint was present on large boulders and at the bottom of cliffs, including at the coastal outflow of a vegetated drainage channel, immediately adjacent to the proposed Ness of Quoys Horizontal Directional Drilling (HDD) area. The location of this spraint suggests otters may use this field drain as a corridor to move into terrestrial habitats from the coast, or potentially otters may utilise the dense riparian vegetation for resting purposes as a “couch”. Further east along the coast a possible holt and additional couch was identified; located at the base of coastal cliffs, adjacent to the Ness of Huna.

18.53 Field evidence observed during the survey suggests that locally, otters utilise coastal habitats to a greater extent than fresh-water watercourses, pools and field drains. However, evidence also suggests that otters are likely to use burns and field drains in the area (including within the Project footprint) as corridors to other habitats such inland holts and freshwater pools, for foraging purposes and to obtain shelter. Notably, the Caithness and Sutherland Peatlands SAC (designated for its otter population) is located less than 2km away from the onshore Project footprint; it is therefore possible that otters originating from the SAC use habitats within the Project footprint as a corridor to the marine environment or for sheltering / foraging purposes. Refer to Figure 18.4 for details regarding the location of otter field evidence identified within the Project footprint.

Scottish wildcat

18.54 No field evidence of wildcat was identified within the Project footprint or in the surrounding environment. Habitats including grassland / heathland mosaic and farmland may provide foraging habitat for this species; however the level of localised habitat disturbance (due to agricultural activities, peat extraction and forestry operations) may make this area unsuitable for this cryptic species. One dated record of wildcat (National Biodiversity Network, 1985) occurs at the boundary of the Ness of Quoys PCC site and the footprint of potential underground cable routes within the central area of the Project footprint; however there are no further National Biodiversity Network records of this species occurring in the surrounding area or wider environment. More recent sightings of wildcat (Scottish Wildcat Association, 2007) show two records of wildcat occurring in the Caithness region, located approximately 10km to the south of the site.

18.55 According to the Wildcat Association, less than 400 individual wild cats remain in the wild, with the highest percentage of wildcat records occurring in Aberdeenshire, followed by Inverness-shire, Ardnamurchan and Morvern, then Perthshire and the central Highlands (Davis and Gray, 2010). Due to the Project location it is considered unlikely that habitats within the Project footprint are of particular importance to this species. However due to their ecology, wildcats have extensive territories with potential to cover large distances of up to 10km in one night[3]. It is therefore possible that wildcats may occasionally use habitats within the Project footprint and surrounding environment for foraging purposes, however as noted; habitats within the Project footprint are unlikely to be of key importance to this species. Further consideration of wildcat is not deemed necessary.

Badger

18.56 No field evidence of badger was observed within the Project footprint or in the surrounding environment. Habitats such as grassland (particularly improved and semi-improved grassland) occurring within the Project footprint may provide suitable badger foraging habitat. However, the absence of badger field evidence and paucity of historical badger records in the wider area strongly suggests that badgers are not present within the Project footprint or are present within the surrounding environment. Further consideration of this species is not necessary.

Water vole

18.57 No field evidence of water vole was identified during the survey, both within the Project footprint and in the surrounding environment. However, habitats occurring within the Project footprint, predominantly small watercourses including vegetated burns and field drains, were identified as having potential to support this species. Notably, water vole habitat is protected against damage and destruction, and water voles are protected against disturbance whilst using their habitats[4].

3 Scottish Wildcat Association webpage. www.scottishwildcats.co.uk/ [Accessed 12/07/2011}.
4 SNH. Conserving Scotland’s Water Voles. www.snh.org.uk/publications/on-line/wildlife/voles/default.asp [Accessed 05/2011]

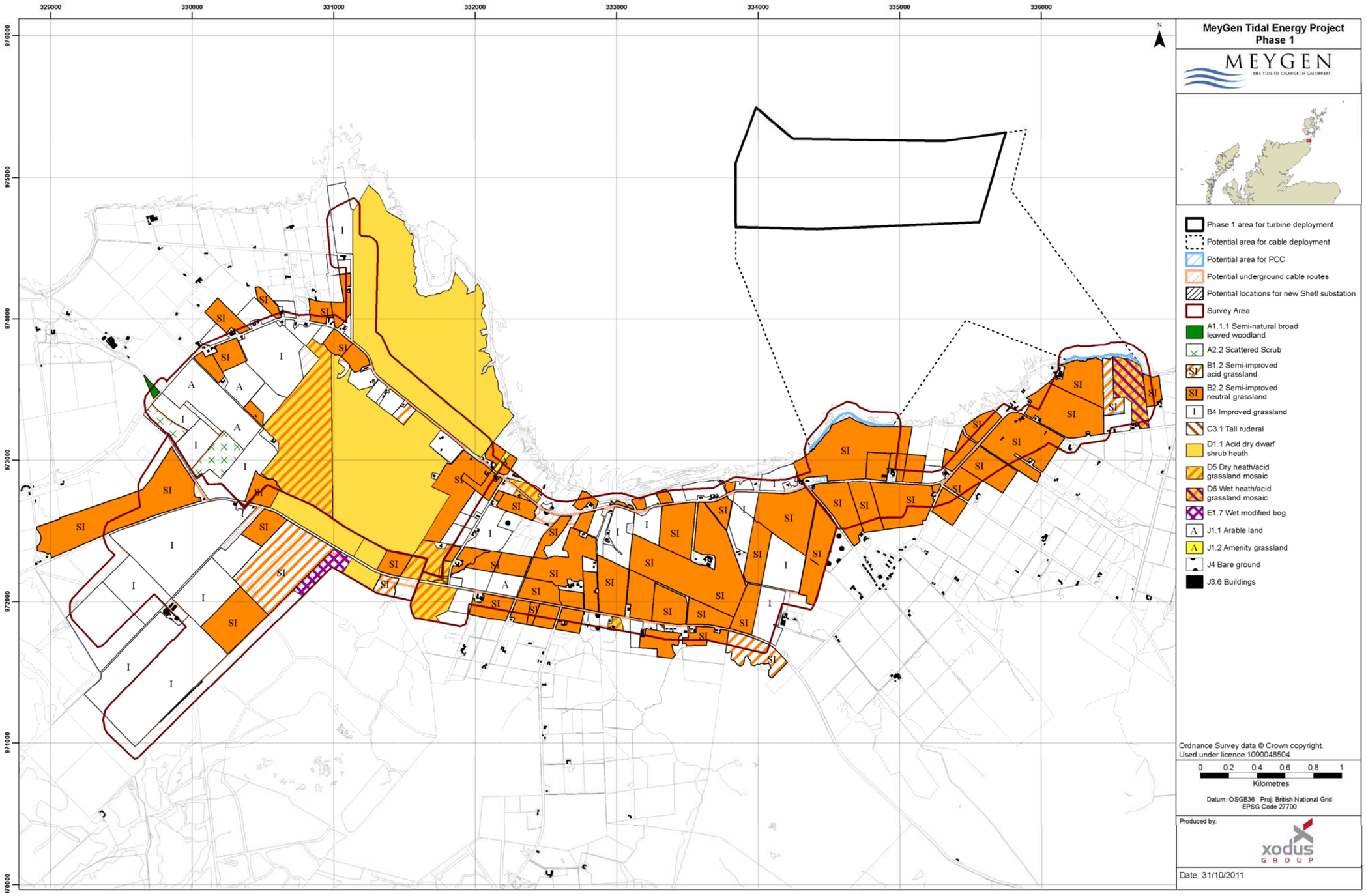

Figure 18.3: Summary of Phase 1 Habitat survey results

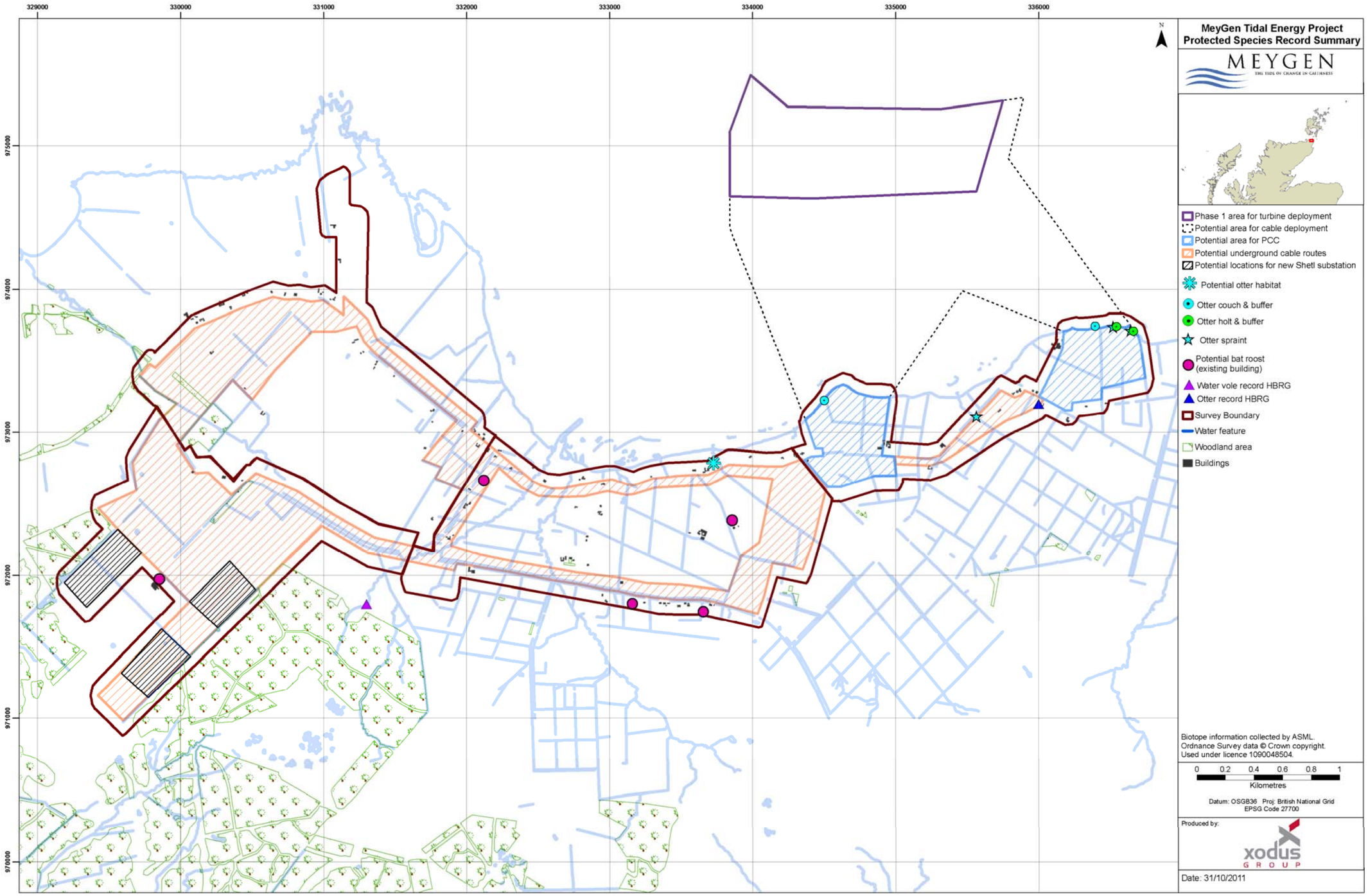

Figure 18.4: Summary of protected species survey results

18.58 Relatively recent records of water vole (National Biodiversity Network, 2008) occur in close proximity to the west of the Project footprint (in close proximity to the proposed SHETL substation locations and potential underground cable routes) and additionally along minor watercourses which flow into the site boundary. These watercourses may suffice as corridors to habitats within the Project footprint; it is therefore possible that this protected species is present within the Project footprint and / or immediate surrounding environment.

Red squirrel

18.59 Despite the presence of occasional blocks of coniferous woodland within the western area of the Project footprint and coniferous woodland occurring adjacent to the proposed substation locations (within Area 1), woodland habitats were assessed as largely unsuitable for red squirrel. Coniferous plantation was dominated by spruce species, with very small areas of deciduous woodland occurring around the site. Mature coniferous plantation dominated by Sitka Spruce will likely support only low densities of red squirrel[5], however the lack of connectivity to other woodland habitats within the surrounding environment makes it very unlikely that red squirrels will be present within this habitat. Notably, there are no known records of red squirrel occurring in either the local or wider area; further consideration of this species is therefore not required.

Amphibian species

18.60 No permanent ponds or lochans were identified within the potential Project footprint; however two ponds were identified adjacent to the survey extent, south of the potential underground cable route at West Canisbay and to the south-west of the proposed substation location and potential cable routes to the west of the Project footprint. Temporary and occasional pools were present in areas of wet heathland; during the field survey a common frog was observed in wet heathland / acid grassland mosaic habitat within the footprint of a potential underground cable route, to the central and south of the Project footprint. Records of common toad and common frog exist for the wider area, and one record of both palmate and great crested newt occurs in the surrounding environment. Notably, these newt records are relatively remote from the site (greater than 10km for the closest great crested newt record and approximately 2km for the closest palmate newt record). The paucity of amphibian records for the local area and absence of suitable breeding habitat makes it very unlikely that habitats within the Project footprint are of importance to amphibian species. Further consideration of amphibian taxa is therefore not deemed necessary.

Reptile species

18.61 Habitats within the Project footprint were assessed to be largely unsuitable for reptile species, due to the absence of suitable hibernacula sites, abundance of grazed grassland, poor connectivity to other more suitable habitats, northerly aspect and location on the northern coast of Scotland. The northerly aspect of the Project footprint and likely exposure to strong northerly winds makes it unlikely that environmental conditions suitable for reptile species will occur in the locality. No known reptile records occur within the Project footprint; however two relatively dated records of adder (National Biodiversity Network, 1989) occur approximately 2km south-east of the Project footprint. Habitats in which reptile species are more likely to occur are remote from the Project footprint; further consideration of reptile species is not required.

18.5.5 Terrestrial ecology baseline summary

18.62 The Project footprint does not fall within the boundaries of any statutorily protected nature conservation sites (Figure 18.1); however it is acknowledged that Caithness and Sutherlands Peatlands SAC is located approximately 0.2km from the study area. Whilst recommendations are provided in the extended Phase 1 habitat survey report for further pre-construction studies to ascertain the status of several protected species potentially occurring within the Project footprint (including otter and water vole); habitats occurring within the survey area are considered to be of limited ecological value. Grassland (with various degrees of grazing pressure), heathland and coniferous plantation are widespread in the surrounding environment. Where recorded, these habitats were often degraded and supported commonly occurring botanical species, typical of the region. The majority of habitats within the Project footprint (approximately 70%) are comprised of improved and semi-improved grassland used for agricultural grazing. The remaining approximate 30% of habitat occurring within the Project footprint is comprised of coniferous woodland, heathland and heathland / grassland mosaic.

18.63 Heathland, peatland, mire and woodland habitats occur outwith the Project footprint (particularly to the south of the survey area); these habitats are exposed to less anthropogenic pressure and therefore are likely to be of greater ecological significance than habitats occurring within the Project footprint, supporting more established and diverse botanical communities, and potentially offering increased opportunities for protected species.

18.64 Field evidence of otter was recorded in coastal habitats and along the Burn of Huna during the field survey; habitat continuity observed within the Project footprint suggests it is possible for otter to occur elsewhere in the local environment. No field evidence of water vole was observed during the field survey; however suitable vole habitat was identified along vegetated burns and field drains (including the East and West Burn of Gills, and the Burn of Huna). Additionally, recent records of water vole occur in close proximity to the Project boundary, suggesting that there is potential for water vole to be present within the Project footprint (see Figure 18.4 for further details). Several residential and agricultural buildings were also identified as having potential to support roosting bats; however the status of bat species within the Project footprint is currently unknown. Further consideration of bat species will not be necessary unless current design proposals change and buildings identified as potential roosting sites are affected by the proposed works.

18.6 Impacts during Construction and Installation

18.6.1 Impact 18.1: Impact to statutorily protected sites

18.65 Construction of subterranean cable routes may have temporary implications for the local hydrological regime. It is recognised that several water dependant statutorily protected sites (including areas of blanket bog, a UKBAP priority habitat) are located in close proximity to the proposed Project footprint; it is notable that these protected sites occur at a slightly higher elevation than the proposed Project. Philips Main Mire SSSI consists of a complex of blanket bog habitat and is situated in the vicinity of the Project; however, this habitat is surrounded by an extensive area of coniferous woodland which may buffer indirect hydrological impacts resulting from the construction works. Although Philips Main Mire SSSI and other designated sites local to the Project footprint are of high value, indirect impacts on the local hydrological regime (due to construction activities) are considered to be of a temporary nature and local to the construction footprint only, with restoration of habitats to an original condition where affected. Within the hydrological assessment, relevant potential Project effects including modification of the drainage regime and impact to surface flows were assessed as not significant. For further details regarding the likely hydrological impacts resulting from the Project, refer to Section 17. Also see Section 18.11 on Habitats Regulations Appraisal.

Impact significance

18.66 Due to the high ecological value of the statutorily protected sites, the sensitivity of this ecological receptor is considered very high; however, the temporary and localised nature of construction impacts is considered of a negligible magnitude.

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Very high	Negligible	Minor	Not Significant

MITIGATION IN RELATION TO IMPACT 18.1
▪ No proposed mitigation proposed as no significant impact is predicted.

5 Red Squirrels in South Scotland. Habitat Management for Red Squirrels. Available at http://www.red-squirrels.org.uk/habitat.asp [Accessed 12/07/2011].

18.6.2 Impact 18.2: Disturbance to terrestrial habitats

18.67 Throughout the construction phase, particularly during site preparation including vegetation clearance and excavation works for the installation of subterranean cable routes, there is potential for disturbance impacts to terrestrial habitats; both within the Project footprint and in the immediate surrounding environment. It is acknowledged that construction related disturbance impacts will be of a temporary nature only.

18.68 Construction of cable route, HDD and PCC site will likely cause direct physical disturbance to habitats across the site. Construction activities likely to cause disturbance impacts to terrestrial habitats include the following; vegetation clearance, ground excavations, materials storage, increased noise, localised increases in ground vibrations, increased road traffic and an increase in general human presence. Temporary works during the onshore construction and installation phase of the Project including; HDD site establishment, PCC construction and subterranean cable installation, will likely include one or more of the following;

- Creation of a lay-down areas;
- Fencing for pubic safety and cable security;
- Topsoil storage;
- Spoil and water management;
- Traffic management at entrance to work area; and
- Road crossings.

18.69 Habitats occurring within the cable route footprints are comprised predominantly of semi-improved and improved grassland, with localised areas of dry dwarf shrub heath and agricultural drainage channels; these habitats are modified and are considered of low ecological value. In addition to potential for impacts to grassland habitats, construction activities taking place in the western region of the Project (within the proposed footprint of potential underground cable routes and the SHETL substation option locations), may indirectly impact upon coniferous trees (forming part of plantation woodland), located immediately adjacent to the proposed Project footprint.

18.70 Habitats likely to be affected by construction related disturbance impacts consist of widespread and modified habitat types of undesignated importance and of no conservation concern; therefore, the sensitivity of this ecological receptor is considered negligible. As noted above, construction impacts will be of a temporary nature and will be confined to the Project footprint and working area only.

Impact significance

18.71 The sensitivity of terrestrial habitats present within the Project footprint is considered negligible. No significant impact is expected, with full recovery of affected habitats expected, through habitat restoration works undertaken as part of completion of construction. The magnitude of disturbance impacts to terrestrial habitats is therefore assessed as minor.

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Negligible	Minor	Negligible	Not Significant

18.72 Additionally, it is recognised that disturbance to terrestrial habitats, particularly in coastal areas, such as around the Ness of Quoys or Ness of Huna and to minor watercourses, may have implications for protected species including otter and water vole. Otters are present in coastal habitats immediately adjacent to the proposed PCC locations; construction activities taking place in these areas have potential to indirectly impact upon this protected species through habitat disturbance, increased noise, ground vibrations and human presence. This has been recognised and is accounted for in the proposed mitigation outlined below.

18.73 The status of water vole within the Project footprint and surrounding environment is currently unknown. Should further ecological investigation confirm water vole presence within the Project footprint, construction-related habitat disturbance will be assessed in conjunction with regulatory consultation, to ascertain appropriate licensing requirements and mitigation. Further ecological investigation in relation to otter and water vole will be undertaken in advance of construction, to inform Project design and construction methodologies, with the aim to reduce disturbance related impacts where possible.

MITIGATION IN RELATION TO IMPACT 18.2

- Although no significant impact has been identified, mitigation measures have been provided as a precautionary approach to ensure this remains the case.
- Employment of best working practices during construction works, including restoration of affected habitats to an original condition, where conditions allow.
- Submission of Construction Environmental Management Plan (CEMP), including details of measures to reduce construction disturbance to terrestrial habitats and species where possible.
- Further ecological investigation in relation to otter and water vole status (once onshore Project specifics are confirmed), to ascertain protected species licensing requirements.
- Application for a EPS licence in relation to disturbance of otter habitat and application for a water vole habitat disturbance licence, if either licensing requirement is deemed necessary.

18.6.3 Impact 18.3: Terrestrial habitat loss

18.74 Terrestrial habitat loss will occur within the Project footprint, specifically where permanent onshore structures are built, including the area of cable landfall and PCC location. Habitat loss will be localised and will only occur within the Project footprint. Habitats likely to be impacted by permanent habitat loss comprise widespread and modified habitats; predominantly agricultural semi-improved and improved grassland, and potentially a small area of wet / heath acid grassland mosaic located within the footprint of the Ness of Huna cable landfall area (should this option be selected). Habitat loss at the selected PCC will be permanent.

Impact significance

18.75 Habitats likely to be affected by habitat loss are undesignated, widespread and of no conservation concern, therefore the sensitivity of this receptor is considered negligible. The magnitude of the impact is considered minor.

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Negligible	Minor	Negligible	Not Significant

MITIGATION IN RELATION TO IMPACT 18.3

- Although no significant impact has been identified, mitigation measures have been provided as a precautionary approach to ensure this remains the case.
- Where ecologically sensitive habitat loss does occur, compensatory measures (such as replanting of lost tress) will be considered as part of completion of construction and restoration of habitats to

an original condition (where project operations allow).

- Where otter habitat is disturbed (particularly in the vicinity of the PCC location where long term disturbance may occur), application for a European Protected Species Licence will be undertaken and a programme of relevant mitigation will be implemented where necessary.

18.6.4 Impact 18.4: Disturbance to otters

18.76 Construction related impacts including habitat disturbance, increased noise, increased ground vibrations and an increase in human activity (including an increase in local road traffic and vessel presence in nearshore waters) may result in indirect disturbance to otters. Otters are present in coastal habitats around the Ness of Huna and Ness of Quoys and additionally have been recorded in close proximity to the Project footprint. It is therefore likely, where present, that otters will be vulnerable to disturbance during the construction phase of the Project, especially during intrusive activities such as HDD activity.

18.77 Should fish species in marine habitats be disturbed or displaced during offshore construction works, it is recognised that there is also potential for otters to be indirectly displaced to meet foraging requirements. In coastal habitats otters predominantly forage in waters of 2m depth (McCafferty, 2005) and have been recorded at depths of up to 15m (Twelves, 1983), therefore impacts to otters using marine habitats are most likely to take place during the construction and installation phase, particularly during HDD activities. Potential for disturbance and displacement of fish species in the marine environment is discussed further in Section 13; it is considered unlikely that the proposed development will significantly impact upon the behaviour or movements of fish species in the Inner Sound, therefore indirect impacts to otter foraging are not anticipated.

18.78 A particular risk to otters (as a secondary impact from construction disturbance) is the potential for increase in road traffic due to a temporary increase in construction traffic and use of temporary access routes; this may increase the risk of fatality due to an increase in the likelihood of road traffic accidents during the construction phase. It is acknowledged that an increase in construction related road traffic will be small and a temporary impact only (refer to Section 22); however the potential for significant impact to the local otter population (i.e. increased road fatality) during the construction phase remains.

18.79 Additionally, habitat disturbance and loss will likely occur, which may result in an increase in local otter movements (away from disturbance sources). Specific mitigation will be put in place to reduce this impact where possible.

Impact significance

18.80 Due to the European Protected Species and 'near threatened[6]' status of otter, the sensitivity of this ecological receptor is considered high. The magnitude of impact is considered moderate.

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
High	Moderate	Major	Significant

MITIGATION IN RELATION TO IMPACT 18.4

- Once specific Project details are known, further targeted investigation will be undertaken to ascertain the status, distribution and habitat use of otters within the Project footprint and surrounding environment.
- Where it is ascertained that disturbance to otters will be likely, application for a European Protected Species licence will be made.
- As part of the licence, implementation of on otter management plan may be necessary; this will outline best industry practices to minimise disturbance to otters where possible.
- Where increased otter road fatality risk is identified, specific mitigation measures will be put in place; this may include otter culverts (for new access tracks), steering fences and wildlife reflectors. It is recognised that installation of such measures may comprise a condition of (European Protected Species) licence, if deemed necessary and should be implemented as part of the Construction Environmental Management Plan (CEMP).

Residual impact

18.81 Following implementation of the mitigation measures outlined above, the sensitivity of the ecological receptor will remain high; however the magnitude of impact will be considered negligible. Management of indirect disturbance to otters will therefore be necessary throughout the construction phase, to ensure effective mitigation is applied to reduce this impact to an acceptable level and that the viability of the local otter population is not affected.

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
High	Negligible	Minor	Not Significant

18.6.5 Impact 18.5: Disturbance to water vole

18.82 The status of water vole within the Project footprint and in the surrounding habitat is currently unknown; however, historical records of water vole exist in the local environment and suitable habitat has been identified within the Project footprint. There is potential for this species to be present within the Project footprint and therefore potential to cause disturbance to water vole habitat. Impacts to water vole are most likely to occur in Area 3, where the East and West Burn of Gills are located, in addition to numerous field drains. Notably, these habitats are located downstream of minor water courses where water vole has been previously recorded. Disturbance impacts will likely arise from construction of subterranean cable routes; this may result in physical habitat disturbance, increased ground vibrations, increased noise and increased human presence.

Impact significance

18.83 Water voles are a protected species, therefore the ecological sensitivity of this ecological receptor is considered medium. The magnitude of impact is considered moderate.

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Medium	Moderate	Moderate	Significant

MITIGATION IN RELATION TO IMPACT 18.5

- Once specific Project details are known, further ecological investigation will be undertaken to ascertain the status of water vole within the onshore Project footprint and surrounding environment.
- Should water vole be present within the Project footprint, application for a relevant licence will be necessary and habitat protection measures will be implemented during the construction phase to prevent causing disturbance to water voles and water vole habitat. This will likely be included as part of a water vole mitigation plan and / or CEMP.
- Should water vole habitat be impacted by construction, affected areas will be restored to an original condition to minimise long term impacts on the local water vole population.

[6] IUCN Red List of threatened species. Available at www.iucnredlist.org [Accessed 01/09/2011]

Residual impact

18.84 Following implementation of mitigation as outlined above, the sensitivity of the ecological receptor will remain medium; however the magnitude of impact will be reduced to negligible. Management of mitigation to reduce indirect disturbance to water vole during the construction phase will be necessary, to ensure that levels of disturbance to water vole are reduced where possible.

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Medium	Negligible	Negligible	Not Significant

18.7 Impacts during Operations and Maintenance

18.7.1 Impact 18.6: Temporary disturbance to otters during maintenance operations

18.85 The Project will have a planned operational life of 25 years. The majority of maintenance activities will be associated with the offshore turbines which will be retrieved from their turbine support structures (TSS) and brought ashore for maintenance. Although the specific maintenance / servicing base has not yet been determined, it will likely be removed from the onshore PCC and will utilise one of the nearby harbour / port facilities. Onshore Project components, including the PCC and grid connections will also require maintenance throughout the Project duration, although onshore components will not normally be manned. This may result in a small increase in human activity in the local environment and potentially may involve small-scale construction activities. These may result in localised habitat disturbance including increased noise and ground vibrations. There is potential for maintenance and operational activities to cause temporary disturbance to otters, particularly if sensitive habitats (otter holts and resting sites) are located in close proximity to such activities. Localised increases in road traffic may also temporarily increase the risk of otter road fatality. The results of the baseline assessment have indicated otter is the only protected species that requires detailed consideration in the impact assessment during the operational and maintenance Project phases. With reference to water vole it is their habitat that is protected and not the species itself; potential impacts on water vole habitat have therefore been give apt consideration in relation to construction and decommissioning impacts only.

18.86 Notably, coastal process modelling has confirmed that there will be no effects on coastal habitats during the operation of the tidal array (see Section 9).

Impact significance

18.87 Due to the European Protected Species and 'near threatened[7]' status of otter, the sensitivity of this ecological receptor is considered high. The temporary nature and small scale of proposed operational and maintenance activities have given a magnitude impact of negligible.

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
High	Negligible	Minor	Not Significant

MITIGATION IN RELATION TO IMPACT 18.6

- Although no significant impact has been identified, mitigation measures have been provided as a precautionary approach to ensure this remains the case.
- Once specific onshore Project details are known, further, targeted investigation will be undertaken to ascertain the status, distribution and habitat use of otters within the Project footprint and surrounding environment.
- Should sensitive habitats (i.e. otter holts and resting sites) be located in close proximity to where onshore maintenance and operational activities are taking place (including near shore vessel activities), best industry practices and relevant mitigation measures will be implemented, to avoid causing unnecessary disturbance.
- Where disturbance impacts from small scale construction activities involved in the operations and maintenance of the PCC cannot be avoided, acquisition of a European Protected Species licence will be undertaken to ensure potentially disturbing works are legally permitted.
- Long term mitigation against increased risk of otter road fatality will be put in place from the construction phase onwards; it is anticipated that mitigation measures such as otter culverts (for new access tracks) and wildlife reflectors will remain effective at deterring otters from crossing roads throughout the duration of the Project.

18.8 Impacts during Decommissioning

18.8.1 Impact 18.7: Temporary disturbance to habitats during decommissioning operations

18.88 It is possible that decommissioning will involve localised construction activities such as building demolishment, with potential for temporary habitat disturbance. Precise details regarding decommissioning have yet to be confirmed; however, it is likely that disturbance impacts to terrestrial habitats will be confined to the Project footprint and immediate surrounding area. Decommissioning activities will be of a temporary nature and where occurring onshore, will have potential to cause temporary disturbance to terrestrial habitats through direct physical disturbance, increased noise, increased ground vibrations and increased human presence. Where excavations will be necessary as part of decommissioning; vegetation clearance and ground disturbance may be required.

Impact significance

18.89 Due to the modified and widespread nature of terrestrial habitats (which notably are not of conservation concern) occurring within the Project footprint, the sensitivity of this ecological receptor is considered negligible. As described above, disturbance impacts will be of a temporary nature and will likely be confined to the Project footprint and working area only. No significant impact is expected, with full recovery of affected habitats to an original condition expected through habitat restoration works, undertaken as part of completion of decommissioning activities. The magnitude of disturbance impacts to terrestrial habitats is therefore assessed as minor.

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Negligible	Minor	Negligible	Not Significant

MITIGATION IN RELATION TO IMPACT 18.7

- Although no significant impact has been identified, mitigation measures have been provided as a precautionary approach to ensure this remains the case.
- Employment of industry best practise during decommissioning works, including restoration of affected terrestrial habitats to an original condition.
- Adherence to the Environmental Management Plan (and where relevant, working method statements) throughout the decommissioning phase, aiming to reduce disturbance to terrestrial habitats where possible.

[7] IUCN Red List of threatened species. Available at www.iucnredlist.org [Accessed 01/09/2011].

18.8.2 Impact 18.8: Temporary disturbance to otters during decommissioning operations

18.90 Decommissioning operations will comprise offshore works, likely to involve vessels in near shore marine environments. Additionally, onshore decommissioning operations may include localised onshore activities occurring within the Project footprint, such as building demolishment. Precise details regarding decommissioning have yet to be confirmed; however, it is likely that any disturbance impacts to otters will be confined to the Project footprint and immediate surrounding area.

18.91 Decommissioning activities will be of a temporary nature and where occurring onshore, will have potential to cause temporary disturbance to terrestrial habitats through direct physical disturbance. Increased activity within the Project footprint may also potentially result in a localised increase in road traffic; this may have implications for otters within the surrounding environment by temporarily increasing the risk of road fatality. Offshore decommissioning activities involving near shore vessels may also cause temporary disturbance to otters utilising coastal habitats in close vicinity to the Project.

Impact significance

18.92 Due to the European Protected Species and 'near threatened[8]' status of otter, the sensitivity of this ecological receptor is considered high. The magnitude of impact is considered minor, due to the temporary nature of decommissioning activities and the fact the activities will be less than during the construction phase.

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
High	Minor	Moderate	Significant

MITIGATION IN RELATION TO IMPACT 18.8

- Although the impact is of a temporary nature, it will require some management to ensure that temporary disturbance to otters from decommissioning activities remains within acceptable levels.
- Should sensitive habitats (i.e. otter holts and resting sites) be located in close proximity to where onshore and inshore decommissioning activities are taking place, best working practices and relevant mitigation measures will be implemented to avoid causing unnecessary disturbance to otters where practicably possible.
- Where disturbance impacts to otters from decommissioning activities cannot be avoided, acquisition of a EPS licence will be undertaken, to ensure potentially disturbing works are legally permitted.
- Long term mitigation against increased risk of otter road fatality will likely be in place from the construction phase onwards; it is anticipated that mitigation measures such as otter culverts (for new access tracks), steering fences and wildlife reflectors will remain effective at deterring otters from crossing roads, throughout the duration of the Project and beyond.

Residual impact

18.93 Following implementation of the mitigation outlined above, the sensitivity of otters to decommissioning disturbance impacts will remain very high; however the magnitude of impact will be reduced to negligible.

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
High	Negligible	Minor	Not Significant

[8] IUCN Red List of threatened species. Available at www.iucnredlist.org [Accessed 01/09/2011].

18.9 Potential Variances in Environmental Impacts

18.94 Impact assessment in relation to terrestrial ecology has included consideration of all potential onshore Project options with assessment of impacts using a 'Rochdale envelope' approach. Both terrestrial habitats and relevant / protected species occurring within the maximum Project footprint have been given due consideration, therefore further consideration of potential variances is not required.

18.95 Existing terrestrial habitats and species occurring within the Project footprint are unlikely to change significantly in the near future. Localised changes in land use may occur due to agricultural rotation or small-scale private development; it is considered that these changes will have a limited and very localised impact (if any), on terrestrial ecology components.

18.10 Cumulative Impacts

18.10.1 Introduction

18.96 MeyGen has in consultation with Marine Scotland and The Highland Council identified a list of other projects (MeyGen, 2011) which together with the Project may result in potential cumulative impacts. The list of these projects including details of their status at the time of the EIA and a map showing their location is provided in Section 8; Table 8.3 and Figure 8.1 respectively.

18.97 Having considered the information presently available in the public domain on the projects for which there is a potential for cumulative impacts, Table 18.12 below indicates those with the potential to result in cumulative impacts from a terrestrial ecology perspective. The consideration of which projects could result in potential cumulative impacts is based on the results of the project specific impact assessment together with the expert judgement of the specialist consultant.

18.98 The following sections summarise the nature of the potential cumulative impacts for each potential project phase:

- Construction and installation;
- Operations and maintenance; and
- Decommissioning.

Project title	Potential for cumulative impact	Project title	Potential for cumulative impact	Project title	Potential for cumulative impact
MeyGen Limited, MeyGen Tidal Energy Project, Phase 2	✓	SHETL, HVDC cable (onshore to an existing substation near Keith in Moray)	✗	OPL, Ocean Power Technologies (OPT) wave power ocean trial	✗
ScottishPower Renewables UK Limited, Ness of Duncansby Tidal Energy Project	✓	Brough Head Wave Farm Limited, Brough Head Wave Energy Project	✗	MORL, Moray Offshore Renewables Ltd (MORL) offshore windfarm	✗
Pelamis Wave Power, Farr Point Wave Energy Project	✗	SSE Renewables Developments (UK) Limited, Costa Head Wave Energy Project	✗	SSE and Talisman, Beatrice offshore Windfarm Demonstrator Project	✗
Sea Generation (Brough Ness) Limited, Brough Ness Tidal Energy Project	✗	EON Climate & Renewables UK Developments Limited, West Orkney North Wave Energy	✗	BOWL, Beatrice Offshore Windfarm Ltd (BOWL) offshore windfarm	✗

Project title	Potential for cumulative impact	Project title	Potential for cumulative impact	Project title	Potential for cumulative impact
		Project			
Cantick Head Tidal Development Limited, Cantick Head Tidal Energy Project	✗	EON Climate & Renewables UK Developments Limited, West Orkney South Wave Energy Project	✗	Northern Isles Salmon, Chalmers Hope salmon cage site	✗
SSE, Caithness HVDC Connection - Converter station	✓	ScottishPower Renewables UK Limited, Marwick Head Wave Energy Project	✗	Northern Isles Salmon, Pegal Bay salmon cage site	✗
SSE, Caithness HVDC Connection - Cable	✓	SSE Renewables Developments (UK) Limited, Westray South Tidal Energy Project	✗	Northern Isles Salmon, Lyrawa salmon cage site	✗
RWE npower renewables, Stroupster Windfarm	✓	EMEC, Wave Energy test site (Billia Croo, Orkney)	✗	Scottish Sea Farms, Bring Head salmon cage site	✗
SSE, Gills Bay 132 kV / 33 k V Substation Phase 1: substation and overhead cables (AC)	✓	EMEC, Tidal energy test site (Fall of Warness, Orkney)	✗	Northern Isles Salmon, Cava South salmon cage site	✗
SSE, Gills Bay 132 kV / 33 k V Substation Phase 2: HVDC converter station and new DC buried cable	✓	EMEC, Intermediate wave energy test site (St Mary's Bay, Orkney)	✗	Scottish Sea Farms, Toyness salmon cage site	✗
SHETL, HVDC cable (offshore Moray Firth)	✗	EMEC, Intermediate tidal energy test site (Head of Holland, Orkney)	✗	Northern Isles Salmon, West Fara salmon cage site	✗

Table 18.12: Summary of potential cumulative impacts

18.10.2 Potential cumulative impacts during construction and installation

18.99 The construction operations of the projects listed in Table 18.12 (identified with potential for cumulative impact) will likely involve disturbance and localised loss of terrestrial habitats as the likely cumulative impacts to terrestrial ecology. Although specific construction details and timescales are not presently available the following summarises potential cumulative impacts from the information available to date.

18.100 The proposed Ness of Duncansby onshore infrastructure and Gills Bay substation, cable corridors and HVDC components may impact upon ecologically sensitive and important habitats such as blanket bog, which comprise designated features of protected sites. It is likely that construction related habitat disturbance will be temporary; cumulative impacts of habitat disturbance and loss may be significant where ecologically sensitive or valuable habitats are affected; however this is not applicable to the Project in consideration, where affected habitats have been assessed as modified, widespread and of little ecological value.

18.101 With regards to protected species, cumulative impacts to otter and water vole may occur during the construction phase of the Project and of the projects identified as having potential for cumulative impact. Cumulative impacts to otters and water vole of habitat disturbance and specifically to otters (potential for) displacement of prey species is recognised, however it is noted that these impacts are likely to be temporary and localised, occurring during construction and maintenance project phases only.

18.102 A key potential cumulative impact to the local otter population may be a temporary increase in road fatality risk due to an increase in road traffic during the construction phases of the Project and other projects occurring in the surrounding environment. This impact will likely be temporary and implementation of relevant project specific mitigation will reduce road fatality risk to otters throughout the region.

18.10.3 Potential cumulative impacts during operations and maintenance

18.103 Phase 2 of the MeyGen Tidal Energy Project will comprise the deployment of a further 312MW of tidal turbines offshore and associated cables to shore and onshore infrastructure. The exact geographical location, extent and nature of the onshore facilities required for Phase 2 are not yet defined and will incorporate lessons learned from and technology advancements beyond Phase 1. These factors will influence the potential for, nature of and significance of any cumulative impacts. From a terrestrial habitats and ecology perspective the requirement for additional land for onshore infrastructure has the potential for cumulative impacts. The onshore land requirement for the MeyGen Tidal Energy Project Phase 2 will not involve use of any land of conservation importance. Significant cumulative impacts are therefore not expected.

18.104 It is also acknowledged that there is potential for cumulative impacts to protected species, particularly to otters. Maintenance activities may result in disturbance to terrestrial and possibly marine otter habitats, including the potential for a slight increase in road traffic, resulting in temporary implications for otter road fatality risk. However again, significant cumulative impacts are not expected.

18.10.4 Potential cumulative impacts during decommissioning

18.105 At present it cannot be determined what concurrent works will be ongoing in the area of the Project at the time of decommissioning, other than Phases 1 and 2 of the MeyGen Project will be decommissioned at the same time, and therefore it is not possible to determine potential cumulative impacts. However, if any other works ongoing at the time are undertaken to recognised good practice standards and make use of mitigation similar to that set out for this Project, cumulative impacts will be minimised.

18.10.5 Mitigation requirements for potential cumulative impacts

18.106 No mitigation is required over and above the Project specific mitigation.

18.11 Habitats Regulations Appraisal

18.107 For projects which could affect a Natura site, a competent authority (in this case The Highland Council) is required to determine whether the proposal will have a likely significant effect on the conservation objectives of a site or any of its qualifying interests, and depending on the outcome of this determination, undertake an Appropriate Assessment of the implications of the proposal on the Natura site's conservation objectives. The responsibility for provision of information with which to inform the Appropriate Assessment rests with the applicant.

18.108 There is one SAC in the area surrounding the proposed Project, Caithness and Sutherland Peatland SAC which needs to be considered from a HRA perspective. The impact assessment work undertaken has concluded there is no likely significant effect on the habitat qualifying species for this SAC. However there is potential for impacts on otters originating from this SAC. Further information to support the Appropriate Assessment is provided in the HRA report (see HRA document on the supporting CD, MeyGen 2012).

18.109 SPAs have been considered in Section 12, Ornithology.

18.12 Proposed Monitoring

18.110 Once specific onshore development areas are known, further investigation of potential species, specifically otter and water vole will required to ascertain the status of these protected species and their habitat within the Project footprint and immediate surrounding environment. Targeted species surveys will be undertaken to determine otter and water vole presence and distribution to inform protected species licensing and monitoring requirements (should monitoring be deemed necessary), throughout the duration of the Project.

18.111 The construction contractors Environmental Clerk of Works (or equivalent) will monitor the construction team to avoid any accidental disturbance or damage to protected species or their habitats.

18.13 Summary and Conclusions

18.112 The baseline assessment identified various habitats within the Project footprint; including include semi-improved neutral and acidic grassland, improved grassland, coniferous plantation, mixed woodland, scattered trees, heathland / acid grassland mosaic, dry dwarf shrub heath and small areas of wet modified bog. These habitats are locally widespread, modified and support commonly occurring species typical of the region; no rare botanical species were observed during the field survey. Additionally, terrestrial habitats occurring within the Project footprint are not of conservation concern; therefore the sensitivity of this ecological receptor was considered negligible. Impacts to terrestrial habitats are likely to be temporary and apparent during the construction and decommissioning phases only; with affected habitats rapidly restored to an original condition following exposure to disturbance related impacts. Overall impacts associated with terrestrial habitats have been assessed as insignificant.

18.113 Although impacts on terrestrial habitats have been assessed as insignificant, habitats within the Project footprint and immediate surrounding environment may be of value to protected species; specifically water vole and otter. Terrestrial habitats including minor water courses, littoral habitats and sublittoral areas may provide these species with opportunities for shelter and foraging. Otters are present in coastal habitats adjacent to the Project footprint, therefore there is potential to cause disturbance to this species throughout the construction, operation and decommissioning phases of the Project.

18.114 Assuming a precautionary approach, impacts to otters are considered significant, albeit temporary. Potentially significant impacts to otters are only likely to occur during the construction phase of the Project, though direct disturbance to otters and otter habitats with some potential for localised habitat loss. Additionally, it is recognised there is potential to increase baseline levels of local road traffic, potentially increasing the risk of otter road fatality, particularly during the construction phase. Proposed mitigation, where implemented effectively, will manage potential impacts to otters throughout Project duration; ensuring impacts, temporary or long term, remain within acceptable levels and do not affect the viability of the local otter population.

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19 LANDSCAPE, SEASCAPE AND VISUAL IMPACT ASSESSMENT

19.1 The table below provides a list of all the supporting studies which relate to the Landscape, Seascape and Visual Assessment. All supporting studies are provided on the accompanying CD.

Details of study	Location on supporting studies CD
MeyGen Socio Landscape, Seascape & Visual Impact Assessment. Technical Appendix (HRI, 2011)	ONSHORE\Landscape, seascape and visual assessment

19.1 Introduction

19.2 This section addresses the impacts of the Project on the landscape and seascape and also the impacts on visual amenity. The assessment had the following contributors:

- HRI Architects – visual amenity; and
- Mike Wood Consultant – landscape and seascape.

19.3 The main aim of the landscape/seascape and visual impact assessment (LSVIA) is to identify the areas of landscape, seascape and visual amenity of the local area that will be impacted by the Project; identify what the likely effects on these resources will be; indicate measures to avoid, reduce, remedy or compensate for these effects and provide an assessment of the nature and significance of those effects. The effects studied involve both objective and subjective impacts such as changes in perception of the local landscape/seascape.

19.4 Landscape/seascape impacts are changes in the character and quality of the landscape as a result of a particular development. The process of landscape/seascape character assessment (LSCA) is used to assess these changes to enable better planning, conservation, restoration, management and enhancement. LSCA is based on the principle that all landscapes/seascapes have a range of features and characteristics which not only give them their appearance, but also contribute to their wider character, for example through historical, artistic and social associations. In combination, these features and characteristics provide landscapes/seascapes with their 'character' or 'distinctiveness'.

19.5 Visual impacts are a subset of landscape impacts. The assessment is a subjective process as it involves individual perception, aesthetic tastes and visual comprehension. It is possible, however, to bring objectivity to the assessment and treatment of visual impact by considering the factors which influence it, including height, colour, size and associations with nearby features, including, for example, the presence of rock outcrops and existing manmade features. These factors are ultimately influenced by meteorological, topographic position, season and observer characteristics.

19.6 This section addresses the specific landscape, seascape and visual impacts of the Project in terms of:

- Onshore development; site development, access requirements, building(s) development, related land and civil engineering works;
- The assessment covers installation and operational phases for onshore and offshore works and facilities, and
- The assessment is based on installation, operational and site/building(s) development requirements as defined by the Project technical definitions (Section 5).

19.7 As the offshore aspects of the development will not result in any permanent infrastructure above water, no photomontages have been produced for this aspect of the development. The presence of vessels in the seascape during installation and ongoing operations and maintenance has however been addressed qualitatively.

19.8 MeyGen has considered two sites for the combined Horizontal Directional Drilling (HDD) activities during cable installation and the Power Conversion Centre (PCC). This assessment has addressed the potential landscape, seascape and visual impacts for both these options; Ness of Quoys and Ness of Huna. Site layouts, building design options and photomontages have been provided for both sites. At this stage in the development programme of the Project it is not possible to confirm which of these sites will be taken forward. As such planning applications will be submitted for both of these sites, however only one will be developed for Phase 1 of the Project.

19.9 The cable connections between the Power Conversion Unit Buildings (PCUBs) and the grid connection point will be installed underground and therefore not result in any long term landscape, seascape or visual impacts. As such, this aspect of the development is not considered.

19.10 Impacts on cultural heritage setting are addressed within the Onshore Cultural Heritage section (Section 20).

19.2 Assessment Parameters

19.2.1 Rochdale Envelope

19.11 In line with the Rochdale Envelope approach, this assessment considers the maximum ('worst case') project parameters. Identification of the worst case scenario for each receptor (i.e. Environmental Impact Assessment (EIA) topic) ensures that impacts of greater adverse significance would not arise should any other development scenario be taken forward in the final scheme design. Table 19.1 describes the detail of the project parameters that have been used in this assessment and explains why these are considered to be worst case. The potential impacts from alternative Project parameters have been considered in Section 19.7.

Project parameter relevant to the assessment		'Maximum' Project parameter for impact assessment	Explanation of maximum Project parameter
Onshore Power Conversion Centre (PCC)	Construction, operation/maintenance and decommissioning	3 PCUBS (dimensions 45m l x 30m w x 13m h) and control building (17m l x 7m w x 4.5m h) at both Ness of Quoys and Ness of Huna assessment areas	Assessment of potential impacts associated with the construction, operation and decommissioning of new buildings at both the Ness of Huna and Ness of Quoys potential PCC locations. Photomontages have been produced for the permanent above ground infrastructure only.
Onshore cable routes between PCC and SHETL substation	Construction, operation/maintenance and decommissioning	All potential cable corridors between PCC locations and SHETL substation proposed at Phillips Mains (see Figure 2.1) (at EIA commencement)	Assessment of potential impacts associated with cable installation along all potential cable corridors identified between PCC locations and SHETL substation proposed at Phillips Mains. As all cables will be buried, there has been no requirement to assess impacts during construction or produce photomontages for the operational phase of the Project.
Cable landfall	HDD site	Maximum potential footprint of both Ness of Quoys and Ness of Huna (at EIA commencement)	Assessment of potential impacts associated with the HDD of the cable bores, during the Project construction phase. Cable landfall will be underground HDD bores and therefore there is no landscape, seascape or visual impacts associated with the permanent cable landfall.
Offshore Project	Installation vessel physical	1 Dynamic Positioning (DP)	Installation activities will be carried out

Project parameter relevant to the assessment		'Maximum' Project parameter for impact assessment	Explanation of maximum Project parameter
components	presence	vessel for the duration of the installation for year 1 and 2 2 DP vessels for year 3 installation	by a single DP vessel during year 1 and 2, all installation activities to be undertaken using a single DP vessel. If other smaller vessels used to undertake some of the work of the DP vessel, no concurrent multiple vessel activities will take place, i.e. no more than one vessel on site at any one time. Year 3 installation will require a maximum 2 DP vessels for TSS installation. These two vessels may be present on site at the same time during year 3.
	Maintenance vessel physical presence	1 DP vessel present every 2.8 days	Based on a maximum 86 turbine array, 1 DP vessel will be present a maximum of 130 times (i.e. single slack tide operation) per year i.e. the DP vessel present on site every 2.8 days.

Table 19.1: Rochdale Envelope parameters for the landscape, seascape and visual impact assessment

19.2.2 Study area

19.12 Taking into account current guidance on other development types, and on discussions at the EIA Scoping and pre-application stages with Scottish Natural Heritage (SNH) and The Highland Council (THC), it was concluded that on a realistic and pragmatic basis the proposed development is unlikely to result in significant seascape, landscape, or visual impacts beyond a 10km radius from the centre of the site. The study area shown on Figure 19.1 was therefore selected.

19.13 It should be noted that since this assessment was completed on a larger project area (Figure 19.1) this has since been refined to a smaller footprint at both the Ness of Quoys and Ness of Huna PCC sites and a single cable corridor to the SHETL substation option areas. The final project is described in Section 5 and shown in Figure 5.2; the selection process for these is discussed in Section 4.

19.3 Legislative Framework and Regulatory Context

19.3.1 Relevant legislation

19.14 The EIA Regulations are the only legislation directly relevant to this assessment.

19.3.2 Policy and guidance

19.15 The methodology for the landscape, seascape and visual assessment has been agreed with THC and SNH. It takes into account best practice methodologies and the undernoted policy and landscape / seascape characterisation guidance:

- Handbook on Environmental Impact Assessment 2011 - Appendix 1: LSVIA assessment, SNH (2011);
- Guidance on Landscape / Seascape Carrying Capacity for Aquaculture, SNH (2008);
- Highland Renewable Energy Strategy (HRES) and planning guidelines, The Highland Council (May 2006);
- Visualisation Standards for (wind energy) developments, The Highland Council (2009);
- Caithness Local Plan 2002: R9/10 and general policies[1], The Highland Council (2002);
- Assessment of Highland Special Landscape Areas, The Highland Council (2011);
- Advice Note 01/11, Photography and photomontage in landscape and visual assessment, Landscape Institute;
- 'Landscape Character Assessment for England and Scotland', Scottish Natural Heritage (SNH) and The Countryside Agency (2002);
- Guidance for Landscape and Visual Impact Assessment, The Landscape Institute and the Institute of Environmental Management and Assessment (IEMA), second edition (2002);
- Cumulative Effects of Windfarms' – Version 2, Revised 13.04.05, SNH (2005);
- Visual Representation of Windfarms Good Practice Guidance, SNH commissioned report F03 AA 308/2 (2006);
- Policy Statement No 02/03 – Wildness in Scotland's Countryside', SNH (2002);
- Assessing the Impacts on Wild Land – Interim Guidance, SNH (2007);
- An assessment of the sensitivity and capacity of the Scottish seascape in relation to offshore windfarms. Scottish Natural Heritage Commissioned Report No.103 (ROAME No. F03AA06), Scott, K.E., Anderson, C., Dunsford, H., Benson, J.F. and MacFarlane, R. (2005);
- Caithness and Sutherland Landscape Character Assessment Scottish Natural Heritage (SNH) Review No 103, Stanton, C. (1998);
- The siting and design of aquaculture in the landscape: visual and landscape considerations, SNH (2011);
- An Inventory of Gardens and Designed Landscapes[2];
- The consolidated Scottish Planning Policy (SPP), which supersedes SPP 6 Renewable Energy, NPPG 13 Coastal Planning and NPPG Natural Heritage;
- The Highland Structure Plan 2001[3]; The Highland Council (2001);
- The Highland-wide Local Development Plan (HWLDP), The Highland Council (2012)[4]; and
- SNH Policy Statement No. 05/01; SNH's Landscape Policy Framework.

19.16 It should also be noted that in the EIA Scoping Opinion received from Marine Scotland reference was made to draft SNH guidance on the Landscape and Visual Impact Assessment of Marine Renewables – Guidance for Scoping an Environmental Statement (ES). However, this draft guidance is not yet publically available and therefore it has not been possible to reference it during this assessment.

[1] Still in force at time of EIA and ES compilation.
[2] http://data.historic-scotland.gov.uk/pls/htmldb/f?p=2400:10:0
[3] Still in force at time of EIA and ES compilation.
[4] Not adopted at the time of the EIA and ES compilation.

Figure 19.1: Study area

19.4 Assessment Methodology

19.4.1 Overview methodology

19.17 The methodology applied to assess the landscape, seascape and visual impacts of the Project consists of baseline assessment and assessment of impacts.

19.18 A baseline assessment consists of:

- A desk study to establish the existing conditions, including the landscape and seascape context and character of the study area and the principal visual influences and viewpoints in the area, including the preparation of a Zone of Theoretical Visibility (ZTV) for the Project;
- Field survey work to verify the important landscape, seascape and visual characteristics of the area highlighted by the desk study; and
- The identification of receptors, which were confirmed after stakeholder review.

19.19 An assessment of impacts, which includes:

- Identification and evaluation of potential physical impacts on the landscape: Physical effects are restricted to the area within the Project site boundary, and are the direct effects on the fabric of the Project site, such as the removal or addition of trees and alteration to ground cover;
- Identification and evaluation of potential impacts on landscape character: Landscape character is "the distinct and recognisable pattern of elements that occurs consistently in a particular type of landscape, and how this is perceived" (GLVIA, 2002). Impacts on landscape character arise either through the introduction of new elements that physically alter this pattern of elements, or through visibility of the proposed development, which may alter the way in which the pattern of elements is perceived. This category of effects occurs on landscape character receptors, which fall into two groups; landscape character areas and designated areas;
- Identification and evaluation of potential impacts on seascape character: Seascape character is analogous to landscape character, and has been defined as "the physical characteristics of hinterland, coast and sea plus a range of perceptual responses to the seascape, as well as visual aspects." (Scott *et al*, 2005). Impacts on seascape character arise from visibility of the proposed development, which may alter the way in which the pattern of physical elements is perceived;
- Identification and evaluation of potential visual impacts: Visual impacts arise from the introduction of the Project affecting views throughout the study area, which have been selected to be representative of visual receptors including settlements and routes; and
- Identification and assessment of cumulative impacts.

19.4.2 Scoping and consultation

19.20 Since the commencement of the Project, consultation on landscape, seascape and visual impact assessment issues has been ongoing. Table 19.2 summarises all consultation relevant to landscape, seascape and visual impact assessment. In addition, relevant comments from the EIA Scoping Opinion are summarised in Table 19.3, together with responses to the comments and reference to the ES sections relevant to the specific comment.

Date	Stakeholder	Consultation	Topic/specific issue
7th April 2011	Marine Scotland and SNH	Pre-Scoping meeting	EIA surveys and studies required and the data needs for each EIA study.
27th May 2011	Marine Scotland, statutory consultees and non statutory consultees	Submission of EIA Scoping Report	Request for EIA Scoping Opinion from Marine Scotland and statutory consultees and request for comment from non statutory consultees.
30th June – 2nd July 2011	Local stakeholders	Public Event - EIA Scoping	Public event to collate information/opinions on proposed EIA scope.
7th July 2011	The Highland Council Planning Service	Meeting	LSVIA methodology / project scope / visual impact / design / planning procedure / details of submission.
14th July 2011, 26th July 2011, and 16th August 2011	The Highland Council and SNH	E mail correspondence	Briefing / receptor viewpoint locations / onshore design issues.
26th July 2011	The Highland Council Planning Service	Meeting	Visual impact / installation works / LSVIA viewpoint definition.
28th July 2011	SNH	Meeting	Presentation of the LSVIA methodology.
6th September 2011	The Highland Council, The Highland Council's Historic Environment Team, SNH	Onsite Workshop in Caithness	Onsite workshop to discuss the LSVIA and historical setting aspects of the project and agree viewpoints for visual impact assessment.
14th September 2011	The Highland Council	Meeting	Planning pre application meeting. Presentation on overall project and results of EIA studies to date. Included discussion on building design / development extent sustainable design additional viewpoints required.
31st September 2011	Marine Scotland, The Highland Council, statutory consultees and non statutory consultees	Receipt of EIA Scoping Opinion	Receipt of response to EIA Scoping Report and other comments from non statutory consultees.
10th October 2011	The Highland Council	Receipt of pre application advice	Receipt of pre application advice from Highland Council.
16th November 2011	The Highland Council	Telephone call	Confirmation that photomontages only need to meet SNH's standards and guidance and do not need to meet The Highland Council's Visualisation Standards for Wind Energy Developments (2010).
6th – 7th December 2011	Local stakeholders	Public Event – pre application consultation	Public event to communicate the findings of the EIA to local stakeholders.

Table 19.2: Consultation undertaken in relation to the LSVIA

Name of organisation	Key concerns	Response	ES section within which the specific issue is addressed
SNH	We welcome the pre-application consultation with the landscape architects employed by MeyGen Ltd, with discussions focusing on the landscape and visual impact assessment. The following advice on the approach and methodology presented in the EIA Scoping Report is in addition to advice previously given and the draft SNH guidance - 'Landscape and visual impact assessment of marine renewables – guidance for scoping an Environmental Statement' (2011).	Noted; consultation meeting 21/07/11. Guidance and methodology referenced and incorporated in LSVIA.	Section 19.3 Legislative Framework and Regulatory Context
SNH	In general, the seascape and visual impact assessment should consider: • the potential impacts during installation, maintenance and decommissioning operations, and • the potential	The LSVIA has addressed all Project operations described. There are no proposed lighting and/or buoys and neither will	Sections 19.2.1 Rochdale Envelope and 19.6: Assessment of

Name of organisation	Key concerns	Response	ES section within which the specific issue is addressed
	impacts of all lighting and buoys that accompany installation, operation and decommissioning. • the potential impacts during periods if / when structures break the surface.	the tidal turbines ever break the sea surface.	Impacts
SNH	Proposed on-shore works – cable-landing, cable vault, substation, construction compounds and work in the inter-tidal zone are considerable (see figure 6 of the EIA Scoping Report). These will require a full landscape and visual impact assessment. We will be able to provide more advice in this regard when the proposals are further progressed and the applicant is able to provide further detail.	The LSVIA has addressed all potential onshore infrastructure for all Project operations.	Sections 19.2.1 Rochdale Envelope and 19.6 Assessment of Impacts
SNH	Baseline environment - Fieldwork is a fundamental part of EIA. The Seascape and Landscape Character Assessment needs to examine both the regional and local coastal landscapes and seascape. While SNH's Scottish seascape (Scott *et al*. 2005) report is a helpful reference we emphasise that it is a strategic assessment, a 'nationwide' look at the coast, with general descriptions of seascape character types. These were tested against a specific, set theoretical windfarm scenario to explore issues of sensitivity and visibility. Furthermore, in this study fieldwork was not a major part of the assessment process, which was limited to a strategic desk-based approach. Thus, the seascape units are of only limited use in appraising actual development proposals and need refinement in order to examine the impacts of a specific proposal.	Seascape assessment has followed general guidance and also been informed by site specific fieldwork, analysis and assessments.	Section 19.5 Baseline Description and Section 19.6 Assessment of Impacts
SNH	Field work is required to do this, and we recommend that the applicant uses the coastal character methodology developed for aquaculture capacity studies. This approach identifies areas of consistent seascape character with strong integrity, like a specific bay or stretch of coast. We recommend that these local coastal character areas are defined at a scale comparable to the existing LCAs and will be informed by them and field work.	Noted and referenced. Seascape assessment has been informed by site specific fieldwork, analysis and assessments.	Sections 19.3 Legislative Framework and Regulatory Context and 19.4 Assessment Methodology
SNH	The Highland Coastal Development Strategy (May 2010) will assist in identifying stretches of isolated and undeveloped coast. Another source that may help initially with coastal characterisation is a critical appraisal of the relevant sections of The Beaches of Scotland series (SNH Commissioned Reports Series 1969-1981) – available from SNH publications. This series of regional reports offers a quantified description of many aspects of Scotland's coastline, including associated dunes, links and machair areas that can be useful in informing and defining local coastal character areas.	As above.	Sections 19.3 Legislative Framework and Regulatory Context and 19.4 Assessment Methodology

Name of organisation	Key concerns	Response	ES section within which the specific issue is addressed
SNH	EIA Methodology - We recommend that Chartered Landscape Architects, preferably a team of at least two, should carry out the landscape and visual impact assessment.	Fieldwork to define seascape character areas, refine landscape character areas, assess landscape and seascape impacts and validate viewpoint impacts was carried out by a Chartered Landscape Architect. Other fieldwork was undertaken by qualified architects.	Section 19.4 Assessment Methodology
SNH	The described approach uses the accepted good practice outlined in 'Guidelines for Landscape and Visual Impact Assessment' (LI-IEMA, 2002). The assessment process for coastline, landscape and seascape is essentially the same, although each area has its own specific characteristics, as well as other shared characteristics. It is important to consider the key elements that are specific to each environment, whether land-based or marine. It is these that differ, not the method of character assessment.	Referenced and guidance informs LSVIA.	Sections 19.3 Legislative Framework and Regulatory Context
SNH	Although the techniques and methods developed to evaluate seascapes are helpful, (such as SNH's seascapes work) it needs to be critically assessed. This is because of Scotland's specific coastal conditions and qualities, but also because the report findings relate to offshore windfarm development. While our knowledge of the likely impacts of the new tidal technology is limited, some of the principles developed in relation to the siting and design of aquaculture may be relevant. With this in mind we refer the applicants to SNH guidance on Marine Aquaculture and the Landscape .	Noted and referenced.	Section 19.3 Legislative Framework and Regulatory Context
SNH	Essentially, a coastal landscape assessment clearly related both 'seawards' and 'landwards' is required. Once the baseline is established, judgments on sensitivity and impacts can then be made. Establishing the relationship of landscape character to seascape character (and vice versa) is fundamental to the assessment. Important elements to consider include the contrast of form, pattern, texture and colours between the landscape and sea; and the effects of the development's form, pattern, texture and colours within this.	Noted and referenced; onshore and offshore viewpoint's incorporated.	Section 19.6 Assessment of Impacts
SNH	Visibility and Zones of theoretical visibility - In assessing visibility, reference should be made to SNH's guidance on the Visual Representation of Wind farms (December 2007). Although the VRW guidance relates to onshore wind farms, this gives practical guidelines on the preparation, presentation and application of visibility maps, viewpoints and visualisations.	Noted and referenced; informs ZTV mapping.	Section 19.4 Assessment Methodology
SNH	Viewpoint Selection and Assessment - Viewpoints should be selected in negotiation with MS LOT and statutory consultees, principally the Local Planning Authority and SNH. Viewpoints selected by the	An iterative viewpoint selection and assessment process has been undertaken. Initially 30 receptor points assessed and	Section 19.4.6 Viewpoints

Name of organisation	Key concerns	Response	ES section within which the specific issue is addressed
	planning authority may include additional residences and public buildings, as local authorities have other interests in addition to those of SNH. Initially lengthy, the viewpoint list is likely to be shortened as viewpoints that best illustrate the most significant likely impacts, or help the most with design iteration, become obvious.	discussed / evaluated with THC / SNH to agree chosen viewpoints for photomontages. Viewpoint and selection process also presented to Marine Scotland.	
SNH	Public consultation on viewpoint selection is recommended. The selection of viewpoints and the direction of views selected should be based on the identification of potentially sensitive receptors (people, places and activities) and potentially significant views, locations or landscapes, taking into account the likely impacts of the tidal array.	Extensive viewpoint selection and assessment process has been undertaken in conjunction with The Highland Council and SNH. The viewpoints used in this assessment have been agreed with The Highland Council and SNH. This process was presented to and discussed with the public in the pre application consultation phase.	Section 19.4.6 Viewpoints
SNH	The choice of all viewpoints should be informed by the cumulative ZTV as well as the individual ZTV. Although it is possible to add supplementary viewpoints as part of a cumulative VIA, it is preferable to use all or some of the same viewpoints for both the individual and cumulative VIA.	Chosen viewpoints informed by ZTV mapping. Cumulative assessment informed by likely extent of study areas of projects which identified might contribute to cumulative impacts.	Section 19.4 Assessment Methodology and 19.8 Cumulative Impacts
SNH	View type - Viewpoints should be selected in order to show: a) Areas of high landscape or scenic value; both designated and non designated. For example NSA's, AGLV's, GDL's, search areas for wild land, tourist routes and local amenity spaces; b) A full representation of views from a range of distances, aspects, landscape character types and visual receptors; to include coastal views looking out to the coast and back, as well as across water to opposing shores c) All aspects of the Project, i.e. illustrate it "in the round" to help in the design development and assessment processes. This will also enable assessment of a range of light conditions e.g. side-lit, back-lit and front-lit; d) Visual composition. For example focussed or panoramic views, simple or complex; e) The variety of images that the tidal array will present from coastal areas as well as important coastal hilltops and landmarks; f) A range of distances; g) A range of elevations; h) Sequential along specific routes; i) The full range of different types of views, e.g. popular hilltops, footpaths and other recreational routes, key transport routes (on and offshore where relevant), minor roads where the array will be the focus of the view, settlements, cultural and recreational foci, and so on.	Guidance referenced and informed viewpoint selection incorporating onshore and offshore viewpoints. All field sheets for each viewpoint are included in the LSVIA Technical Appendix.	Section 19.4.6 Viewpoints and LSVIA Technical Appendix
SNH	Viewer Type - j) The full range of receptor groups, e.g. residential, work, road users and other travellers, walkers, other recreational users, etc.; k) Various modes of movement. For example those moving through the landscape, across ferry and popular recreational sailing routes, or stationary	All viewer types listed have been considered in the assessment. All field sheets including details of receptor types for each viewpoint are included in the LSVIA Technical Appendix.	Sections 19.4.6 Viewpoints, Section 19.6 Assessment of Impacts and LSVIA Technical Appendix
SNH	In addition to representative viewpoints, it is important to consider viewpoints that are already important vantage points within the landscape, for example local visitor attractions, scenic routes, or places with cultural landscape associations.	All viewpoint types listed have been considered in the assessment. All field sheets including details of receptor types for each viewpoint are included in the LSVIA Technical Appendix.	Sections 19.4.6 Viewpoints, Section 19.6 Assessment of Impacts and LSVIA Technical Appendix
SNH	The developer should be aware that further or alternative viewpoints may need to be considered throughout the VIA process.	Understood and iterative process undertaken included negotiation on viewpoints for photomontage production.	Section 19.4.6 Viewpoints and 19.6 Assessment of Impacts
SNH	The local planning authority may have additional considerations regarding viewpoint selection. Elevated viewpoints, for example those on coastal walks and hilltops are particularly useful in exploring the layout and design. Precise adjustment of the viewpoint location should be made to avoid underestimation of the visual effect by, for example, the judicious positioning of screening objects.	Viewpoint analysis included consultation with THC.	Section 19.4.6 Viewpoints
SNH	The precise location of the viewpoint (including 12 figure OS grid reference and a brief description), viewpoint height (mAOD), nature of view (width of view in degrees and bearing of key foci within view) and conditions of assessment should be given. This should give details of the orientation to and distance from the Project, date, time of day and weather conditions and visual range, when the photographs were taken and the assessment made. It is helpful if a small insert map (based on a 1:50000 OS base map) showing the viewpoint's detailed location and direction is given alongside each visualisation.	Incorporated in viewpoint schedule and mapping and incorporated in baseline photography and photomontage sections.	LSVIA Technical Appendix.
SNH	All viewpoint information should be presented in a table and cross-referred to a ZTV map on which all of the numbered viewpoints are plotted.	All viewpoints listed in a table and included on a map, indicating which ones have been taken forward for assessment and photomontage production.	Section 19.4 Assessment Methodology
SNH	The characteristics visible from each viewpoint that are sensitive development on the sea-surface should be described and assessed, particularly in relation to changes the development would cause. Factors such as season, weather, air clarity, movement, orientation to prevailing winds, in relation to the viewer, and any screening elements may be relevant. The design and layout of lighting and buoys associated with the tidal array, as it would appear from each viewpoint, should also be described and assessed.	Vessel activities associated with the Project have been considered. There are no proposed lighting and/or buoys and neither will the tidal turbines ever break the sea surface.	Section 19.6 Assessment of Impacts

Name of organisation	Key concerns	Response	ES section within which the specific issue is addressed
SNH	Details of the types of receptors, and an assessment of their sensitivity, should be included.	Included in assessments and details provided in field sheets.	Section 19.4 Baseline Description and Section 19.6 Assessment of Impacts
SNH	Cumulative Impacts - A cumulative SLSVIA is likely to be required in relation to future operations, but also in respect of other PFOW lease sites such as Ness of Duncansby. There may be other development types that may also need to be considered. Any cumulative SLSVIA should be carried out with reference to the current SNH guidance on cumulative effects (2005), though please be aware that this guidance is currently being updated. Whether it follows the draft guidance or not, the reasoning behind judgments should be made clear. This is because there is more than one type of cumulative impact and their assessment quickly becomes complicated.	Guidance noted and referenced. Cumulative assessment included.	Section 19.3 Legislative Framework and Regulatory Context and Section 19.8 Cumulative Assessment
The Highland Council	The developer is aware that The Highland Council has been engaged with partners and stakeholders (including the developer) in North Highland Onshore Visioning work, mainly focussed on the onshore development that will be necessary in North Highland to enable and support wave, tidal and offshore wind power. The Prince's Foundation for the Built Environment (PFBE) facilitated workshops held at the Castle of Mey in August 2010 and February 2011 and prepared a short Report which gives a record of the issues and key locations discussed at the workshops and gives recommendations. Following on from these recommendations, The Highland Council has published a 10-point Action Plan which it is developing with key partners, to help plan for the growth of the marine renewable energy industry in North Highland. More information on progress with undertaking the actions will be made available on the following webpage: http://www.highland.gov.uk/yourenvironment/planning/energyplanning/renewbleenergy/ Further planning guidance and information is to be produced and, depending upon timing, may be available for the developer to refer to in preparing their proposals and undertaking related assessments. The developer is encouraged therefore to remain in contact with the Council regarding these matters.	Noted and referenced / informs LSVIA and assessments. Discussed with stakeholders during LSVIA development. Pre-Application pack issued by THC 10/10/11, referenced and requirements incorporated. Ongoing consultation with THC on onshore design aspects of the Project.	Section 19.3 Legislative Framework and Regulatory Context
The Highland Council	With respect to the Landscape and Seascape section of the developer's Scoping Document, it is noted that there is no reference made to the Special Landscape Areas (SLAs) that have been identified by The Highland Council. The Scoping Document does not clearly indicate the extent of the study area for the purposes of the EIA; however, it is assumed that it extends to include the Dunnet Head SLA and the Duncansby Head SLA and these should be referenced and taken into account in the assessment. I attach a map (Annex 2) showing the location of these two SLAs. In undertaking assessment, reference should be made to the citations contained within the Assessment of Highland Special Landscape Areas which is available via the following webpage: http://www.highland.gov.uk/yourenvironment/planning/developmentplans/developmentplanpolicyguidance/Special+Landscape+AreaCitations.htm	SLA's referenced and incorporated in landscape, seascape and visual assessment where applicable.	Section 19.5 Baseline Description

Table 19.3: Scoping comments relevant to the LSVIA

19.4.3 Desk based study

19.21 In order to determine the potential impact associated with the Project it is important to understand both the physical and experiential characteristics of the landscape and seascape which include:

- Landform and land cover characteristics;
- Coastline shape and dynamics;
- Seascape and sea conditions;
- Identification of human influences, trends and pressures on the land and sea; and
- Location of key visual receptors including houses and settlements, roads, walking trails, designated areas, viewpoints and important views.

19.22 A number of sources were reviewed to understand the landscape character and the value placed on the landscape of the site and its landscape/seascape setting. The desk review also identified the sensitivities of the landscape character types to development. The sources of information used for the desk review included:

- OS Maps (1:50000 and 1:25000);
- Landscape character assessment Scottish Natural Heritage; Caithness and Sutherland Landscape Character assessment no.103; 1998;
- Current development plans including the Highland Structure Plan (2001)[3] and Caithness Local Plan (2002)[1]; and
- The Highland – wide Local Development Plan (HWLDP), The Highland Council (2012)[4].

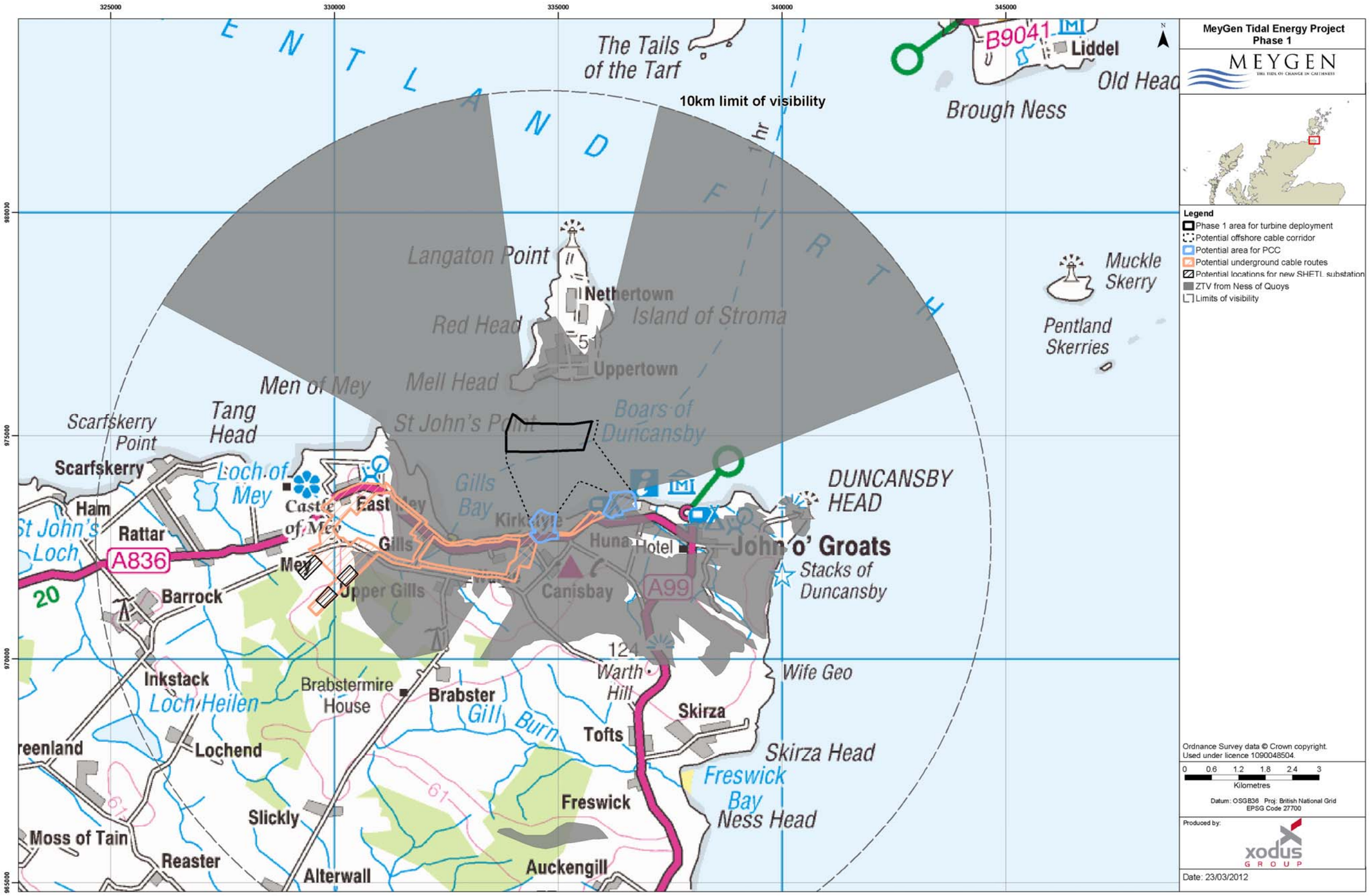


Figure 19.2: ZTV map – Ness of Quoys

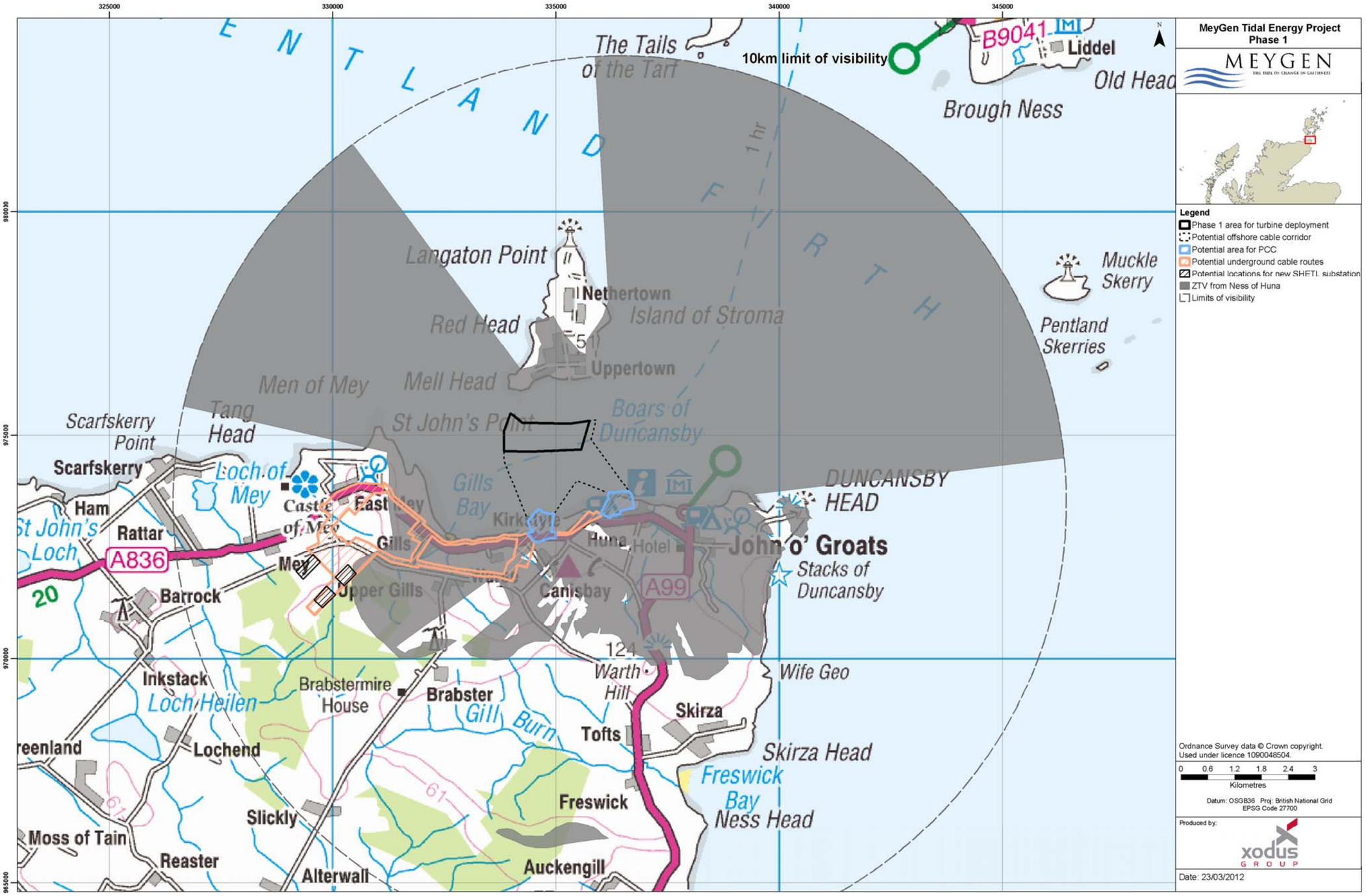


Figure 19.3: ZTV map – Ness of Huna

Zone of Theoretical Visibility development

19.23 The identification of potential landscape, seascape and visual impacts is based on Zone of Theoretical Visibility (ZTV) maps developed on a bare ground O.S. 1:50,000 contour and point height information at 10m intervals (Figure 19.2 and Figure 19.3).

19.24 The ZTV maps have been prepared using the digital format Ordnance Survey Open Data Landform Panorama map tiles to determine the theoretical visibility of the new development proposals. From these maps locations were selected for photographic viewpoints and photomontage preparation. These locations have been agreed with the stakeholders; The Highland Council, Scottish Natural Heritage and Historic Scotland.

19.4.4 Field survey

19.25 Field survey work included separate visits in differing weather conditions during June, July, August 2011 and January 2012. The field surveys assessed the visual influence of the development, principal viewpoints and sensitive receptors identified by the desk based study, refined the baseline landscape character areas, determined baseline seascape character areas and was used to assess impacts on landscape and seascape character.

19.26 Fieldwork to define seascape character areas, refine landscape character areas, assess landscape and seascape impacts and validate viewpoint impacts was carried out by a Chartered Landscape Architect (CMLI). Other survey work was undertaken by two suitably qualified persons (M.Arch / C.Arch). For the purposes of cross referencing of observations and notation, standard format field sheets were used for recording of this work and are included in the Technical Appendix which is available on the accompanying supporting studies CD (HRI, 2011).

19.27 Field survey work was used to further understand the nature of the landscape and seascape around the site and to identify the principal components that make up its character. The character types identified from the published landscape and seascape character assessment, within the range of the ZTV, were reviewed, including specific features contributing to landscape and seascape character. Information was recorded through the use of field notes, map annotations and photographic records as appropriate.

19.28 A walkover survey of the Project sites was undertaken to identify those features which contribute to the character of the sites or those which are important to its wider setting.

19.29 A number of viewpoints within the ZTV were selected for assessment as detailed below.

Viewpoint definition

19.30 Following discussion and site inspections with SNH and THC, the viewpoints have been chosen according to the following criteria:

- Being publicly accessible, except in exceptional circumstances (including private roads and properties with a prominent view of the Project site);
- Having a reasonably high potential number of viewers or being of particular significance to the viewers affected;
- Providing a representative range of viewing distances (i.e. short, medium and long distance views);
- Providing a representative range of viewing experiences (i.e. sequential views for example from the trunk road and local unclassified (U/C) public highways, and static views for example from designated viewpoints or car parks;
- Ensuring that views from areas recognised for their landscape quality, in particular nationally designated areas, are considered;
- Ensuring that views from or including buildings of (listed) historic importance are considered; and
- Ensuring that the assessment includes areas or viewpoints with specific features to enable assessment of the possible effects of the proposal in the context of such features.

19.31 Figure 19.4 shows the viewpoint schedule with the agreed eleven viewpoints emboldened. It should be noted that some viewpoints had multiple photomontages produced in order to capture views of both the Ness of Quoys and Ness of Huna. Figure 19.5 and Figure 19.6 show the viewpoint locations from Ness of Quoys and Ness of Huna respectively.

19.4.5 Photomontages

19.32 Photomontages have been generated for the views from the key selected viewpoints noted in Figure 19.4, Figure 19.5 and Figure 19.6.

19.33 Photographs of each view taken from each viewpoint looking towards the sites, indicating views as existing and photomontaged to indicate the Project can be found in the LSVIA Technical Appendix on the accompanying CD. Montages are provided for each of the two potential sites. In addition, the following information is given for each viewpoint montage;

- OS reference; this is the alpha numerical grid reference for the location of each viewpoint;
- Distance from the sites; from the viewpoint to the nearest site boundary;
- Included angle; the horizontal angle of view that is included in the photograph; and
- A thumbnail map showing the sites locations, the location of the viewpoint and the included angle.

19.4.6 Viewpoints

19.34 The agreed viewpoints have been assessed to the classifications detailed above in terms of visual impacts.

19.35 Photographic work conformed to Landscape Institute advice note 01/11, THC Visualisation Standards 2007 and SNH Handbook on Environmental Impact Assessment 2011; Appendix 1; LSVIA assessment and SNH referred guidance publication Visual Representation of Windfarms – Good Practice Guide dated 29th March 2006. It is to be noted that the scale of this development is significantly smaller than a windfarm both in terms of height and spread (proposed buildings of a light industrial scale) and as such the visualisations have been moderated such that the banding system in the guidance is inappropriate. This approach has been discussed and agreed with The Highland Council and SNH. The photographic survey was prepared using a Nikon D90 digital SLR with 23.6 x 15.8mm sensor utilising 75mm lens tripod mounted, providing landscape format images from agreed viewpoints (the lens setting is equivalent to a 50mm lens on a 35mm format camera). Composite panoramic images have been generated where considered necessary and appropriate following initial assessment, as a basis for photomontage images.

19.4.7 Significance criteria

19.36 ***The significance criteria approach used for this impact assessment varies slightly from the core methodology presented in Section 8. Specific details are provided in the following sections.***

19.37 The significance criteria defined in this section conform to SNH guidance (Handbook on Environmental Impact Assessment 2011) and is based on the methodology described in Section 8.

19.38 The significance criteria applied to the assessment and defined in this section conform to SNH guidance and are based on a series of scales which were produced using guidelines from the Landscape Institute (2002). The assessed sensitivity of the receptor and magnitude of landscape seascape and visual impacts are as defined below.

MEYGEN - PENTLAND FIRTH INNER SOUND TIDAL STREAM | PHOTO & LANDSCAPE ASSESSMENT DATA POINTS

					SITE 1 NESS OF QUOYS			**SITE 2** NESS OF HUNA			**VP REQUESTED BY:**			
LOCATION	EASTING	NORTHING	DESCRIPTION	VIEWS TO WHICH SITE?	VISIBLE	PARTLY VISIBLE	NOT VISIBLE	VISIBLE	PARTLY VISIBLE	NOT VISIBLE	PLANNING	SNH	VIEWPOINTS AGREED FOR PHOTOMONTAGES	NOTES
1	337240	970290	A99 at Warth Hill viewpoint											Sites not visible - no reason for VP
2	337140	970550	A99 at pull off											Limited value of VP
3	337000	971330	Layby on u/c road to Stemster											Limited value of VP
4	336810	971690	Slight bend on u/c road to Stemster											Limited value of VP
5	336610	971960	Jnct. u/c road Huna & Canisbay											Typical VP south of Huna, elevated.
6.1	**336296**	**972165**	**u/c road to A836 and Canisbay**	NESS OF QUOYS										**Easterly views of sites**
6.2	**336296**	**972165**	**u/c road to A836 and Canisbay**	NESS OF HUNA										**Easterly views of sites**
7A	337200	973340	John O'Groats mill											Mill in dip - neither site visible
7B	336940	973220	Jnct A836 & u/c road to Stemster											Nearest point to mill that views sites
8	336800	973610	Coastal walk west of Huna House											limited visibility; covered by VP 7
9.1	**336310**	**973220**	**Rear of village hall at Huna**	NESS OF HUNA										**Typical transient receptor close to Huna**
9.2	**336310**	**973220**	**Rear of village hall at Huna**	NESS OF QUOYS										**Typical transient receptor close to Huna**
10	335280	972810	Jnct. A836 & u/c road to Canisbay											Transient receptor
11	**334360**	**972820**	**Canisbay Church & burial ground**	NESS OF QUOYS										**Significant receptor - curtilage of historic building**
12	332700	972920	Gills bay ferry terminal											Sites not visible
13	331220	973770	A836 at Mey hill											Most westerly VP transient receptors
14	**331890**	**973110**	**A836 at lay-by**	NESS OF QUOYS										**Transient receptor - typical of A836 Western approach**
15.1	**334190**	**971640**	**War memorial**	NESS OF HUNA										**Significant receptor**
15.2	**334190**	**971640**	**War memorial**	NESS OF QUOYS										**Significant receptor**
16.1	**335140**	**972480**	**Canisbay north side**	NESS OF HUNA										**Significant receptor - main settlement and historic sites (Agreed as required VP in discussion with landowner & MeyGen staff).**
16.2	**335140**	**972480**	**Canisbay north side**	NESS OF QUOYS										**Significant receptor - main settlement and historic sites (Agreed as required VP in discussion with landowner & MeyGen staff).**
17	**337960**	**973480**	**John O'Groats pier**	NESS OF HUNA										**Significant receptor - but sites not highly visible. Significant offshore works VP**
18	333200	975700	Ferry - West of Stroma											Covered by VP 20
19	336400	976200	Ferry - East of Stroma											Covered by VP 20
20.1	**333200**	**974250**	**Ferry - South West of Stroma**	NESS OF QUOYS										**Representative VP from sea / scheduled sites on Stroma - ferry approach**
20.2	**333200**	**974250**	**Ferry - South West of Stroma**	NESS OF HUNA										**Representative VP from sea / scheduled sites on Stroma - ferry approach**
21	333050	971870	Upper Gills u/c road											Part of Settlement
22	332200	972050	West of Upper Gills on u/c road											Sites not visible
23	**331100**	**975150**	**St. John's Point - Fort**	NESS OF QUOYS / HUNA										**Historic Fort - open views over site(s) from West**
24	335300	975250	Ferry - South of Stroma											Significant for Stroma
25	**340500**	**973250**	**Duncansby Head**	NESS OF QUOYS / HUNA										**Significant receptor - tourist destination and VP site(s) in wide landscape / seascape context**
26	337110	969840	Cairn at Warth Hill											Covered by VP 23
27	**335641**	**973198**	**A836 West of Huna**	NESS OF QUOYS										**Transient receptor**
28	333496	971825	Upper Gills u/c road											Sites not visible
29	334714	972426	Manse at Canisbay											Manse in dip - only Quoys site slightly visible - Discounted due to limited views
30	333542	972356	Mains of Warse											Both sites visible; but limited value of VP

Figure 19.4: Viewpoint schedule

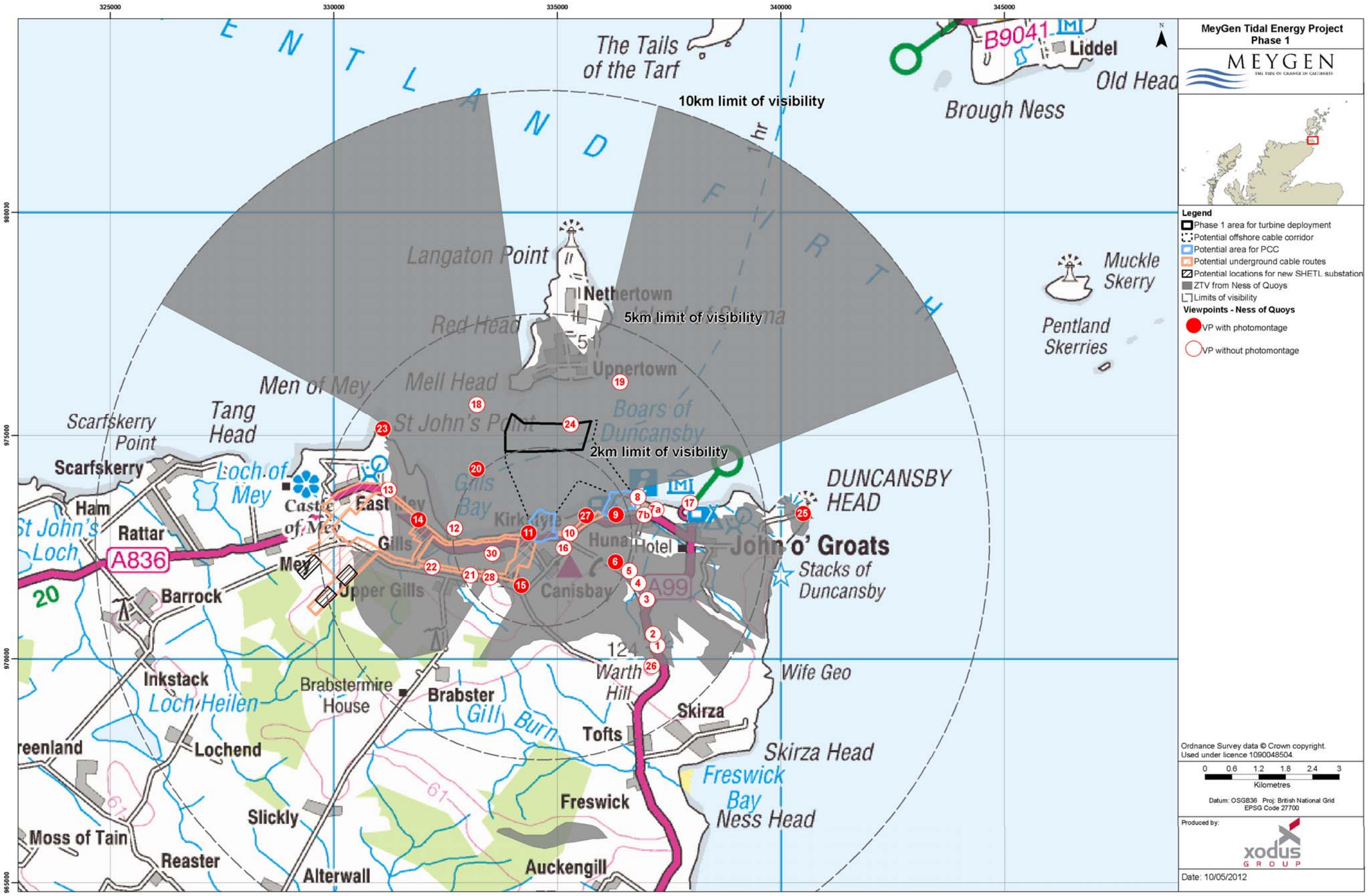


Figure 19.5: ZTV map – Ness of Quoys

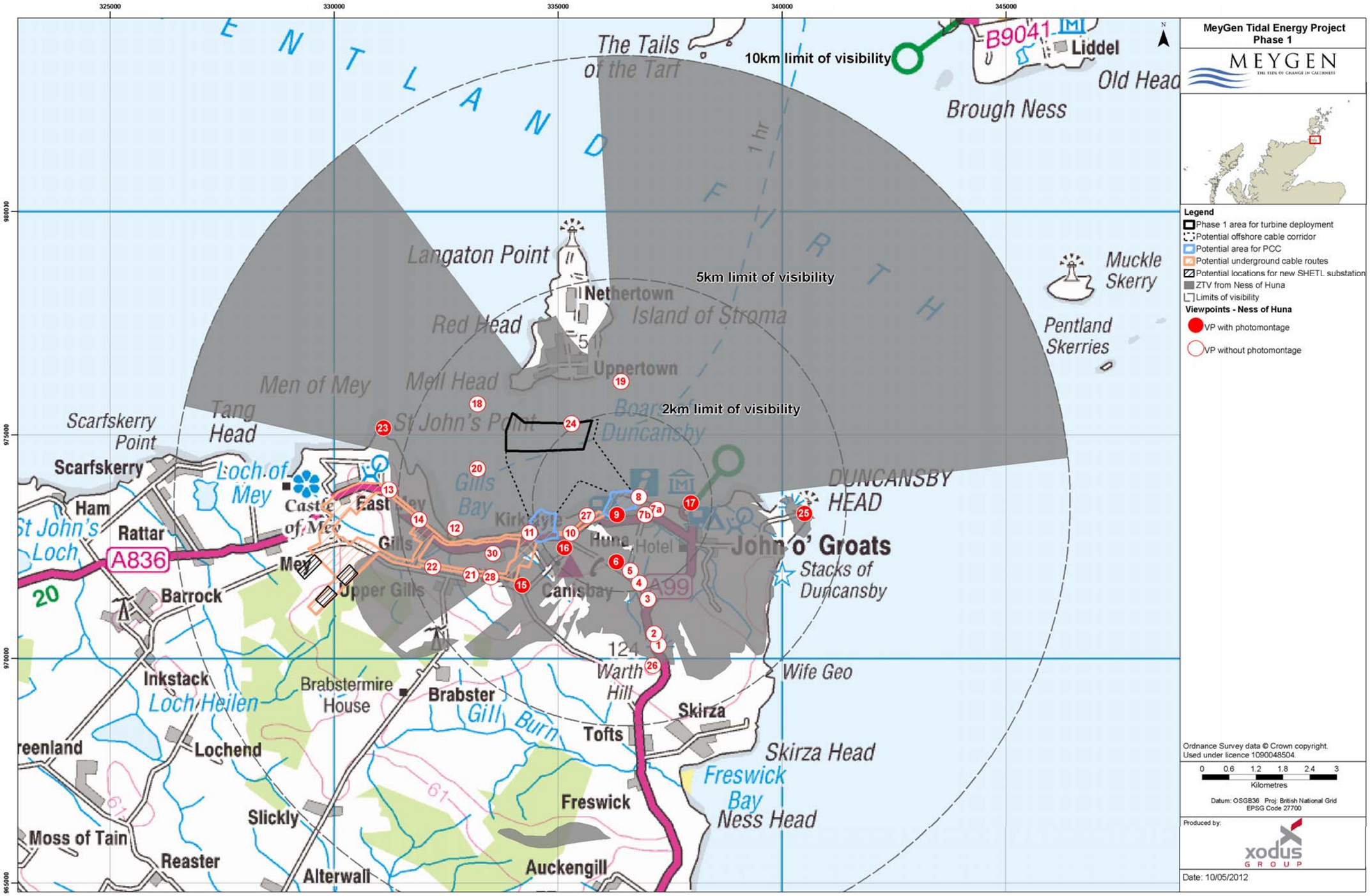


Figure 19.6: ZTV map – Ness of Huna

19.39 The sensitivity of the receptor and the magnitude of impact are combined to define the environmental consequence of the impact. This has been described with reference to a matrix in Section 8 (Table 8.1). It is important to note that with regard to Landscape, Seascape, and Visual effects this matrix has been used **as a guide only**. The matrix is not used as a prescriptive tool and the analysis of specific effects must make allowance for the exercise of professional judgement. Therefore, in some instances, a particular parameter may be considered as having a determining effect on the analysis at the expense of the matrix. It should also be noted that likelihood of impact is not considered a relevant parameter for landscape, seascape and visual effects and has not been included in the assessment.

19.40 The significance of impacts in relation to the EIA Regulations is defined in Section 8, Table 8.2.

Landscape sensitivity to change

19.41 The relative sensitivity of the landscape character within each character area is specific to the proposed change and depends upon a range of criteria. A five point scale has been utilised in accordance with the overall EIA Methodology (Section 8). For the purposes of this assessment the following definitions have been applied as noted in Table 19.4 below.

Sensitivity of receptor	Definition/Criteria
Very High	▪ Very high value placed on the landscape, e.g. designated National Scenic Area, National Park, World Heritage Site. ▪ Landscapes of very high quality and condition: with consistent, intact, well-defined, and distinctive attributes, well-managed, in exceptional state of repair. ▪ Landscapes with very high levels of wildness/perceived naturalness as reflected in occurrence within Search Areas for Wild Land (SAWL).
High	▪ High value placed on the landscape e.g. Highland Special Landscape Area, Historic Gardens and Designed Landscapes. ▪ Landscapes of high quality and condition. ▪ Landscapes with high levels of wildness/perceived naturalness.
Medium	▪ Landscapes of moderate quality and condition. ▪ Landscapes may be locally valued but with no explicit designation or recognition of value. ▪ Landscapes dominated by agricultural or other man-modified land uses, although with some perceived naturalness.
Low	▪ Landscape intrinsically able to accommodate proposed change without key characteristics being diminished. ▪ Settled landscapes, with complex land use patterns where built elements and structures are already a strong part of the landscape character.
Negligible	▪ Heavily developed, industrial landscapes. ▪ Landscapes of low or poor quality and condition.

Table 19.4: Definitions of landscape sensitivity

Magnitude of landscape change

19.42 Establishment of the baseline and sensitivities to change enables the magnitude of change as a result of the proposed Project to be determined. A five point scale has been utilised in accordance with the overall EIA Methodology (Section 8). For the purposes of this assessment the following definitions have been applied as noted in Table 19.5 below:

Magnitude of change	Definition
Severe	▪ Permanent removal or loss of the key characteristics of the landscape. ▪ Fundamental change to key characteristics of the landscape. ▪ All or very high proportion of landscape elements or very large spatial scale of landscape unit affected. ▪ Loss that cannot be replaced or change that cannot be mitigated.
Major	▪ Permanent loss of or substantial change to key characteristics of landscape. ▪ High proportion of landscape elements or large spatial scale of landscape unit affected. ▪ Indirect impacts perceived at very close range. ▪ Limited scope for replacement or mitigation.
Moderate	▪ Partial removal of or material change to characteristics of the landscape. ▪ Moderate proportion of landscape elements or spatial scale landscape unit affected. ▪ Indirect impacts perceived at moderate separation distances. ▪ Loss or change that can be partially replaced or mitigated.
Minor	▪ Discernable but small scale changes to landscape element or unit. ▪ Small proportion of landscape elements or small spatial scale of landscape unit affected. ▪ Indirect impacts perceived at large separation distances. ▪ Larger scale losses that can be fully mitigated.
Negligible	▪ Changes which are not discernable or have no effect on the integrity of the element or unit.

Table 19.5: Definitions of magnitude of Landscape change

Sensitivity to change of seascape

19.43 The relative sensitivity of the seascape within the local coastal character areas is specific to the proposed change and depends upon a range of criteria which take account of the coastline, and both landward and seaward perspectives. The published Guidance on Landscape/Seascape Capacity for Aquaculture (SNH 2008) was referred to in developing and applying the criteria. A five point scale has been utilised in accordance with the overall EIA Methodology (Section 8). For the purposes of this assessment the following definitions have been applied as noted in Table 19.6 below:

Sensitivity of receptor	Definition/Criteria
Very High	▪ Seascapes located within and which contribute to the value of landscapes designated at national and international level. ▪ Seascapes with very distinctive physical characteristics including shape, enclosure, fragmentation, and prominent historic, cultural, or geological features. ▪ Seascapes with intact and very pronounced qualities of wildness and isolation, with strong evidence of and exposure to natural forces. ▪ Seascapes with spectacular views, very complex visual composition, very high diversity of detail, and aesthetic qualities which are intact and uncompromised.
High	▪ Seascapes located within and which contribute to landscapes of high value, recognised at regional or local level. ▪ Seascapes with distinctive physical characteristics including shape, enclosure, fragmentation, and specific historic, cultural, geological features. ▪ Seascapes with qualities of wildness and inaccessibility. ▪ Seascapes with striking/expansive views, diverse visual composition and aesthetic qualities which are predominantly intact.
Medium	▪ Seascapes with relatively unremarkable physical characteristics including linear shape, large-scale, and little fragmentation, and few specific historic, cultural, geological features of interest. ▪ Seascapes with some qualities of wildness, compromised to a degree by existing development and accessibility. ▪ Seascapes with relatively simple visual composition. ▪ Seascapes where settings of key views include some developed features and shipping or other maritime activity.
Low	▪ Seascapes comprising well-settled and readily accessible coastlines and hinterlands. ▪ Seascapes with prominent and frequent shipping or other maritime activity.
Negligible	▪ Seascapes comprising urban coastlines and hinterlands dominated by development. ▪ Seascapes with seaward views dominated by shipping or other maritime activity.

Table 19.6: Definitions of seascape sensitivity

Magnitude of change to seascapes

19.44 Establishment of the baseline and sensitivities to change enables the magnitude of change as a result of the proposed Project to be determined. A five point scale has been utilised in accordance with the overall EIA Methodology (Section 8). For the purposes of this assessment the following definitions have been applied as noted in Table 19.7 below:

Magnitude of change	Definition
Severe	▪ Permanent removal or loss of the key characteristics of the seascape. ▪ Fundamental change to key characteristics. ▪ All or very high proportion of seascape elements or very large spatial scale of seascape unit affected. ▪ Loss that cannot be replaced or change that cannot be mitigated.
Major	▪ Permanent loss of or substantial change to key characteristics of seascape. ▪ High proportion of seascape elements or large spatial scale of seascape unit affected. ▪ Indirect impacts perceived at very close range. ▪ Limited scope for replacement or mitigation.
Moderate	▪ Partial removal of or material change to characteristics of the seascape. ▪ Moderate proportion of seascape elements or spatial scale of seascape unit affected. ▪ Indirect impacts perceived at moderate separation distances. ▪ Loss or change that can be partially replaced or mitigated.
Minor	▪ Discernable but small scale changes to seascape element or unit. ▪ Small proportion of seascape elements or small spatial scale of seascape unit affected. ▪ Indirect impacts perceived at large separation distances. ▪ Larger scale losses that can be fully mitigated.
Negligible	▪ Changes which are not discernable or have no effect on the integrity of the element or unit.

Table 19.7: Definitions of magnitude of change to seascape

Visual sensitivity to change

19.45 The relative sensitivity of the visual receptors is specific to the proposed change and depends upon a range of criteria. A five point scale has been utilised in accordance with the overall EIA Methodology (Section 8). For the purposes of this assessment the following definitions have been applied as noted in Table 19.8 below:

Sensitivity of receptor	Definition/Criteria
Very High	▪ Very high value placed on the View: celebrated viewpoint included in tourist guides, view located within a landscape designated at national or international level. ▪ Very sensitive viewer types/occupations: Residents with views of the development. Users of strategic outdoor recreational facilities (including national long distance footpaths, national cycle routes). ▪ Duration of view typically long, view studied/enjoyed for considerable duration. ▪ Very large numbers of viewers.
High	▪ High value placed on the View: recognised viewpoint marked on maps, views within landscapes designated at regional or local level, views from designated tourist routes, views of (or from) landscape or built features with important physical, cultural or historic attributes. ▪ Highly sensitive viewer types/occupations: Users of outdoor recreational facilities (including recreational footpaths, cycle routes or rights of way), whose attention may be focused on the landscape; special interest groups where landscape setting is important. ▪ Duration of view not curtailed by physical parameters. Viewers stationary or slow moving. ▪ Large numbers of viewers.
Medium	▪ Lower value or no explicit value placed on view: e.g. views from within settlements, commercial buildings. ▪ Less sensitive viewer types/occupations: people engaged in outdoor sports, people travelling through or past the landscape, people at places of work, whose attention may be focused on their activity rather than the wider landscape. ▪ Duration of view relatively short. Time to absorb or contemplate view curtailed by physical parameters. ▪ Relatively small numbers of viewers.
Low	▪ Low value placed on view: e.g. views from roads and transport routes. ▪ Less sensitive viewer types/occupations: people engaged in outdoor sports or recreation, people travelling through or past the landscape, people at places of work, whose attention may be focused on their activity rather than the wider landscape. ▪ Duration of view short. Glimpse or interrupted views. Viewers moving at speed. ▪ Small numbers of viewers.
Negligible	▪ Very small numbers of viewers. Location unlikely to be visited.

Table 19.8: Definitions of visual sensitivity

Magnitude of change to visual receptors

19.46 Establishment of the baseline and sensitivities to change enables the magnitude of change as a result of the proposed Project to be determined. A five point scale has been utilised in accordance with the overall EIA Methodology (Section 8). For the purposes of this assessment the following definitions have been applied as noted in Table 19.9 below:

Magnitude of change	Definition
Severe	▪ Proposed change will define view. ▪ All of development clearly visible. ▪ Development will be the dominant feature in the view. ▪ Impacts perceived at very close range.
Major	▪ High proportion of development visible, no significant screening effects. ▪ Large proportion of field of view occupied by development. ▪ Strong contrasts with key visual characteristics of the baseline view e.g. scale, horizontality, composition. ▪ Angle of view to development coincides with focus of receptor activity/viewpoint/road alignment, etc. ▪ Development breaks horizon/skyline with no backdrop. ▪ Impacts perceived at short separation distance.
Moderate	▪ Development partially screened by topography, vegetation, etc.. ▪ Development viewed against backdrop. ▪ Some conflicts with key visual characteristics of the baseline view e.g. scale, horizontality, composition. ▪ Angle of view to development does not coincide with focus of receptor activity/viewpoint/road alignment, etc. ▪ Impacts perceived at moderate separation distances.
Minor	▪ Development substantially screened by topography, vegetation, etc. ▪ Development compatible with key visual characteristics of the baseline view e.g. scale, horizontality, composition. ▪ Impacts perceived at large separation distances.
Negligible	▪ Changes which are not discernable.

Table 19.9: Definitions of magnitude of visual change

19.4.8 Data gaps and uncertainties

19.47 There are not considered to be any major data gaps and uncertainties associated with the seascape, landscape and visual impact assessment undertaken. As previously mentioned in the absence of specific guidance on such impact assessments for tidal developments, MeyGen has made reference to other relevant guidance.

19.5 Baseline Description

19.48 In this section the existing conditions of the landscape, seascape and visual resources of the study area are described to provide a basis against which changes can be assessed.

19.5.1 Landscape resource

Overview

19.49 The landform of the study area is typically gently rolling, and is generally less than 100m above sea level. There is correspondingly relatively little visual containment and views are both panoramic and extensive; often enhanced by the presence of the adjacent sea. The land cover is predominantly agricultural with an abundance of grassland or improved grassland, reflecting the high reliance on livestock for meat and dairy production. Land cover and landform gradually changes to the south towards a predominance of moorland and peatland. The uninhabited island of Stroma beyond the Inner Sound is similarly low lying with mixed moorland and coastal grassland areas.

Settlement pattern

19.50 Settlements are sparse and relatively scattered along the A836 coast road and define the agricultural zone which lies within approximately 2km of the sea, beyond which the land rises to heather and moorland; primary settlements are John o' Groats, including housing, visitor facilities and hotels / guesthouse establishments, and Canisbay, a similarly dispersed settlement extending to West Canisbay and upper Gills to the east and Stemster/Huna to the east. Additionally there are numerous single dwellings, farmsteads and agricultural buildings along the A836.

Communications and infrastructure

19.51 As with the settlement pattern, the transportation corridor is along the coast. The principal road is the A836 which joins the main A9(T) at John o' Groats and runs west to Castletown and Thurso where it joins the A882(T) to the south. A number of unclassified single track roads and tracks connect small settlements, and individual houses and crofts/farmsteads, to the main road.

19.52 The A9 trunk road and A836 are also significant through routes; serving tourist traffic to John o' Groats and along the north coast and feeding the John o' Groats – South Ronaldsay ferry (foot traffic only) running through the summer to Orkney; and the Gills Bay – St Margaret's Hope vehicle ferry.

19.53 Infrastructural services comprise mains service feeders routed from the A9 / A836 corridors. Existing power and telecom supplies are generally routed over ground.

Project sites: Ness of Quoys

19.54 The site is located on the north coast of Caithness, 3.8km east of John o' Groats. Its key physical landscape characteristics are:

- Open agricultural character with no buildings currently present on the site;
- Flat landform, falling imperceptibly northwards towards low cliffline from southern site boundary at A836;
- Uniform landcover of pasture grassland, subdivided by post and wire fencing; and
- Stone wall enclosing Canisbay Kirk burial ground abuts western site boundary.

19.55 Overall the above characteristics are considered to have a Low/Medium Sensitivity to the introduction of the development.

Project sites: Ness of Huna

19.56 The site is located on the north coast of Caithness, 2.3km east of John o' Groats. Its key physical landscape characteristics are:

- Open agricultural character with no buildings currently present on the site;
- Flat landform, falling gradually northwards towards cliffline from southern site boundary at A836. Cliffline is higher than at Ness of Quoys site;
- Uniform land cover of pasture grassland, subdivided by post and wire fencing, and significant areas of mature gorse scrub ;
- Farm building group near Huna House adjacent to western site boundary; and
- Properties on A836 adjacent to southern site boundary.

19.57 Overall the above characteristics are considered to have a Low/Medium Sensitivity to the introduction of the development.

Forces for change

19.58 Forces for change are those that are currently affecting the character of the landscape resource and which may, consequently, affect the perception of the Project in the future:

- Industry - Any future local industrial development, outwith this proposal, is likely to be limited to the Gills Bay harbour area, where traffic numbers have grown steadily in recent years and where small scale facility development is underway. Future renewables development predicated by the Pentland Firth and Orkney Waters marine renewables Agreement for Lease (AfL) areas may impact on the wider landscape and seascape;
- Tourism – John o' Groats in a nationally known tourist / visitor destination and significant redevelopment of the settlement and its facilities is planned. While the majority of traffic and visitor movements to and from John o' Groats are via the A9 trunk route, increasing movements along the north coast via the A836 may be anticipated, together with a degree of 'spin off' development in visitor accommodation and related facilities between John o' Groats and Mey, incorporating future growth in the Orkney terminal at Gill's Bay;
- Agriculture - Agriculture within the region will continue to be influenced by the provision of subsidies and grants through Common Agricultural Policy (CAP) and other funding mechanisms. It is not clear how current or future changes in subsidies or agricultural policy will affect the local landscape but historically such changes as far as they affect the landscape, are likely to be minor; and,
- Housing and settlement –Numerous initiatives and development programmes – including tourism and renewables development – are in place to sustain the local economy and population. It is not envisaged that there will be any significant housing development within the study area with any settlement development comprising single house renewals or additions.

19.5.2 Landscape character

Landscape Character Types

19.59 Landscape Character Types (LCTs) occurring within the Study Area are shown in Figure 19.7. It is stressed that these were identified following a process which included review of the Caithness and Sutherland landscape character assessment (SNH Review No 103), supplemented by field study focussing on the specific local characteristics present in the study area. It was noted during the process that identification of a number of the LCTs in the SNH Report is closely related to land use type, and that the balance of this may have changed over the period since its publication in 1998. The resulting classification therefore represents an adaptation of the SNH types for the specific purposes of this project assessment.

19.60 The descriptions of key characteristics in Table 19.10 below largely reflect text within the Caithness and Sutherland landscape character assessment, selected and adapted to apply to the specific units of each type present within the study area, as distinct from the overall generic type, which may occur more widely throughout Caithness and Sutherland. In some cases it was not considered possible to positively identify discrete areas of certain subtypes included in the SNH classification. In these instances local characteristics of the subtypes have been included in the key characteristics of the larger aggregated area.

Landscape character type	Key characteristics	Sensitivity to proposed development
Sweeping Moorland	▪ Vast scale. ▪ Wide open space with high exposure and extensive visibility. ▪ Simple visual composition. ▪ Fairly flat or gently sloping or undulating landform. ▪ Pockets of improved grazing. ▪ Occasional streams and lochs. ▪ Settlements generally restricted to outer edges of type. ▪ Service elements tend to be highly visible. ▪ Coniferous plantations locally dominant. ▪ Characteristics of Flat Peatland subtype locally dominant.	LOW Reasons: ▪ Existing patterns include prominent service elements and frequent large geometric plantations. ▪ Views outwards commonly include settlements and other built development on margins. ▪ Large extent of this type in a regional context - no landscape designations present.
High Cliffs and Sheltered Bays	▪ Open exposure to elements. ▪ Long stretches of high cliffs. ▪ Expansive views along the coast and out to sea. ▪ Dominating presence of sea/land edge. ▪ Experientially and physically very dramatic and dynamic. ▪ Lighthouse forms focal point and landmark. ▪ Landcover dominated by grassland, often grazed by sheep.	HIGH Reasons: ▪ Dominance of natural characteristics and dramatic experiential qualities. ▪ Includes Special Landscape Area designated for quality of landscape features and views.
Mixed Agriculture and Settlement	▪ Vast and open. ▪ Horizontal emphasis. ▪ Extremely exposed. ▪ Simple, gently sloping landform. ▪ Complex visual composition of varying landcover and land uses, lines formed by field boundaries, roads, powerlines. ▪ Focal points include houses, castles, masts, and woodland blocks. ▪ Historic features, local evidence of decline and abandonment, including island of Stroma. ▪ Confusing arrangement of dwellings and roads, often no distinct edge or separation between communities and settlements. ▪ Small estates with large house, boundary wall, woodland, and estate houses (eg Mey Estate).	LOW Reasons: ▪ Large scale and horizontal emphasis compatible with overall development form. ▪ Complex mix of existing characteristics not readily affected by introduction of new elements. ▪ Supported by LCA judgement that "Many areas able to accommodate new changes without their intrinsic quality being marred".
Small Farms and Crofts	▪ Human settlement and land uses dominate. ▪ Repetitive pattern of enclosure and land uses discernable, often relative to coastal edge. ▪ Semi-enclosed, less open and of smaller scale relative to Mixed Agriculture and Settlement type. ▪ Frequent new housing, often of generic "kit" type not related to the local landscape or architectural style. ▪ Holiday homes common, contrasting with working crofts and farms. ▪ Abandoned/ruined buildings, field boundaries.	LOW Reasons: ▪ Existing dominance of human settlement features ▪ No landscape designations present. ▪ Outward views not a key attribute of existing character.

Table 19.10: Baseline landscape character

The Highland Council Special Landscape Areas

19.61 In June 2011 The Highland Council published the Assessment of Highland Special Landscape Areas (AHSLA). This document reviewed the existing local landscape designations (Regional Scenic Areas and Areas of Great Landscape Value) which had been identified within the Highland Structure Plan (2001). The assessment provides a citation for each of the Special Landscape Areas (SLAs) describing key landscape and visual characteristics, special qualities, key sensitivities to landscape change, and possible enhancement measures.

19.62 The Duncansby Head Special Landscape Area is the only SLA occurring within the study area. Its location and extent are shown on Figure 19.7. Its key characteristics and special qualities are set out in the Citation Report and coincide to a large extent with the descriptions of the High Cliffs and Sheltered Bays LCA (Table 19.10) and the Duncansby Head- Skirza Head Local Coastal Character Area (Paragraphs 19.78 and 19.79).

19.63 Its sensitivity to introduction of the proposed Project is considered to be high, due primarily to its landscape designation which highlights inter alia the quality of distant views and dramatic experiential qualities.

Historic Gardens and Designed Landscapes (HGDL)

19.64 These are gardens and landscapes listed in the Inventory of Gardens and Designed Landscapes in Scotland, first compiled and published in 1987. Sites listed in the Inventory are not statutorily designated but are considered to be a national consultation issue under planning legislation.

19.65 Castle of Mey is the only HGDL occurring within the study area. Its location and extent are shown on Figure 19.7. Its key characteristics as set out in the Inventory include:

- Outstanding scenic value in the surrounding landscape; and
- Provides the setting for the Castle which is a Category A listed building.

19.66 Its sensitivity to introduction of the proposed Project is considered to be HIGH, due primarily to its inclusion in the Inventory.

Historic buildings / structures

19.67 Full details of buildings/structures of historic interest are provided in the Section 20. The key features of note are The Grade A listed Canisbay Kirk and graveyard and the Grade B listed East Canisbay Manse.

19.5.3 Seascape resource: Seascape character

19.68 Seascape Character Areas (SCAs) were identified by applying the methodology set out in Guidance for Landscape/Seascape Capacity for Aquaculture (SNH, 2008). Under this methodology, the units are termed Local Coastal Character Areas, representing a more detailed breakdown of the "Seascape Character Types" identified in Scott *et al* (2005). The Local Coastal Character Areas are shown in Figure 19.7 and are described briefly below.

LCCA 1: Ham to St. John's Point

19.69 Location and Extent:

- Coastline from study area boundary east of Ham Berry to St John's Point; and
- Represents a local subdivision of the broader SNH Seascape classification for this area (Seascape Character Type 2: "Mainland Rocky Coastline with Open Sea Views").

19.70 Key Landscape and Visual Elements:

- Linear, generally east-west trending coastline;
- Majority of coastal edge formed by low cliffs or rough vegetated slopes typically around 10m high, with rocky wave-cut platform below;
- Sheltered cove and pier at Wester Haven/Harrow;
- Geos common in section west of Scarfsferry Point;
- Frequent evidence of historic features – including chambered cairns, chapel, and broch;
- Expansive seaward views: including northwards to Orkney, west to Dunnet Head, and east to St John's Point; and
- Diverse hinterland including crofts, holiday homes, mixed agriculture and settlement, moss, lochs, and Castle of Mey estate.

19.71 Overall sensitivity to proposed Project = Medium/Low (Table 19.11).

Attribute	Potential sensitivity	Reasons
Maritime Influences	Medium	▪ Dominant open expanse of sea to north. ▪ Views of offshore islands. ▪ Views of ferries and other shipping.
Character and Experience of Coast/Key Views	Medium	▪ Diverse, open sea views to east and west. ▪ Hinterland views over diverse land use types.
Setting of Landmarks and Features	Medium/Low	▪ Key features have settings characterised mainly by agricultural land uses and/or built development.
Experience of Wildness	Low	▪ Minor road with frequent crofts and housing runs close to coastal edge.
Aesthetic Qualities	Medium	▪ Includes good seaward views west towards Dunnet Head and north towards Orkney.

Table 19.11: Potential sensitivity to proposed Project

LCCA 2: St. John's Point to Gills Bay

19.72 Location and Extent:

- Coastline from St John's Point to Gills Bay pier and ferry terminal; and
- Represents a variation of the broader SNH Seascape classification for this area (SNH Seascape Character Type 1 "Remote High Cliffs"). The cliffs in this seascape unit are generally lower and less remote than the typical areas as described in the SNH classification.

19.73 Key Landscape and Visual Elements:

- Generally north-west to south-east trending coastline;
- Majority of coastal edge formed by low cliffs typically around 20m high, with rocky wave-cut platform below;
- Northern section near St John's Point more rugged with deeply indented geos and higher cliffs up to 30m high;
- Small sheltered cove at Scotland's Haven;
- Evidence of historic features – remains of fort on St John's Point headland;
- Expansive seaward views: including northwards to Stroma and Orkney, west to Dunnet Head, east to Duncansby Head;
- Hinterland predominantly of rough moorland grasses, gorse and heather; and
- Main landmark and viewpoint at St John's Point headland, also good views east from A836 east of Mey Hill.

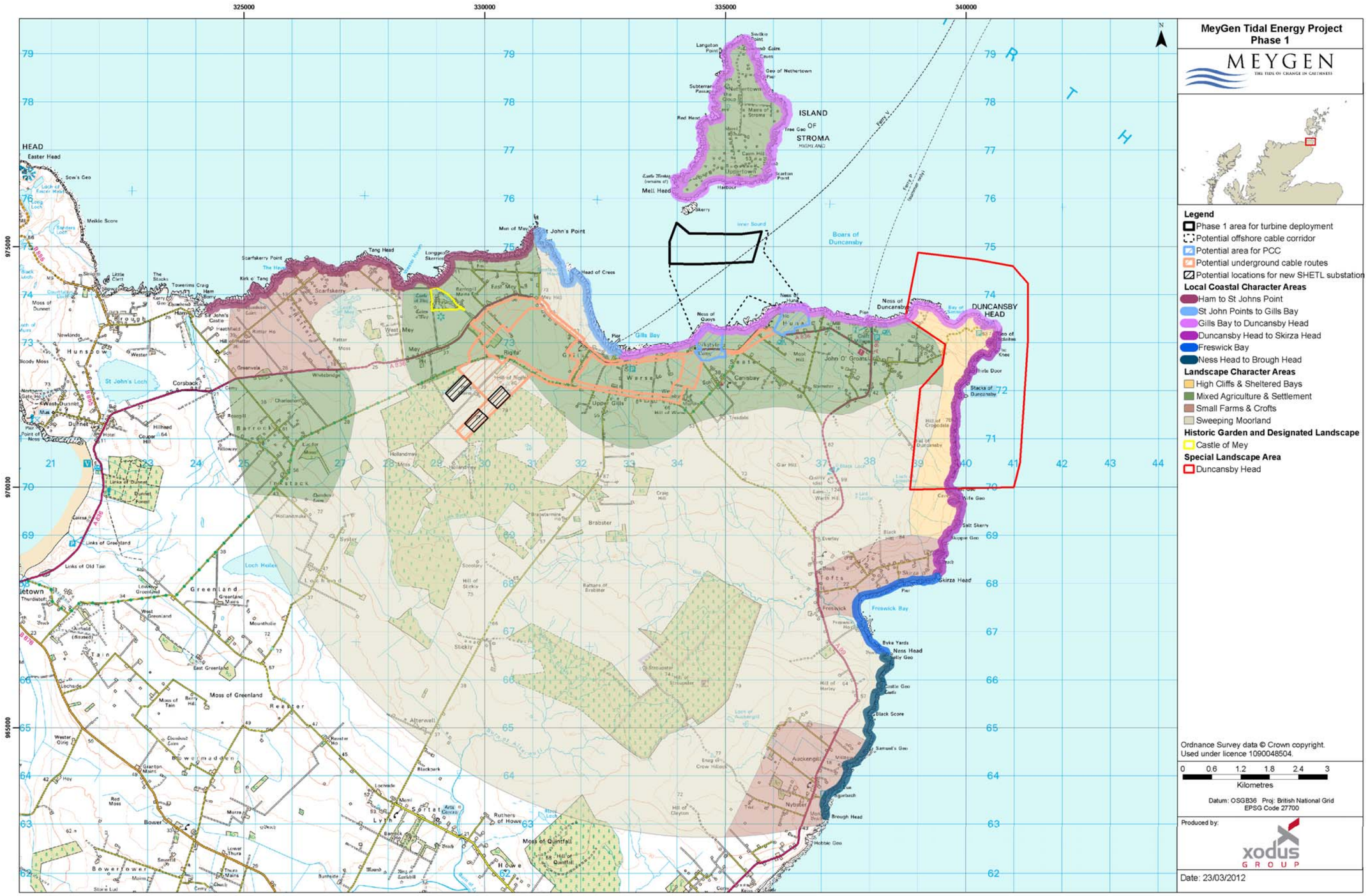


Figure 19.7: Landscape character map (Based upon SNH Caithness and Sutherland landscape character assessment no.103; 1998)

19.74 Overall sensitivity to proposed Project = Medium/High (Table 19.12).

Attribute	Potential sensitivity	Reasons
Maritime Influences	Medium	▪ Dominant open expanse of sea to north. ▪ Views of offshore islands. ▪ Views of ferries and other shipping. ▪ Tidal turbulence in Inner Sound.
Character and Experience of Coast/Key Views	Medium	▪ Diverse, open sea views to east and west. ▪ Hinterland views over perceived natural vegetation types to settled agriculture, roads, etc.
Setting of Landmarks and Features	Medium	▪ Natural landscape settings for key landmark at St John's Point and adjacent historic fort.
Experience of Wildness	Medium/High	▪ Footpath only access to St John's Point, other sections rough footpaths at best. ▪ Relatively high perceived naturalness of hinterland vegetation cover.
Aesthetic Qualities	Medium/High	▪ Include some striking seaward views across Inner Sound and Pentland Firth to Stroma, Orkney, and Pentland Skerries.

Table 19.12: Potential sensitivity to proposed Project

LCCA 3: Gills Bay to Duncansby Head

19.75 Location and Extent:

- Coastline from Gills Bay pier and ferry terminal to Duncansby Head, also including the coastline of the Island of Stroma; and
- Represents a local subdivision of the broader SNH Seascape classification for this area (Seascape Character Type 2 "Mainland Rocky Coastline with Open Sea Views") Note: Stroma not included in SNH Classification.

19.76 Key Landscape and Visual Elements:

- Linear, generally east-west trending coastline;
- Subsidiary headlands at Ness of Quoys, Ness of Huna, and Ness of Duncansby form shallow embayments;
- Majority of coastal edge formed by low cliffs typically around 10m high, with rocky wave-cut platform below. Occasional stretches of sandy beach east of John o' Groats;
- Stroma: Prominent uninhabited offshore island rising to highpoint of 53m AOD with rocky shoreline and low cliffs, and abundant abandoned dwellings;
- Piers at Gills Bay and John o' Groats, with ferry services to Orkney (seasonal only from John o' Groats);
- Expansive seaward views: including northwards to Stroma and Orkney, west to St John's Point and in clear conditions to Dunnet Head, east to Duncansby Head and Pentland Skerries;
- Tidal turbulence within Inner Sound clearly visible from shoreline;
- Hinterland predominantly of mixed agriculture; including larger settlements at John o' Groats, Canisbay, and Gills Bay;
- A836 coastal road John o' Groats to Thurso forms dominant linear feature immediately inland;
- Key landmarks include John o' Groats pier and settlement, Gills Bay pier and ferry terminal, the old Kirk at Canisbay, Huna House, and the old mill east of Huna; and
- Warth Hill to the south, and the lighthouses at Duncansby, Pentland Skerries, and on Stroma, form key reference points although outside the unit.

19.77 Key overviews of this unit include from Warth Hill on A99, and Mey Hill on the A836. Overall sensitivity to proposed Project = Medium/Low (Table 19.13).

Attribute	Potential sensitivity	Reasons
Maritime Influences	Medium	▪ Dominant open expanse of sea to north. ▪ Views of offshore islands. ▪ Tidal turbulence in Inner Sound. ▪ Views of ferries and other shipping.
Character and Experience of Coast/Key Views	Medium/Low	▪ Diverse, open sea views but agricultural hinterland, settlement and roads also prominent.
Setting of Landmarks and Features	Medium/Low	▪ Settings for key landmarks include agriculture, roads and settlement.
Experience of Wildness	Low	▪ A well-settled and readily accessible stretch of coastline, but with visible evidence of strong natural tidal forces. ▪ Abandoned uninhabited island creates sense of remoteness.
Aesthetic Qualities	Medium/High	▪ Include some striking seaward views across Inner Sound and Pentland Firth to Stroma, Orkney, and Pentland Skerries.

Table 19.13: Potential sensitivity to proposed Project

LCCA 4: Duncansby Head to Skirza Head

19.78 Location and Extent:

- Coastline from Duncansby Head Lighthouse extending south to Skirza Head, where there is a sharp change in direction westwards at entrance to Freswick Bay;
- Represents a local subdivision of the broader SNH Seascape classificatiion for this area (Seascape Character Type 1 "Remote High Cliffs"); and
- Includes Duncansby Head Special Landscape Area designated by The Highland Council.

19.79 Key Landscape and Visual Elements:

- Relatively simple linear north-south coastline of high sandstone cliffs, (up to 70m) with smaller scale detail variation provided by erosional landforms including stacks, arches, geos and wave-cut platforms;
- Distant expansive views: eastwards to open sea, and at Duncansby Head also northwards to Orkney and Pentland Firth, and west along northern coastline;
- Strong "wild land" influences: high, exposed position and rugged terrain, away from Duncansby Head visitor facility the unit has a remote feel with no roads and few footpaths, and few modern artefacts or structures (Note: Minor Road to Skirza Head allows views to Freswick Bay but no views to this unit); and
- Key viewpoints are Duncansby Head trig point, and clifftop footpath leading southwards: these provide key views over cliffs and stacks with undeveloped open settings.

19.80 Overall sensitivity to proposed Project = High (Table 19.14).

Attribute	Potential sensitivity	Reasons
Maritime Influences	Medium /High	▪ Dominant open expanse of sea to east. ▪ From Duncansby Head influence of ferry activity, lighthouses, jetties, etc on north coast is evident.
Character and Experience of Coast/Key Views	Medium /High	▪ Dominance of open, undeveloped character with strong perceived naturalness, moderated by development at Duncansby Head and views along north coast. ▪ Key views within SLA currently include very few developed features.
Setting of Landmarks and Features	High	▪ Existing undeveloped open settings for key landmarks.
Experience of Wildness	High	▪ Majority of unit sensitive to experience of new modern artefacts or structures.
Aesthetic Qualities	High	▪ Northern part of unit within SLA designated for special landscape qualities, these are also present within the remainder of the unit although less marked.

Table 19.14: Potential sensitivity to proposed Project

LCCA 5: Freswick Bay

19.81 Location and Extent:

- Coastline from Skirza Head south to Ness Head, encompassing the well-defined feature of Freswick Bay; and
- Represents a local subdivision of and variation from the broader SNH Seascape classification for this area (SNH Seascape Character Type 2 “Mainland Rocky Coastline with Open Sea Views”).

19.82 Key Landscape and Visual Elements:

- Well-defined crescent-shaped embayment interrupting generally north-south trending linear coastline;
- Rocky wave-cut platform forms majority of coastline with small sandy beach and dune system at innermost section of bay;
- Cliffs at Skirza Head and Ness Head contrast with internal section of unit;
- Distant expansive views: eastwards to open sea;
- Good views across bay from enclosing headlands, from elevated sections of A99, and from minor road to Skirza;
- Hinterland predominantly of mixed agriculture and settlement, with most settlement along minor road to Skirza on north side of bay; and
- Freswick House and Mains form important focal features.

19.83 Overall sensitivity to proposed Project = Medium/Low (Table 19.15).

Attribute	Potential sensitivity	Reasons
Maritime Influences	Medium /Low	▪ Dominant open expanse of sea to east. ▪ Distant views of shipping.
Character and Experience of Coast/Key Views	Medium /Low	▪ Dominance of open views but agricultural hinterland, settlement and roads also prominent.
Setting of Landmarks and Features	Medium /Low	▪ Settings for key landmarks including beach, cliffs and castle feature development and agriculture.
Experience of Wildness	Low	▪ A well-settled and readily accessible stretch of coastline.
Aesthetic Qualities	Medium	▪ Diverse views including enclosed bay, open sea, and settled hinterland.

Table 19.15: Sensitivity to proposed Project

LCCA 6: Ness Head to Brough Head

19.84 Location and Extent:

- Coastline from Ness Head to study area boundary south of Brough Head; and
- Represents a local subdivision of the broader SNH Seascape classification for this area (SNH Seascape Character Type 2 “Mainland Rocky Coastline with Open Sea Views”).

19.85 Key Landscape and Visual Elements:

- Generally conforms closely to the generic SNH type;
- Linear, generally north-east/south-west trending coastline;
- Low cliffs and rocky wave-cut platform forms majority of coastal edge, with occasional coves, and geos;
- Distant expansive views: eastwards to open sea;
- Hinterland predominantly of small farm and crofting with frequent relatively new housing around Auckengill and Nybster, minor area of moorland on higher ground at Hill of Harley;
- Evidence of historical associations including ruined castle, dun, and broch; and
- Key Views include from A99 at Hill of Harley.

19.86 Overall sensitivity to proposed Project = Medium/Low (Table 19.16).

Attribute	Potential sensitivity	Reasons
Maritime Influences	Medium/Low	▪ Dominant open expanse of sea to east. ▪ Distant views of shipping.
Character and Experience of Coast/Key Views	Medium/Low	▪ Dominance of open views but crofting hinterland, settlement and roads also prominent.
Setting of Landmarks and Features	Medium	▪ Settings for key landmarks including low cliffs and historic elements also include crofting and settlement.
Experience of Wildness	Low	▪ A well-settled and readily accessible stretch of coastline.
Aesthetic Qualities	Medium	▪ Diverse views including rugged coastline with frequent geological variation.

Table 19.16: Sensitivity to proposed Project

19.5.4 Visual resource

19.87 The baseline condition of visual resources is included in the assessment of impacts on individual viewpoints in 19.6.5 below.

19.6 Assessment of Impacts

19.6.1 Introduction

19.88 This section assesses the residual impacts on landscape, seascape and visual receptors within the study area taking account of the mitigation measures which have been integrated into the design of the development.

19.89 The assessment focuses on the likely significant effects of the development, which are considered to relate exclusively to onshore impacts during the operations and maintenance phase of the Project. offshore impacts, and impacts during the construction and installation, and decommissioning phases, are addressed below as part of this introduction.

Design and mitigation

19.90 The Project design incorporates mitigation measures addressing the Operations and Maintenance phase of the project and these are summarised in Table 19.17 below. The design objectives take account of guidance on both landscape and seascape issues, including specific guidance relating to the "Mixed Agriculture and Settlement" Landscape Character Type in the Caithness and Sutherland Landscape Character Assessment (Stanton, 1998).

19.91 The PCUBs have been designed following consultation with The Highland Council (THC) Planning and Development and Historic Environments Team and Scottish Natural Heritage (SNH). MeyGen has completed a number of design iterations including a design workshop with THC and SNH.

19.92 The design evolution of the PCC started with the concept of a traditional barn structure commonly found in the region and a combination of standard modular building structures to provide the control room. The design workshop (6th September 2011), held on site between MeyGen, THC and SNH was used to discuss the design of all the onshore works.

19.93 The desire expressed by THC was that the buildings should be designed in the spirit of the North Highland Onshore Visioning work[5]. THC recommended that traditional barn structures would not be appropriate and the buildings needed to both celebrate the fact they are a part of the new marine power industry as well as be sympathetic to their surroundings. MeyGen was prepared to support the design approach as long as it could be realised at a small additional cost. It should be noted that it is not the intention of MeyGen to attract uninvited visitors to the PCC as there are to be no facilities for visitors. All visitor information is planned to be located at John o' Groats.

19.94 The design brief was revised to specify a set of functional modern industrial buildings that complied with all the project requirements but also satisfied the statutory historic environment interests (i.e. scheduled monuments and their setting, category A listed buildings and their setting and Inventory designed landscapes). In addition, work was carried out to assess the indications of past anthropogenic activity on the two sites identified to ensure building design and site layout was planned to avoid all potential archaeological sites.

19.95 The landowner's and local resident's views were also taken into account in the design and layout of the sites with particular respect to layout, visual impact, noise and access requirements. The result of all the consultations and considerations was an iterative design process which resulted in a revised design for the PCUB which is still essentially an economic steel enclosure, required to satisfy the functional requirements, but shaped to blend with the exposed landscape and softened by being partly clad in natural materials. The control building is a more traditional structure also clad in natural materials.

[5] http://www.highland.gov.uk/NR/rdonlyres/637F7B9A-0444-45F7-85A5-5860630255F5/0/OnshoreVisioningReportFinal160511c.pdf

MITIGATION OF LANDSCAPE, SEASCAPE AND VISUAL IMPACTS INCORPORATED INTO DESIGN
▪ Reduction of overall site footprint to minimise loss of physical landscape and seascape elements; ▪ Limiting PCUB height and lowering the buildings by taking away superficial soil layers; ▪ Siting of main PCUBs, control building, and other physical infrastructure within the PCC use natural topographic screening to minimise visibility – in terms of both overall visual envelope (ZTV) and actual visibility from key viewpoints; ▪ Building orientation designed to minimise impact in key viewpoints: e.g. orientation of the main PCUBs has been harmonised with the open vistas when viewed from both the Canisbay Kirk and from the ferry route between Gills Bay and Orkney; ▪ Siting, non-alignment and spacing of PCUBs to minimise additional visual confusion and avoid conflict with existing adjacent historic features and buildings; ▪ Building scale designed to be compatible with scale of landscape and seascape character of site and wider context; ▪ Distinctive building form creates strong identity and clear rationale relating to renewable marine energy source; ▪ A curved roof to reflect the surrounding landscape; ▪ Building form and finishes, include use of natural materials, designed to reflect aesthetic qualities associated with landscape and seascape character of site and wider context; and ▪ Use of local stone walling in harmony with existing uses to help screen control building.

Table 19.17: Mitigation

Note on context and design process

19.96 It is important at the outset to put into context the overall nature of the residual landscape, seascape, and visual effects which will result from this development. In terms of basic footprint, height, and massing, the building group formed by the PCUBs, which constitutes the main source of these impacts, will undoubtedly be larger than the great majority of existing built structures in the study area.

19.97 However, it is crucial to note that in terms of scale (as distinct from specific dimensions) relative to the expansive scale of the existing landscape and seascape context, it is not considered that they will appear to be out of scale, rather, they will tend to be accommodated within this context. In addition, except where they are viewed from close range within the development site boundary, it is considered that their form will "read" within the wider landscape context as predominantly horizontal, (as distinct from the predominantly vertical form of a wind turbine for instance), which will also tend towards acceptable accommodation in a landscape dominated by horizontal landforms, big skies, and distant seascape horizons.

19.98 Accordingly, it is stressed that a fundamental consideration for the assessment of this development is that both the overall sensitivity of the landscape and seascape, and the overall magnitude of potential effects, are of a relatively low order, reflecting an inherent compatibility of the development with its context.

Offshore impacts

19.99 As there is no permanent offshore infrastructure, it has not be necessary to assess the impacts associated with the permanent offshore infrastructure. Effects during the operational and maintenance phase relate to additional vessel activity and lighting associated with maintenance works – this is not considered likely to result in any significant change to the seascape, landscape or visual baseline.

Impacts during construction and installation phase

19.100 During this phase, temporary impacts will occur related to technical operations associated with Horizontal Directional Drilling (HDD) works for the cable landfall; subsequent cable installation through the HDD bore; and construction of the Power Converter Unit Buildings (PCUB) and a control building.

19.101 These temporary impacts have been assessed in terms of the landscape, seascape and visual receptors as identified for the Operations and Maintenance phase. Changes to the landscape and seascape resource due to these operations will not be discernable. While activities associated with drilling, cable drawing and construction and installation of the permanent PCUB's and associated access roadway, hard standings and land forming etc will be visible to varying degrees, mitigation including direction and masking of lighting, minimising disturbed areas, and use of temporary bunding and appropriately designed screen fencing, will ensure that the magnitude of change relating to visual amenity will be negligible.

19.102 Accordingly, it is not considered that there will be any significant residual landscape, seascape, or visual impacts during the Construction and Installation phase.

Impacts during decommissioning phase

19.103 Decommissioning of the onshore facilities will involve removal of plant, dismantling and a high degree of recycling of the building enclosures and regarding / replanting of the site. The endpoint of the decommissioning process will be the return of the site to the pre-development (i.e. as existing) condition. Therefore there will be no residual landscape or visual impacts.

19.6.2 Assessment of landscape impacts - physical changes to the landscape

19.104 Landscape impacts are assessed in relation to two categories: physical changes to the landscape of the development site; and changes to landscape character.

Ness of Quoys

19.105 In addition to the introduction of the built components of the development (described fully in Section 5) there will be a loss of an area of pasture grassland of low landscape and conservation value.

19.106 The introduction of the three PCUB buildings and control building, together with the access road, car park and other ancillary elements, represent a large scale and fundamental change to the physical characteristics of the site. Although other changes will be minor, overall this is considered to result in a major magnitude of change. The sensitivity of the receptor as described in the baseline description in low/medium.

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Low/Medium	Major	Moderate	Significant

Ness of Huna

19.107 In addition to the introduction of the built components of the development (described fully in Section 5) the following changes will occur to the landscape:

- loss of an area of pasture grassland of low landscape and conservation value; and
- loss of areas of gorse scrub of moderate landscape and conservation value.

19.108 The introduction of the three PCUB buildings and control building, together with the access road, car park and other ancillary elements, represent a large scale and fundamental change to the physical characteristics of the site. Although other changes will be minor, overall this is considered to result in a major magnitude of change. The sensitivity of receptor, as described in the baseline description is low/medium.

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Low/Medium	Major	Moderate	Significant

19.6.3 Assessment of landscape impacts - changes to landscape character and designated areas

Mixed Agriculture and settlement LCT

19.109 Two discrete geographical units of this LCT occur within the study area. One is located on the western margin of the study area, including the townships of Barrock and Inkstack, and is not affected by the ZTVs of either site. The discussion below focuses on the larger unit which extends from the Mey estate in the west to John o' Groats in the east, and includes the Island of Stroma.

- Ness of Quoys

19.110 The magnitude of change will be inherently limited within this landscape type within the context of continuing change of composition and balance over many years:

- Although the majority of this landscape unit will be affected by visibility of the development, higher ground at Hill of Mey, Hill of Warse, and Mool Hill effectively screen the development, giving smaller areas unaffected by visibility in the western, southern, and eastern margins of the unit, including the coast at John o' Groats;
- The theoretical views occur at separation distances varying from zero approaching the site to approximately 7km: while the impact at close range will be large, over much of the unit the development elements will not generally form recognisable new components and will be viewed as part of the wider landscape; and
- Although sited to minimise visual conflict, the development will tend to form a new focal point within the setting of Canisbay Kirk.

19.111 Taking account of all of the above, the overall magnitude of change is considered to be moderate. The sensitivity of the receptor, as described in the baseline, is low.

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Low	Moderate	Minor	Not Significant

- Ness of Huna

19.112 With the exception of an additional area of theoretical visibility on the coastline and south of John o' Groats, the change resultant from the Ness of Huna site will not differ in any significant detail from the Ness of Quoys site. Accordingly the overall magnitude of change is considered to be moderate. The sensitivity of the receptor, as described in the baseline, is low.

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Low	Moderate	Minor	Not Significant

Sweeping Moorland LCT

19.113 Two discrete geographical units of this LCT occur within the study area. One small unit is located between Gills Bay and the headland at St John's Point, and has a dominant coastal aspect. Accordingly it is assessed fully as part of the Seascape Assessment in Section 19.6.4. The discussion below focuses on the larger unit which covers the majority of the southern section of the study area.

- Ness of Quoys

19.114 The ZTV indicates that theoretical visibility of the development will be confined to the northern margin of the unit, on the northern slopes of Warth Hill, extending west to Hill of Rigifa (305722). To the south of this higher ground, the remaining much larger proportion of the unit will be unaffected, with the exception of a small area of high ground at Hill of Stroupster.

19.115 South and east of Hill of Rigifa, and at Hill of Stroupster, actual visibility is currently screened by coniferous plantation.

19.116 The theoretical views occur at separation distances varying from approximately 1.5 to 5km: at these distances the development elements will not generally form recognisable new components and will be viewed as part of the wider landscape.

19.117 Taking account of all of the above, the overall magnitude of change is considered to be minor. The sensitivity of the receptor, as described in the baseline, is low.

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Low	Minor	Minor	Not Significant

- Ness of Huna

19.118 The change resultant from the Ness of Huna site will not differ in any significant detail from the Ness of Quoys site.

19.119 The overall magnitude of change is considered to be minor**.** The sensitivity of the receptor, as described in the baseline, is low.

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Low	Minor	Minor	Not Significant

High Cliffs and Sheltered Bays LCT

19.120 A single discrete geographical unit of this LCT occurs within the study area, located between Duncansby Head and Skirza Head. (This is closely related to the Local Coastal Character Area Duncansby Head to Skirza Head and the assessment below should be read in conjunction with paragraphs 19.166 to 19.170).

- Ness of Quoys

19.121 The ZTV indicates that there would be theoretical visibility of the development from the northern and central parts of the unit, affecting the following areas:

- The immediate vicinity of Duncansby Head; and
- An area of higher ground inland from the Head, extending from approximately 2km east of the lighthouse, to link with the Hill of Crogodale in the central part of the unit, and including the clifftop path adjacent to the Stacks of Duncansby.

19.122 The areas with theoretical visibility fall within the Duncansby Head SLA (See also Paragraphs 19.129 to 19.133).

19.123 The theoretical views occur at separation distances of approximately 6km: at this distance the development elements will not be a prominent feature and will be viewed as part of the wider landscape.

19.124 The views to the development do not coincide with the major focus of views from within this unit, which are eastward to the Stacks and the open sea – the exception to this being the panorama from the Duncansby Head car park.

19.125 Taking account of all of the above, the overall magnitude of change is considered to low**.** The sensitivity of the receptor, as described in the baseline, is high.

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
High	Minor	Minor	Not Significant

- Ness of Huna

19.126 The change resultant from the Ness of Huna site will differ from the Ness of Quoys only to the extent that the theoretical visibility will occur over rather shorter separation distances (2.5-4km compared to 4-6km).

19.127 The overall magnitude of change is considered to be minor. The sensitivity of the receptor, as described in the baseline, is high.

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
High	Minor	Minor	Not Significant

Small Farms and Crofts LCT

19.128 Three discrete geographical units of this LCT occur within the study area, in the townships of Skirza, Nybster/Auckengill, and Rattar/Scarfsferry. None of these units are affected by the ZTVs of either site.

Duncansby Head Special Landscape Area

- Ness of Quoys

19.129 The ZTV indicates that there would be theoretical visibility of the development from almost the entire extent of the SLA. The views to the development do not coincide with the major focus of views from within the SLA, which are eastward to the Stacks and the open sea; the exception to this being the panorama from the Duncansby Head car park.

19.130 The theoretical views occur at separation distances of approximately 4-6km: at these distances the development elements will not be a prominent feature and will be viewed as part of the wider landscape.

19.131 There will be some compromise of the special experiential qualities of the SLA including the perceived naturalness and wildness of the coastline due to visibility of the new development.

19.132 Taking account of all of the above, the overall magnitude of change is considered to be moderate. The sensitivity of the receptor, as described in the baseline, is high.

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
High	Minor	Minor	Not Significant

- Ness of Huna

19.133 The change resultant from the Ness of Huna site will differ from the Ness of Quoys only to the extent that the theoretical visibility will occur over rather shorter separation distances (2.5-4km compared to 4-6km). The overall effects however are considered to fall into the same categorisation.

19.134 The overall magnitude of change is considered to be moderate. The sensitivity of the receptor, as described in the baseline, is high.

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
High	Minor	Minor	Not Significant

Castle of Mey Historic Garden and Designed Landscape (HGDL)

19.135 This site does not fall within the ZTV of either of the two sites and accordingly there will be no effects.

Search Areas for Wild Land (SAWL)

19.136 There are no SAWL areas present within the study area of this assessment.

19.6.4 Assessment of seascape impacts

19.137 This section assesses the indirect effects of the proposed development on the seascape character of the Local Coastal Character Areas within the study area as identified and described in the baseline section above (Section 19.5).

19.138 Under the definitions as set out in the methodology the effects are confined to the Local Coastal Character Areas which fall within the Zones of Theoretical Visibility of either or both of the project sites.

19.139 Local Coastal Character Areas within the study area which are not affected are:

- Freswick Bay
- Ness Head – Brough Head

19.140 The areas are described in turn in clockwise order around the coastline starting at the north-west boundary of the study area.

LCCA 1: Ham to St John's Point

- Ness of Quoys

19.141 This unit does not fall within the ZTV of the Ness of Quoys site and accordingly there will be no seascape character effects.

- Ness of Huna

19.142 The overall extent of the seascape unit affected by change will be very localised and will amount to less than a tenth of the total length of the coastline of the unit.

19.143 The ZTV indicates that there would be theoretical visibility of the development from a short section of coastline immediately west of St John's Point for a distance of approximately 600m. The remainder of the coastline within the unit (a length of approximately 8km) does not fall within the ZTV.

19.144 The change will affect some key landscape and visual characteristics to a limited degree. The areas with theoretical visibility occur within rough, uncultivated ground adjacent to St John's Point. The theoretical views occur at separation distances of approximately 6km: at this distance the development elements will not be a prominent feature and will be viewed as part of the wider landscape. There will be some limited effects on the seascape experience due to visibility of the new development including on the perceived naturalness and wildness of the coastline.

19.145 Taking account of all of the above, the overall magnitude of change is considered to be minor/negligible**.** The sensitivity of the receptor, as described in the baseline, is medium/low.

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Medium/Low	Minor/Negligible	Minor	Not Significant

LCCA 2: St John's Point to Gills Bay

- Ness of Quoys

19.146 The overall extent of the seascape unit affected by change will be large. The ZTV indicates that there would be theoretical visibility of the development over the entire length of the coastline (c.3.5km).

19.147 The change will affect key landscape and visual characteristics including view and the settings of historical features.

19.148 The theoretical views occur at separation distances of between approximately 2 and 4km: at these distances the development elements, although not dominant, will constitute recognisable new components in the landscape.

19.149 There will be some limited effects on the seascape experience due to visibility of the new development including on the perceived naturalness and wildness of the coastline.

19.150 Taking account of all of the above, the overall magnitude of change is considered to be moderate/minor**.** The sensitivity of the receptor, as described in the baseline, is medium/high.

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Medium/High	Moderate/Minor	Moderate/Minor	Not Significant

- Ness of Huna

19.151 The overall extent of the seascape unit affected by change will be large. The ZTV indicates that there would be theoretical visibility of the development over the entire length of the coastline (c.3.5km).

19.152 The change will affect key landscape and visual characteristics, including views and settings of historical features.

19.153 The theoretical views occur at separation distances of between approximately 3.5-5.8km: at these distances the development elements will not generally form recognisable new components and will be viewed as part of the wider landscape.

19.154 There will be some limited effects on the seascape experience due to visibility of the new development including on the perceived naturalness and wildness of the coastline.

19.155 Taking account of all of the above, the overall magnitude of change is considered to be minor. The sensitivity of the receptor, as described in the baseline, is medium/high.

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Medium/High	Minor	Minor	Not Significant

LCCA 3: Gills Bay to Duncansby Head

- Ness of Quoys

19.156 The ZTV indicates that there would be theoretical visibility of the development over approximately 4.7km of coastline in the western section of the unit, between Gills Bay Pier and Ness of Huna. Southern and eastern sections of the coastline of the island of Stroma (a length of approximately 4.3km) also fall within the ZTV. The remainder of the coastline within the unit (a length of approximately 7.3km) does not fall within the ZTV.

19.157 The change will affect some key landscape and visual characteristics to a limited degree. Views, including seaward views, views of and from Stroma, views east and west parallel to the coastline, views from Gills Bay pier, and settings of historical features including Canisbay Kirk.

19.158 The theoretical views occur at separation distances of between approximately 2km to zero on the mainland approaching the site itself: at these distances the development elements will constitute relatively prominent new components in the landscape.

19.159 There will be some limited effects on the aesthetic qualities of the seascape experience due to visibility of the new development.

19.160 Taking account of all of the above, the overall magnitude of change is considered to be moderate**.** The sensitivity of the receptor, as described in the baseline, is medium/low.

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Medium/Low	Moderate	Moderate/Minor	Not Significant

- Ness of Huna

19.161 With the exception of Bay of Sannick, the ZTV indicates that there would be theoretical visibility of the development over the entire mainland length of the coastline (approximately 8.3km). Southern and eastern sections of the coastline of the island of Stroma (a length of approximately 4.3km) also fall within the ZTV.

19.162 The change will affect some key landscape and visual characteristics to a limited degree. Views, including seaward views, views of and from Stroma, views east and west parallel to the coastline, views from Gills Bay and John O'Groats piers, and settings of historical features including Canisbay Kirk and the old mill at Huna.

19.163 The theoretical views occur at separation distances of between approximately 3.75km and zero approaching the site itself: at these distances the development elements will constitute recognisable to relatively prominent new components in the landscape.

19.164 There will be some limited effects on the aesthetic qualities of the seascape experience due to visibility of the new development.

19.165 Taking account of all of the above, the overall magnitude of change is considered to be moderate/major**.** The sensitivity of the receptor, as described in the baseline, is medium/low.

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Medium/Low	Moderate/Major	Moderate	Significant

LCCA 4: Duncansby Head to Skirza Head

- Ness of Quoys

19.166 The overall extent of the seascape unit affected by change will be localised and will amount to less than a third of the total length of the coastline of the unit.

19.167 The ZTV indicates that there would be theoretical visibility of the development from the northern part of the unit, affecting the immediate vicinity of Duncansby Head, including the car park and cliffs to the north, the lighthouse area, and the footpath southwards from the 63m AOD trig point for a distance of approximately 600m and the cliffs and cliff-top path adjacent to the Stacks of Duncansby for a distance of approximately 1km (a dip in the topography between Duncansby Head and the Stacks screens views to the west towards the development).

19.168 The remainder of the coastline within the unit (a length of approximately 3.5km) does not fall within the ZTV.

19.169 The change will affect some key landscape and visual characteristics to a limited degree:

- The areas with theoretical visibility fall within the Duncansby Head SLA;
- The theoretical views occur at separation distances of approximately 4-6km: at these distances the development elements will not be a prominent feature and will be viewed as part of the wider landscape;
- The views to the development do not coincide with the major focus of seascape views from within this unit, which are eastward to the Stacks and the open sea – the exception to this being the panorama from the Duncansby Head car park; and
- There will be some limited effects on the seascape experience due to visibility of the new development including on views of key features and their settings, and the perceived naturalness and wildness of the coastline.

19.170 Taking account of all of the above, the overall magnitude of change is considered to be low**.** The sensitivity of the receptor, as described in the baseline, is high.

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
High	Minor	Minor	Not Significant

- Ness of Huna

19.171 The change resultant from the Ness of Huna site will differ from the Ness of Quoys site only to the extent that the theoretical visibility will occur over rather shorter separation distances (2.5-4km compared to 4-6km). The overall effects however are considered to fall into to same categorisation as follows:

19.172 The overall magnitude of change is considered to be low**.** The sensitivity of the receptor, as described in the baseline, is low.

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
High	Minor	Minor	Not Significant

19.6.5 Assessment of visual impacts

19.173 Visual impacts are assessed on a total of 11 specific viewpoints. The location of each of these viewpoints is illustrated on Figure 19.5 and Figure 19.6. Photomontages relating to the different viewpoints are presented in Figures 19.8 to 19.17 for Ness of Quoys and Figures 19.18 to 19.25 for Ness of Huna. The photomontages are also included in the LSVIA Technical Appendix on the accompanying CD.

19.174 Assessment of other receptor categories, including settlements, roads, and ferry routes is not presented independently for the purposes of this study. Rather, these categories have been included by the selection of viewpoints, which was specifically designed to be representative of all categories of receptor likely to experience significant effects.

19.175 The assessment is based on the visibility of the Project throughout the ZTV area and detailed analysis of possible visual impacts from the viewpoints chosen following the desk study and field analysis, and subsequently agreed with SNH and THC. An onsite workshop was held with these stakeholders on 6th September 2011 to refine the selection of viewpoints based on actual visibility. A number of provisional viewpoints were omitted and others added as a result of this process. A number were also added at the request of THC (Pre-application advice ref. 11/03214 part 8).

19.176 The effects on each viewpoint are presented with reference to a set of images; for pragmatic purposes these are arranged to show firstly impacts on all viewpoints of the Ness of Quoys site, followed by the impacts on all viewpoints of the Ness of Huna site.

Visual Impacts - Ness of Quoys

- Viewpoint 06.1-U/C road to A836 and Canisbay

19.177 This viewpoint is located at the junction of two unclassified minor roads between Stemster and Canisbay, at an elevation of approximately 45m AOD. There is a wide northerly view towards Orkney and Stroma. The land falls towards the coastal strip and the development site is partially hidden at a lower elevation. Scattered buildings at near and intermediate distances form visual foci. Field boundaries are strong horizontal elements in the landscape.

19.178 The sensitivity of this receptor is assessed as low.

19.179 The prevalent landforms, proximity of Mool Hill and the falling levels from this receptor point towards the shoreline means that the development is partly obscured and indistinct. Not all of the PCC buildings will be seen and existing closer buildings, field boundaries and fencing elements mitigate against significant impacts. The magnitude of change is assessed as minor.

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Low	Minor	Minor	Not Significant

- Viewpoint 09.2– Rear of Village hall at Huna

19.180 This viewpoint is located at the Huna village / meeting hall adjoining the A836. It represents a transient receptor point for traffic in both directions on the 'A' road. The road is the predominant feature, with individual houses and agricultural buildings set within field boundaries defined by fencing and hedging. The grassland / pasture predominant in the landscape falls in gently rolling forms to the shoreline. Overhead power lines are visible breaking the seascape at the horizon line.

19.181 The sensitivity of this receptor is assessed as low.

19.182 The receptor addresses the open level grassland / pasture with agricultural developments and hedgerow field boundaries typical of landscape character types 10, 14 and 15 (Figure 19.7). There are open views across the site to the north towards Stroma and Orkney. The land falls somewhat before rising towards the shore escarpment. The impact of the PCC buildings to the west of the receptor will be modified by following prevalent ground levels. The magnitude of impact is considered to be minor.

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Low	Minor	Minor	Not Significant

- Viewpoint 11 - Canisbay kirk & graveyard

19.183 This viewpoint is located at the 'A' listed Canisbay Kirk and its adjoining graveyard. The church and burial ground are predominant and important landscape features and attract high numbers of visitors as well as local worshippers. Beyond the drystone walled enclosure the landform to the shore escarpment is regular and undulating grass and pastureland. The view is of the Ness of Quoys site at a similar elevation, with the Ness of Huna headland beyond and Huna House on the horizon.

19.184 The sensitivity of this receptor is assessed as high.

19.185 The PCC development is clearly visible relatively close to the receptor. Landform mitigates the vertical scale of the development and it is largely outwith the predominant views to Stroma and the Orkney islands to the north. However the buildings will break the open sea views and landscape horizon to the east and the magnitude of impact is therefore assessed as major.

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
High	Major	Major	Significant

- Viewpoint 14 - A836 at lay-by

19.186 This viewpoint is located on the main A832 eastward of Mey Hill and is a typical transient receptor for traffic moving east towards John O'Groats. Similar to the St John's point viewpoint, the hill descent provides wide and panoramic views to the east and north east. The landscape scale is very large and individual elements in it, such as Canisbay Kirk, Huna House, Canisbay settlement etc, are visible but of insignificant scale.

19.187 The sensitivity of this receptor is assessed as low.

19.188 The Project is visible but within the landscape scale and distance from the receptor, appears as insignificant. It does not break the horizon line formed by the Pentland Firth to the north-east and Duncansby head to the east, and lies in a context of grouped agricultural and residential buildings. The magnitude of impact is therefore assessed as minor.

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Low	Minor	Minor	Not Significant

- Viewpoint 15.2 -War memorial

19.189 This viewpoint located at the War Memorial above Canisbay settlement and overlooks the site and the firth from an elevated position. There are substantial mature deciduous trees and hedgerows in the foreground and significant individual and grouped buildings in the Canisbay settlement, with the coastal grasslands and sea beyond, which combine to form a structured and sequential wide vista to the north east. The Ness of Quoys site is obscured by trees but will be partly visible over the winter months.

19.190 The sensitivity of this receptor is assessed as medium.

19.191 The PCC site will be obscured by the deciduous trees in the foreground, and partly obscured by the Georgian house immediately to the NE of the receptor point. In the winter months the development will be partially visible but, given the distance of the development site from the receptor, will appear as a new element of comparable visual scale to the agricultural buildings in the foreground, Canisbay Church and settlements visible to the north-east. The magnitude of impact is therefore assessed as minor.

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Medium	Minor	Minor	Not Significant

- Viewpoint 16.2 – Canisbay north side

19.192 This viewpoint located at the eastern entry/exit to the Canisbay settlement 1.5Km south of the A832. Although small and relatively scattered, Canisbay is the most significant settlement east of John O'Groats. The view from its eastern access point is at a relatively low elevation but of a panoramic nature, with intermediate ground levels falling to the north and opening the view to the westerly Pentland Firth and Hoy on the horizon. The Ness of Quoys site is located in this vista, although at a lower elevation.

19.193 The sensitivity of this receptor is assessed as medium.

19.194 The Quoys site lies on the land / sea horizon line, but will not break the horizon line and will be partly contained within the mass of St Johns point beyond. Not all the PCUB's will be seen and will be visible at a low level. The landscape impact is considered as moderate.

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Medium	Moderate	Moderate	Significant

- Viewpoint 20.1 Ferry; South West of Stroma

19.195 This viewpoint is a typical transient receptor for passengers on the Gills Bay – St Margaret's Hope ferry; and for receptors on Stroma. Transient views extend from N and NW Stroma to the Gills Bay harbour entrance to the west of the site. The view to the shore is defined by horizontals, seascape and panoramic views to the east towards Duncansby Head. Canisbay Kirk is a significant feature. The lower lying coastal grasslands and settlements are visually contained by the rising land to moorland at the horizon.

19.196 The sensitivity of this receptor is assessed as medium.

19.197 The Quoys site is some 2km from the easternmost ferry approach and the development will appear as contained below the land horizon to the south of Duncansby Head. The landscape scale adjoining the Quoys site from this receptor is also modified by Mool Hill to the south of the site which will mitigate the scale of the development. The development appears as a significant feature in the coastal landscape although visually contained below the horizon line of moorland beyond. The magnitude of change is considered to be moderate.

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Medium	Moderate	Moderate	Significant

- Viewpoint 23 - St John's Point: fort

19.198 This viewpoint located at St John's Point (ruined Fort site) on Mey Hill, elevated at approximately 60m AOD to the west of the site. Views to the east towards Duncansby head incorporate the site at some 3.5km distance. This view is defined by the sweep of Gills Bay; the headlands beyond, culminating at Duncansby; and the head of Crees in the foreground. Huna House and Canisbay Kirk are visible features although at considerable distance. While the Ness of Quoys is visible, it is at some distance from this viewpoint and contained within the landscape by the rising moorlands beyond and the strong horizontal geology of the foreshores and the very large scale of the view.

19.199 The sensitivity of this receptor is assessed as medium.

19.200 The PCC will be visible from this elevated receptor; the building forms will be visually contained within the pastureland landscape and will relate to the developed agricultural field / building group patterns. From this viewpoint the three PCUBs will appear as a linear formation but proposed cladding / roof colours and landform / adjoining planting mitigation will reduce impact. The magnitude of impact is therefore assessed as minor.

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Medium	Minor	Minor	Not Significant

- Viewpoint 25 - Duncansby head

19.201 This viewpoint located at the Duncansby Head visitor car park, elevated at approximately 40m AOD and 5.5km east of the site. It provides extensive open and panoramic views to the Orkney Islands and the mainland north coast. John O' groats is in the foreground with Stroma in the middle distance with St Johns Point and Mey Hill prominent some 9km due west. This receptor point is of high significance due to its geographic prominence and attractiveness to visitors and tourists.

19.202 The sensitivity of this receptor is assessed as high.

19.203 This receptor point is over 5km east of the PCC site. Although the development is visible it appears as a relatively minor and insignificant element of the wider landscape. As such the magnitude of visual impact is assessed as minor.

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
High	Minor	Minor	Not Significant

- Viewpoint 27 - A835 West of Huna

19.204 This is a transient receptor, indicative of the views from the A835 for westbound traffic. The Quoys site is visible in the middle distance with Mey Hill beyond. Scattered agricultural and residential properties break the near and far horizons. There are open views to the Inner Firth and Stroma offshore.

19.205 The sensitivity of this receptor is assessed as low.

19.206 The development is clearly visible on the near horizon although largely contained below the far Mey Hill headland beyond. The scale of the PCC buildings is mitigated by local land form and its horizontal roof forms. The magnitude of change is assessed as moderate.

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Low	Moderate	Minor	Not Significant

19.207 Each of the viewpoints assessed above for Ness of Quoys are illustrated in Figures 19.8 to 19.17 below.

6.1

E336296 | N972165

NESS OF QUOYS

Viewpoint **1.7km** from nearest Ness of Quoys site boundary.

35° included angle

Figure 19.8: Ness of Quoys viewpoint 06.1 – please refer to Technical Appendix for larger version

9.2

E336310 | N973220

NESS OF QUOYS

Viewpoint **1.5km** from nearest Ness of Quoys site boundary.

55° included angle

Figure 19.9: Ness of Quoys viewpoint 09.2 – please refer to Technical Appendix for larger version

11

E334360 | N972820

NESS OF QUOYS

Viewpoint **0.1km** from nearest Ness of Quoys site boundary.

80° included angle

Figure 19.10: Ness of Quoys viewpoint 11 – please refer to Technical Appendix for larger version

14

E331890 | N973110

NESS OF QUOYS

Viewpoint **2.5km** from nearest Ness of Quoys site boundary.

50° included angle

Figure 19.11: Ness of Quoys viewpoint 14 – please refer to Technical Appendix for larger version

15.2

E334190 | N971640

NESS OF QUOYS

Viewpoint **1.2km** from nearest Ness of Quoys site boundary.

55° included angle

Figure 19.12:Ness of Quoys viewpoint 15.2 – please refer to Technical Appendix for larger version

16.2

E335140 | N972480

NESS OF QUOYS

Viewpoint **0.3km** from nearest Ness of Quoys site boundary.

85° included angle

Figure 19.13: Ness of Quoys viewpoint 16.2 – please refer to Technical Appendix for larger version

20.1

E333200 | N974250

NESS OF QUOYS

Viewpoint **1.6km** from nearest Ness of Quoys site boundary.

85° included angle

Figure 19.14: Ness of Quoys viewpoint 20.1 – please refer to Technical Appendix for larger version

23

E331100 | N975150

NESS OF QUOYS

Viewpoint **3.8km** from nearest Ness of Quoys site boundary.

65° included angle

Figure 19.15: Ness of Quoys viewpoint 23 – please refer to Technical Appendix for larger version

25

E340500 | N973250

NESS OF QUOYS

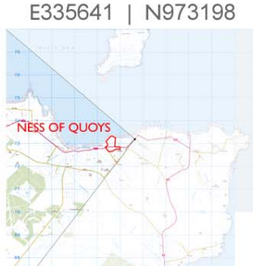
Viewpoint **3.8km** from nearest Ness of Quoys site boundary.

65° included angle

Figure 19.16: Ness of Quoys viewpoint 25 – please refer to Technical Appendix for larger version

27

E335641 | N973198



NESS OF QUOYS

Viewpoint **0.9km** from nearest Ness of Quoys site boundary.

95° included angle

Figure 19.17:Ness of Quoys viewpoint 27 – please refer to Technical Appendix for larger version

Visual Impacts - Ness of Huna

- Viewpoint 06.2 - Junction u/c roads Huna and Canisbay

19.208 This viewpoint is located at the junction of two unclassified minor roads between Stemster and Canisbay, at an elevation of approximately 45m AOD. There is a wide northerly view of Orkney and Stroma. The land falls towards the coastal strip and the development site(s) are partially hidden at a lower elevation. Scattered buildings at near and intermediate distances are visually significant. The landscape character changes from peripheral moorland at the viewpoint to coastal grassland and crofts. Field boundaries are strong horizontal elements in the landscape. Mool Hill to the north between the viewpoint and the coast obscures Huna.

19.209 The sensitivity of this receptor is assessed as low.

19.210 The prevalent landforms, proximity of Mool Hill and the falling levels from this receptor point towards the shoreline means that the development is partly obscured and indistinct. Not all of the PCC buildings will be seen and existing closer buildings, field boundaries and fencing elements mitigate against significant impacts. The magnitude of change is assessed as minor.

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Low	Minor	Minor	Not Significant

- Viewpoint 09.1 - Village hall, Huna on A836

19.211 This viewpoint is located at the Huna village / meeting hall adjoining the A836. It represents a transient receptor point for traffic in both directions on the 'A' road. The road is the predominant feature, with individual houses and agricultural buildings set within field boundaries defined by fencing and hedging. The grassland / pasture predominant in the landscape falls in gently rolling forms to the shoreline. Overhead power lines are visible breaking the seascape at the horizon line.

19.212 The sensitivity of this receptor is assessed as low.

19.213 The receptor addresses the open level grassland / pasture with agricultural developments and hedgerow field boundaries. There are open views across the site to the north towards Stroma and Orkney. The land falls somewhat before rising towards the shore escarpment. The impact of the Huna PCC buildings will be modified by following prevalent ground levels. The magnitude of impact is considered to be moderate.

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Low	Moderate	Minor	Not Significant

- Viewpoint 15.1 - War memorial

19.214 This viewpoint located at the War Memorial above Canisbay settlement and overlooks the sites and the firth from an elevated position. There are substantial mature deciduous trees and hedgerows in the foreground and significant individual and grouped buildings in the Canisbay settlement, with the coastal grasslands and sea beyond, which combine to form a structured and sequential wide vista to the north east.

19.215 The sensitivity of this receptor is considered to be medium.

19.216 The Huna site is NE of the receptor and appears as immediately above the Canisbay settlement. The PCUB's break the land / sea horizon but are contained within the sea horizon. The distance from the receptor point, and the more proximate Canisbay settlement, mean that the PCUB's will be perceived at a comparable scale to the settlement. The magnitude of change is considered to minor.

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Medium	Minor	Minor	Not Significant

- Viewpoint 16.1 - Canisbay north side

19.217 This viewpoint located at the eastern entry/exit to the Canisbay settlement 1.5km south of the A832. Although small and relatively scattered, Canisbay is the most significant settlement east of John o' Groats. The view from its eastern access point is at a relatively low elevation but of a panoramic nature, with intermediate ground levels falling to the north and opening the view to the westerly Pentland Firth and Hoy on the horizon. The Ness of Huna site is located in this vista, although at a lower elevation.

19.218 The sensitivity of this receptor is considered to be medium.

19.219 The Huna site lies on the land / sea horizon line, proximate to Huna House and grouped residential / agricultural buildings adjoining the A836 at this point. The PCUB's will bear a relationship with the group of buildings on the A road and beyond. The magnitude of change is considered to be minor.

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Medium	Minor	Minor	Not Significant

- Viewpoint 17 – John o' Groats Pier

19.220 This viewpoint located at John o' Groats pier, indicative of the viewpoints for visitors to the tourist attraction. The view from the pier is strongly defined by the shoreline escarpments and foreshore rock strata. The Ness of Huna headland is visible although mainly concealed by projecting coastal headland and its escarpment. The magnitude of impact is therefore considered negligible.

19.221 The sensitivity of receptor is considered medium.

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Medium	Negligible	Negligible	Not Significant

- Viewpoint 20.2 – Ferry; South West of Stroma

19.222 This viewpoint is a typical transient receptor for passengers on the Gills bay – St Margaret's Hope ferry; and for receptors on Stroma. Transient views extend from N and NW Stroma to the Gills Bay Harbour entrance to the West of the site. The view to the shore is defined by horizontals, seascape and panoramic views to the east towards Duncansby Head. Canisbay church is a significant feature. The lower lying coastal grasslands and settlements are visually contained by the rising land to moorland at the horizon.

19.223 The sensitivity of this receptor is assessed as medium.

19.224 The Huna site is some 3km from the easternmost ferry approach and the development will appear as well contained below the land horizon to the south of Duncansby Head. The landscape scale adjoining the site from this receptor is also peripherably modified by Mool Hill to the south which will mitigate the scale of the development somewhat. The development appears as a significant feature in the coastal landscape although at distance from the receptor and visually contained below the horizon line of moorland beyond. Accordingly the landscape impact is considered to be minor.

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Medium	Minor	Minor	Not Significant

- Viewpoint 23 - St John's Point; fort

19.225 This viewpoint located at St John's Point (ruined Fort site) on Mey Hill, elevated at approximately 60m AOD to the West of the site. Views to the east towards Duncansby head incorporate the site at some 3.5km distance. This view is defined by the sweep of Gills Bay; the headlands beyond, culminating at Duncansby; and the Head of Crees in the foreground. Huna House and Canisbay Kirk are visible features although at considerable distance. While the Ness of Quoys and Ness of Huna sites are visible, they are at some distance from this viewpoint and contained within the landscape by the rising moorlands beyond and the strong horizontal geology of the foreshores and the very large scale of the view.

19.226 The sensitivity of this receptor is considered to be medium.

19.227 The Huna site lies some 5km to the east of this receptor and the elevated receptor position relative to the site means that it is wholly contained within the wider landscape and the horizon line of Duncansby Head to the east. Although the PCUB's are larger in scale than Huna House and the adjoining settlement on the A836, the separation distance to the receptor means that the impact will be minor.

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Medium	Minor	Minor	Not Significant

- Viewpoint 25 - Duncansby Head

19.228 This viewpoint is located at the Duncansby Head visitor car park, elevated at approximately 40m AOD and 5.5Km east of the site. Extensive open and panoramic views to the Orkney Islands and the mainland north coast. John o' Groats is in the foreground with Stroma in the middle distance with St Johns Point and Mey hill prominent some 9km due west.

19.229 The sensitivity of this receptor is considered to be high.

19.230 The Huna site is visible from this receptor but well contained within the vast seascape context and below the horizon line formed by Mey Hill some 8km to the west. The PCUB configuration and location on the site will result in a high degree of landscape integration and a relatively low visual profile. The separation distance is over 5km. The magnitude of change is considered to be minor.

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
High	Minor	Minor	Not Significant

19.231 The Ness of Huna viewpoints assessed above are illustrated in Figures 19.18 to 19.25 below.

6.2

E336296 | N972165

NESS OF HUNA

Viewpoint **1.0km** from nearest Ness of Huna site boundary.

30° included angle

Figure 19.18:Ness of Huna viewpoint 6.2 – please refer to Technical Appendix for larger version

9.1

E336310 | N973220

NESS OF HUNA

Viewpoint **0.0km** from nearest Ness of Huna site boundary.

85° included angle

Figure 19.19: Ness of Huna viewpoint 9.1 – please refer to Technical Appendix for larger version

15.1

E334190 | N971640

NESS OF HUNA

Viewpoint **2.5km** from nearest Ness of Huna site boundary.

85° included angle

Figure 19.20: Ness of Huna viewpoint 15.1 – please refer to Technical Appendix for larger version

16.1

E335140 | N972480

NESS OF HUNA

Viewpoint **1.2km** from nearest Ness of Huna site boundary.

115° included angle

Figure 19.21:Ness of Huna viewpoint 16.1 – please refer to Technical Appendix for larger version

17

E337960 | N973480

NESS OF HUNA

Viewpoint **1.2km** from nearest Ness of Huna site boundary.

60° included angle

Figure 19.22: Ness of Huna viewpoint 17 – please refer to Technical Appendix for larger version

20.2

E333200 | N974250

NESS OF HUNA

Viewpoint **3.0km** from nearest Ness of Huna site boundary.

85° included angle

Figure 19.23: Ness of Huna viewpoint 20.2 – please refer to Technical Appendix for larger version

23

E331100 | N975150

NESS OF HUNA

Viewpoint **5.2km** from nearest Ness of Huna site boundary.

65° included angle

Figure 19.24: Ness of Huna viewpoint 23 – please refer to Technical Appendix for larger version

25

E340500 | N973250

NESS OF HUNA

Viewpoint **4.0km** from nearest Ness of Huna site boundary.

65° included angle

Figure 19.25:Ness of Huna viewpoint 25 – please refer to Technical Appendix for larger version

19.7 Potential Variances in Environmental Impacts

19.232 As noted above, this assessment has of necessity considered two potential sites for the PCC and related onshore development and landscape/seascape and visual impacts have been assessed and included for both sites, pending a decision (which will be based on technical, site availability and related factors still to be determined at the time of writing).

19.233 This assessment has included the potential variances of impact arising from the differing landscape and visual consequences from the key receptors and transient perceptions, which will occur from the development on either site. However for the onshore aspects of the Project, as only one site will be developed as part of the Project, the actual impact will be less than that presented in this assessment.

19.234 Offshore installation and maintenance / operational impacts will not vary with either onshore development option.

19.8 Cumulative Impacts

19.8.1 Introduction

19.235 MeyGen has in consultation with Marine Scotland and The Highland Council identified a list of other projects (MeyGen, 2011) which together with the Project may result in potential cumulative impacts. The list of these projects including details of their status at the time of the EIA and a map showing their location is provided in Section 8; Table 8.3 and Figure 8.1 respectively.

19.236 Having considered the information presently available in the public domain on the projects for which there is a potential for cumulative impacts, Table 19.18 below indicates those with the potential to result in cumulative impacts from a Landscape, Seascape and Visual perspective. The consideration of which projects could result in potential cumulative impacts is based on the results of the project specific impact assessment together with the expert judgement of the specialist consultant.

Project title	Potential for cumulative impact	Project title	Potential for cumulative impact	Project title	Potential for cumulative impact
MeyGen Limited, MeyGen Tidal Energy Project, Phase 2	✓	SHETL, HVDC cable (onshore to an existing substation near Keith in Moray)	×	OPL, Ocean Power Technologies (OPT) wave power ocean trial	×
ScottishPower Renewables UK Limited, Ness of Duncansby Tidal Energy Project	✓	Brough Head Wave Farm Limited, Brough Head Wave Energy Project	×	MORL, Moray Offshore Renewables Ltd (MORL) offshore windfarm	✓
Pelamis Wave Power, Farr Point Wave Energy Project	×	SSE Renewables Developments (UK) Limited, Costa Head Wave Energy Project	×	SSE and Talisman, Beatrice offshore Windfarm Demonstrator Project	×
Sea Generation (Brough Ness) Limited, Brough Ness Tidal Energy Project	×	EON Climate & Renewables UK Developments Limited, West Orkney North Wave Energy Project	×	BOWL, Beatrice Offshore Windfarm Ltd (BOWL) offshore windfarm	✓
Cantick Head Tidal Development Limited, Cantick Head Tidal Energy Project	×	EON Climate & Renewables UK Developments Limited, West Orkney South Wave Energy Project	×	Northern Isles Salmon, Chalmers Hope salmon cage site	×
SSE, Caithness HVDC Connection - Converter station	×	ScottishPower Renewables UK Limited, Marwick Head Wave Energy Project	×	Northern Isles Salmon, Pegal Bay salmon cage site	×
SSE, Caithness HVDC Connection - Cable	×	SSE Renewables Developments (UK) Limited, Westray South Tidal Energy Project	×	Northern Isles Salmon, Lyrawa salmon cage site	×
RWE npower renewables, Stroupster Windfarm	✓	EMEC, Wave Energy test site (Billia Croo, Orkney)	×	Scottish Sea Farms, Bring Head salmon cage site	×
SSE, Gills Bay 132 kV / 33 k V Substation Phase 1: substation and overhead cables (AC)	✓	EMEC, Tidal energy test site (Fall of Warness, Orkney)	×	Northern Isles Salmon, Cava South salmon cage site	×
SSE, Gills Bay 132 kV / 33 k V Substation Phase 2: HVDC converter station and new DC buried cable	✓	EMEC, Intermediate wave energy test site (St Mary's Bay, Orkney)	×	Scottish Sea Farms, Toyness salmon cage site	×
SHETL, HVDC cable (offshore Moray Firth)	×	EMEC, Intermediate tidal energy test site (Head of Holland, Orkney)	×	Northern Isles Salmon, West Fara salmon cage site	×

Table 19.18: Summary of potential cumulative impacts

19.237 The following sections summarise the nature of the potential cumulative impacts for each potential Project phase:

- Construction and installation;
- Operations and maintenance; and
- Decommissioning.

19.8.2 Potential cumulative impacts during construction and installation

19.238 The cumulative impacts of the construction and installation phases of the Project onshore and marine activity offshore have degrees of joint visibility which vary with receptor sensitivity and proximity. Offshore activity, consisting of specified vessels at varying degrees of frequency and location, and to varying degrees tidal related, may be considered to be of a transient nature. Although there will be a degree of joint visibility, the differing nature and frequencies of onshore and offshore activities will mitigate against more significant cumulative impacts. The ZTV mapping for both sites indicates a limited potential for significant cumulative impact in terms of assessed viewpoints.

19.8.3 Potential cumulative impacts during operations and maintenance

19.239 Wider cumulative impacts can arise from the joint visibility of a range of developments. Those noted below are considered to have potential for cumulative impacts due to *simultaneous* or *successive* visibility (Guidance on Cumulative Effect of Windfarms SNH, 2005).In the case of the windfarms listed below, it is noted that due to the fundamental distinction in nature between them and the proposed Project, with no prominent visual characteristics in common, potential cumulative impacts will be minimal.

- MeyGen Tidal Energy Project , Phase 2 (total 398MW in the Inner Sound); Phase 2 of the MeyGen Tidal Energy Project will comprise the deployment of a further 312MW offshore and associated

cables to shore and onshore infrastructure. The exact geographical location, extent and nature of the onshore facilities required for Phase 2 are not yet defined and will incorporate lessons learned from, and technology advancements beyond Phase 1 of the Project. These factors will influence the potential for, nature of and significance of any cumulative impacts;

- Ness of Duncansby Tidal Energy Project (Scottish Power Renewables UK Ltd); proposed 95MW wave energy development and associated onshore facilities; details and onshore site unknown but adjoins Duncansby Head. Onshore facilities will of necessity be located close to Duncansby Head and close to sea level and any cumulative impact is not likely to be significant;

- Gills Bay 132kV/33kV substation (SHETL); construction of enclosed substation close to Gills Bay. Precise nature and location not known. The development may fall within the ZTVs dependant on precise location and a degree of cumulative impact may occur;

- Stroupster Windfarm. Consented windfarm of 12 turbines to tip height of 113m. It is likely that the ZTV of this project will overlap with the ZTVs of both Ness of Quoys and Ness of Huna and there may be simultaneous or successive visibility;

- MORL, Moray Offshore Renewables Ltd (MORL) offshore windfarm. Approximately 200 turbines of 158.5-182m tip height. Assuming a study area of 35km radius from the outer edge of the MORL development area, there will be overlap with the MeyGen Phase 1 study area and dependent on the ZTV potentially therefore a degree of cumulative impact may occur; and

- BOWL, Beatrice Offshore Windfarm Ltd (BOWL) offshore windfarm. Approximately 920MW offshore windfarm development consisting up to 184 turbines of maximum tip height of approximately 150m. Assuming a study area of 35km radius from the outer edge of the Beatrice development area, there will be overlap with the MeyGen Phase 1 study area and dependent on the ZTV potentially therefore a degree of cumulative impact may occur.

19.8.4 Potential cumulative impacts during decommissioning

19.240 As noted above, decommissioning operations for the onshore facilities will involve removal of plant, dismantling and a high degree of recycling of the building enclosures, and regrading / replanting of the site. These works will have a very restricted visual envelope and it is not considered that they would lead to any significant cumulative impacts with the above projects.

19.8.5 Mitigation requirements for potential cumulative impacts

19.241 No mitigation is required over and above the project-specific mitigation.

19.9 Proposed Monitoring

19.242 None required.

19.10 Summary and Conclusions

19.243 This LSVIA has assessed the residual onshore and offshore impacts of the proposed Project, in terms of the construction and installation, operation and maintenance, and decommissioning phases. Assessments have been prepared and included for two potential sites, only one of which will be developed during Phase 1 of the Project.

19.244 The assessment has noted two primary considerations at the outset.

19.245 Firstly, that the baseline characteristics of the landscape, seascape, and visual resources of the study area, (notably its expansive scale, and dominant horizontality of visual composition) are inherently compatible with the proposed development.

19.246 Secondly, that the assessment has proceeded in parallel with the development of specific design objectives to ensure that residual impacts on these resources are minimised. Taking account of professional guidance from both a seascape and landscape perspective, and having regard to particular local attributes of the sites and their settings, the design incorporates substantial “embedded” mitigation measures relating not only to the primary issues of scale and form, but detailed considerations including micrositing, orientation, natural topographic screening, and materials and finishes.

19.247 The combination of inherent compatibility and sensitive design result in a limited number of impacts which are considered to be significant. These are exclusively related to onshore infrastructure and would occur during the Operations and Maintenance phase.

19.248 For the Ness of Quoys site, significant impacts are as follows:

- Direct physical changes to the landscape of the site itself;
- Indirect landscape impacts due to visibility on the Duncansby Head Special Landscape Area; and
- Impacts on the visual amenity of three viewpoints: VP 11, Canisbay Kirk, VP16.2 Canisbay village and VP 20, the route of the Gills Bay ferry within Inner Sound.

19.249 For the Ness of Huna site, significant impacts are as follows:

- Direct physical changes to the landscape of the site itself;
- Indirect landscape impacts due to visibility on the Duncansby Head Special Landscape Area;
- Impacts on the visual amenity of 1 viewpoint: VP 17 John O’Groats Pier; and
- Impacts on the seascape of Local Coastal Character Area 3, Gills Bay to Duncansby Head.

19.250 Direct residual landscape impacts to both sites are acknowledged as still being significant notwithstanding the design mitigation. Similarly, significant visual impacts from a small number of the closest range viewpoints are to be expected, but it is again stressed that design mitigation has avoided and/or reduced the large majority of the residual visual impacts to levels which are not considered significant. The significant impact of the Ness of Huna alternative on the Gills Bay to Duncansby Head seascape unit is due predominantly to the large geographical extent of the ZTV along the immediate coastline, reflecting the difficulty of mitigating visual effects from this perspective.

19.251 Neither site was considered to have significant residual cumulative impacts in conjunction with the agreed list of additional existing or planned projects.

19.11 References

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20 ONSHORE CULTURAL HERITAGE

20.1 The table below provides a list of all the supporting studies which relate to the onshore cultural heritage impact assessment. All supporting studies are provided on the accompanying CD.

Details of study	Location on supporting studies CD
Inner Sound, Canisbay Onshore Cultural Heritage Environmental Impact Assessment (ORCA, 2012)	ONSHORE\Onshore Cultural Heritage
Inner Sound Canisbay, Caithness Geophysical Survey 2011 Final Report. Report for MeyGen Ltd (ORCA, 2011b)	ONSHORE\Onshore Cultural Heritage

20.1 Introduction

20.2 This section addresses the potential impacts on the onshore historic environment assets by the Project. The assessment has been undertaken by the Orkney Research Centre for Archaeology (ORCA).

20.3 The section identifies any sites or areas of cultural heritage significance that might be affected by the Project. Such resources include[1] World Heritage Sites; Scheduled Ancient Monuments (SAMs); Listed Buildings; Gardens and Designed Landscapes; Historic Battlefields; Conservation Areas; Other archaeological sites and monuments; and other non-designated historic environment assets. The potential for the discovery of unknown remains will also be identified.

20.4 The possible effects of the Project on the identified cultural heritage assets are then assessed, including those for both the Ness of Quoys and the Ness of Huna. Direct and indirect effects may occur during the construction, operation and decommissioning of the proposed development, and there may be cumulative effects when the proposed development is considered along with others proposed in the area. Management or mitigation strategies are outlined, addressing any identified issues and impacts concerning the cultural heritage resource.

20.5 The assessment of indirect impact issues including setting incorporates information provided by other studies, including that presented in Sections 19 (Landscape, Seascape and Visual) and 23 (Noise and Dust).

20.2 Assessment Parameters

20.2.1 Rochdale Envelope

In line with the Rochdale Envelope approach, this assessment considers the maximum ('worst case') project parameters. Identification of the worst case scenario for each receptor (i.e. Environmental Impact Assessment (EIA) topic) ensures that impacts of greater adverse significance would not arise should any other development scenario be taken forward in the final scheme design. Table 20.1 describes the detail of the project parameters that have been used in this assessment and explains why these are considered to be worst case. The potential impacts from alternative Project parameters have been considered in Section 20.9.

Project parameter relevant to the assessment		'Maximum' Project parameter for impact assessment	Explanation of maximum Project parameter
Onshore Power Conversion Centre (PCC)	Construction, operation/maintenance and decommissioning	Maximum potential footprint of both Ness of Quoys and Ness of Huna (at EIA commencement); daytime working for Power Conversaion Centre (PCC) construction and decommissioning	Assessment of potential physical impacts associated with the construction of and long term presence of new buildings at both the Ness of Huna and Ness of Quoys potential PCC locations. Impact assessment considered both potential physical impacts during construction and impacts on historical setting from the long term presence of the new onshore infrastructure. Potential physical impacts from construction of permanent access road, temporary hard standing using a light excavator, dumper truck and roller. The topsoil will be removed and scraped down to the bedrock; some rock breaking (by excavator breaker) may be required to level the site for PCC foundations.
	Noise from construction, and decommissioning	Noise from construction of the PCC at either Ness of Quoys or Ness of Huna; daytime working for PCC construction	Use of a light excavator, dumper truck and roller. Some rock breaking (by excavator breaker) may be required. Daytime working only assumed for PCC construction and decommissioning activities.
	Noise from operation	Operating noise from the PCC at either Ness of Quoys or Ness of Huna; 24 hour operation of PCC	Assessment of potential impacts associated with the operation of the PCC at both Ness of Huna and Ness of Quoys. PCC will be operational 24 hours a day and PCC equipment noisiest when the tide running fastest.
Onshore cable routes between PCC and SHETL substation	Construction, operation/maintenance and decommissioning	All potential cable corridors between PCC locations and SHETL substation proposed at Phillips Mains (see Figure 2.1) (at EIA commencement)	Assessment of potential impacts associated with cable installation and long term presence along all potential cable corridors identified between PCC locations and SHETL substation proposed at Phillips Mains. Impact assessment limited to potential physical impacts as no long term visible infrastructure associated with underground cable routes.
	Construction and decommissioning noise	All potential cable corridors between PCC locations and SHETL substation proposed at Phillips Mains (see Figure 2.1) (at EIA commencement); daytime working for cable installation and decommissioning	Use of single tractor and cable plough (ploughing method) or single light excavator (cut and backfill method) to bury the cables. Daytime working only assumed for cable installation and decommissioning activities.
Cable landfall	HDD site construction and reinstatement	Maximum potential footprint at both Ness of Quoys and Ness of Huna (at EIA commencement); daytime working for PCC construction and reinstatement	Construction of temporary access off the permanent access road, temporary hard standing for the Horizontal Directional Drilling (HDD) compound using a light excavator and dumper truck. The topsoil will be removed and scraped down to the bedrock; some rock breaking (by excavator breaker) may be required to level the site. The HDD compound will move to new positions for each different phase of drilling. A new compound area prepared for each phase and the previous area reinstated. Daytime working only assumed for HDD site construction and reinstatement activities.
	HDD bores	A single HDD bore required for each turbine cable – i.e. 86 Maximum potential footprint of both Ness of Quoys and Ness	Assessment of potential impacts associated with the HDD of the cable bores, during the Project construction phase. As the HDD bores will be drilled underground through the

[1] See Scottish Planning Policy 2010, paragraphs 110-124, and the Historic Environment (Amendment) (Scotland) Act 2011, sections 11 & 14 for definitions.

Project parameter relevant to the assessment		'Maximum' Project parameter for impact assessment	Explanation of maximum Project parameter
		of Huna (at EIA commencement)	intertidal zone, the potential physical impacts on archaeology in the intertidal zone have not been considered. Impact assessment limited to potential physical impacts as no long term visible infrastructure associated with underground cable routes.
	HDD noise	24 hour working during the drilling of 86 bores	24 hour working assumed for HDD activities.
Offshore Project components	Installation vessel physical presence	1 Dynamic Positioning (DP) vessel for the duration of the installation for year 1 and 2 2 DP vessels for year 3 installation	Installation activities will be carried out by a single DP vessel during year 1 and 2, all installation activities to be undertaken using a single DP vessel. If other smaller vessels used to undertake some of the work of the DP vessel, no concurrent multiple vessel activities will take place, i.e. no more than one vessel on site at any one time. Year 3 installation will require a maximum 2 DP vessels for TSS installation. These two vessels may be present on site at the same time during year 3.
	Maintenance vessel physical presence	1 DP vessel present every 2.8 days	Based on a maximum 86 turbine array, 1 DP vessel will be present a maximum of 130 times (i.e. single slack tide operation) per year i.e. the DP vessel present on site every 2.8 days.

Table 20.1: Rochdale Envelope parameters for the onshore cultural heritage assessment

20.2.2 Area of assessment

20.6 The focus of the onshore cultural heritage assessment is the potential impacts of the Project infrastructure on the areas that could be directly impacted and on the setting of adjacent areas and historic environment receptors within the Zone of Theoretical Visibility (ZTV) as defined during the visual impact assessment (Section 19).

20.7 The worst-case scenario approach required the assumption in the EIA that the whole of the onshore development option areas, including all possible cable routes would be subject to intrusive ground clearance and thus the magnitude of direct impact on any identified cultural remains within the area will be high (for sites partly within the development area) or very high (for sites completely within the development area), with occasional lower magnitudes of impact assigned if the site is almost completely outwith the development area. Thus, in many cases, this approach has resulted in the over-rating of how significant many of the impacts will be in reality, since the project design has taken into account the results of the assessment.

20.8 In terms of considering impact on setting, as part of the worst case scenario the EIA assumed that the buildings in the two PCC locations will be 13m high and, with ancillary car park, hard-standing and security fencing, spread across the full area. This will clearly not be the case, shown by the project design and site layout in Section 5. The assessment of the significance of residual impacts on setting in 20.7.2 below also takes this into account.

20.9 It should be noted that this assessment was completed on a more extensive geographical project area as defined in 2011 (Figure 20.1) and this has since been refined to a smaller footprint at both the Ness of Quoys and Ness of Huna PCC sites and to a single cable corridor to the SHETL substation option areas. Therefore, the quantity of significant impacts identified in this section is greater than that of the final project design in reality. The final project is described in Section 5 and shown in Figure 5.2; the selection process for these is discussed in Section 4.

20.10 **Following the completion of the EIA, landowner consultation has identified potential issues with small areas of the proposed cable route. It has therefore been necessary to include areas outside that surveyed for the onshore impact assessments. The area is 0.50km^2 and is shown in Figure 2.1. Unfortunately this issue was not identified at the time of ES compilation and therefore is not addresses in this document. Work to survey and assessment of any changes required to the original impact assessment as a result of the altered cable route is ongoing and will be provided in an ES addendum.**

20.3 Legislative Framework and Regulatory Context

20.3.1 Legislation

International and European

20.11 The *European Convention on the Protection of the Archaeological Heritage* (revised), (the *Valletta Convention*), was ratified by the UK Government in 2000, This contains provisions for the identification and protection of archaeological heritage both under water and on land, preferably *in situ*, but with provisions for appropriate recording and recovery if disturbance is unavoidable.

20.12 *The European Landscape Convention*, ratified by the UK Government in 2006, promotes the protection, management and planning of landscapes in Europe, including the historical and cultural aspects of landscapes.

20.13 European Directives on environmental impact assessment incorporated into UK legislation by various regulations, including the *Town and Country Planning (Environmental Impact Assessment) (Scotland) Regulations* 2011. This includes the requirement that the historic environment be included in the process to identify the environmental effects of development proposals to prevent, reduce and offset any adverse impacts resulting from them.

UK and Scottish

20.14 The *Ancient Monuments and Archaeological Areas Act* 1979 (AMAAA), concerns sites that warrant statutory protection due to being of national importance and are Scheduled under the provisions of the Act. The Act is administered in Scotland by Historic Scotland (HS). Such sites or areas may include any "monument which in the opinion of the Secretary of State is of public interest by reason of the historic, architectural, traditional, artistic or archaeological interest attaching to it". A monument is defined within the Act as:

"any building, structure or work above or below the surface of the land, any cave or excavation; any site comprising the remains of any such building, structure or work or any cave or excavation; and any site comprising or comprising the remains of any vehicle, vessel or aircraft or other movable structure or part thereof" (Section 61 (7))", with the addition of "any thing, or group of things, that evidences previous human activity" from Section 14 of the Historic Environment (Amendment) (Scotland) Act 2011.

20.15 The criteria for the determination of national importance are contained in Historic Scotland's *Scottish Historic Environment Policy* (SHEP) 2011.

20.16 The *Planning (Listed Buildings and Conservation Areas) (Scotland) Act* 1997 and amendments governs the listing and protection of buildings and areas of special architectural or historic interest. The Act requires planning authorities, when determining applications for planning permission or listed building consent, to have regard to preserving the building or its setting or any features of special architectural or historic interest which it possesses.

20.17 Planning authorities are required prior to granting planning permission to consult Scottish Ministers (through HS) on any development proposals that may affect the site or setting of a Scheduled Monument, an A-Listed building, an Inventoried Garden or Designed Landscape or an Inventoried Historic Battlefield.

20.3.2 Policy and guidance

National

20.18 Scottish Ministers' vision and strategic policies for the historic environment are set out in Historic Scotland's *Scottish Historic Environment Policy* (SHEP) 2011. More detailed guidance is provided the Managing Change in the Historic Environment guidance series, to be found at the HS website[2]. The Scottish Ministers' key policy principles include that:

"*there should be a presumption in favour of preservation of individual historic assets and also the pattern of the wider historic environment; no historic asset should be lost or radically changed without adequate consideration of its significance and of all the means available to manage and conserve it*" (para 1.14);

that the conservation of the historic environment should:

"have regard to retaining, or where appropriate enhancing, the setting of the site, monument, building or landscape; ensure that, where change is proposed, it is appropriate, carefully considered, authoritatively based, properly planned and executed, and (if appropriate) reversible;" (para 1.15);

and that there should be

"*provision for recording where continued preservation is no longer possible or where loss is taking place through change or ongoing decay, and ensure that all records are retained in readily accessible archives*" (para 1.15).

20.19 Scottish Planning Policy (SPP 2010), with the companion Planning Advice Note (PAN 2/2011): *Planning and Archaeology* 2011, sets out the Scottish Government's planning policy on how the historic environment should be handled under the development plan and development control systems, and incorporates the above policy principles.

Local

20.20 The primary means by which Local Authorities must determine applications for planning consent is through the Local Development Plan Framework. Currently, the Highland Council's *Caithness Local Plan* (2002) and The Highland Council's *Structure Plan* (2001) set out the strategic framework for development of land in Caithness[3]. These will be supplemented and eventually superseded by the Highland-wide Local Development Plan (HwLDP), the September 2010 proposed version of which is a material planning consideration[4]. These plans encourage appropriate developments while at the same time protecting *inter alia* archaeology and built heritage (see HwDLP Appendix 6.2 for definitions).

20.21 Structure Plan policies BC1-5 are specifically concerned with the built and cultural heritage of the Highlands. For example, Highland Structure Plan Policy BC1: "Archaeological sites [and in Strategic Policy G2 their setting] affected by development proposals should be preserved, or, in exceptional circumstances where preservation is impossible, the sites will be recorded at developers' expense to professional standards. Provision will be made in Local Plans for the appropriate protection, preservation and enhancement of archaeological sites"; Policy BC4 "The Council will seek to preserve historic gardens and designed landscapes identified in the published inventory and in any additions to it. Local Plans will contain policies for their protection"; and Policy BC5 "The Council will seek to preserve Highland's buildings and groups of buildings of historic or architectural interest, some of which may be at risk from neglect, by the identification in Local Plans of opportunities for their productive and appropriate use".

20.22 The draft HwLDP includes Policy 58, which states that

"*All development proposals will be assessed taking into account the level of importance and nature of heritage features, the nature and scale of development, and any impact on the feature and its setting. The following criteria will also apply: 1. For features of* ***local/regional importance*** *we will allow developments if we believe that they will not have an unacceptable impact on the amenity and heritage resource. 2. For features of* ***national importance*** *we will allow developments that can be shown not to compromise the 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.*"

[2] http://www.historic-scotland.gov.uk/index/heritage/policy/managingchange.htm
[3] Still in force at the time of EIA and ES compilation.
[4] Not adopted at the time of EIA and ES compilation.

20.4 Assessment Methodology

20.4.1 Scoping and consultation

20.23 Consultation on onshore cultural heritage issues has been ongoing since the commencement of the Project. Table 20.2 summarises all consultation relevant to onshore cultural heritage. In addition, relevant comments from the Scoping Opinion are summarised in Table 20.3 together with responses to the comments and reference to the ES sections relevant to the specific comment. As the project has progressed, many concerns have been incorporated into the project design in order to reduce potentially significant impacts.

Date	Stakeholder	Consultation	Topic/specific issue
7th April 2011	Marine Scotland and Scottish Natural Heritage (SNH)	Pre-Scoping meeting	EIA surveys and studies required and the data needs for each EIA study.
27th May 2011	Marine Scotland, statutory consultees and non statutory consultees	Submission of Scoping Report	Request for Scoping Opinion from Marine Scotland and statutory consultees and request for comment from non statutory consultees.
30th June – 2nd July 2011	Local stakeholders	Public Event - EIA Scoping	Public event to collate information/opinions on proposed EIA scope.
26th August 2011	Historic Scotland	Submission of document for comment	Copy of onshore baseline report provided for comment.
30th August 2011	Highland Council's Historic Environment Team	Submission of document for comment	Copy of onshore baseline report provided for comment.
5th September 2011	Historic Scotland	Letter	Comments for input to onshore design workshop on 6th September 2011.
6th September 2011	The Highland Council (THC), Highland Council's Historic Environment Team, SNH	Onsite Workshop in Caithness	Onsite workshop to discuss the LSVIA and historical setting aspects of the project and agree viewpoints for visual impact assessment.
14th September 2011	Historic Scotland	Email	No need for a meeting as content that Project will not impact on statutory historic environments.
14th September 2011	The Highland Council	Meeting	Planning pre application meeting. Presentation on overall project and results of EIA studies to date. Included discussion on building design / development extent sustainable design additional viewpoints required.
27th September 2011	Highland Council's Historic Environment Team	Submission of document for comment	Provision of report detailing results of geophysical survey investigation and proposed mitigation strategy going forward for Ness of Quoys and Ness of Huna sites.
31st September 2011	Marine Scotland, The Highland Council, statutory consultees and non statutory consultees	Receipt of Scoping Opinion	Receipt of response to Scoping Report and other comments from non statutory consultees.
6th October 2011	The Highland Council's Historic Environment Team	E mail	Confirmation on acceptance of proposed mitigation strategy going forward for Ness of Quoys and Ness of Huna sites.
10th October 2011	Highland Council	Receipt of pre application advice	Receipt of pre application advice from Highland Council.

Date	Stakeholder	Consultation	Topic/specific issue
6th – 7th December 2011	Local stakeholders	Public Event – pre application consultation	Public event to communicate the findings of the EIA to local stakeholders.

Table 20.2: Consultation undertaken in relation to onshore cultural heritage

Name of organisation	Key concerns	Response	ES section within which the specific issue is addressed
Historic Scotland	That an assessment is made of the direct impact of the development on cultural heritage assets including: Castle Mestag, fortified sea stack, Stroma (Index No. 9763); St John's Point, fort and site of St John's Chapel (Index No. 2689); Castle of Mey (HB No. 1797) and grounds, as included in the Inventory of Gardens and Designed Landscapes; Canisbay Parish Church (HB No. 1795).	Full assessment has been made in the EIA.	Section 20.5 Baseline description and sections 20.6, 20.7 and 20.8 Impact assessment
	That an assessment is made of the indirect impact of the development on cultural heritage assets, including those listed above.	Full assessment has been made in the EIA.	Section 20.7 Impact assessment
	That in assessing impact upon the setting of cultural heritage assets, Managing Change in the Historic Environment is consulted for guidance.	The document has been consulted and the guidance used.	Section 20.3 Policy and guidance
	That permanent development at Ness of Quoys would potentially impact on the setting of the Category A listed Canisbay Parish Church (HB No. 1795) and associated churchyard, together with the fields to the north and east which provide an open landscape setting around the monument.	After further consultation, HS stated that "the current proposals do not appear to raise significant issues for our statutory historic environment interests (i.e. scheduled monuments and their setting, category A listed buildings and their setting, Inventory designed landscapes and designated wrecks)" .	Section 20.7 Impact assessment
	That three new SHETL substation options could potentially impact on the setting of the Castle of Mey (HB No. 1797) and grounds, as included in the Inventory of Gardens and Designed Landscapes, particularly as they would appear in the designed vista to the south of the castle.	The SHETL substations do not form part of this development (the impacts associated with the SHETL substations are subject of an EIA presently being undertaken by SHETL) and therefore are not considered except in terms of cumulative impact.	Section 20.10 Cumulative impacts
Highland Council Historic Environment Team (HC HET)	That the impact on cultural heritage assets by the proposed development be duly considered.	Full assessment has been made in the EIA.	Section 20.5 Baseline description, sections 20.6, 20.7 and 20.8 Impact assessment
	That, where possible, cultural heritage assets be preserved in situ.	MeyGen are in agreement with this approach and onshore site layout design will seek to wherever possible avoid cultural heritage assets (within the technical constraints of the project)	Section 20.5 Baseline description
	That a full assessment of historic environment assets above and below ground be undertaken.	Full assessment has been made in the EIA	Sections 20.6, 20.7 and 20.8 Impact assessment
	That the building and landscape design be sympathetic to the landscape and historic environment.	The appearance and design of the buildings and landscaping are being formulated with this in mind and in consultation with Highland Council Historic Environment Team (amongst others).	Sections 19 LSVIA and section 20.7 impact assessment
	That where avoidance of archaeological remains is not practicable or possible that an appropriate mitigation strategy is put in place.	Appropriate mitigation strategies have been formulated	Sections 20.6, 20.7 and 20.8 Impact assessment
	That the most significant cultural heritage issue remains the setting of Canisbay Kirk. This issue should be given precedence over other similar issues when considering the siting and design of the development.	Impact and mitigations addressed in the EIA. The appearance and design of the buildings and landscaping are being formulated to address this issue.	Section 20.7 Impact assessment
Caithness Archaeological Trust	No concerns raised	-	-
Caithness Field Club	Raised no specific concerns. Provided information on local assets and recommended the consultation of the Caithness Coastal Survey undertaken in the 1980s by Colleen Batey and the further investigation of a purported Cromwellian battery and magazine at the Ness of Quoys.	The Caithness Coastal Survey report was used as a main source for the baseline assessment. If the design layout cannot avoid it, it is proposed to evaluate the Battery to investigate the identification and propose further mitigation if appropriate.	Section 20.5 Baseline description, and sections 20.6, 20.7 and 20.8 Impact assessment
Public Meetings	Concerns were raised concerning the landscape and visual impacts of the development, including the use of overhead cables for the connection of substations.	Visual and setting impacts have been considered in the EIA. MeyGen propose to underground all onshore cables.	Section 20.7 Impact assessment

Table 20.3: Scoping comments relevant to onshore cultural heritage

20.4.2 Desk based assessment

20.24 The desk based assessment (DBA) was executed in accordance with the Institute for Archaeologists (IfA) *Standard and Guidance for archaeological desk-based assessment* (revised 2008, at www.archaeologists.net) and the relevant parts of The Highland Council's *Guidance for Archaeological Contractors* (available at www.highland.gov.uk).

20.25 The DBA covered the area of mainland Caithness as shown in Figure 20.1. This was to identify any sites that might be directly affected by the proposed development and their immediate context. The DBA reviewed the following sources:

- The National Monuments Record of Scotland, using the Canmore and Pastmap database websites; http://www.rcahms.gov.uk/ ;

- The local Sites and Monuments Record using the Highland Council website; http://her.highland.gov.uk/;
- Ordnance Survey maps including County Series 1:2500 (25" to 1 mile) 1st edition 1877, Caithness-shire; County Series 1:2500 (25" to 1 mile) 1st Revision (second edition) 1907' Caithness-shire; OS Explorer Map, 1: 25 000, 2007 edition, Thurso and John o' Groats;
- Relevant historic maps available on the National Library of Scotland website;
- The Canisbay parish entries in the *Old* and *New Statistical Accounts of Scotland*, 1791-99 and 1834-45 respectively, via the Edina website; stat-acc-scot.edin.ac.uk;
- Statutory lists, registers and designated areas, including List of Scheduled Ancient Monuments, Listed Buildings, Inventories of Gardens & Designed Landscapes and Historic Battlefields, and local authority Conservation Areas;
- High resolution aerial photographs of the study area supplied by Xodus;
- The Bulletins of the Caithness Field Club, available at http://www.caithness.org/caithnessfieldclub/bulletins/linkindex.htm;
- Information in the scoping responses from various organisations (see Section 20.3.1); and
- Various other readily available archaeological and historical reports, databases and publications were consulted for information about the study area (such as Barber 2006, Batey *et al* 1993, Calder 1887, Davidson & Henshall 1991, Omand 1989) and, where used, will be cited in the report.

20.26 Each cultural heritage site, monument, area and building identified within the assessment area was assigned an individual site number, prefixed by ORCA (e.g. ORCA 25). All sites identified by the DBA and the importance and significance of each individual site, are shown on Figures 20.2 and 20.3 and presented in detail in the supporting onshore archaeology EIA report (ORCA, 2012), provided on the supporting studies CD.

20.4.3 Walkover survey

20.27 The walkover survey was executed in accordance with the relevant sections of the Institute for Archaeologists (IfA) *Standard and Guidance for Archaeological Field Evaluation* (revised 2008, at www.archaeologists.net) and the relevant parts of The Highland Council's *Guidance for Archaeological Contractors* (available at www.highland.gov.uk).

20.28 The area fieldwalked was the Project area only as shown on Figure 20.1. Any features or sites identified were assigned an individual site number, in the same sequence as the sites identified in the DBA. All sites identified by the walkover survey and the importance and significance of each individual site, are shown on Figures 20.2 and 20.3 and presented in detail in the supporting onshore archaeology EIA report (ORCA, 2012), provided on the supporting studies CD.

20.29 Any sites identified by the DBA within the development area were also visited to evaluate their nature, condition and potential impacts of the proposed works. Subsequently, targeted geophysical surveys have been undertaken over potentially sensitive sites in the Ness of Quoys and Ness of Huna areas in order to inform appropriate mitigation measures (ORCA, 2011b) and some of the results are discussed in Section 20.5. The report of the geophysical survey is also provided on the accompanying supporting studies CD (ORCA, 2011b).

20.4.4 Zones of Theoretical Visibility

20.30 The Zones of Theoretical Visibility (ZTV) for the Ness of Quoys and Ness of Huna were established by a process described in Section 19, and photomontages from cultural heritage viewpoints / viewpoints relevant to cultural heritage assets are included in Section 19 and the Technical Appendix to that section. Several sites within the ZTVs for were visited for the consideration of setting issues. Each archaeological or historical site, monument and building identified within the ZTV of each potential HDD and PCC location was assigned an individual site number in the same sequence as those identified by the DBA and walkover survey. Identified sites and the importance and significance of each individual site within the ZTVs are shown on Figure 20.6 and Figure 20.7 and presented in detail in the supporting onshore archaeology EIA report (ORCA, 2012), provided on the supporting studies CD.

20.31 Guidance indicates that if a historic asset is not within the visual envelope of a development then most factors contributing to the setting of the asset will not be affected.[5] Thus it is not considered that the underground cable routes will have an effect on setting. The distance from which a development is seen is important in considering the impact on setting, which has resulted in the potential impact of the development on the setting of heritage assets being assessed in zones: within 2km of the PCC, 2-5km away and 5-10km away. Beyond this it is most unlikely that the Project will have an impact.

20.4.5 Significance criteria

20.32 Where appropriate, the methodology used follows that outlined in Section 8. Variations from this are explained in the following sections.

Criteria for importance, significance and sensitivity

20.33 The importance and significance attributed to each identified area, site or feature will be determined using the criteria in Table 20.4 which incorporate general guidelines and values relating to a site's intrinsic, contextual and associative characteristics[6] used by statutory agencies such as HS, outlined in SHEP 2011, SPP 2010 and PAN 2/2011. It should be noted that a site that has not been statutorily designated can still be of national importance and that although Listed Buildings have a hierarchy of relative importance, in law all listed buildings receive equal legal protection, and protection applies equally to the interior and exterior of all listed buildings regardless of category[7]. Features that would require considerable further work to interpret them have been recorded as of uncertain importance and significance.

20.34 The level of significance usually correlates a site's importance, as in Table 20.4. However, some professional judgement may be needed when assessing significance, using factors such as:

- The relative rarity of the archaeological feature concerned;
- The completeness of the feature / whether it is a particularly good example of its type;
- The historical or cultural associations of the feature;
- The value given to the feature by the local community;
- The potential value of the feature as an in situ educational or research resource; and
- The potential value of retaining the feature for tourism or place-making".[8]

20.35 Although there is no statutory definition, 'setting' is an important consideration in assessing changes to the historic environment in the planning process (SPP 2010, para 113). Setting is defined in various guidance and policy documents.[9]

[5] http://www.historic-scotland.gov.uk/setting-2.pdf, sections 2 to 4
[6] See SHEP 2011 Annexes 1-6 for detailed explanations of such criteria.
[7] http://www.historic-scotland.gov.uk/index/heritage/historicandlistedbuildings/listing.htm
[8] PAN 2/2011, para 6
[9] E.g. SPP2010, para 113; http://www.international.icomos.org/xian2005/xian-declaration.htm

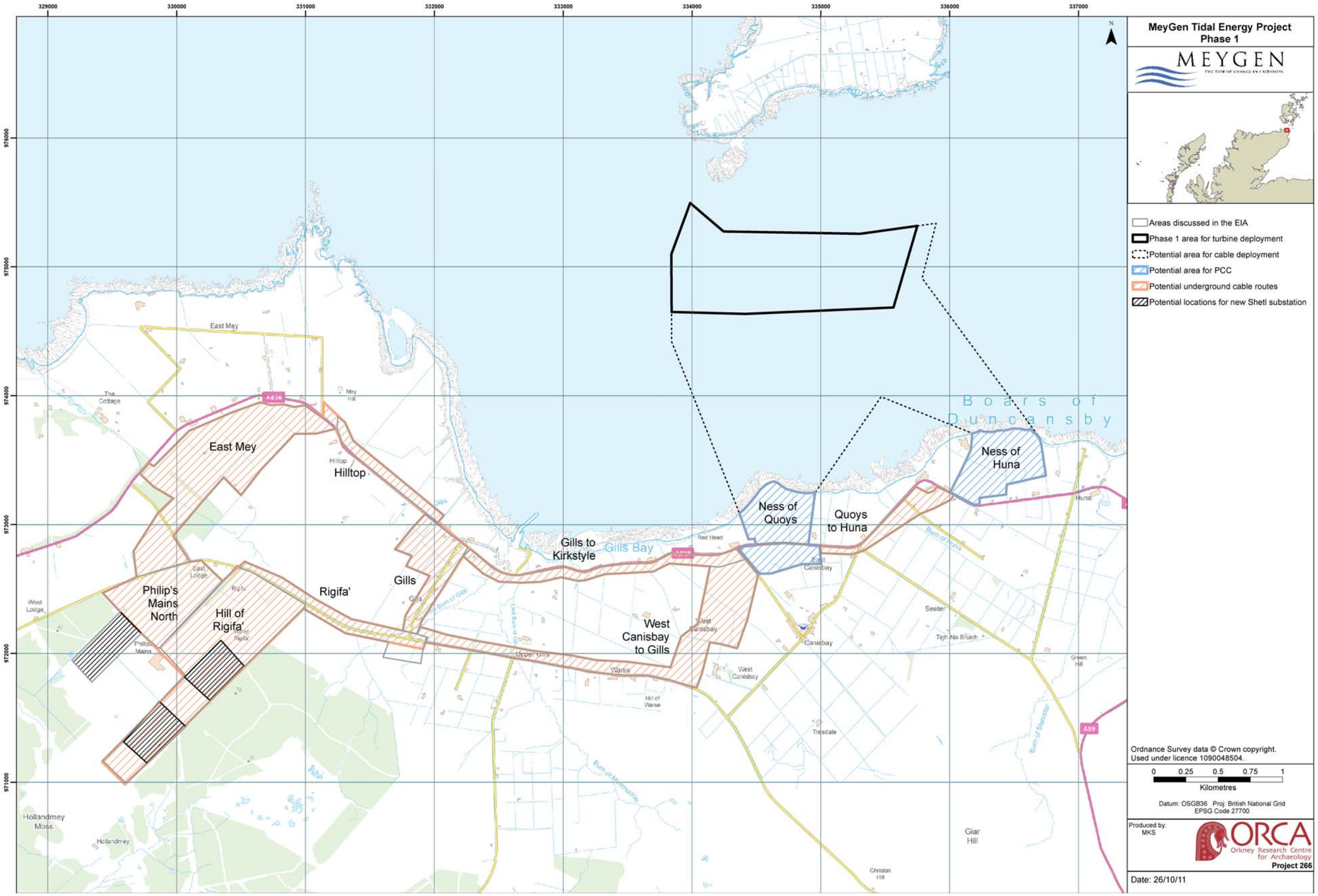

Figure 20.1: The onshore cultural heritage assessment area

Level of asset significance	Importance criteria
Very High	▪ Archaeological and historical sites or areas of international importance, such as World Heritage Sites, and may also include some Category A Listed Buildings, Scheduled Ancient Monuments, Designed Gardens & Landscapes and Historic Battlefields that are not only of national but of international importance.
High	▪ Archaeological and historical sites or areas of national importance, Scheduled Ancient Monuments, Category A and some Category B Listed Buildings, Inventoried Designed Gardens & Landscapes, Inventoried Historic Battlefields.
Medium	▪ Sites and areas of regional importance, Some Category B Listed Buildings and Category C(s) Listed Buildings.
Low	▪ Locally important archaeological sites or areas and unlisted buildings/structures which may have elements of architectural value.
Negligible	▪ Features that have been recorded but assessed as of no or negligible archaeological or historical importance, such as modern clearance cairns, 18th to 20th-century dykes and buildings that have been demolished or have been so altered or ruined that they no longer have any features of any historic merit.
Uncertain	▪ Features or sites that cannot be identified without further or detailed work, but potentially may be of some interest; findspots, which may represent an isolated find, or could represent the location of a hitherto unknown site. An estimate may be given of maximum likely potential significance, depending on field survey evidence.

Table 20.4: Definitions of importance and significance of cultural heritage assets

20.36 The HS 2010 guidance on setting in the *Managing Change in the Historic Environment* series[10] defines it as how monuments were:

"deliberately positioned with reference to the surrounding topography, resources, landscape and other monuments or buildings. These relationships will often have changed through the life of a historic structure. Setting can be thought of as the way in which a historic structure's surroundings contribute to how it is experienced, understood and appreciated. Setting often extends beyond the immediate property boundary of a historic structure into the broader landscape" .

20.37 A range of factors may contribute to the setting of a site, and their assessment will ultimately rely on professional judgement. The HS guidance note (Section 3) lists ten factors and indicates this is not exhaustive:

- Current landscape or townscape context;
- Visual envelope, incorporating views to, from and across the historic structure;
- Key vistas, framed by rows of trees, buildings or natural features that give a structure a context, whether or not intentional;
- The historic structure's prominence in views throughout the surrounding area;
- Character of the surrounding landscape;
- General and specific views including foregrounds and backdrops;
- Relationships between both built and natural features;
- Aesthetic qualities;
- Other non-visual factors such as historical, artistic, literary, linguistic, or scenic associations, intellectual relationships (e.g. to a theory, plan or design), or sensory factors; and
- A 'Sense of Place': the overall effect formed by the above factors.

20.38 All but the last three of the factors listed above are visual or landscape-related and it is usually only necessary to address these to filter out all but the significant effects. It is clear that if a cultural heritage asset is not visible on the ground surface, then none of these factors apply and it is unlikely that its setting is sensitive, unless it is part of a proven subsurface landscape of archaeological deposits.

20.39 The level of sensitivity to change of the setting of cultural heritage assets can be broadly defined as in Table 20.5, with any other factors particular to a site (such as noise, see Section 23) addressed separately when appropriate.

Setting Sensitivity	Landscape guideline criteria	Visual guideline criteria
Very High	Areas of landscape that are critical in their contribution to a site's appreciation or understanding, unique or distinctive historic landscapes, or considered susceptible to any changes because a heritage site is a critical part of it, World Heritage landscapes.	Receptors from or to which (or for whom) the view is critical and where any changes would be particularly noticed. For example, World Heritage Sites and Areas, some Inventoried Designed Landscapes, Historic Battlefields, SAMs and Listed Buildings, where the view in question is of historic or heritage importance and critical to it; sites that have or are a highly visible part of critical views; sites that are a critical element of an Inventoried designed landscape.
High	Areas of landscape that are highly valued in their contribution to a site's appreciation or understanding, particularly rare or distinctive historic landscapes, or considered susceptible to small changes because a heritage site is a key part of it.	Receptors from or to which (or for whom) the view is important and where changes would be particularly noticed. For example, the setting of nationally important sites such as SAMs, where the view in question is of historic or heritage importance and relevant to it; highly visited sites; sites that have or are a clearly visible part of highly valued or key views; sites that are a major element of an Inventoried designed landscape.
Medium	Areas of landscape that are moderately valued in their contribution to a site's appreciation or understanding, are considered of historic value locally, are tolerant of moderate levels of change because heritage sites are not key to the landscape.	Receptors for whom or from which or to which the change in the view is a small element in the overall view, not critical to the visual setting, or where the nature of the view is of secondary importance. For example, sites that have or are part of little valued, secondary or minor views; sites that are little visited or usually only seen from moving vehicles (except tourist attractions or feature on tourist routes); sites that are a secondary element of a designed landscape, or hardly visible in highly valued or key views.
Low	Areas of landscape that are generally more commonplace and/or contribute little to a site's appreciation or understanding, are considered potentially tolerant of noticeable change, or undergoing substantial development such that their character is one of change and heritage sites within it have therefore experienced much change to their surroundings.	Receptors from/to which or for whom the change is of little importance.
Negligible	Areas of landscape that are commonplace and/or contribute nothing to a site's appreciation or understanding (especially if the site is completely sub-surface), are considered tolerant of noticeable change, or have undergone substantial development such that their character is one of complete change and heritage sites within it have no relation to their surroundings.	Receptors from/to which or for whom the change is irrelevant, including assets that do not show on the ground surface.

[10] http://www.historic-scotland.gov.uk/setting-2.pdf

Setting Sensitivity	Landscape guideline criteria	Visual guideline criteria
Unknown	Areas of landscape where it is uncertain how they contribute to a site's appreciation or understanding, because the feature or asset itself could not or has not been understood or interpreted.	Receptors that are not understood or interpreted, so that it is uncertain how visual factors relate to them.

Table 20.5: Definitions of setting sensitivity

Criteria for assessing magnitude and likelihood of impact

20.40 The magnitude of any potential adverse impact on a cultural heritage asset and the historic environment caused by the development proposals was determined using the criteria shown in Table 20.6.

Magnitude of impact	Direct / Construction impact criteria	Indirect / Setting / Operational impact criteria
Very High	Works would result in the complete loss of a site.	The removal of, or a fundamental and irreversible change to, the relationship between a heritage asset and a historically relevant landscape. Major change to a highly sensitive or valued landscape, which removes or prevents appreciation of characteristics key to a heritage asset, or permanent change to or removal of less sensitive or valued landscape. The proposed development overpowers, dominates and radically alters or removes the view and completely changes its character and quality. For example, the development is the only view in the near-ground; lies directly in the foreground removing a line of view to which the site has been deliberately oriented or designed. An irreversible and radical change to the setting, removing or preventing appreciation of key characteristics of a highly sensitive asset.
High	Works would result in the loss of an area, features or evidence fundamental to the historic character and integrity of the site. Severance would result in the complete loss of physical integrity.	A noticeable change to a key relationship between a heritage asset and a highly sensitive, valued or historically relevant landscape over a wide area or an intensive change to a less sensitive or valued landscape over a limited area. The proposed development dominates the view and substantially changes its character and quality. This is more likely to be the case for the setting of sites in the ZTV within 2km. For example, the development in full view in the near-ground; lies directly in the near-ground of the line of view to which the site has been deliberately oriented or designed; it projects well above the horizon or skyline in the near- or middle-ground A fundamental or key change to the setting of a highly sensitive asset.
Moderate	Works would result in the loss of an important part of the site or some important features and evidence, but not areas or features fundamental to its historic character and integrity. Severance would affect the integrity of the site, but key physical relationships would not be lost.	Noticeable change to a landscape not key to a heritage asset, tolerant of moderate levels of change. Small changes to the relationship between a heritage asset and a historically relevant landscape over a wide area or noticeable change over a limited area. The proposed development is clearly noticeable in the view and affects its character or quality, but is not critical to the receptor. This is more likely to be the case for the setting of sites in the ZTV within 2-5km. For example, the development is in full view in the middle-ground of an otherwise open view; lies in the middle ground of a designed view, but does not block or completely dominate or badly break the skyline. A material but non-fundamental change to the setting.
Low	Works or the severance of the site would not affect the main features of the site. The historic integrity of the site would not be significantly affected.	Very minor changes to the relationship between a heritage asset and a historically relevant landscape over a wide area or minor changes over a limited area. Minor changes to a landscape considered tolerant of change in relation to heritage asset. The proposed development does not affect the character and quality of the view, or it is a minor element likely to be overlooked by the casual observer. This is more likely to be the case for the setting of sites in the ZTV within 5-10km. For example, the development visible in the background or part of a wide view. A detectable but non-material change to the setting.
Negligible	Works or the severance of the site would be confined to a relatively small, peripheral and/or unimportant part of the site. The integrity of the site, or the quality of the surviving evidence would not be affected.	Changes to a historically relevant landscape cannot be discerned or perceived in relation to the heritage asset. The proposed development cannot be discerned in views relevant to the setting of heritage assets. No detectable change to the setting.
Unknown	Groundbreaking works over features that have not been fully interpreted would reduce the chance of interpretation in the future. In the event of significant features this would constitute impact of high magnitude; for sites of lesser significance it is less problematical. Nevertheless, it remains an issue where features have not been or could not be interpreted.	Changes to a landscape, views or other possible setting factors where it is uncertain how these contributes to a site's appreciation or understanding, because the feature or asset itself could not or has not been understood or interpreted.

Table 20.6: Definitions of magnitude of impact

Criteria for assessing significance of impact

20.41 The calculation of the significance of any potential adverse impacts from the development proposal on any cultural heritage assets, prior to the application of any management or mitigation strategies, has been determined by combining the magnitude of the impact with the significance of each cultural heritage asset, as shown in Table 20.7, similar to the way consequence is derived in ES Section 8.

20.42 Under EIA Regulations, impacts of moderate or higher significance are considered to be significant effects that may require consideration by the competent authorities and will require control, management and mitigation[11]. However, it should be noted that impacts of minor significance may still require some management or mitigation to remain within acceptable levels (see ES Section 8, Table 8.2).

Asset significance or sensitivity	Magnitude of impact					
	Very High	High	Moderate	Low	Negligible	Uncertain
Very High	Severe	Severe	Major	Moderate	Minor	Uncertain/ Severe
High	Severe	Major	Moderate	Minor	Negligible	Uncertain/ Major
Medium	Major	Moderate	Moderate	Minor	Negligible	Uncertain/ Moderate
Low	Moderate	Minor	Minor	Negligible	Negligible	Uncertain/ Minor
Negligible	Minor	Negligible	Negligible	Negligible	Negligible	Uncertain/ Negligible
Uncertain	Uncertain/ Severe	Uncertain/ Major	Uncertain/ Moderate	Uncertain/ Minor	Uncertain/ Negligible	Uncertain/ Negligible

Table 20.7: Determination of significance of impact

[11] See Scottish Planning Series Planning Circulars 8-2007: *The Environmental Impact Assessment (Scotland) Regulations 1999*, and 3-2011: *The Town and Country Planning (Environmental Impact Assessment) (Scotland) Regulations 2011*,

20.4.6 Assessment limitations

20.43 The cultural heritage impact assessment has been produced with the assumption that identified receptors of uncertain significance have been assigned the highest likely significance until or unless further investigation proves otherwise. Some targeted geophysical surveys have been undertaken in the PCC and HDD areas and the results incorporated into the Project design, reducing the risk of impacts on cultural heritage assets at the earliest possible opportunity (ORCA, 2011b).

20.44 It is assumed that there will be no direct impacts on the historic environment during reinstatement and decommissioning, because all direct effects are likely to have occurred during construction and it is assumed that decommissioning works will not go outside the ground-breaking footprint of the construction phase. The effects of reinstatement are considered to be neutral since work will restore what was there before, rather than improve on what was there before.

20.5 Cultural Heritage Baseline Description

20.5.1 Historic landscape and setting

20.45 The **modern landscape** in the locality of the development is described and characterised in Section 19[12].

20.46 The Ness of Quoys site is dominated by the Canisbay Kirk and adjacent Kirkstyle farmstead to the south west and the large agricultural shed at Quoys farm to the southeast. The west side of the Ness of Huna site is dominated by the derelict Huna House and surrounding new farm buildings, including a farm house, banks of bulldozed earth and flattened vehicle turning areas. This activity has compromised the modern setting of any historic asset here and in the 1980s partly destroyed the Norse settlement to the west (ORCA 76-79).

20.47 The **historic landscape**[13] is one of late 18th- and 19th-century rectilinear fields and farming and crofting (including many abandoned croft houses). There are both active and relict areas of peat cutting, especially between the Hills of Mey and Rigifa' and several small abandoned flagstone quarries. Certain buildings dominate the historic landscape, especially the late 18th- and early 19th-century two-storey houses, such as the derelict Huna House (ORCA 80), the John o' Groats House Hotel, the B-Listed West Canisbay House (ORCA 62) and East Canisbay Manse (ORCA 59), and the A-Listed Canisbay Kirk and its graveyard (ORCA 53 and 55). Some, such as Huna House and Canisbay Kirk, were used as navigational aids, as is the early 20th-century Duncansby Head lighthouse, which has no significant architectural merit. There are some 19th century piers and boathouses, as at John o' Groats, Huna House and Gills and other buildings representing activities of times gone by, such as the B-Listed mill complex west of John o' Groats (ORCA 85-89), the ruined distillery (ORCA 51) and the old school (ORCA 435) at Kirkstyle and the 18th-century bridges over West and East Burns of Gills (535 and 536). Stroma, on the north side of the sound, has a similar landscape, and includes the late 17th-century B-Listed dovecote and burial vault (ORCA 490).

20.48 Although sites earlier than the 18th century sites are known, few are as prominent as the Stroma dovecote or Canisbay Kirk, and many hardly visible on the surface (such as the Norse sites at Huna (ORCA 76-79) and Robertshaven east of John o' Groats). Other than those already mentioned, the most evident sites are the Scheduled promontory fort and early Christian chapel site of St John's Point (ORCA 21 and 22) and the Scheduled fortified seastack of Castle Mestag (ORCA 486) at the south-western tip of Stroma. However, their prominence is more due to being cliff-girt headlands, rather than archaeological sites. There are two possible standing stones of uncertain date (ORCA 352 and 407), which appear to have no particular prominence and there are known Iron Age broch sites in the vicinity, which are now low and much disturbed mounds (ORCA 20, 40, 46, 54, 70), all of them surviving in a continually changing landscape. It is only the open moorland (ignoring the extensive peat cutting and relict quarries) sweeping round from St John's Point and Mey Hill to Warth Hill surmounted by Neolithic or Bronze Age burial cairns (ORCA 475 and 476) that is most likely to remain something like it appeared in the Iron Age, Norse and mediaeval periods when the brochs were built, the Vikings settled and the Kirk was built.

[12] See also Stanton, C., 1998. Caithness and Sutherland Landscape Character Assessment, SNH commissioned report No. 130 Available at http://www.snh.org.uk/publications/on-line/LCA/CaithnessSutherland.pdf
[13] as defined on Historic Land-use Assessment maps, produced by HS and RCAHMS http://hla.rcahms.gov.uk

20.5.2 Identified cultural heritage assets and cultural heritage potential

20.49 The types of sites identified within the different parts of the onshore development area and their significance is summarised in Table 20.8 and Table 20.9 and shown in Figure 20.2 and Figure 20.3. There are no designated sites, monuments, areas or buildings within the development area, although there are some nearby (see Section 20.5.1 above).

Ness of Quoys: Identified cultural heritage assets

20.50 Four sites of potentially moderate or higher significance were identified. A mound (ORCA 64) at the centre of the area, which also shows as a geophysical anomaly (ORCA 2011b) has the potential to be of archaeological significance. At the point of the Ness, a rectilinear dry stone enclosure (ORCA 414) at the shoreline has been identified as a magazine related to a Cromwellian gun battery (not visible) some 50m to the west (Pottinger 1993). However, this identification remains to be proven. A stone spread (ORCA 416) found on the coastal slope, may be part of an earlier site eroding out from the land. Norse sites have been observed eroding out along this coast, particularly in the vicinity of Huna. A small area of possibly connected geophysical anomalies have been identified 30-40m to the south east in the development area. It is possible that the Lyrequoy well (ORCA 242), a formalised spring that could contain waterlogged artefacts, has some longevity of use, and may even be associated with ecclesiastical use given its proximity to Canisbay Kirk.

20.51 Sites of low and negligible significance include a roadside well used by local families and wayfarers (ORCA 412), a possible flag tank structure, the location of a grave marker probably removed by coastal erosion (ORCA 65), 19th Century dykes and stone clearance piles.

Ness of Quoys: cultural heritage potential

20.52 Canisbay Kirk (ORCA 53) is first mentioned in the 13th-century and it seems likely that the mound on which it sits is a large broch site (ORCA 54), dating to the Iron Age, and prehistoric finds have been found in the graveyard. There is extensive evidence for the continuity of use of Iron Age sites into the Norse and later period in Caithness as noted by Batey (Smith and Banks 2002: 185 – 190). The kirk and mound sit just outside the south west corner of the Ness of Quoys development area, and geophysical survey has indicated that it is possible that associated archaeological remains extend east and south east into it (ORCA 2011b). South of the kirk the geophysical anomalies extend some 30m south of the main A836 road in the corner formed with the minor road from Canisbay, and they extend some 30m east of the graveyard in a band some 15m wide on the north side of the main A836 road.

Ness of Huna: Identified cultural heritage assets

20.53 Two sites of moderate or higher significance were identified. An enclosure containing mounds (ORCA 84) seen on a 1946 aerial photograph could not be identified on the surface as this area has been intensively plough-cultivated, but could remain truncated below ground. It did not show in geophysical survey results, which could indicate that the site has been ploughed away or that the site is non-domestic in nature (ORCA, 2011). The precise location of a supposed "Picts Village" (ORCA 82) is unknown and nothing indicating the presence of such a site was visible here on the surface. The lack of evidence from geophysical survey indicates that this site does not exist or the oral tradition relates to the enclosure in the adjacent field (ORCA 84) or the Norse settlement (ORCA 76, 78, 79) west of Huna House.

20.54 The remaining sites are viewed to have a negligible significance – these include peat cuttings, dumps of modern material, an old fenceline and a small quarry.

Ness of Huna: Cultural heritage potential

20.55 Although bypassed by the modern road, in the 19th century Huna was an important place to the islanders of Stroma and to seafarers in the Pentland Firth. The area may have been occupied from at least the later prehistoric period, indicated by the enclosure (ORCA 84) and the oral tradition of the "Picts Village" (ORCA 82). Immediately to the west of Huna House (ORCA 80), a series of Norse sites including a ship burial and settlement evidence (ORCA 76, 78, 79) indicate the remains of significant Norse activity within this vicinity, although a significant amount of this may have been destroyed (Batey 1993: 152).

Geophysical survey indicates that subsurface remains associated with it do not extend eastwards into the development area (ORCA, 2011).

Underground Cable Routes: Identified cultural heritage assets

20.56 The discussion of the cable route options is organised into areas (see Figure 20.1 for area names), so that the potential effects using different cable routes can be compared.

- **Philip's Mains North**

20.57 Two sites of uncertain significance were identified. An elongated mound (ORCA 371) respected by ridge and furrow may be of archaeological significance. A hole with stone in the sides may indicate the location of a post-medieval collapsed well or drain or an older archaeological feature (ORCA 374).

20.58 The sites of low and negligible significance include late post-medieval ridge and furrow (ORCA 366, 370), field boundaries, enclosures, stone clearance heaps, a small flagstone construction of uncertain date (ORCA 376) and a relict late 18th-century stone quarry (ORCA 148).

- **East Mey**

20.59 Six sites of potentially moderate or higher significance were identified. A low ridge with visible stone (ORCA 389) may indicate an archaeological site. Three mounds (ORCA 379, 382 and 383) in an unimproved, boggy field may be of some antiquity as may another mound (ORCA 391). East Lodge and its gate piers (ORCA 18) are not part of the Mey Estate Inventoried Designed Landscape, but do represent an extension to this estate, possibly dating to the 14th Earl's activities in the mid-late 19th century (Houston 1996:399-401).

20.60 The sites of low and negligible significance include 19th- to 20th-century pre-enclosure land divisions including turf dykes (ORCA 380, 381), stone clearance heaps, farmsteads, both occupied and abandoned, but all with some vernacular elements (ORCA 137, 140, 163), flag and stone dykes, quarries, areas of peat cutting, a stone tank and a well.

- **Hilltop**

20.61 Only two sites were identified, both of low significance, one a relict quarry (ORCA 171), the other the Marl Well, reputedly built by Cromwell's troops (ORCA 167).

- **Gills**

20.62 Two sites of unknown significance were identified. Both were mounds (ORCA 397, 400) near boggy areas and thus have some potential for being prehistoric features such as burnt mounds.

20.63 The sites of low significance and negligible significance include farmsteads, both occupied and abandoned, but all with some vernacular elements (ORCA 178, 193, 195, 198, 199 and 396), clearance piles, a pre-mid 19th-century well (ORCA 200) and two dammed ponds with sluices (ORCA 184 and 185).

- **Gills to Kirkstyle**

20.64 One site of unknown significance was identified. This is a mound (ORCA 404) in close proximity to Canisbay Kirk, and has the potential to be of archaeological significance.

20.65 The sites of low significance and negligible significance include a well, perhaps a formalized spring (ORCA 249), flag dykes and a milestone (ORCA 403) displaced early in WW2 due to fear of German invasion (Houston 1996: 29).

- **Ness of Quoys to Ness of Huna**

20.66 Six sites of low significance were identified, comprising four farmsteads or crofts that were cleared in the 19th century (ORCA 260, 261, 262, 264) and an occupied house (ORCA 266), perhaps the old farmstead modernised or possibly a new house on the cleared site.

- **West Canisbay to Gills**

20.67 Three sites of potentially moderate or higher significance were identified. A slab of stone (ORCA 419) may have once stood upright and could be associated with a nearby mound (ORCA 422), which may have archaeological potential. A trackway (ORCA 410), edged with flags and overgrown formal beech and hawthorn hedging, is part of the designed landscape of the B-Listed West Canisbay house and estate (ORCA 62).

20.68 The sites of low and negligible significance include a relict 19th –century quarry, possibly associated with the construction of the B-Listed West Canisbay House, a well, bridge and peat cuttings.

- **Rigifa'**

20.69 No significant sites were identified. The sites of low and negligible significance comprised areas of peat cuttings, showing deep and extensive peat.

- **Hill of Rigifa'**

20.70 Two sites of uncertain significance were identified. A standing stone with initials carved into it (ORCA 352) may be 19th-century rather than prehistoric. A small rectangular cropmark (356) may have archaeological potential, but could be from recent farming practices.

20.71 The sites of low and negligible significance include 19th-century pre-enclosure agricultural practices, such as a ruined farmstead with vernacular elements (ORCA 152) and sections of three late pre-enclosure turf dykes (ORCA 346, 347 and 351), quarries and stone clearance mounds.

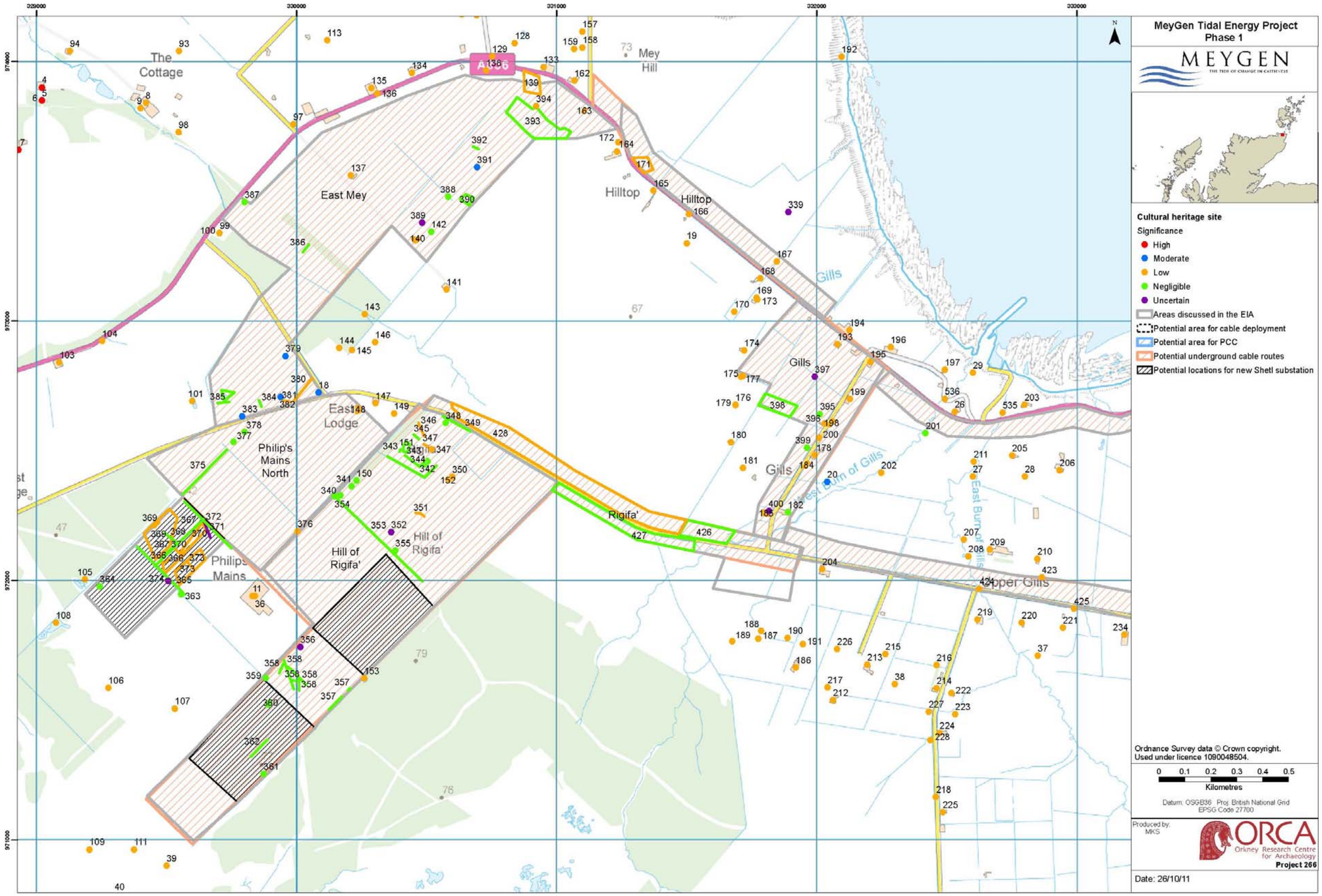

Figure 20.2: Western half of assessment area: identified cultural heritage assets

Figure 20.3: Eastern half of assessment area: identified cultural heritage assets

Site type	Philip's Mains North	East Mey	Hilltop	Gills	Gills to Kirkstyle	Quoys to Huna	West Canisbay to Gills	Rigifa'	Hill of Rigifa'	Ness of Quoys	Ness of Huna	Total
Bridge							424					1
Cairn											1	1
Cropmark									356			1
Dam				184, 185								2
Ditch	367, 368											3
Drain									358			1
Enclosure	378								344	414	84	4
Farmstead		137, 140		178, 182, 193, 195, 198, 199, 396		260, 261, 262, 264, 266, 274			151			16
Fence line											431	1
Findspot							48					1
Flag dyke	365, 372, 375	384, 385, 386			401							7
Gravemarker										65		1
Lodge		18										1
Milestone					403							1
Mound	371	379, 382, 383, 391		397, 399, 400	404		422		341, 350	64	81, 432	15
Orthostat							409					1
Peat cuttings		390, 393						426, 427, 428			429	6
Quarry	148	102, 139	171				251		150, 153, 360		430	9
Ridge				398			405, 406		353		417, 418	6
Ridge and furrow	366, 369, 370, 373											4
Spoil heap									349			1
Standing stone									352			1
Stone							419		361			2
Stone dyke		392					420, 421			415		4
Stone pile		388							340, 354, 355, 359	411, 413		7
Stone spread	364, 377	387, 389			402				348, 357	416		8
Strainer				395								1
Structure	376	163					408		152			4
Tank		394										1
Trackway							49, 410					2
Turf dyke		380, 381							342, 343, 345, 346, 347, 351, 362			9
Well	374	142	167	200	249		423			242, 412		8
TOTAL	**16**	**23**	**2**	**15**	**5**	**6**	**14**	**3**	**27**	**9**	**9**	**129**

Table 20.8: Summary totals of identified cultural heritage assets in development areas

Significance	Philip's Mains North	East Mey	Hilltop	Gills	Gills to Kirkstyle	Quoys to Huna	West Canisbay to Gills	Rigifa'	Hill of Rigifa'	Ness of Quoys	Ness of Huna	Total
Very high	0	0	0	0	0	0	0	0	0	0	0	0
High	0	0	0	0	0	0	0	0	0	0	0	0
Moderate	0	18, 379, 382, 383, 391	0	0	0	0	410, 422	0	0	64, 242, 414	82, 84	12
Low	148, 366, 369, 370, 373, 376	137, 139, 140, 163, 380, 381, 394	167, 171	178, 184, 185, 193, 195, 198, 199, 200, 396	249	260, 261, 262, 264, 266, 274	48, 49, 251, 423, 424	428	152, 153, 346, 347, 350, 351	65, 412	0	45
Negligible	364, 365, 367, 368, 372, 375, 377, 378	102, 142, 384, 385, 386, 387, 388, 390, 392, 393	0	182, 395, 398, 399	401, 402, 403	0	405, 406, 408, 409, 420, 421	426, 427	150, 151, 340, 341, 342, 343, 344, 345, 348, 349, 353, 354, 355, 357, 358, 359, 360, 361, 362	411, 413, 4153	81, 417, 418, 429, 430, 431, 432	62
Uncertain	371, 374	389	0	397, 400	404	0	419	0	352, 356	416	0	10
TOTAL	**16**	**23**	**2**	**15**	**5**	**6**	**14**	**3**	**27**	**9**	**9**	**129**

Table 20.9: Summary of significance of identified cultural heritage assets in development areas

Underground cable routes: Cultural heritage potential

20.72 No significant post-mediaeval cultural heritage assets were identified and there is a negligible potential for further post-medieval remains of any significance to be undiscovered.

20.73 It is possible that significant subsurface remains associated with the prehistoric site (ORCA 54) on which Canisbay Kirk (ORCA 53) is built extend southwest into the east end of the Gills to Kirkstyle area of cable route., since geophysical survey has identified probable archaeological remains extending southeast and east into the Ness of Quoys development area (ORCA 2011b).

20.74 Given the evidence for prehistoric and Norse activity in Canisbay, remains may lie hidden beneath the surface where areas have substantial peat cover or have been intensively cultivated, especially in the proximity of known sites. In these cases, the archaeology would only be revealed when the ground is disturbed during development.

20.6 Impacts During Construction and Installation

20.75 The visual impacts of the project during construction and installation on the setting of cultural heritage sites are considered too short-term to be significant and are not discussed further. Similarly, it is considered unlikely that there will be any significant vibrations from drilling and construction and thus there will be no adverse impact on the stability of historic buildings or archaeological sites.

20.6.1 Impact 20.1: Construction and drilling noise

20.76 The detailed study of predicted construction noise levels, their impact and mitigation is provided in Section 23. No significant impacts on historic assets are predicted for the Ness of Huna or installation of the underground cable. The A-Listed Canisbay Kirk (ORCA 53) is the key historic asset for considering the impact of construction noise levels on the setting of cultural heritage assets. The kirk (called Quoys Church / Kirkstyle in Section 23) is a specifically identified receptor in the study and all impacts and mitigations strategies are detailed in that Section, leading to a minor residual impact intermittent over the 3 year onshore installation and construction phase (Section 23.6). Therefore, this potential impact is not addressed further this section.

20.6.2 Impact 20.2: Direct damage, removal or destruction of onshore cultural heritage assets

20.77 The detailed assessment of the magnitude and significance of direct construction and installation phase impacts on cultural heritage assets, caused by the HDD operations, PCC construction (with associated hardstanding, carpark areas, security fencing), and by cable trenching is presented in detail in the supporting onshore archaeology EIA report (ORCA, 2012), provided on the supporting studies CD. This has been assessed in terms of a worst-case scenario (see Section 20.2.1).

20.78 The worst-case scenario approach made the assumption in the EIA that the whole of the onshore development option areas, including all possible cable routes would be subject to intrusive ground clearance and thus the magnitude of direct impact on any identified cultural remains within the area would be high (for sites partly within the development area) or very high (for sites completely within the development area), with occasional lower magnitudes of impact assigned if the site is almost completely outwith the development area.

20.79 The results of the impact assessment are summarised here in Table 20.10 and shown in Figure 20.4 and Figure 20.5. There are many sites where potentially significant (moderate or higher) impacts could occur (see Table 20.10). There could be a significant impact on subsurface archaeological remains identified by geophysical survey south of Canisbay Kirk and east of the kirkyard in the Ness of Quoys area (ORCA 2011b). It is also possible that there could be a significant impact on subsurface remains associated with the prehistoric site (ORCA 54) on which Canisbay Kirk (ORCA 53) is built if they extend southwest into the east end of the Gills to Kirkstyle area of cable route. Targetted geophysical survey would identify the presence / absence and extent of archaeological remains so that potential impact can be managed or mitigated. Adopting a precautionary approach (consistent with the Rochdale Envelope approach used in this ES) makes impacts on sites of low significance appear to be higher than they warrant, because it is assumed that they will be completely destroyed. It is clear that many of the 129 identified cultural heritage assets will not be impacted to such a degree as predicted, usually because they will be avoided. However, this can only be known when precise cable trench routes and the actual area of drilling and construction are finalised.

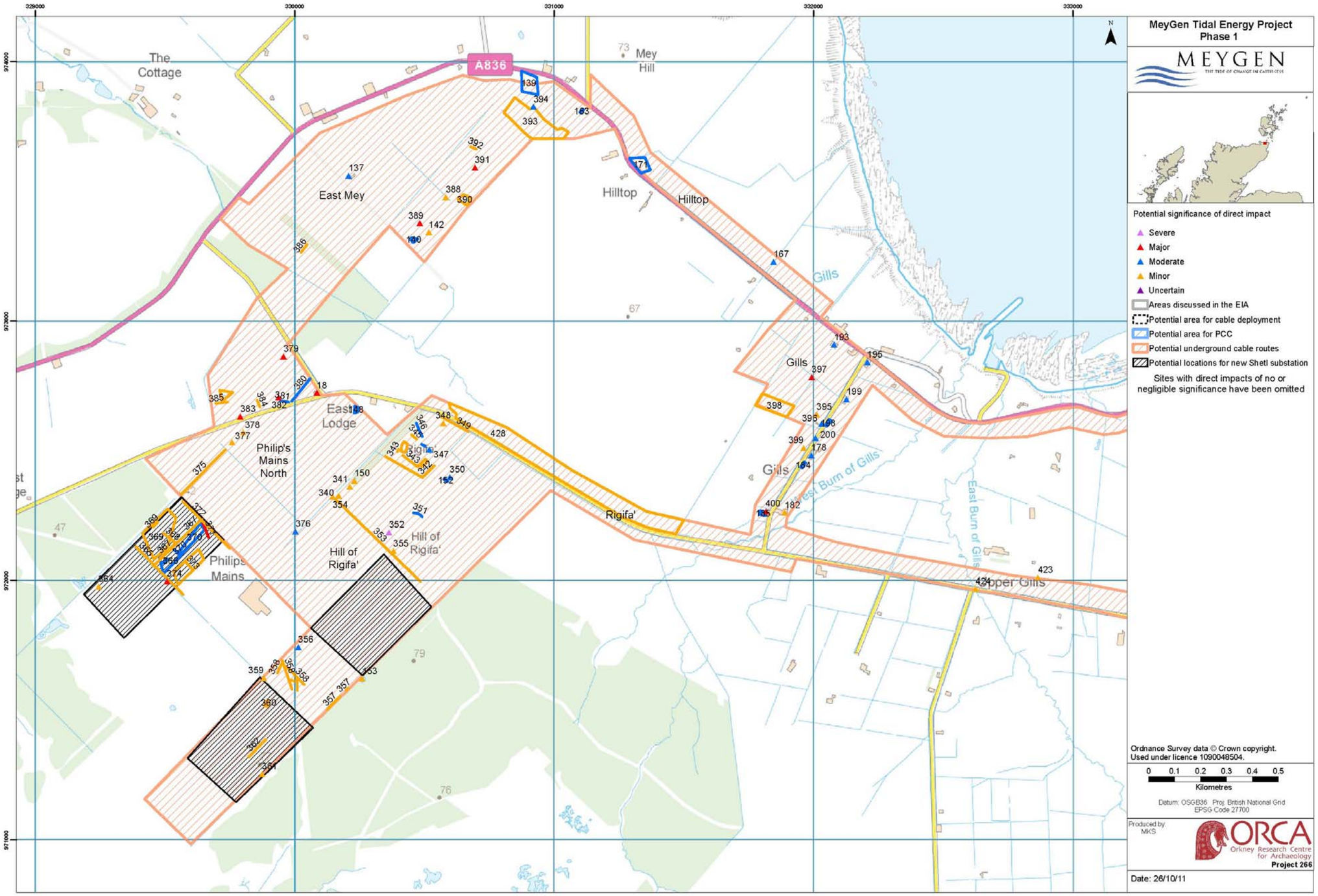

Figure 20.4: Western half of onshore assessment area: potential significance of predicted direct (construction) impacts

Figure 20.5: Eastern half of assessment area: potential significance of predicted direct (construction) impacts

Construction impact significance	Significance (EIA Regs)	Philip's Mains North	East Mey	Hilltop	Gills	Gills to Kirkstyle	Quoys to Huna	West Canisbay to Gills	Rigifa	Hill of Rigifa	Ness of Quoys	Ness of Huna	Total
Severe	Significant									352			1
Major	Significant	371, 374	18, 379, 382, 383, 389, 391		397, 400	404		410, 419, 422			64, 242, 414, 416	82, 84	20
Moderate	Significant	148, 366, 370, 376,	137, 139, 140, 163, 380, 381, 394,	167, 171	178, 184, 185, 193, 195, 198, 199, 200, 396,	249	260, 261, 262, 264, 266	251		152, 346, 347, 350, 351, 356	65, 412		37
Minor	Not Significant	364, 365, 367, 368, 369, 372, 373, 375, 377, 378	102, 142, 384, 385, 386, 388, 390, 392, 393		182, 395, 398, 399	401, 402, 403		48, 49, 405, 406, 408, 409, 423 424	428	150, 151, 153, 340, 341, 342, 343, 344, 345, 348, 349, 353, 354, 355, 357, 358, 359, 360, 361, 362	411, 413, 415	81, 417, 418, 429, 430, 431, 432,	65
Negligible	Not Significant		387				274	420, 421	426, 427				6
Positive	Not Significant												0
TOTAL SITES	**-**	**16**	**23**	**2**	**15**	**5**	**6**	**14**	**3**	**27**	**9**	**9**	**129**

Table 20.10: Summary of the significance of potential construction impact (impact 20.2)

20.80 Ideally, it is best to manage the presence of cultural heritage sites by locating building footprints and routeing cables and other infrastructure to avoid them, because preservation of assets *in situ* is the preferred outcome[14]. However, where this is not possible various mitigation strategies (which should be conducted according to professional standards and guidelines) can be put in place that preserve the asset by record. The exact measure(s) suggested for each of the 129 sites is included in the supporting onshore archaeology EIA report (ORCA, 2012), provided on the supporting studies CD. The impact on many sites of negligible significance do not require mitigation, although it should be noted that impacts of minor significance may still require some management or mitigation to remain within acceptable levels.

MITIGATION IN RELATION TO IMPACT 20.2

- *Avoidance.* All sites of major significance will be avoided and the cable route will be designed to avoid most cultural heritage assets. Assets in the Ness of Quoys and Ness of Huna will be avoided where possible by the design and layout of the development.
- *Targetted geophysical survey* has already been conducted to identify the presence / absence and extent of archaeological remains at the Ness of Quoys and Ness of Huna in order to manage potential impact. The design will avoid these where possible and intrusive evaluations will be conducted as the next step where it is not. Further survey is recommended at the east end of the Gills to Kirkstyle cable route to identify whether remains extend into it from the prehistoric mound (54) below Canisbay Kirk.
- *Survey.* A detailed topographic / photographic and / or standing building survey of an appropriate level will be conducted for earthworks or vernacular buildings if they cannot be avoided.
- *Intrusive archaeological evaluation* will be conducted if appropriate on remains that cannot be avoided, including those identified by geophysical survey, or to assess the nature and significance of sites that may be of archaeological importance so that appropriate action can be taken.
- *Archaeological Watching Brief.* This will be conducted during ground-breaking construction works if there is a significant potential for but no conclusive proof of archaeological remains, or as a precautionary measure if a site has been identified nearby. The works will allow opportunity for salvage excavation on remains that cannot be avoided.
- *Archaeological Excavation* may be necessary as a result of evidence gathered by other mitigation strategies if archaeological remains cannot be avoided and if required by HC HET. Agreement should be made with HC HET on the standards and extent of excavation and the provisions for post-excavation work and reporting.
- A *Reporting Protocol* for the accidental discovery of archaeological remains will be instated, the nature of which will be agreed with HC HET.
- MeyGen will ensure that construction contractors have cultural heritage site maps and lists so that they know what is to be avoided; that the construction teams have a cultural heritage induction, especially if reporting protocols are to be used; and that the construction works manager or Environmental Clerk of Works marks off all sites within or close to edge of the development areas to ensure that they are avoided and not accidentally run over or otherwise impacted.

Residual impacts

20.81 In many cases, a precautionary approach has resulted in the over-rating of likely residual impacts (see Section 20.4.6). Despite this, it should be noted that with mitigation the number of cultural heritage assets that may experience a significant direct impact has been reduced from 58 to 19. Details of this can be seen in the supporting onshore archaeology EIA Report (ORCA, 2012), provided on the supporting studies CD, and the residual impact is summarised below in Table 20.11. Since the impact assessment was completed, impacts have been reduced further by the selection of a single cable route and the design of the PCC sites. For example, the number of significant impacts predicted for the cable routes has been more than halved by the selection of a single preferred route.

[14] E.g. PAN2/2011 *Planning and Archaeology,* para 14; Highland Council *Structure Plan* (2001), Policy BC1

PCC Sites

- **Ness of Quoys**

20.82 The identified moderately significant residual impacts are the results of the ongoing process of investigations, which are not yet complete. Final mitigations have yet to be identified dependent on the investigation results and should lead to a further reduction in the level of residual impact, especially if sites such as the Lyrequoy Well (ORCA 242) can be avoided and intrusive evaluation shows stone remains (ORCA 414 and 416) to be of less significance than originally thought.

- **Ness of Huna**

20.83 The identified moderately significant residual impacts are the results of the ongoing process of investigations, which are not yet complete. Final mitigations have yet to be identified dependent on the investigation results and should lead to a further reduction in the level of residual impact, especially if the final analysis of the geophysical survey does show that the supposed Pictish village (ORCA 82) does not exist.

Underground cable routes

20.84 The identified significant residual impacts are often the results of the need ensure avoidance is agreed or to instigate further investigations to identify if further management and mitigation is necessary, which will lead to further reduction in the level of residual impact.

- **Philip's Mains North**

20.85 In the Philip's Mains North area, both of the significant residual impacts (ORCA 371 and 374) are dependent on the need to avoid or investigate further.

- **East Mey**

20.86 In the East Mey area, the five significant residual impacts are dependent on the need to avoid or investigate further the four mounds and stony ridge, all of which may be of archaeological significance. The results of further work will reduce the residual impact.

- **Hilltop**

20.87 No significant residual impacts have been identified for the Hilltop area.

- **Gills**

20.88 In the Gills area, the two significant residual impacts (ORCA 397 and 400) are dependent on the need to avoid or investigate further the mounds, which are of unknown date and function - possibly prehistoric or mediaeval. The results of further work should reduce the residual impact.

- **Gills to Kirkstyle**

20.89 In the Gills to Kirkstyle area, the significant residual impact (ORCA 404) is dependent on the need to avoid or investigate further the mound, which may be of archaeological significance. The results of further work should reduce the residual impact.

- **Quoys to Huna**

20.90 No significant residual impacts have been identified for the Quoys to Huna area.

- **West Canisbay to Gills**

20.91 In the West Canisbay to Gills area, the two significant residual impacts are dependent on the need to avoid or investigate further the large stone slab (ORCA 419) and the mound (ORCA 422), which may be of archaeological significance. The results of further work should reduce the residual impact.

- **Rigifa'**

20.92 No significant residual impacts have been identified for the Rigifa' area.

- **Hill of Rigifa'**

20.93 In the Hill of Rigifa' area, the significant residual impact is dependent on the need to avoid or investigate further the standing stone (ORCA 352), which is of uncertain date and significance. The results of further work will reduce the residual impact.

Residual impact significance	Significance (EIA Regs)	Philip's Mains North	East Mey	Hilltop	Gills	Gills to Kirkstyle	Quoys to Huna	West Canisbay to Gills	Rigifa	Hill of Rigifa	Ness of Quoys	Ness of Huna	Total
Severe	Significant												0
Major	Significant									352			1
Moderate	Significant	371, 374	379, 382, 383, 389, 391		397, 400	404		419, 422			64, 242, 414, 416,	82, 84	18
Minor	Not Significant	148, 376	139, 140, 163, 380, 394	167	184, 185, 198, 200	249	260, 261, 262, 264	251, 410		152, 346, 347, 350, 351, 356	412		26
Negligible	Not Significant	366, 370	18, 137, 381	171	178, 193, 195, 199, 396		266				65		13

Table 20.11: Summary of the residual significance of potential construction impact

20.7 Impacts during Operations and Maintenance

20.94 No significant direct impacts on cultural heritage have been identified from the operational and maintenance aspects of the development. The coastal process modelling indicates that there will be no increased coastal erosion (or deposition) that will affect onshore cultural heritage assets (see Section 9).

20.7.1 Impact 20.3: PCC operational noise

20.95 The detailed study of predicted PCC operational noise levels, their impact and mitigation is provided in Section 23. No significant impacts on historic assets are predicted for the Ness of Huna PCC or the underground cable. The A-Listed Canisbay Kirk (ORCA 53) is the key historic asset for considering the impact of operational noise levels on the setting of cultural heritage assets. The kirk (called Quoys Church / Kirkstyle in Section 23) is a specifically identified receptor in the study and all impacts and mitigations strategies are detailed in that section, leading to a negligible residual impact (Section 23.7). Therefore, this potential impact is not addressed further this section.

20.7.2 Impact 20.4: Setting

20.96 Potential impacts during the operation and maintenance of the proposed development comprise impacts on the setting of historic environment assets from the presence of the PCC and other buildings at each potential landfall, associated hardstanding, car parking, access road and security fencing. These impacts on setting largely relate to landscape and visual factors (noise is addressed separately above). The details of how the installations at the Ness of Huna and Ness of Quoys may appear and sit in the landscape can be found in Sections 5 and 19. Photomontages from cultural heritage viewpoints and viewpoints relevant to cultural heritage assets are included in the Technical Appendix to that section and referred to in Table 20.12 and Table 20.13.

- **Ness of Quoys**

20.97 The historic and current landscape setting of identified cultural heritage sites within the ZTV is summarised in the baseline description above and the sites with potentially affected settings are shown on Figure 20.6.

Site No.	Site name and type	SAM / LB grade	Zone	Section 19 appendix viewpoint / plate	Magnitude of potential impact	Significance of potential impact	Significance (EIA Regs)
21, 22	St John's Point, promontory fort & chapel	SAM	2-5km	VP23; P08	Moderate	Moderate	Significant
53, 55	Canisbay Kirk and graveyard	A	0-2km	VP11; P03	High	Major	Significant
59	East Canisbay Manse	B	0-2km	VP29; P11	Moderate	Moderate	Significant
62	West Canisbay House	B	0-2km	VP15; P05	Low	Minor	Not Significant
85-89	John o' Groats mill complex	B	2-5km	VP7	None	None	Not Significant
475, 476	Warth Hill burial cairn	SAM	2-5km	VP26	None	None	Not Significant
486	Castle Mestag, Stroma	SAM	2-5km	VP18, P7	Moderate	Moderate	Significant
487	Girnieclett mound, Stroma	SAM	2-5km	VP18, P7	Moderate	Moderate	Significant
488	Cairn Hill burnt mound, Stroma	SAM	2-5km	VP19, P7	Low	Minor	Not Significant
489	Uppertown long cairn, Stroma	None	2-5km	VP19, P7	Moderate	Moderate	Significant
490	Stroma dovecote and burial vault	B	2-5km	VP19, P7	Moderate	Moderate	Significant
0	Castle of Mey & Inventoried Designed Gardens & Landscape	A	5-10km	None	None	None	Not Significant

Table 20.12: Summary of impact of Ness of Quoys PCC on sites with sensitive settings

20.98 Many of the moderately significant sites that in theory could be affected are actually low mounds or potential subsurface archaeology and as such have no significant setting issues, although there may be a potential impact of moderate significance on those sites within the original PCC and HDD area simply because of the proximity of the Project.

20.99 Many of the other theoretically affected sites, often of low or negligible significance are mostly ruined or substantially altered post-medieval buildings such as farmsteads and associated evidence of agricultural practices. The setting of these sites is one of change and no longer seems to be a sensitive or a significant factor in terms of their cultural heritage value.

20.100 This leaves certain sites with more sensitive settings for consideration (including those mentioned by HS) as listed in Table 20.12. Three of these are not in the ZTV due to localised landform and will not be affected.

20.101 In theory, there could be a moderately significant impact on several of the sites with sensitive settings in the ZTV. However, in the 2-5km zone, the Project will blend into the landscape when seen from Stroma (ORCA 486-490) even more than is indicated by the visualization shown for VP 20 (Section 19 and Technical Appendix, to that section), which is some 2km closer to the development. While visible from part of St John's Point (ORCA 21 and 22), the development will be in a narrow and insignificant view that is not key to the monument and will not break the horizon. The main façade of West Canisbay House (ORCA 52) is oriented to the south away from the site, and views to the site from the rear of the house are screened in summer and filtered in winter by mature sycamore

20.102 Potentially, the most affected sites are Canisbay Kirk and graveyard (ORCA 53 and 55) and East Canisbay Manse (ORCA 59). The two are related and the manse is designed to have views to and from the kirk. The kirk is the highest and most prominent building in the area both from land and sea and is set in an open landscape, even though there has been some change to its setting over the centuries – a post-medieval farmstead and ruined schoolhouse stands next to it and it is adjacent to the main road. Many modern buildings, both houses and agricultural buildings, have also been constructed in the general area. During the design process MeyGen recognised that without careful design, the PCC buildings would have the potential to dominate the kirk and graveyard and interrupt both open views and the sightline between the kirk and the manse. Therefore they have engaged in a reflexive consultation process with The Highland Council Historic Environments Team and Historic Scotland regarding the design and layout of the onshore installation in order to address any such concerns, which included a design workshop held in Caithness on 6th September 2011 and subsequent meetings/conference calls to discuss site layout and building design.

20.103 The results of the EIA surveys and studies and ongoing consultation have informed the project design and allowed the refinement (since EIA commencement) of the onshore Project area and design for the planning applications. These have been taken into account when assessing the residual impact.

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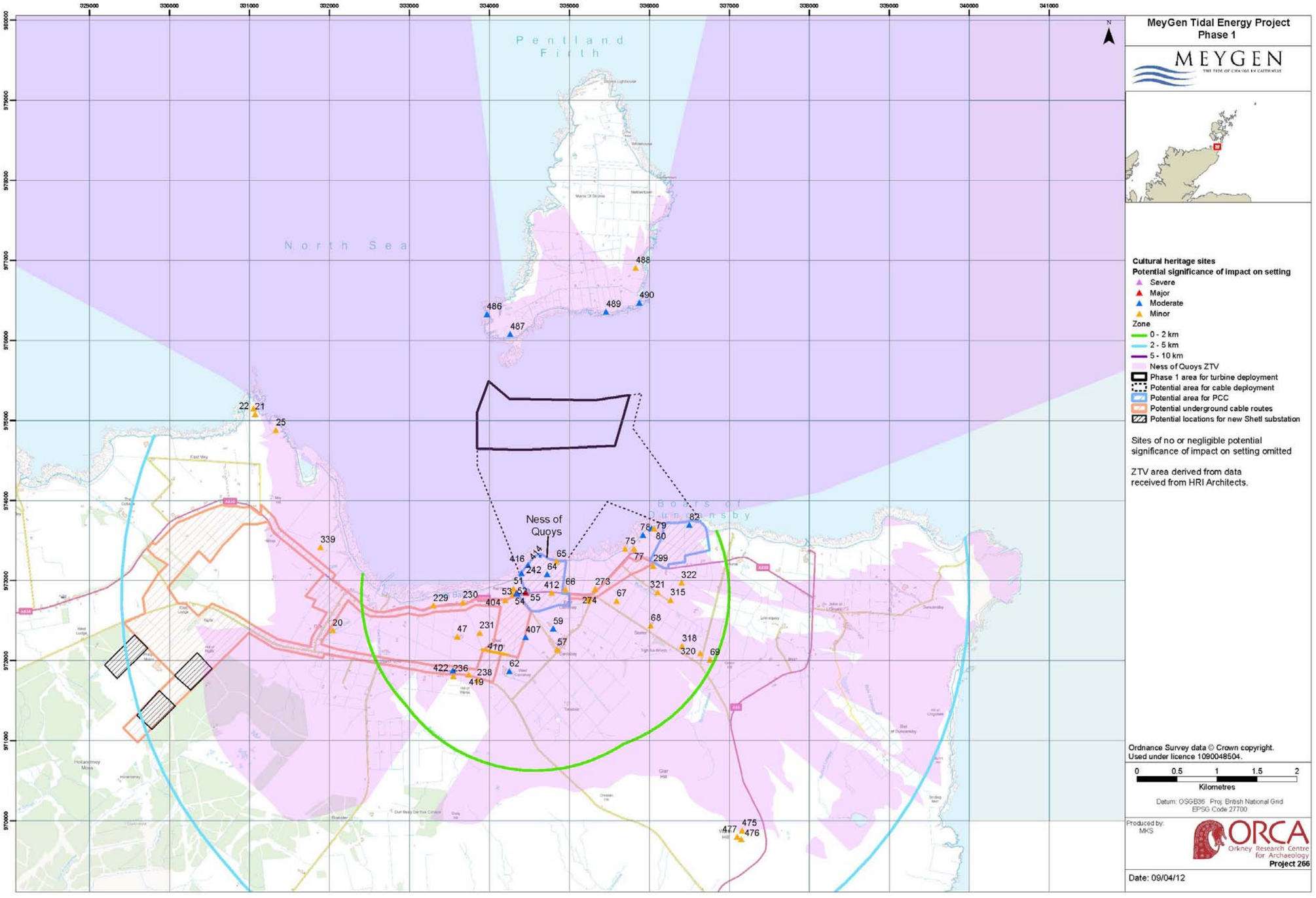

Figure 20.6: Ness of Quoys: Residual impacts on setting of cultural heritage assets in ZTV

- Ness of Huna

20.104 The historic and current landscape setting of identified cultural heritage sites within the ZTV is summarised in the baseline description above and the sites with potentially affected settings are shown in Figure 20.7.

20.105 Many of the moderately significant sites that in theory could be affected are actually low mounds or potential subsurface archaeology and as such have no significant setting issues. Many of the other theoretically affected sites, often of low or negligible significance are mostly ruined or substantially altered post-medieval buildings such as farmsteads and associated evidence of agricultural practices. The setting of these sites is one of change and no longer seems to be sensitive or a significant factor in anything other than as a general open landscape. The modern farm and activities around Huna House have also significantly compromised the immediate setting of the Ness of Huna.

20.106 This leaves certain sites with more sensitive settings for consideration (including those mentioned by HS) as listed in Table 20.13. Four of these are not in the ZTV due to localised landform and will not be affected.

Site No.	Site name and type	SAM / LB grade	Zone	Section 19 viewpoint / plate	Magnitude of potential impact	Significance of potential impact	Significance (EIA Regs)
21, 22	St John's Point, promontory fort & chapel	SAM	5-10km	VP23; P18	Low	Minor	Not Significant
53, 55	Canisbay Kirk and graveyard	A	0-2km	VP11	Low	Minor	Not Significant
59	East Canisbay Manse	B	2-5km	VP29	None	None	Not Significant
62	West Canisbay House	B	2-5km	VP15; P14	None	None	Not Significant
85-89	John o' Groats mill complex	B	0-2km	VP7	None	None	Not Significant
475, 476	Warth Hill burial cairn	SAM	2-5km	VP26	Low	Minor	Not Significant
486	Castle Mestag, Stroma	SAM	2-5km	VP20; P17	Low	Minor	Not Significant
487	Girnieclett mound, Stroma	SAM	2-5km	VP20; P17	Low	Minor	Not Significant
488	Cairn Hill burnt mound, Stroma	SAM	2-5km	VP20; P17	Low	Minor	Not Significant
489	Uppertown long cairn, Stroma	None	2-5km	VP20; P17	Low	Minor	Not Significant
490	Stroma dovecote and burial vault	B	2-5km	VP20; P17	Low	Minor	Not Significant
0	Castle of Mey & Inventoried Designed Gardens & Landscape	A	5-10km	None	None	None	Not Significant

Table 20.13: Summary of potential impact of Ness of Huna PCC on sites with sensitive settings

20.107 There will be no significant impact on any of the sites with sensitive settings in the ZTV. In the 2-5km zone, the development will blend into the landscape from Stroma (ORCA 486-490) and Warth Hill (ORCA 475 and 476), and while visible from part of St John's Point (ORCA 21 and 22), the development will be in a narrow and insignificant view that is not key to the monument and will not break the horizon..

20.108 The effect on Canisbay Kirk and graveyard (ORCA 53 and 55), is minor, since the Ness of Huna development is at some distance and with many modern buildings breaking up the landscape in between. East Canisbay Manse (ORCA 59) is not in the ZTV.

20.109 The mitigation strategies for impacts on setting are the same for the Ness of Quoys and the Ness of Huna.

MITIGATION IN RELATION TO IMPACT 20.4: Setting

- Reduction of overall site footprint to minimise loss of setting of cultural heritage assets.
- Siting of main PCUBs, Control Building, and other physical infrastructure within the PCC use natural topographic screening to minimise visibility – in terms of both overall visual envelope (ZTV) and actual visibility from key heritage assets.
- Building orientation designed to minimise impact in key view: e.g. orientation of the main PCUBs has been harmonised with the open vistas when viewed from both the Canisbay Kirk and from Stroma.
- Siting, non-alignment and spacing of PCUBs to minimise additional visual confusion and avoid conflict with existing adjacent historic features and buildings.
- Building scale designed to be compatible with scale of landscape and seascape character of site and wider landscape setting.
- Distinctive building form creates strong identity and clear rationale relating to renewable marine energy source.
- Building form and finishes, include use of natural materials, designed to reflect aesthetic qualities associated with landscape and seascape character of site and wider landscape setting.
- Use of local stone walling in harmony with existing uses to help screen buildings.
- Design ensures that the prominence of Canisbay Kirk and its dominance of the local landscape is not challenged by the size and height of the buildings and ensuring that the buildings do not break the horizon when looking to them from the sea.
- Design ensures that the key view between the kirk and the manse is not interrupted.

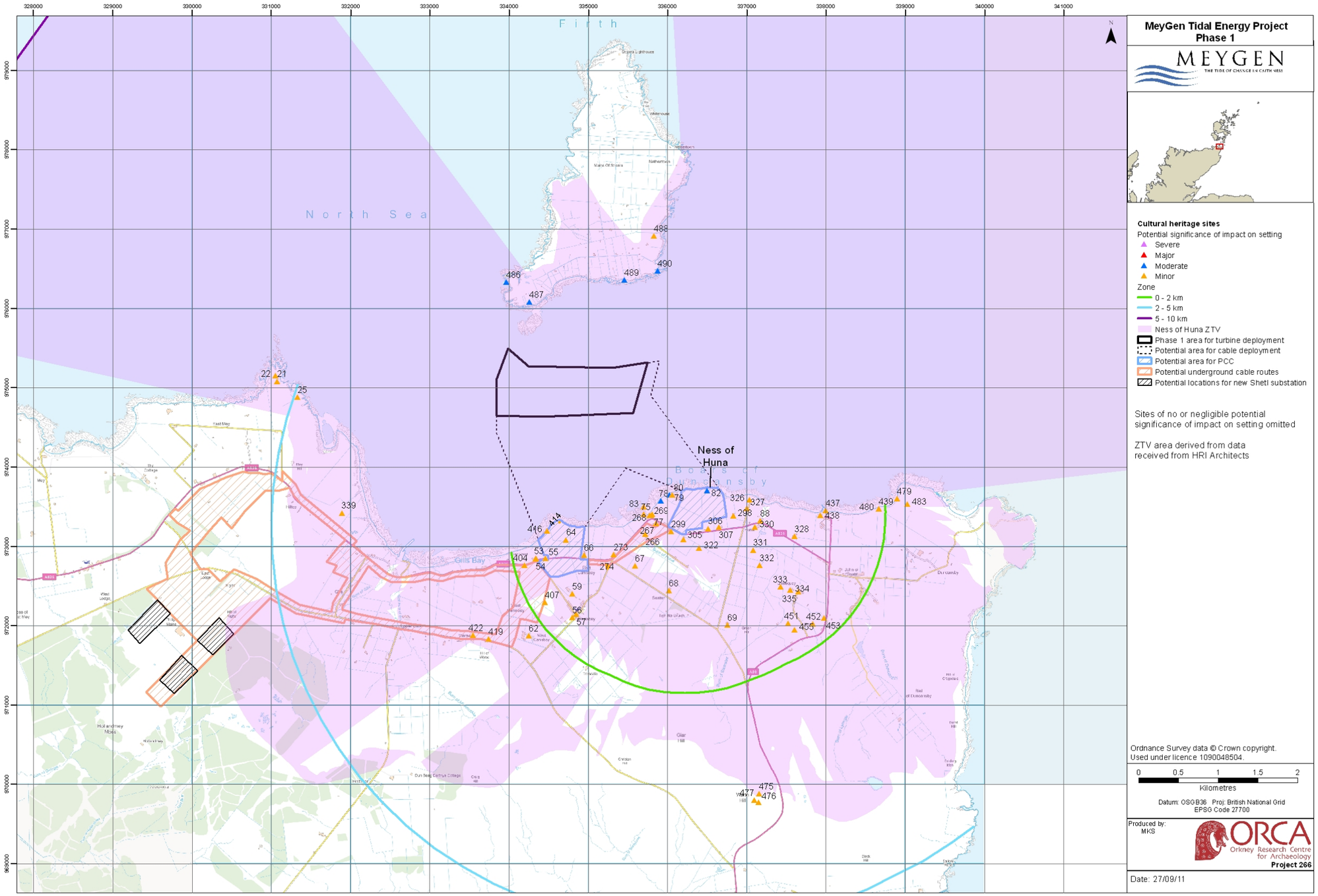

Figure 20.7: Ness of Huna: Potential impacts on setting of cultural heritage assets in ZTV

Residual impact

20.110 With regards to residual impacts, only those potentially signifincat impacts pre mitigation have been discussed. No potentially signifincat impacts on setting from the Ness of Huna site have been identified, therefore it is only Ness of Quoys that has been considered further. The mitigation strategies, which have already included geophysical survey identifying that Site 82 does not exist (ORCA 2011b), result in a residual impact on setting with an overall Minor or Negligible Significance on all identified sites except for Canisbay Kirk and Graveyard (Table 20.14). Here there will still be a material change to the setting of major significance. However, it will not be fundamental to the setting, and with the EIA studies and consultations taken into account over the design of the PCC (as in Section 5) will be a change that is at an acceptable level.

20.111 Historic Scotland has stated (in an e-mail dated 14th September 2011) that the proposals do not appear to raise significant issues for their statutory historic environment interests (i.e. scheduled monuments and their setting, category A listed buildings and their setting, Inventory designed landscapes and designated wrecks).

Site No.	Site name and type	SAM / LB grade	Zone	Section 19 appendix viewpoint / plate	Significance of residual impact	Significance (EIA Regs)
21, 22	St John's Point, promontory fort & chapel	SAM	2-5km	VP23; P08	Minor	Not Significant
53, 55	Canisbay Kirk and graveyard	A	0-2km	VP11; P03	Major	Significant
59	East Canisbay Manse	B	0-2km	VP29; P11	Minor	Not Significant
486	Castle Mestag, Stroma	SAM	2-5km	VP18, P7	Minor	Not Significant
487	Girnieclett mound, Stroma	SAM	2-5km	VP18, P7	Minor	Not Significant
489	Uppertown long cairn, Stroma	None	2-5km	VP19, P7	Minor	Not Significant
490	Stroma dovecote and burial vault	B	2-5km	VP19, P7	Minor	Not Significant

Table 20.14: Residual impact of Ness of Quoys PPC site on sensitive settings

20.8 Impacts during Decommissioning

20.112 No adverse impacts have been identified during the decommissioning phase on the assumption that there will be no new areas subject to groundworks that have not already been subject to disturbance during the construction and operation phases. If the onshore buildings are to be decommissioned and removed, and the area fully reinstated, the effects of reinstatement are considered to be neutral since work will restore what was there before, rather than improve on what was there before.

20.9 Potential Variances in Environmental Impacts

20.113 This assessment has addressed the potential impacts associated with all potential onshore development areas. However, it will only be certain areas within this footprint that will be developed – there will be only one PCC and HDD site and not all of the underground cable routes will be used. Therefore the actual impacts (both direct and indirect) of the Project will be less than those predicted here.

20.10 Cumulative Impacts

20.10.1 Introduction

20.114 MeyGen has in consultation with Marine Scotland and the Highland Council identified a list of projects (MeyGen, 2011) which together with the Project may result in potential cumulative impacts. The list of these projects including details of their status at the time of the EIA and a map showing their location is provided in Section 8; Table 8.3 and Figure 8.1 respectively.

20.115 Having considered the information presently available in the public domain on the projects for which there is a potential for cumulative impacts, the ticked items in Table 20.15 below indicates those with the potential to result in cumulative impacts from an Onshore Cultural Heritage perspective. The consideration of which projects could result in potential cumulative impacts is based on the results of the project specific impact assessment together with the expert judgement of the specialist consultant.

Project title	Potential for cumulative impact	Project title	Potential for cumulative impact	Project title	Potential for cumulative impact
MeyGen Limited, MeyGen Tidal Energy Project, Phase 2	✓	SHETL, HVDC cable (onshore to an existing substation near Keith in Moray)	✗	OPL, Ocean Power Technologies (OPT) wave power ocean trial	✗
ScottishPower Renewables UK Limited, Ness of Duncansby Tidal Energy Project	✓	Brough Head Wave Farm Limited, Brough Head Wave Energy Project	✗	MORL, Moray Offshore Renewables Ltd (MORL) offshore windfarm	✓
Pelamis Wave Power, Farr Point Wave Energy Project	✗	SSE Renewables Developments (UK) Limited, Costa Head Wave Energy Project	✗	SSE and Talisman, Beatrice offshore Windfarm Demonstrator Project	✗
Sea Generation (Brough Ness) Limited, Brough Ness Tidal Energy Project	✗	EON Climate & Renewables UK Developments Limited, West Orkney North Wave Energy Project	✗	BOWL, Beatrice Offshore Windfarm Ltd (BOWL) offshore windfarm	✓
Cantick Head Tidal Development Limited, Cantick Head Tidal Energy Project	✗	EON Climate & Renewables UK Developments Limited, West Orkney South Wave Energy Project	✗	Northern Isles Salmon, Chalmers Hope salmon cage site	✗
SSE, Caithness HVDC Connection - Converter station	✗	ScottishPower Renewables UK Limited, Marwick Head Wave Energy Project	✗	Northern Isles Salmon, Pegal Bay salmon cage site	✗
SSE, Caithness HVDC Connection - Cable	✗	SSE Renewables Developments (UK) Limited, Westray South Tidal Energy Project	✗	Northern Isles Salmon, Lyrawa salmon cage site	✗
RWE npower renewables, Stroupster Windfarm	✓	EMEC, Wave Energy test site (Billia Croo, Orkney)	✗	Scottish Sea Farms, Bring Head salmon cage site	✗
SSE, Gills Bay 132 kV / 33 k V Substation Phase 1: substation and overhead cables (AC)	✓	EMEC, Tidal energy test site (Fall of Warness, Orkney)	✗	Northern Isles Salmon, Cava South salmon cage site	✗
SSE, Gills Bay 132 kV / 33 k V Substation Phase 2: HVDC converter station and new DC buried cable	✓	EMEC, Intermediate wave energy test site (St Mary's Bay, Orkney)	✗	Scottish Sea Farms, Toyness salmon cage site	✗
SHETL, HVDC cable (offshore	✗	EMEC, Intermediate tidal energy test site (Head of Holland,	✗	Northern Isles Salmon, West	✗

Project title	Potential for cumulative impact	Project title	Potential for cumulative impact	Project title	Potential for cumulative impact
Moray Firth)		Orkney)		Fara salmon cage site	

Table 20.15: Summary of potential cumulative impacts

The following sections summarise the nature of the potential cumulative impacts for each potential project phase:

- Construction and installation;
- Operations nad maintenance; and
- Decomissioning.

20.10.2 Potential cumulative impacts during construction and installation

20.116 Phase 2 of the Meygen Project will comprise the deployment of more tidal turbines offshore and associated cables to shore and onshore infrastructure. The exact geographical location, extent and nature of the onshore facilities required for Phase 2 are not yet defined and will incorporate lessons learned from and include technology advancements beyond Phase 1 of the Project. These factors will influence the potential for, nature of and significance of any cumulative impacts. From an onshore cultural heritage perspective the requirement for additional land for onshore infrastructure has the potential for increased direct impacts, although wherever possible important cultural heritage assets will be avoided.

20.117 The exact location of ScottishPower Renewables' Ness of Duncansby Tidal Array's cable landfall, control building/substation compound and grid connection have yet to be defined. However, it has been stated that 'they will be sited sensitively after taking the cultural heritage assets into account' (ScottishPower Renewables: *Proposed Ness of Duncansby Tidal Array Request for a Scoping Opinion* January 2011, Section 4.4.4.5). It is therefore expected that the cumulative effects will be of Minor significance.

20.118 The Scoping Report for Scottish and Southern Energy Power Distribution's Gills Bay 132kV / 33kV Substation and overhead power lines was not available in time for this assessment. There are three potential options for the location of the substation (see Figure 20.1), which may be turned into an HVDC Converter station in Phase 2 if there is sufficient demand. The potential options for the substation / converter station location have differing cumulative effects. The location west of Philips Mains may have a major direct impact on two cultural heritage assets (ORCA 371 and 374 - see Figure 20.2). However, since the MeyGen underground cable will be designed to avoid such direct impacts, the cumulative effect is of Minor significance.

20.10.3 Potential cumulative impacts during operations and maintenance

20.119 The exact geographical location, extent and nature of the onshore facilities required for Phase 2 of the Meygen Project are not yet defined. These factors will influence the potential for, nature of and significance of any cumulative impacts on setting, but potentially may occur.

20.120 The exact location of the onshore infrastructure for ScottishPower Renewables' Ness of Duncansby Tidal Array proposal has yet to be defined. However, it has been stated that 'they will be sited sensitively after taking the cultural heritage assets into account' (see above). It is therefore expected that the cumulative effects on setting will be of Minor significance.

20.121 The overhead power lines for Scottish and Southern Energy Power Distribution's Gills Bay 132kV / 33kV Substation lines will be on 11m high wooden poles and lead away from plantations in the Phillip's Mains area out of view of Canisbay. It is therefore expected that the cumulative effects on cultural heritage setting in the Canisbay area will be of Minor significance.

20.122 There are unlikely to be cumulative setting effects on the setting of cultural heritage assets in the Canisbay area caused by any of the potential HVDC Converter station locations in Phase 2 of the Scottish and Southern Energy Power Distribution's Gills Bay project. On the assumption that the buildings will not be higher than the tree tops, they will be screened by coniferous plantations and Rigifa Hill.

20.123 Stroupster Windfarm. Consented windfarm of 12 turbines to tip height of 113m. It is likely that the ZTV of this project will overlap with the ZTVs of both Ness of Quoys and Ness of Huna and there may be *simultaneous* or *successive* visibility.

20.124 MORL, Moray Offshore Renewables Ltd (MORL) offshore windfarm and BOWL, Beatrice Offshore Windfarm Ltd (BOWL) offshore windfarm. Assuming a study area of 35km radius from the outer edge of these development areas, there will be overlap with the MeyGen Phase 1 study area and dependent on the ZTVs potentially therefore a minor degree of cumulative impact may occur.

20.10.4 Potential cumulative impacts during decommissioning

20.125 No adverse cumulative impacts have been identified during the decommissioning phases of any of the projects identified for which there is a potential for cumulative impacts in terms of onshore cultural heritage.

20.10.5 Mitigation requirements for potential cumulative impacts

20.126 No mitigation is required over and above the Project specific mitigation.

20.10.6 Potential cumulative setting impacts

20.127 There are unlikely to be significant cumulative effects on the setting of cultural heritage assets in the Canisbay area caused by any of the developments outlined above.

20.11 Proposed Monitoring

20.128 The construction contractors Environmental Clerk of Works (or equivalent) will monitor the construction team to avoid any accidental damage to identified cultural heritage assets. A reporting protocol will be put in place in the event of discovery of previously unknown cultural heritage sites or material. Depending on the significance of the find there may be a requirement for further investigation and recording in line with the mitigation proposed in this Section.

20.12 Summary and Conclusions

20.129 The rich and varied archaeological heritage of the Canisbay area is clearly evident. There are no SAMs, Listed Buildings or other statutorily designated assets within the proposed development areas. However, there are such sites close by and the setting of two of them (the A-Listed Canisbay Kirk and Graveyard and the B-Listed East Canisbay Manse) are key issues. Mitigation in building design and location will ensure that the key aspects of their setting will not be lost and that the change to the setting, although of moderate residual significance, will be of an acceptable nature.

20.130 Both the Ness of Quoys and Ness of Huna landfall and PCC areas have potential for significant archaeology to be present. However, this is being mitigated by targeted geophysical surveys so that archaeological remains will be avoided where at all possible. In consultation with HC HET, intrusive evaluations will be conducted where remains cannot be avoided in order to establish whether or not significant remains do exist and thus identify any risks. The results could lead on to further management strategies, such as excavation or watching briefs, or may indicate that there are no further issues.

20.131 It is clear that there is a moderately high potential for further culturally significant remains to be concealed in some parts of the cable route options, and consideration will be given to the potential for further sites to remain below surface in the vicinity of known significant sites and for peat and intensive cultivation to have

masked remains. It will be possible to route the cable to avoid known remains and further investigations could be targeted at areas thought to present most risk in order to establish whether or not significant remains exist. The results would enable the formulation, if shown to be required, of further management or mitigation strategies, such as avoidance, excavation or watching briefs, or may indicate that there are no further issues. A reporting protocol for the accidental discovery of archaeological remains can also be instated.

20.132 No adverse impacts have been identified during the decommissioning phase on the assumption that there will be no new areas subject to groundworks that have not already been subject to disturbance during the construction and operation phases.

20.133 Three other developments that may contribute towards a cumulative impact on onshore cultural heritage assets in the area have been identified. All seek to avoid significant cultural heritage assets where at all possible and will formulate mitigation strategies where it is not. Cumulative impacts on setting will be very much dependent on the location of onshore infrastructure, but potentially may occur.

20.134 Other than the effect on the setting of Canisbay Kirk, which will be carefully managed, it is therefore concluded that, with the appropriate mitigation strategies, the proposed development will not significantly impact onshore cultural heritage.

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21 SOCIO-ECONOMICS, TOURISM AND RECREATION

21.1 Introduction

21.1 The table below provides a list of all the supporting studies which relate to the socio-economic, tourism and recreation impact assessment. All supporting studies are provided on the accompanying CD.

Details of study	Location on supporting studies CD
Socio-economic Impact Assessment Report (RTP, 2011)	ONSHORE\Socio-economics

21.2 This section addresses the socio-economic, recreation and tourism impacts from the onshore and offshore aspects of the Project. This includes any potential adverse effects upon the local tourism economy, business interests and tourism and recreational interests; and any potential positive effects on the local economy in terms of income and job creation through the supply chain. The assessment has been undertaken by Roger Tym & Partners (RTP), but also draws on the findings of the following other Environmental Statement (ES) sections:

- Section 9: Physical Environment and Sediment Dynamics;
- Section 14: Commercial Fisheries;
- Section 15: Shipping and Navigation; and
- Section 19: Landscape, Seascape and Visual Assessment (LSVIA).

21.2 Assessment Parameters

21.2.1 Rochdale Envelope

21.3 In line with the Rochdale Envelope approach, this assessment considers the maximum ('worst case') Project parameters. Identification of the worst case scenario for each receptor (i.e. Environmental Impact Assessment (EIA) topic) ensures that impacts of greater adverse significance would not arise should any other development scenario be taken forward in the final scheme design. Table 21.1 summarises the maximum Project parameters that have been assumed for the impact assessment and explains why these are considered to be worst case. In addition, the economic impacts derived from the Project through the supply chain and employment etc. are not affected by the Power Conversion Centre (PCC) location, but rather related to the potential availability, capacity and capability of the supply chain businesses in the local area. For the purposes of the economic impact assessment it is assumed the worst case is where only 50% of the manufacturing and assembly employment and related economic benefits would be available to the local area. The potential impacts from alternative Project parameters have been considered in Section 21.9.

Project parameter relevant to the assessment		'Maximum' Project parameter for impact assessment	Explanation of maximum Project parameter
Onshore	Construction of PCC at Ness of Quoys or Ness of Huna and related HDD and cable works	Total potential onshore construction related jobs ~70 jobs over an accrued period of 14 months	Assessment of potential impacts associated with the construction new buildings at either the Ness of Huna or Ness of Quoys potential PCC locations and associated Horizontal Directional Drill (HDD)and cable works.
	Operation	Presence of Ness of Quoys or Ness of Huna PCC	The presence of the PCC at either of these locations could have a potential impact on the visitors and recreational users in the surrounding area.
	Decommissioning	Total potential onshore decommissioning related jobs ~70 jobs over an accrued period of 14 months	Assessment of potential impacts associated with the decommissioning of the PCC and all export cables. Based on the onshore infrastructure required by the Project, MeyGen has estimated the potential number of jobs during the onshore construction phase of the Project.
Offshore Project components	Construction	Operations and maintenance (O&M) employment offshore ~50 jobs	Assessment of potential impacts associated with the assembly and installation and long term operation and maintenance of the offshore infrastructure; Turbine Support Structures (TSS), turbines and cables. UK assembly of TSS and turbine components assumed. Published data on the potential job numbers generated by marine energy development quote a number of potential offshore installation jobs per MW (rather than turbine). MeyGen has estimated the potential number of jobs during the offshore operation and maintenance phase of the Project.
	Operation	Installation of 86MW and associated offshore infrastructure; O&M employment offshore ~50 jobs	Assessment of potential impacts associated with the assembly and installation and long term operation and maintenance of the offshore infrastructure; TSS, turbines and cables. UK assembly of TSS and turbine components assumed. Published data on the potential job numbers generated by marine energy development quote a number of potential offshore installation jobs per MW (rather than turbine). MeyGen has estimated the potential number of jobs during the offshore operation and maintenance phase of the Project.
	Decommissioning	Decommissioning of 86MW and associated offshore infrastructure; O&M employment offshore ~50 jobs	Assessment of potential impacts associated with the assembly and installation and long term operation and maintenance of the offshore infrastructure; TSS, turbines and cables. UK assembly of TSS and turbine components assumed. Published data on the potential job numbers generated by marine energy development quote a number of potential offshore installation jobs per MW (rather than turbine). MeyGen has estimated the potential number of jobs during the offshore operation and maintenance phase of the Project.

Table 21.1: Rochdale Envelope parameters for the socio-economics, tourism and recreation assessment

21.2.2 Area of assessment

21.4 It is also important to define the geographical extent of the assessment area. The focus of the economic assessment is all appropriate local business infrastructure and supply chain within Caithness and Pentland Firth and Orkney Waters (PFOW) strategic area. For the purpose of the tourism and recreation assessment a radius of 30km from the PCC locations has been used. The selection of the radius was

influenced by a number of factors including the Zone of Theoretical Visibility (ZTV) as defined in Section 19.

21.5 It should be noted that this assessment was completed on a larger project area that has since been refined to a smaller footprint at both the Ness of Quoys and Ness of Huna PCC sites and a single cable corridor to the SHETL substation option areas. The final Project is described in Section 5 and shown in Figure 5.2; the selection process for these is discussed in Section 4.

21.3 Legislative Framework and Regulatory Context

21.3.1 Assessment methodology

21.6 There are no statutory guidelines for the assessment of economic impacts. However, the approach adopted here follows UK Government guidelines and best practice for the production of such assessments. The methodology used to estimate the impacts of the Project follows the guidance set out in the HM Treasury's Green Book[1] and English Partnerships (EP) Additionality Guide[2], as well as taking into account the Department for Business Innovation and Skills (BIS) research on additionality[3].

21.7 In addition, the draft report on the preparation of a generic socio-economic methodology[4] for the assessment of marine projects in the Pentland Firth and Orkney Waters (PFOW) strategic area recently produced for The Crown Estate (TCE) outlines an approach, which is broadly reflected in this assessment, although the draft approach has not been refined to a sufficient level as to be fully reflected in this assessment. In addition, a number of the data-sets referred to in the draft report are currently not available for use in such assessments at a sufficiently fine-grained level. However, the generic list of potential impacts and effects derived from marine projects are a useful benchmark in that they have been used as a check-list against which this assessment has been undertaken.

21.8 In terms of establishing the potential impact on tourism and recreation within an area, there are no specific requirements or statutory guidelines for the assessment of tourism and recreation impacts and effects, neither set out by relevant EIA Regulations, nor in any other statutory guidance on the preparation of an ES.

21.9 However, in terms of the sub-elements of tourism and recreation, 'industry standards' for the production of such assessments are based around the following practice:

21.10 In terms of defining and assessing 'tourism impacts or effects' the 2008 Scottish Wind Farm Research study,[5] recommended the preparation of a Tourism Impact Assessment, which comprises an assessment of the:

- Number of tourists travelling past on routes to elsewhere;
- Impacts on views from tourist accommodation in the area;
- Relative scale of tourism impact – local to national;
- Potential positive impacts; and
- Impacts on outdoor activities in the area.

[1] http://www.hm-treasury.gov.uk/d/green_book_complete.pdf
[2] Additionality Guide – A Standard Approach to Assessing the Additional Impacts of Projects: English Partnerships (2008)
[3] http://www.bis.gov.uk/assets/biscore/economics-and-statistics/docs/09-1302-bis-occasional-paper-01
[4] A Socio-Economic Methodology and Baseline for Pentland Firth and Orkney Waters Round 1 Wave and Tidal Developments: ABPMer for the Crown Estate (in draft) (July 2011)
[5] The Economic Impacts of Wind Farms on Scottish Tourism: Scottish Government (2008) – section 13.4 http://www.scotland.gov.uk/Resource/Doc/214910/0057316.pdf

21.11 While it is accepted that this methodology is designed to answer the requirements of applications for onshore wind farms, the preparation of such an impact assessment incorporating these elements has become the industry standard of good practice. Hence, we have ensured that our approach reflects these requirements / recommendations.

21.12 In terms of assessing 'recreation impacts and effects' guidance on 'Outdoor Access Impact Assessment' is provided by Scottish Natural Heritage[6] (SNH). This guidance provides the approach to the assessment of recreation impacts and effects broadly adopted here, examples of which include:

- Loss / closure / extinguishment / diversion of links, routes, or walks etc;
- Reduction in amenity;
- Enhancement in amenity;
- Intrusion;
- Obstructing access routes;
- Enhancing access; and
- Changing to setting and context.

21.13 The guidance with reference to 'windfarms', which can be considered to be relevant to some elements of the Project in terms of energy generation and transmission infrastructure, highlights that these: "can change perception and amenity of both area and linear facilities through visual and noise impacts, access tracks can interfere with / or facilitate public access, general deterrent / attractor effects." This impact assessment highlights such effects and impacts.

21.3.2 Development plan policies

21.14 The Highland Council's Caithness Local Plan (2002)[7] and the Caithness and North Sutherland Regeneration Partnership: Vision for Caithness and North Sutherland, which will be replaced and/or supplement by the Highland-wide Local Development Plan (HwLDP)[8] (expected to be adopted in 2012) provide details of the economic aspirations for Caithness. Caithness is facing many challenges and opportunities and it is important these opportunities help to meet the challenges of regeneration in the area, providing local employment and sustainable economic growth. Specific aspirations are:

- be a regenerating place with a network of strong communities;
- be a competitive place connected to the global economy;
- be a connected and accessible place;
- be a place of outstanding heritage: safe in the custody of local people;
- be a centre of excellence for energy and engineering;
- have become an international centre of excellence for marine renewables;
- have a high quality tourist industry; and
- have a more diverse economy.

[6] SNH's publication 'A Handbook on Environmental Impact Assessment' (February 2006) Appendix 5.
[7] Still in force at time of EIA and ES compilation.
[8] Not adopted at time of EIA and ES compilation.

21.4 Assessment Methodology

21.4.1 EIA Scoping and Consultation

21.15 Since the commencement of the Project, consultation on socio-economic, tourism and recreational issues has been ongoing. Table 21.2 summarises all consultation relevant to socio-economic, tourism and recreation. In addition, relevant comments from the EIA Scoping Opinion are summarised in Table 21.3, together with responses to the comments and reference to the ES sections relevant to the specific comment.

Date	Stakeholder / stakeholder group	Consultation	Topic/specific issue
7th April 2011	Marine Scotland and SNH	Pre-Scoping meeting	EIA surveys and studies required and the data needs for each EIA study.
27th May 2011	Marine Scotland, statutory consultees and non-statutory consultees	Submission of EIA Scoping Report	Request for EIA Scoping Opinion from Marine Scotland and statutory consultees and request for comment from non-statutory consultees.
30th June – 2nd July 2011	Local stakeholders	Public Event - EIA Scoping	Public event to collate information/opinions on proposed EIA scope.
July 2011	Wide range of economic, tourism and recreation stakeholders	Submission of document for comment	Distribution of proposed scope of work for the socio economic, tourism and recreation impact assessment for comment and invitation for input from specific stakeholders. Specific issues raised during this consultation are summarised in the Table below. 45 consultees were contacted directly to obtain their comments on the method statement for the socio economic, tourism and recreation impact assessment. 12 responses were received, and the majority of responses had no issue with the methodology proposed for the Project.
August 2011	Local tourism businesses	Tourism business questionnaire survey	Questionnaire survey to inform baseline description and impact assessment.
September 2011	Potential supply chain	Supply chain questionnaire survey	Questionnaire survey to inform baseline description and impact assessment.
14th September 2011	The Highland Council (THC)	Meeting	Planning pre application meeting. Presentation on overall Project and results of EIA studies to date.
31st September 2011	Marine Scotland, THC, statutory consultees and non-statutory consultees	Receipt of EIA Scoping Opinion	Receipt of response to EIA Scoping Report and other comments from non-statutory consultees.
10th October 2011	THC	Receipt of pre application advice	Receipt of pre application advice from THC.
3rd October 2011	Marine Scotland	Project update meeting	Report on EIA progress and presentation of key findings of the impact assessment.
6th – 7th December 2011	Local stakeholders	Public Event – pre application consultation	Public event to communicate the findings of the EIA to local stakeholders.

Table 21.2: Consultation undertaken in relation to socio-economics, tourism and recreation

Name of organisation	Key Concerns	Response	ES section within which specific issue addressed
Marine Scotland	Economic Benefit – should include relevant economic information connected with the project, including the potential number of jobs, and economic activity associated with the procurement, construction, operation and decommissioning of the Project.	All such information is included.	Sections 21.6, 21.7 and 21.8 Impact Assessment
Marine Coastguard Agency (MCA)	The assessment should include details of possible effects on recreational craft. It should also assess recreational and other sport activities in the offshore environment.	The potential impacts referred to assessed in the recreational impact assessment.	Section 15 Shipping and Navigation and Sections 21.6, 21.7 and 21.8 Impact Assessment
Royal Yachting Association (RYA)	Should include loss of cruising routes, effects on sailing and racing areas.	The potential impacts referred to assessed in the recreational impact assessment and Navigational Risk Assessment (NRA).	Section 15 Shipping and navigation and Sections 21.6, 21.7 and 21.8 Impact Assessment
British Divers Marine Life Rescue	Agreed with the method statement but had concerns over the proximity of the Project to Scotland's Haven. This area has an important pupping colony for grey seals. They were concerned about any disturbances during the construction phase, particularly around the months of November and December, when the pups are born. Any type of disturbance could lead to pups being abandoned in that area. They would be satisfied if some sort of consideration could be taken around the pupping season. Also had concerns over whether seals could be injured or killed by vessels or dredgers. They presumed that every precaution will be taken to prevent injury to marine mammals including cetaceans during the construction phase of the Project.	Addressed in the Marine Mammal impact assessment.	Section 11 Marine Mammals
Sportscotland	Considered it important that governing bodies related to sailing, sea kayaking, surf sports, diving, recreational sea fishing, walking, mountaineering, horse riding and cycling be contacted. Examples of such bodies include RYA (Scotland), Scottish Canoe Association, Scottish Cycling and Horse Scotland. Also considered it important to consult with local sport and recreation clubs and organisations. The views of Local Authority access staff and sport and recreation staff should also be taken into account. Potential impacts on sport and recreation may include: Impede navigation Present a safety hazard Landscape/seascape impacts Impede terrestrial access rights Impact on marine processes which could impact on sport and recreation interests	All bodies referred to have been consulted in the process of the assessment, with the exception of the Scottish Sub Aqua Club, instead of which contact made the Caithness Diving Club. The potential impacts referred to assessed in the recreational impact assessment and navigation assessment.	Section 15 Shipping and Navigation and Section 21.4 Consultation
The Highland	Full range of economic and social benefits	All such issues are included in	Sections 21.6, 21.7

Name of organisation	Key Concerns	Response	ES section within which specific issue addressed
Council Access Team	should be addressed. Considered that the impacts are all likely to be short term with respect to recreational access rights. Any impacts likely will be associated with the construction phase. Public access should be managed during the construction phase for the cable route where it crosses public roads and other tracks. National Cycle Route 1, general recreational access rights, and the John o' Groats – Thurso route corridor are recognized as important issues for assessment..	the assessment.	and 21.8 Impact Assessment
Caithness Access Forum	The Caithness Access Forum consulted the local community as part of the Core Paths process. All paths put forward as candidates were adopted. The Forum is not currently aware of any other paths used by the public in the vicinity of the proposed development area.	Potential impacts on local paths and routes addressed in the recreational impact assessment.	Sections 21.6, 21.7 and 21.8 Impact Assessment
SNH	Considered that it may be more applicable for Local Authorities and Marine Scotland to comment on the methodology of the study, and that it may be worthwhile contacting Sportscotland. Advised they are interested in impacts (positive or negative) on people's ability to enjoy the natural heritage and that they would be able to comment further on this during the EIA process.	Sportscotland consulted with (see above). Impacts associated with people's ability to enjoy the natural heritage, considered as part of the tourism and recreation impact assessments.	Section 21.4 Consultation
Mountaineering Council of Scotland	Advised that their main concerns were about impacts on landscape/seascape rather than economics. Also advised that the Project would pose no physical barrier to mountaineering.	Potential impacts on landscape and seascape addressed in LSVIA.	Section 19 LSVIA
Scottish Mountaineering Club	Advised they had no issue with this type of energy scheme as it was visually more preferable than wind farms. Also felt that the Project would not interfere with any climbing party requiring access to sea cliffs in the area. However, they advised that views of coastal fishermen and yachtsmen should be considered as they might consider the scheme to be of extreme interference.	Addressed in the navigation assessment and recreational impact assessment. Fisherman and yachtsmen have been included in the consultations. The developer has organised a series on face-to-face meetings and / or workshop involving relevant organisations.	Section 15 Shipping and Navigation and Sections 21.6, 21.7 and 21.8 Impact Assessment
Dounreay Stakeholder Group	Advised that they held a substantial contact lists and would be happy to provide information on key consultees and local stakeholders if required. They advised that the Caithness Chamber of Commerce may hold contacts for the business supply chain. For socio-economic impacts they advised looking at baseline study carried out in 2006 by the Caithness & North Sutherland. Regeneration Partnership. In terms of transport capacity they advised speaking to the Caithness Transport Forum.	Suggested consultees contacted. 2006 study reviewed as part of the assessment to test the comprehensive detail of our own baseline assessment. Transport capacity issues addressed in the onshore transport and access impact assessment.	Section 21.4 Consultation and Section 22 Onshore Transport and Access

Name of organisation	Key Concerns	Response	ES section within which specific issue addressed
The British Horse Society (BHS)	Agreed with the assessment approach and wish to engage in the consultation process at a later stage. Provided standard BHS guidance for energy related development.	Guidance followed by assessment.	Section 21
Historic Scotland	Advised they had no comments to make on the proposed methodology. Provided a copy of correspondence they sent to Marine Scotland with their initial views of the Project. Advised consideration of the on-shore impacts on cultural heritage features such as scheduled monuments, category A listed buildings and Inventory designed landscapes. Off-shore effects on historic marine features must also be taken into account.	Addressed in the onshore and offshore cultural heritage impact assessments.	Section 20 Onshore Cultural Heritage and Section 16 Marine Cultural Heritage
Royal Yachting Association (RYA) Scotland	Agreed with the scope of works and method of the assessment as proposed.	N/A	N/A
Pentland Canoe Club	Advised that the business supply chain survey of businesses be carried out in conjunction with the Caithness Chamber of Commerce; and that the assessment of likely impact should include users of all relevant recreational facilities within the area.	Caithness Chamber of Commerce consulted (see below). Recreation impact assessment covers all of these impacts and issues raised.	Section 21.5 Baseline Description
Scottish Surfing Federation	Advised that a number of surfing locations are present in the Gill's Bay area and that the presence and alignment of any cable route might affect the wave and surfing environment.	Assessment covers all of these impacts and issues raised.	Sections 21.6, 21.7 and 21.8 Impact Assessment
Caithness Chamber of Commerce	Considered that the overall scope of work was comprehensive. Interested to see how training needs can be identified for the supply chain, including those of the younger people in the area.	Assessment covers all of these impacts and issues raised. The issue of skills and labour and whether or not this is a constraint is recognised in the assessment. MeyGen has been actively consulting with the Caithness Chamber of Commerce since initial; interest in the area and are in close dialogue with inward investment groups such as Highlands and Islands Enterprise and Scottish Enterprise on this topic. Moreover links have been forged with both Dounreay regeneration partnership and The Highland College in Thurso in trying to identify how their state of the art training facility can be used in order to assist with vocational youth and apprentice training.	Sections 21.6, 21.7 and 21.8 Impact Assessment
Natural Retreats	Considered that the Project would be immensely helpful to the attraction of the area particularly as a feature of renewable energy investment, which Natural Retreats	Assessment covers all of these impacts and issues raised. MeyGen propose to have a	Sections 21.6, 21.7 and 21.8 Impact Assessment

Name of organisation	Key Concerns	Response	ES section within which specific issue addressed
	intends to interpret and promote around the area. Satisfied with the approach to the assessment.	visitor attraction/interpretation boards as part of Natural Retreats program for regeneration of John o 'Groats whereby the wider marine energy industry in the region is intended to be represented.	
Public Event – EIA Scoping	Public events held in Mey and Thurso 30th June – 2nd July 2011. An estimated 192 people attended the event in total. Of this, 48 people returned questionnaires. 33% of respondents to questionnaires identified renewable energy as positive with 31% opportunities for local businesses and 29% local job opportunities. Least positive aspects identified – 29% on construction phase disruption, and 19% disruption to fishing and shipping.	All issues identified addressed in the assessment.	Sections 21.6, 21.7 and 21.8 Impact Assessment
Public event – pre application consultation	Public events held 6th and 7th December 2011 to inform the public of the content of the ES prior to submission of the application.	All issues identified addressed in the assessment.	Sections 21.6, 21.7 and 21.8 Impact Assessment

Table 21.3: Scoping comments relevant to socio economic, tourism and recreational impact assessment

21.4.2 Overview methodology

21.16 The overall assessment is based upon a robust and well tested methodology employing a combination of web-based/desk-based information assessment and site visits. The assessment also makes use of the Physical Environment and Sediment Dynamics (Section 9), Commercial Fisheries (Section 14), Shipping and Navigation (Section 15) and LSVIA (Section 19) as inputs to determine the impact of the Project both on and offshore within the study area. This approach has been previously robustly tested and accepted as valid through various stages of the project development process and at public inquiry, and has also been the subject of testing with consultees as part of this process. The method of approach adopted in this appraisal is as follows.

Sources of information

21.17 The assessment includes an extensive review of information sources to establish existing conditions and to identify current tourism and recreation businesses and resources as well as tourism and recreational activities within the study area. The datasets used in this document are those sources of socio-economic and demographic data from standard available datasets, including the Census, NOMIS, along with sources of tourist and visitor data found on VisitScotland's website on www.scotexchange.net**,** and other individual research, reports, and studies referenced throughout the chapter. A list of references and sources of information is provided at the end of the section.

Socio-Economic

21.18 A socio-economic baseline of the study area is provided covering key issues, trends and the performance of the Highlands and Orkney economies, relative to Scotland and the UK. The assessment focuses upon the Caithness area onshore, and the PFOW offshore, with the Orkney Islands included within the socio-economic baseline as the area has the business infrastructure, and necessary labour market skills to provide goods and services for the Project. In addition, the datasets used in the baseline cover all or part of Caithness and all or part of Orkney, as a definable socio-economic study area, and as such are included within the analysis.

21.19 In addition, the supply chain assessment was undertaken at a local, wider Highlands and Islands Enterprise (HIE), and wider Scotland level.

21.20 The datasets used in the socio-economic assessment relate to different spatial and geographic areas, with these covering as appropriate all of the local authority's administrative area, or are provided on a census ward basis. The study area therefore is incorporated within these, but does not necessarily make a precise spatial fit.

21.21 To undertake the baseline socio-economic assessment a review of socio-economic and demographic data was carried out, on the profile, trends, infrastructure, and labour market in the study area, set in context at a wider Highlands and all of Scotland

21.22 An estimation of the likely potential economic benefits from the Project to the local and regional economy in terms of construction, operation & maintenance, and decommissioning employment has been undertaken. This is based upon data on the employment and economic output likely to be generated by the Project from both MeyGen and also from industry benchmark research. Further, an economic model was established to assess the scale and nature of the resulting economic impacts.

21.23 In addition, the results of the supply chain survey of local businesses and also those within the wider HIE area undertaken as part of the assessment provided a profile of the industry indicating its capacity and capability to support the Project, and other marine based renewable energy projects. The basic survey population list was provided by HIE, and enhanced by further desk based research into the presence of such businesses. This was further supported by a summarised supply chain analysis of the industry in wider Scotland provided by Scottish Enterprise (SE).

Tourism

21.24 The study area for the assessment has been taken as a 30km radius from the likely location of the proposed PCC. This includes the principal towns and settlements within the surrounding area, including Thurso, Wick, John o' Groats and the intermediate areas, and settlements. While the 30km study radius would also include the southernmost part of the Orkney Islands, the Islands have been excluded as none of the Project related facilities would be visible from any point on Orkney, and hence no tourism or recreation effects would be experienced in this area (see Figure 19.2 and 19.3). However, the study area assessment is set in a strategic context at both a wider tourism market and Highlands tourism region level.

21.25 The datasets used in the tourism assessment relate to different spatial and geographic areas, with these covering as appropriate all of the local authority's administrative area, the wider tourism region, or are provided on a census ward basis. The study area therefore is incorporated within these but does not necessarily make a precise spatial fit.

21.26 The baseline assessment of tourism comprises an assessment of tourism volume and value, tourism employment and, the drivers currently impacting upon the industry. The profile of tourism activities, patterns, trends, and facilities at a Highlands level have been reviewed. This sets a context for the remainder of the assessment, and against which any impact can be set. The baseline review draws upon standard available VisitScotland and other tourism related and economic statistic datasets supplemented by a website and database search for additional supporting information on tourism in the local area. A summary of the key factors which impact upon tourism trends and the key drivers influencing the market has been provided.

21.27 The appraisal covers the aspects which make up the tourism product in the area, act as a focus or attraction for visitors, and lead to expenditure by tourists and visitors. It is this expenditure, which acts as the measurement in terms of economic impact upon the tourist sector in the area. The level of impact is derived from the tourism business survey undertaken providing an understanding of tourism impacts as a result of the Project (both positive and negative) on tourism providers across the study area.

21.28 In addition, regarding tourism and visitor facilities and locations, an assessment has been provided on how likely the Project is to influence visitor and tourist attitudes, based upon the visibility of the proposed onshore and offshore development, and any impacts resulting from temporary construction activities.

Recreation

21.29 The study area for the recreation assessment is similar to that for tourism, in covering a local area extending to a 30km radius from the PCC location, but excluding the Orkney Islands (as described above). An assessment of recreation facilities and resources has been undertaken. This includes all those both onshore including walking, cycling and riding routes and paths, rock-climbing, golf, fishing, outdoor sports and leisure activities, and offshore including sailing, sea-fishing, surfing, and kayaking/canoeing, among others. These resources act as attractors to leisure and recreation visitors alike and lead to expenditure in the local economy.

21.30 In terms of the definition and estimation of recreational impact, a potential negative recreational effect is judged to arise, in the absence of mitigation, where there is either a substantial visual effect experienced by the visitor to or user of the resource, or where there is physical interruption of the recreational resource, which in turn would affect the visitor or user receptor. This might represent the recreational user / receptor visiting a specific attraction or location, or indeed those visitors travelling to, through or out of the local area, and which are exposed to views of the Project and related infrastructure, or their visit is in some way physically affected or disturbed, and which might result in a negative effect upon their enjoyment of their visit or trip. Alternatively the negative effect might result in the visitors / receptors not returning to the area in the future.

21.31 The recreational impact is assessed through a combination of the use of the LSVIA to establish potential visual impacts, and by means of assessment of whether or not physical change or disturbance of recreational resources would occur temporarily or permanently as a result of the Project.

21.4.3 Questionnaire survey methodology

21.32 The following section sets out the work undertaken to establish the potential impacts of the Project through the use of questionnaire surveys including socio-economic impacts (through means of the Supply Chain Business Survey) and tourism impacts (through the Tourism Business Survey). The detailed results of the survey questionnaires are provided on the accompanying CD (RTP, 2011).

Supply chain business survey

21.33 A supply chain survey was undertaken in order to inform the assessment of impact upon the local and wider HIE area business infrastructure and economy. The results of the survey indicate the level of support for and available absorption capacity of local businesses. This provides the potential to benefit from the Project that exists within the local business community. In total 106 businesses were surveyed via 'Surveymonkey' and also with the assistance of Energy North, which contacted their business membership, with 36 responses (34% response rate). The businesses provided profile information on their size, business sector, service category, skill profile, current and past business performance, future prospects, turnover, and likely impact derived from the Project for both construction and post-construction phases. However, no distinction was made in the survey between O&M and decommissioning phases of the Project, as this is regarded as being too far into the future to be able to obtain an accurate response from the businesses.

21.34 Further, a qualitative view as to the degree of potential impact and the potential wider benefits to the local economy was also provided by respondents to the survey.

Tourism business survey

21.35 Tourist behaviour will only be affected where the impact of the Project either changes the visitor / user pattern in terms of numbers, and/or where patterns of expenditure may change either positively or negatively. Opportunities for tourist/visitor expenditure, any potential variation in expenditure/visitor numbers, and consequent effect upon turnover or employment, are of key importance. The tourism assessment highlights such impacts and effects, and indeed their likelihood or otherwise through the Tourism Business Survey.

21.36 The overall Tourism Business Survey study area was similar to that as defined above and included those facilities or notable points of focus of visitor attraction and recreational activities, which might be considered to have linked visitor patterns, and indeed to determine the local tourism 'catchment' of the area.

21.37 Tourism businesses across the study area were identified by means of a website search, providing coverage of accommodation providers, visitor attractions, indoor and outdoor facilities, restaurants and other food and drink providers, public houses, and specialist tourist shops / outlets. The survey was undertaken on a telephone basis and a total of 251 tourism businesses were consulted, overall 96 responses (38.2% of total consulted) were received. All the issues raised by the businesses are addressed in the assessment.

21.4.4 Significance criteria

21.38 ***Where appropriate the methodology used follows that outlined in Section 8. Variations from this are explained below.***

21.39 The definition of the sensitivity of receptor and magnitude of impact in terms of economic, tourism and recreation factors are set out in Table 21.4 and Table 21.5.

Sensitivity of receptor	Economic	Tourism	Recreation
Very High	N/A.	International status or high visitor nos.	International status or high visitor nos.
High	N/A.	National status or high visitor nos.	National status or high visitor nos.
Medium	N/A.	Regional status or medium visitor nos.	Regional status or medium visitor nos.
Low	N/A.	Local status or few visitor nos.	Local status or few visitor nos.
Negligible	N/A.	Local status or few visitor nos.	Local status or few visitor nos.

Table 21.4: Definitions for sensitivity of receptor

Magnitude of Impact	Definition			
	Economic - employment	Economic – supply chain	Tourism	Recreation
Severe[9]	N/A	N/A.	N/A.	N/A.
Major	Greater than local scale or which exceed recognised standards. Impact likely to occur.	>15% turnover change or substantial new job nos. Impact likely to occur.	>15% turnover change. Impact likely to occur.	Major visual impact or physical interruption / severance. Impact likely to occur.
Moderate	Noticeable and judged to be important at a local scale. Impact will possibly occur.	10-15% turnover change or numerous new job nos. Impact will possibly occur.	10-15% turnover change. Impact will possibly occur.	Moderate visual impact or physical interruption / severance. Impact will possibly occur.
Minor	Limited or very localised raised as local issues. Impact unlikely to occur.	5-10% turnover change or some new job nos. Impact unlikely to occur.	5-10% turnover change. Impact unlikely to occur.	Minor visual impact or physical interruption / severance. Impact unlikely to occur.
Negligible	Virtually no local scale or wider impact or effect. Impact highly unlikely to occur.	<5% turnover change or very few new job nos. Impact highly unlikely to occur.	<5% turnover change. Impact highly unlikely to occur.	Negligible visual impact or physical interruption / severance. Impact highly unlikely to occur.
Positive	An enhancement in the availability or quality of a resources to the extent of potentially benefiting the wellbeing of the persons utilising that resource benefiting from it in some way.			

Table 21.5: Definitions for magnitude of impact

21.40 While there are no standard significance criteria defined in guidance for socio-economic impacts and effects, Table 21.4 and Table 21.5 above set out those derived from extensive experience of undertaking

[9] Severe category impacts are not relevant to define from a socio economic, tourism and recreational perspective

energy based infrastructure assessments. These levels of significance apply to both adverse and beneficial effects. In addition, qualitative judgement has been made in relation to overall impacts assessed as occurring as a result of the Project.

21.41 Sensitivity has not been assigned to the economy as a single receptor as it is made of many component parts which make it difficult to qualify accurately. The broad economic impact is focussed on the outcomes or results from sensitivity of and magnitude of impact on the various component parts. The definition of tourism sensitivity is based on the qualitative assessment of attractions/resources visitor levels compared to that of other sites in the same study area.

21.42 As described in Section 8, magnitude is a function of the duration, timing, scale and size of the impact as well as the frequency/probability of the impact occurring (likelihood). It is therefore necessary to include likelihood within the magnitude based on applying professional judgement/past experience.

21.43 However, where the magnitude of the impact has been derived from the survey results the likelihood of the impact taking place has not been accounted for. In these instances, impact magnitude determined by the survey results is combined with the likelihood of that impact occurring to provide the overall magnitude (Table 21.6). The assessment continues based on consequence of the impact considered from Table 8.1 and the significance of that impact defined in Table 8.2.

Impact magnitude from survey	Likelihood			
	Likely	Possibly	Unlikely	Highly unlikely
Major	Major	Major	Moderate	Minor
Moderate	Major	Moderate	Minor	Negligible
Minor	Moderate	Minor	Minor	Negligible
Negligible	Minor	Negligible	Negligible	Negligible
Positive	Positive	Positive	Positive	Positive

Table 21.6 Overall magnitude

21.5 Baseline Description

21.5.1 Socio-economic baseline

21.44 This section profiles the socio-economic structure of Caithness and Orkney, compares this profile with Scotland overall. In the context of this assessment the Caithness and Orkney areas are defined as the local economy, as recent data at a disaggregated sub-regional level are not available. The most recent information available has been used where possible. Full details of the socio-economic baseline are set out in the MeyGen Socio Economic Impact Assessment - Technical Appendix, provided on the supporting studies CD (RTP, 2011).

Socio-economic key features

21.45 The study area surrounding the Project contains a growing population. The greatest increase in population will be seen in those over 65 years. Whilst the Highlands are also likely see an increase in the number of children (+8%) and those of working age (+9%), it is projected that Orkney will see a decline in numbers of children (-1%) and a modest increase in working age population (+2%) over the period to 2033.

21.46 Generally the area is economically strong when compared to the Scottish average. However some areas do have significantly lower levels of economic activity. Despite this all wards within the study area have lower levels of benefit claimants than the national average which also indicates the strength of the economy in the area.

21.47 The greatest proportion of jobs within the Highlands and Orkney Islands are in distribution, hotels and restaurants. In particular, those employed in tourism in the Highlands over the past 15 years has been significantly higher than the Scottish average. This is substantiated by both areas having high levels of self-employed people in relation to the national average. This suggests that there are a greater number of independently run businesses which could be perceivably correlated to tourism. This emphasises the particular importance of tourism to the local economy of the Project's surrounding area.

21.48 As a whole both Orkney and The Highlands have lower levels of average earnings than those of Scotland however the male population in Orkney are likely to have considerably higher earnings than the rest of the country. This could possibly be linked to the oil and gas industry and Orkney's involvement in the development of marine renewable energy industry.

The socio-economic context of Dounreay

21.49 Within the socio-economic context of the study area and wider hinterland, of key significance is the presence of the Dounreay fast-breeder nuclear reactor originally commissioned in the mid-1950s, and which ceased operation by being taken off-line in the mid-1990s, and is now passing through the process of de-commissioning, which is likely to extend for another 20 years. The existence of the reactor has led to the area developing a highly skilled labour force, particularly in engineering skills. While at peak operation the reactor employed between 2,000 and 3,000, it currently still employs around 1,900 people, however this number is expected decline over the coming years as decommissioning work reduces.

21.50 In addition to the direct employment at the facility, the presence of the reactor in the area has resulted in and supported a number of specialist supply chain businesses, which are also appropriate for providing the necessary precision engineering, construction, contracting and related skills required by the marine renewable industry.

21.51 Further support infrastructure exists in the form of the presence of a number of facilities and resources in both the local and wider Caithness and Sutherland area including the post-decommissioning activities of the Dounreay Site Restoration Ltd. (DSRL) and the Caithness & North Sutherland Regeneration Partnership, the skills development and diversification programme 'Make the Right Connections', the momentum to develop the local business capacity and capability through the recent series of supply chain and other events, the Highlands and Islands Environmental Research Institute (ERI) in Thurso, Thurso College, and UHI's focus upon renewable energy and low carbon technologies, among others.

Harbour and port facilities

21.52 Further, investment in upgraded harbour and port facilities are also planned to service the needs of the marine and offshore industry, MeyGen has been fully involved in consultation with and participation in such local business and community stakeholder events in the process of developing the Project.

21.53 Scrabster Harbour Trust (Scrabster) and Orkney Marine Services (Lyness) are currently upgrading their facilities including deep water access and heavy lift quay services. Both Wick Harbour Authority and Gill's Bay Harbour Trust has development plans that include expansion for the renewable energy industry.

Scottish Enterprise area excluding HIE area

21.54 Data on the Scottish wide supply chain has drawn on data available from SE, but excluded consideration of the HIE area (to avoid double accounting/consideration of the supply chain in this area). The data provided by SE were drawn from their 'self-registered' database and hence are not necessarily comprehensive. However, the SE analysis does provide a contextual understanding of the make-up and distribution geographically of supply chain businesses elsewhere in Scotland. The businesses which have expressed interest in providing goods and services for marine based projects extend to 144, and these businesses provide expertise and services to the industry across the following broad category headings:

- Construction & Installation;
- Devices and Components;
- Balance of plant manufacture;
- Deployment;

- Grid installation;
- Operation & Maintenance; and
- Decommissioning.

21.55 The detailed activities and services provided within these categories are set out in the MeyGen Socio Economic Impact Assessment (RTP, 2011).

21.56 Table 21.7 sets out the distribution of businesses within the SE area outside the Highlands across the supply chain categories, with the majority operating in the engineering services (19%), component manufacturing (15%), and other services (13%) categories.

21.57 Figure 21.1 sets out the geographic distribution of these supply chain businesses across Scotland, with most located in either Aberdeen / Aberdeenshire (31.4%) or Greater Glasgow (26.5%) as a result of the former location's existing markets in offshore oil and gas, and the latter location's current focus on renewable, aerospace, defence and marine markets.

Business category	Number of businesses	% of all businesses
Engineering Services	27	19%
Component Manufacturers	21	15%
Marine Services	14	10%
Fabrication	11	8%
Environmental Services	10	7%
Cabling Services & Installation	10	7%
Onshore infrastructure	9	6%
Control Systems	7	5%
O&M Services	4	3%
Monitoring Services	4	3%
Civil Engineering	3	2%
Electrical Services	3	2%
Freight Transport	2	1%
Other Services	19	13%
Total	**144**	**100%**

Table 21.7: Supply chain businesses by category (SE area outside the Highlands)

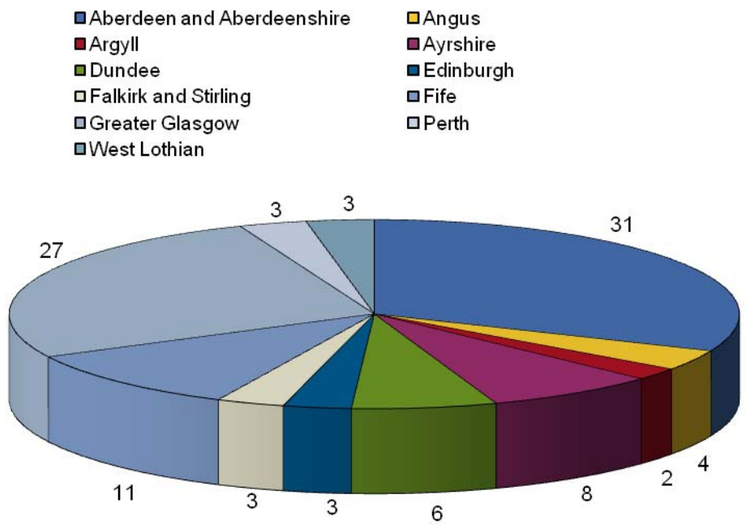


Figure 21.1: Marine supply chain company location

Highlands and Islands Enterprise area

21.58 Supply chain business data from HIE show businesses to be largely distributed across the Highlands area, with some businesses located further afield. Hence there might be some duplication between the two datasets. However, these data show that the business population used for the supply chain survey extended to 106 businesses interested in providing services and expertise in the marine sector.

21.59 The distribution of these businesses is shown in Figure 21.2 below, with the key concentrations of all relevant business located in Inverness (10%), Invergordon, Ross-Shire (9%), Thurso, Caithness (9%), Stornoway, Isle of Lewis (8%) and Wick, Caithness (7%).

21.60 In terms of responses to the supply chain survey, 36 businesses provided detailed information on their profile, activities, services and expertise offered to the industry, and views on business prospects (34% response rate). The distribution of activities and services across the industry categories is set out in Table 21.8 below, with the greatest concentration being in the construction (14%) and marine (14%) categories.

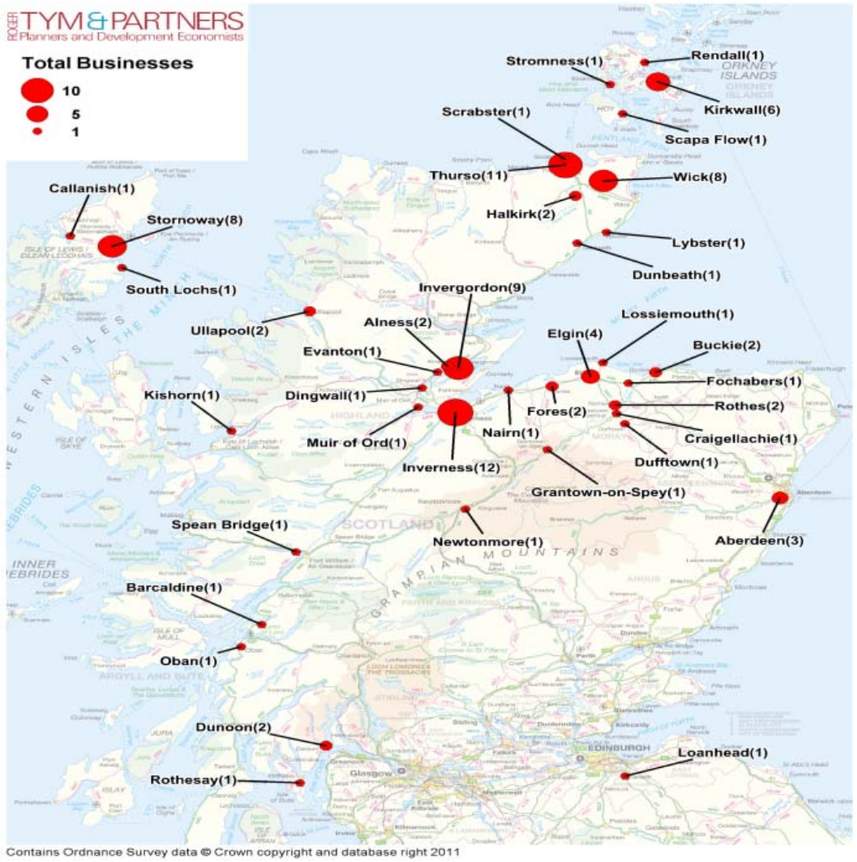


Figure 21.2: Geographic distribution of potential supply chain businesses (HIE based business list)

Sector	Respondent no.	%
Construction	5	14%
Marine	5	14%
All sectors	3	8%
Engineering	3	8%
Oil and gas (various incl. instillation services and maintenance)	3	8%
Ports and harbours	3	8%
Renewable energy, offshore oil & gas, nuclear and power generation	3	8%
Manufacturing	2	6%
Commercial diving	1	3%
Electrical wholesaler supplier	1	3%
Insurance broking	1	3%
Marine renewable	1	3%
Marine, oil and gas	1	3%
Oil and gas and renewable	1	3%
Renewable energy, power distribution	1	3%
Renewables	1	3%
Renewables, construction	1	3%
Total	**36**	**100%**
Source: RTP MeyGen Supply Chain Survey (2011)		

Table 21.8: Respondent business sector

Employees and skills

21.61 Respondent businesses typically have a workforce with full-time (91%) skilled (85%) employees (Table 21.9). Over half (53%) of the businesses were small enterprises (i.e. less than 50 employees) while over a third (38%) were medium sized enterprises with between 50-249 employees. The remaining 9% of respondent businesses were large enterprises with 250 employees or more.

Employees	Employee no.	%
Full-time	3,452	91%
Part-time	359	9%
Total	3,811	100%
Skills		
Skilled	3,245	85%
Unskilled	551	15%
Total	3,796[1]	100%
Organisation size	**Business No.**	
Small (1-49 employees)	18	53%
Medium (50-249 employees)	13	38%
Large (250 + employees)	3	9%
Total	**34**	**100%**
Source: RTP MeyGen Supply Chain Survey (2011)		
[1]A company with 15 employees did not complete this section		

Table 21.9: Employees and skills

Business performance

21.62 Respondent businesses reported relatively strong business performance both recently and over the past three years. The majority (83%) of businesses stated their current business performance was 'good' while almost half (47%) indicated their business performance had been increasing over the last three years. Only 8% stated their business had been declining (Table 21.10 and Table 21.11).

Performance	Respondent no.	%
Good	30	83%
Fair	2	6%
Poor	1	3%
Did not answer	3	8%
Total	**36**	**100%**
Source: RTP MeyGen Supply Chain Survey (2011)		

Table 21.10: Current business performance

Performance	Respondent no.	%
Increasing	17	47%
Stable	13	36%
Declining	3	8%
Did not answer	3	8%
Total	**36**	**100%**
Source: RTP MeyGen Supply Chain Survey (2011)		

Table 21.11: Recent business performance (last 3 years)

21.63 A number of factors were identified as influencing business performance. Growing corporate reputation (69%) and improving market opportunities (58%) were identified as the two most significant factors, followed by price and value for money (56%) and improving business and economic conditions within their business sector (53%) (Table 21.12).

21.64 A growing number of renewable developments coming on-stream were identified by exactly half of business respondents while around a third identified their product (39%) and promotion and marketing (31%) as key influencing factors (Table 21.12).

Factor	Respondent no.	%
Reputation	25	69%
Market opportunities	21	58%
Price & value for money	20	56%
Business and economic conditions	19	53%
Renewable energy developments	18	50%
Product	14	39%
Promotion & marketing	11	31%
Source: RTP MeyGen Supply Chain Survey (2011)		

Table 21.12: Factors influencing business performance

21.65 Two-thirds (67%) of respondents predicted increasing future business performance while a fifth (19%) considered their future business prospects to be stable. Only one business (a construction firm) predicted declining future performance (Table 21.13).

Performance	Respondent no.	%
Increasing	24	67%
Stable	7	19%
Declining	1	3%
Did not answer	4	11%
Total	**36**	**100%**
Source: RTP MeyGen Supply Chain Survey (2011)		

Table 21.13: Future business prospects

21.66 Businesses were asked to provide an indication of their annual turnover. Slightly less than half (44%) of respondent businesses have a turnover in excess of £5 million while a further third (31%) have a turnover of £1 - £5 million (Table 21.14). An extrapolation of these turnover figures provides a broad estimate of the value of respondent businesses at approximately £92.6 - £139.3 million, the median of which is £115.9 million. Assuming the respondents are representative of the industry overall, the total turnover of the supply chain population from the survey would be approximately £341 million.

Turnover (£)	Respondent no.	%	Min (£m)	Max (£m)
Less than £50,000	0	0%	£0.0	£0.0
£50,000 - £100,000	3	8%	£0.2	£0.3
£100,000 - £500,000	4	11%	£0.4	£2.0
£500,000 - £1,000,000	2	6%	£1.0	£2.0
£1,000,000 - £5,000,000	11	31%	£11.0	£55.0
£5,000,000 plus	16	44%	£80.0	£80.0
Total	**36**	**100%**	**£92.6**	**£139.3**

Table 21.14: Annual turnover

21.67 Respondent businesses were asked to identify the services they could provide to the Project. The services were broken down into the broad service groups and sub-groups shown in Figure 21.3, Figure 21.4 and Figure 21.5.

- ***Design Services***

21.68 A quarter of businesses can provide component design and a further quarter can provide infrastructure design services, while a fifth (19%) is able to provide marine services operations. 'Other' design services mentioned by respondents include:

- Specialist design facilities for back-up power supplies and potential for energy storage banks;
- Control System & SCADA Design; and
- Sensor design for measuring processes or operations.

Onshore infrastructure

21.69 A relatively high proportion of firms are capable of supplying onshore infrastructure services. Almost half (42%) can provide construction services while around a third of respondent businesses are capable of providing maintenance (36%); load out quay (31%) and ports facilities (31%).

21.70 Around a quarter of firms stated they can provide electrical equipment such as converters, transformers and cabling (28%); control system hardware and software (25%) and onshore cable laying (25%). Grid connection and site investigation services can only be supplied by a small proportion of firms in the survey (11% and 6% respectively). 'Other' onshore infrastructure services include:

- Marine equipment supply;
- Ancillary steelwork associated with construction;
- Storage facilities;
- Testing and supply services;
- Coating services - marine grade paint on top of galvanized steel;
- Supply of equipment for back-up supplies and potential energy storage, e.g. station batteries; and
- Non-destructive testing, rope access and working from height solutions.

Offshore infrastructure

21.71 Turbine Support Structure (TSS) installation services can be provided by around a quarter (28%) of respondent businesses while site surveying and cable connector services can be supplied by around a fifth of respondent businesses (22% and 19% respectively). There was a limited supply of directional drilling (3%) and subsea cable supply (11%) services available through respondent businesses. No respondent businesses provide site investigation services. 'Other' offshore infrastructure services include:

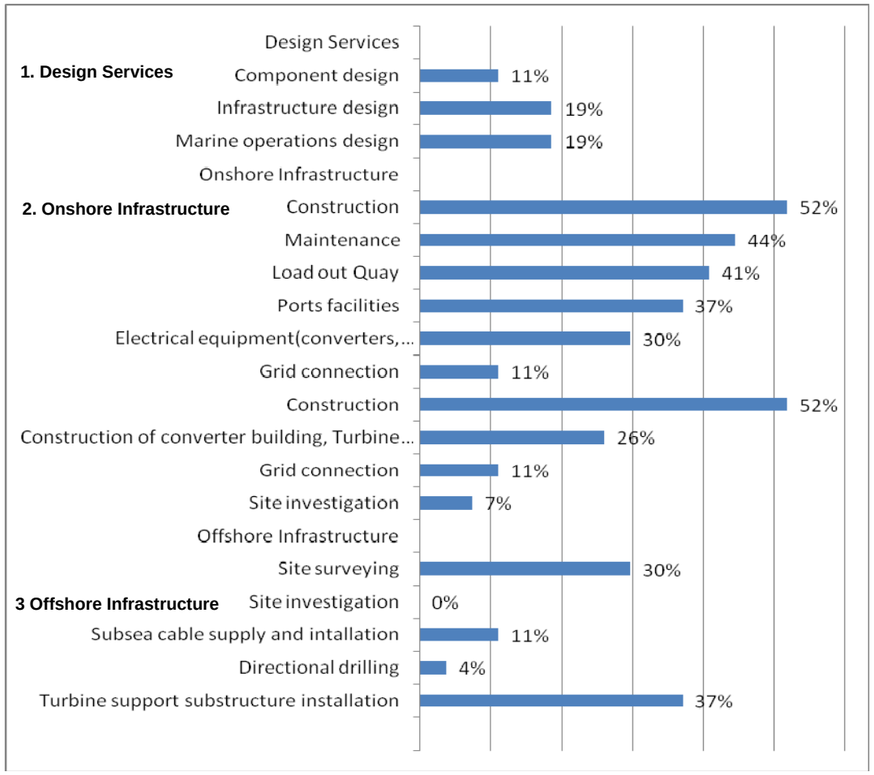
- The supply of equipment to commercial diving companies; and
- Offshore cable testing and termination.

Turbine assembly

21.72 Storage facilities for the turbine assembly stage can be provided by around a quarter of respondent businesses (22%). Testing and commissioning services (17%); final assembly services (14%) and component supply services (11%) can also be supplied by the survey group.

Turbine Support Structure fabrication

21.73 Around a quarter of respondent businesses can provide load out to quayside services (25%) and painting services (22%) while a similar proportion can provide assembly services (17%) fabricated plate services (14%) and testing services (14%). One firm can also provide mooring/ seabed fixing design and supply services.



Source: RTP MeyGen Supply Chain Survey (2011)

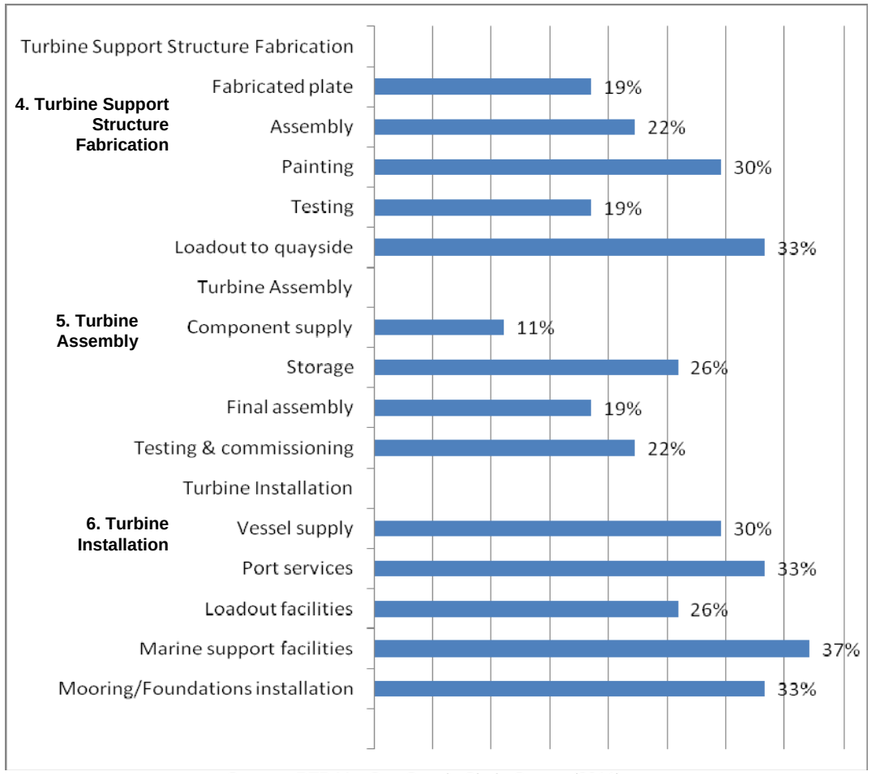
Figure 21.3: Services provided: design; onshore and offshore infrastructure

Turbine installation

21.74 There is a relatively strong supply of turbine installation services within the survey sample. Around a third of business respondents (31%) can provide marine operations services while around a quarter can provide marine support facilities (28%); port services (25%); mooring/ foundation installations (25%) and vessel supply services (22%).

Operations, maintenance and decommissioning

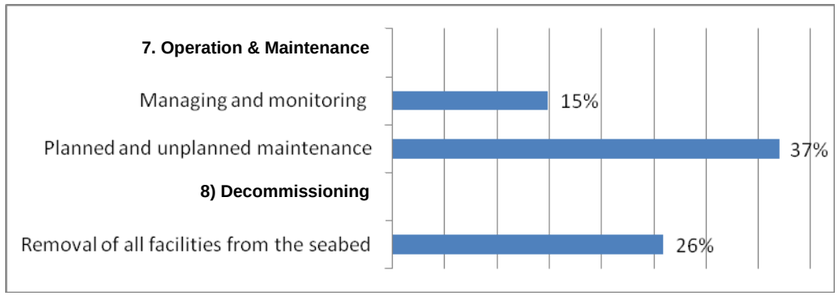
21.75 Over a quarter (28%) of respondent businesses can supply planned and unplanned maintenance (which requires local workshops, storage facilities and quayside space). 11% of businesses stated they can manage and monitor the ongoing environmental impact of the Project.



Source: RTP MeyGen Supply Chain Survey (2011)

Figure 21.4: Services provided: turbines

21.76 A fifth (19%) of businesses can supply decommissioning services which involve the removal of all facilities from the seabed. One business has a licensed decommissioning facility in Lerwick and can supply a reception point for decommissioned plant.



Source: RTP MeyGen Supply Chain Survey (2011)

Figure 21.5: Services provided: operation and maintenance and decommissioning

21.5.2 Summary

21.77 The survey of the supply chain industry in the study and the wider surrounding area has demonstrated that there is an extensive range of businesses able to provide the necessary onshore and offshore services potentially required by the Project. These extend from fabrication and construction to operation and maintenance, and decommissioning capacity and capability.

21.5.3 Tourism and recreation baseline

21.78 This section profiles tourism and recreational volume, value and employment of the local area. It identifies the key drivers behind the tourism economy and identifies patterns and trends to set a baseline for the Project impact to be assessed against.

Geographic context

21.79 The baseline review of the wider tourism market sets out the context of the Project in relation to the defined study area. The Caithness tourism area relative to the rest of Scotland is illustrated in Figure 21.6.

21.80 The analysis is conducted at regional tourist board level (Highlands of Scotland) and is considered against the Scottish average. The most up to date complete datasets on tourism for this area is for the 2009 season, and more up-dated information has been added where available. Full details of the tourism and recreation baseline context at a Highlands level are set out in the MeyGen Socio-economic, Tourism and Recreation Impact Assessment Report (RTP, 2011) as is the detailed profile of the local tourism business community derived from the Tourism Business Survey as part of this assessment.

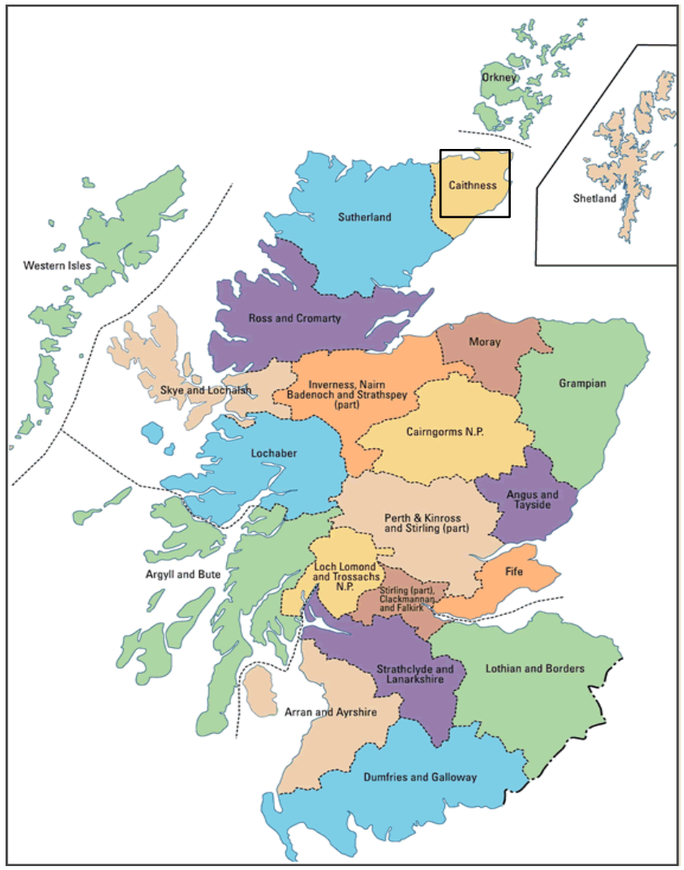
Highlands tourism profile

21.81 The Highlands are more dependent upon tourism as an economic sector that the average for Scotland as a whole, with a much higher proportion of the population employed in this sector (13.2%) than Scotland (8.6%). The Highlands have also experienced an increase in the number of jobs relating to tourism over recent years.

21.82 The profile of Highlands tourism demonstrates that domestic tourist trips account for the significant majority of the total number of trips to the region. In terms of visitor trips and expenditure, for both UK based and overseas visitors these increased in the Highlands over the period between 2005 and 2008. The assessment demonstrates that more visitors, both domestic and from overseas, visit the area for a holiday, compared with the Scottish average. 21% of overseas visitors stay with friends or relatives when they come to the region, lower than the Scottish average of 27%.

21.83 In terms of accommodation used by visitors, between 2005 and 2009 there was a significant move of visitors from traditional accommodation e.g. Hotels, B&Bs etc to staying with friends and relatives, with occupancy rates for all accommodation in the region being highest between April and September. Between 2005 and 2009 there was also a slight increase in occupancy levels during the off-peak season, mainly from October to December perhaps due to a rise in the number of Christmas breaks.

21.84 In respect of visitor attractions, none of the top 5 visitor attractions in the Highlands are located within the study area, with the Castle of Mey being the main visitor attraction.



Map Source: Heritage Paths - http://www.heritagepaths.co.uk/mapsearch.php

Figure 21.6: Tourism map of Scotland with focus on Caithness

Local tourism business profile

21.85 The following local tourism business profile is derived from the Tourism Business Survey, which identified and surveyed 251 businesses within 30km of the PCC location(s). This business total comprised 160 accommodation providers (including hotels, B&Bs, self-catering, caravan and camping sites, and youth hostels), 49 visitor attractions, sports and leisure, and outdoor activities, and 42 restaurants, public houses, specialist tourist shops, and post offices. Of this total 96 businesses provided a response as follows:

- The most popular visitor activities were stopping over in the area before heading on to Orkney (29%) and for visitors not travelling to Orkney, most visitors went sightseeing to attractions including Dunnet Head and Duncansby Stacks (23%) and visits to the Castle of Mey (13%);
- 38% of tourism business respondents were currently experiencing good levels of trading, 36% felt their business was trading at a fair level, while more than a quarter were experiencing poor levels of trading;

- 37% of tourism business respondents had experienced stability in trading over the past 3 years, 36% had recorded a decrease in business levels and 27% had seen an increase in trading level; and

- The future outlook appears positive with 83% of tourism business respondents envisaging either stable (34%) or increased (49%) business performance in the future, with only 17% predicting a decline in future prospects.

21.86 In assessing the tourist, visitor and recreational facilities within the study area, it is those which register most frequently or readily within tourist or visitor websites, brochures, guidebooks, and other media that are taken to represent the principle tourism resources in the area. This is a standard approach taken as a proxy for tourists or other visitors assessing the potential attraction of an area. Therefore the principal attractions and other facilities are set out below, including settlements, tourist routes, walking routes, rights of way, core paths, climbing routes, cycle routes, golf and fishing (i.e. lochs and rivers), forest parks/nature reserves, estates, events, visitor attractions, activity centres and accommodation providers present.

21.87 The area is attractive with wide open spaces and dramatic sea cliffs being among the popular visitor attractions. Caithness has long been a popular destination for tourists around Scotland's Highlands and Islands with popular attractions such as the Castle of Mey and John o' Groats, the start of the road to Land's End. Other activities promoted within the area include walking, climbing, mountain biking, water sports and fishing among many others.

21.88 Those principal tourism and recreation resources within close proximity of the Project's onshore facilities include the Castle of Mey (6km), the services and activities focus of John o' Groats (3km), the A836 coastal route, the Sustrans National Cycle Route (NCR) 1, and the Wick Circular Cycle Route, each of which pass the PCC location; and promoted cycle routes including, the Keiss Corridor, and the Brough to Canisbay Circular (each within 2km), and Duncansby Head and Duncansby Stacks (4km). Offshore / marine activities include sailing trips from John o' Groats, surfing locations in and around Gill's Bay (2km), and beyond both east and west, sea-kayaking and canoeing around Gill's Bay and the Isle of Stroma and wildlife watching (including John o' Groats wildlife tours in the summer months). The Inner Sound is also used as a transit route for sailing craft (see Section 15 for more details). Further afield in the local area there are Dunnet Head, the concentrations of facilities around Castletown, Thurso and Wick, and many walks, footpaths, other cycle routes, the local wildlife and birdlife, and the local beaches, which offer extensive opportunities for recreational activities and leisure

21.89 While none of the Highlands top visitor attractions are located within Caithness, the Castle of Mey attracted 29,000 visitors during season 2010, making it the key visitor attractor locally, not only for onshore visitors, but also for cruise ship visitors who land at Scrabster Harbour as a cruise port of call. In addition, the proposals by Natural Retreats to redevelop the John o' Groats House Hotel into a major visitor, recreation and accommodation facility and attractions, offers major potential to act as a catalyst for enhancing the visitor draw of the local area.

21.90 Figure 21.7 and Figure 21.8 for the Ness of Quoys and Ness of Huna PCC locations illustrate the presence of tourism and recreation resources / receptors in and around the local area close to the PCC location and the wider area up to and including a 30km radius.

21.91 A full audit and detailed description of tourism and recreation facilities and resources is included in the MeyGen Socio Economic Tourism and Recreation Impact Assessment Report (RTP, 2011).

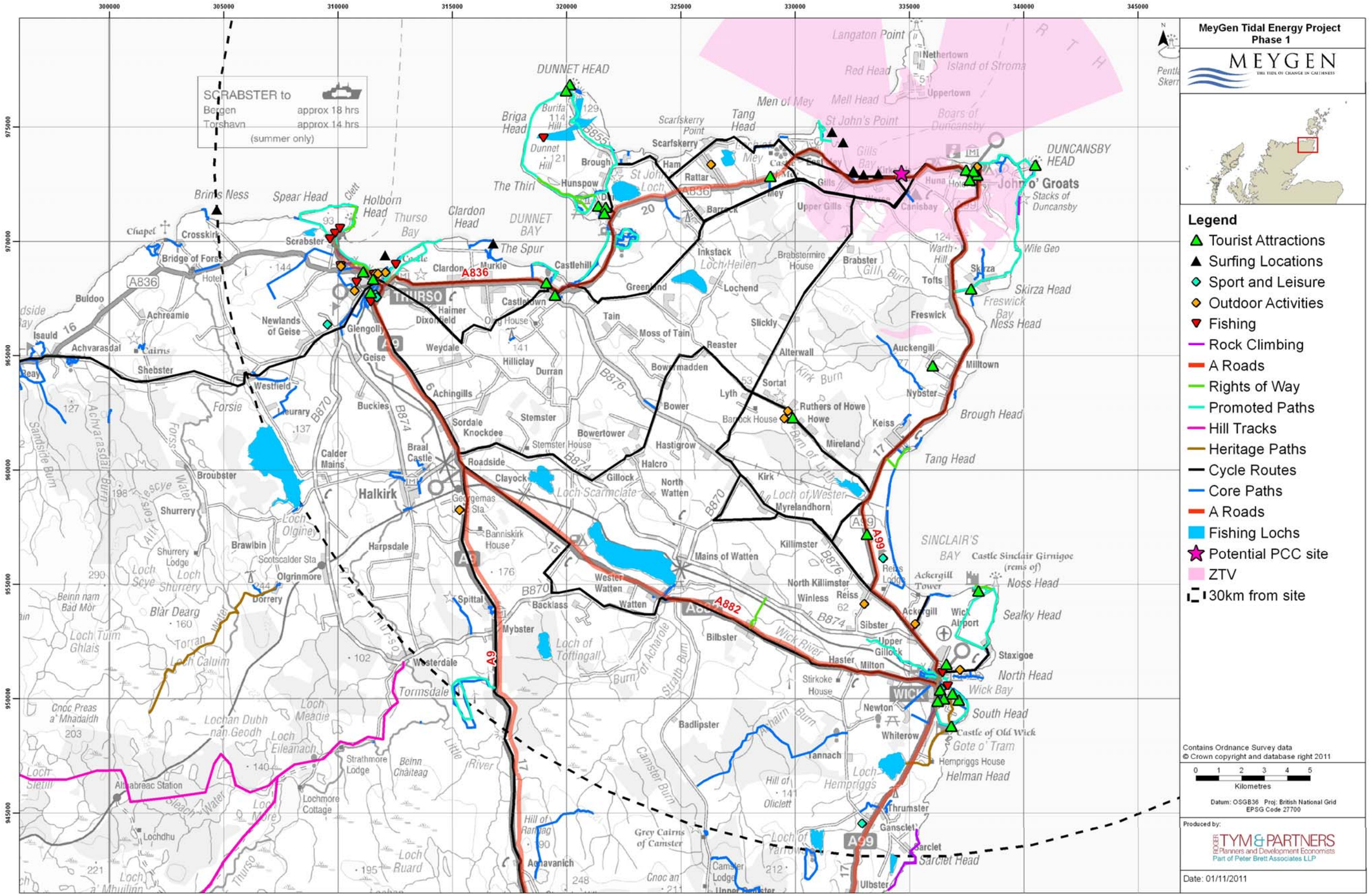


Figure 21.7: Ness of Quoys - tourism and recreation receptors

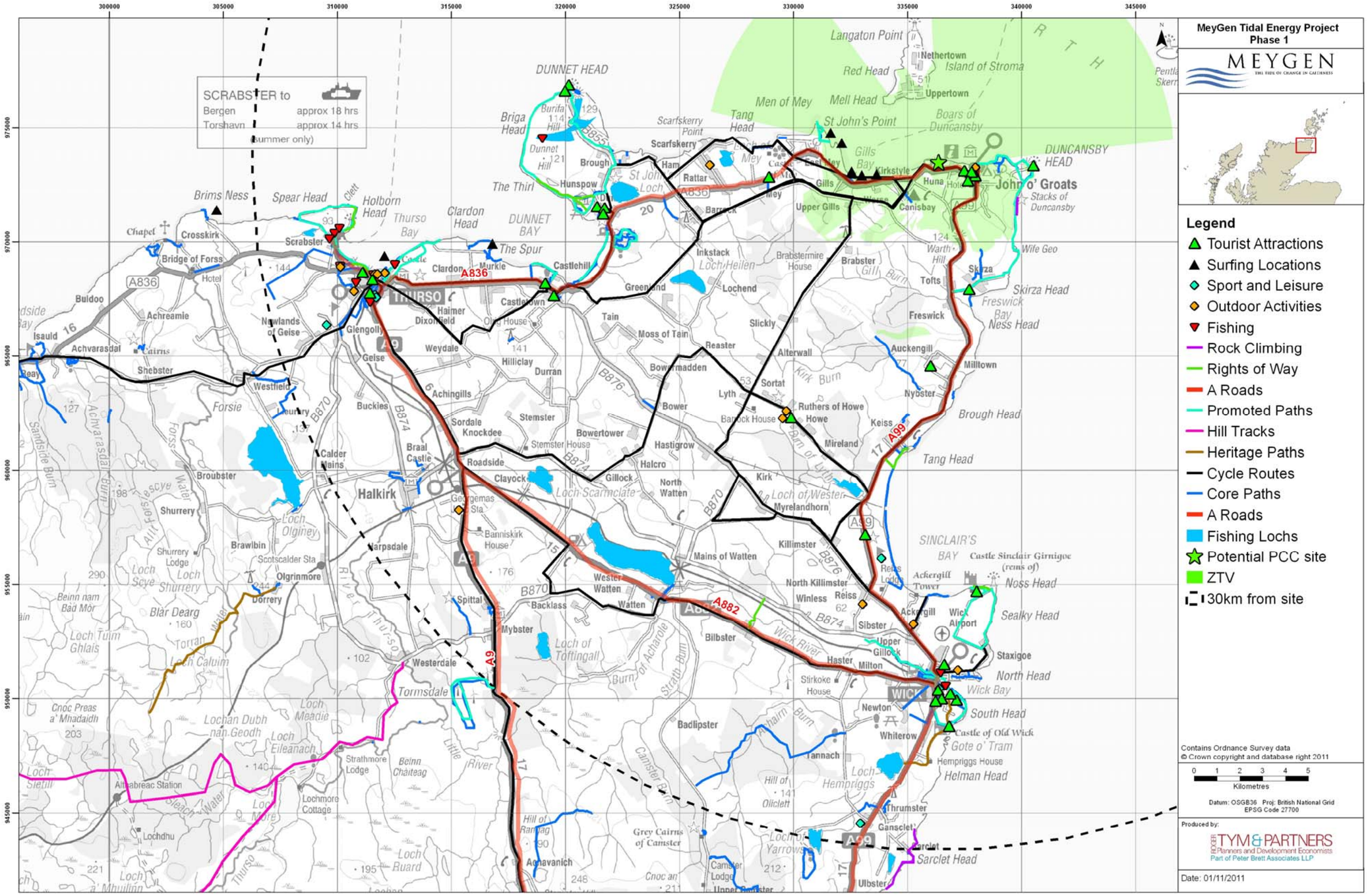


Figure 21.8: Ness of Huna - tourism and recreation receptors

21.6 Impacts during Construction and Installation

21.6.1 Defining socio-economic impacts and effect

21.92 The principal economic impacts, which will result from the Project can be categorised under the following headings:

- Direct economic impacts: Employment and economic output / Gross Value Added (GVA) that are wholly or largely related to construction, operation and maintenance and eventual decommissioning of the Project;
- Indirect economic impacts: Employment and GVA generated in the economy of the study area in the chain of suppliers of goods and services to the direct activities;
- Induced economic impacts: Employment and GVA created by direct and indirect employees' spending in the study area or in the wider economy; and
- Wider economic (catalytic) impacts: employment and income generated in the economy related to the wider role of the Project in influencing economic activities (including wider socio-economic effects). This will include the effects on the tourism sector, on inward investment, elsewhere within the construction sector (e.g. as a result of worker supply) and on other sectors of the economy.

21.93 In addition, the wider socio-economic impacts on local communities due to changes in social conditions and the surrounding environment, together with the direct and indirect effects on recreational and tourist resources.

21.94 The convention for economic appraisals is that construction/decommissioning employment is quoted as 1 Full Time Equivalent (FTE) job is equal to 10 years of temporary employment. This assessment estimates the FTE job basis but also sets out the temporary 'one off' impact or effect of the construction/decommissioning activity in terms of total temporary employment. The latter definition is used in the assessment as a comparison between the output/demand for labour of the Project and the 'absorption capacity' of the local area to meet this demand.

21.6.2 Impact 21.1 Local employment and GVA impacts during construction

21.95 In estimating the economic impacts, which would result from the Project's construction and installation phase of the Project, it is necessary to make use of a number of industry research reports and sources, as full details of potential employment numbers are not available from the MeyGen at the current time.

21.96 Industry estimates for the total CAPEX of the Project at a total for Phase 1 of 86MW maximum, can be established through application of a £pounds per MW factor to the Project as shown in Table 21.15 below.

21.97 This cost range as set out in Table 21.15 is generally supported by other recent research into the costs of marine development10, within which the CAPEX/MW costs for 'tidal stream shallow' (<40m) demonstration projects for a 1st 10MW project were estimated at £4.1-5.7m; and for commercial projects after 50MW deployed at £2.8-3.9m. 'Tidal stream deep' (>40m) equivalent costs were estimated at £3.0-4.1m for demonstration projects and £2.8-4m for commercial projects.

[10] 'Cost of and financial support for wave, tidal stream and tidal range generation in the UK: DECC and Scottish Government (October 2010), http://www.decc.gov.uk/assets/decc/what%20we%20do/uk%20energy%20supply/energy%20mix/renewable%20energy/explained/wave_tidal/798-cost-of-and-finacial-support-for-wave-tidal-strea.pdf

CAPEX per MW[11]	Industry average	MeyGen equivalent
Minimum	£4m	£344m
Median	£5.5m	£473m
Maximum	£7m	£602m

Table 21.15: Estimated CAPEX for the Project

21.98 In determining potential job numbers generated by marine development, available data are currently limited due to the small number of comparative examples. However, research for the Scottish Government's Marine Energy Group[12] suggested a 'marine industry standard' of 20 jobs created per MW.

21.99 Using these data the Project could have the potential to generate a total of 1,720 jobs on a 'jobs/MW installed capacity' basis for the manufacturing, construction and installation phase only.

21.100 The prototype tidal turbines and foundations of the candidate manufacturers that are considered in this application have been assembled in the UK. It is the ambition of MeyGen to work with local supply chain via organisations such as the Caithness Chamber of Commerce, HIE and SE in order to assist and best place the industry supply chain to support the Project. It is too early to state as to whether turbines themselves will be manufactured in the local vicinity / study area but it is the ambition of MeyGen that Scotland directly benefits from this activity.

21.101 In addition, if the percentage of the total CAPEX cost of the turbine nacelles is some 50%[13], and installation/foundations approximately 30%[14], the remaining export cables and onshore infrastructure, etc will represent some 20% of total CAPEX. Thus, a worst case scenario for this assessment is based on a maximum of 50% of the total CAPEX potentially being available to the local and wider area economy, where the turbine manufacturing and assembly is not included within the available supply chain. It should be noted that some of the manufacture and assembly of the prototype turbine nacelle has been undertaken in the UK e.g. heavy metal works and assembly of components. If this 50% factor is applied to the total potential workforce of 1,720 jobs, this represents some 860 jobs.

21.102 The average construction workforce estimated by MeyGen for the onshore components of the overall Project (construction of the PCC and permanent road, temporary HDD site and cable to grid connection point) represents approximately 67-70 jobs over an accrued period of approximately 14 months. Based on this an estimated further 790 temporary jobs would be involved in the fabrication and construction of the offshore works over a period of 3 years. Were these total 860 temporary jobs able to be taken up within the local labour market, this is equivalent to 15.75% of the total employed population at a local level and 5.4% at a Caithness and Orkney level. In terms of temporary GVA these jobs would represent a potential of some £38.8 million.

21.103 For the purposes of understanding the 'absorption capacity' of the area's industry supply chain and its capability in benefiting from these Project outputs, Table 21.16 shows the levels of local capacity and capability available at a Caithness level, which has been derived from the supply chain survey.

Timescale construction phase	Minimum	Maximum	Median
Confirmed Survey Responses			
Temporary Jobs supported	51	66	58
Temporary GVA	£2.03m	£2.61m	£3.0m

[11] Marine Energy Technology Roadmap: Energy Technologies Institute & UK Energy Research Centre (October 2010) http://www.energytechnologies.co.uk/Libraries/Related_Documents/ETI_UKERC_Roadmap.sflb.ashx
[12] Scottish Government's Marine Energy Group – the Marine Energy Supply Chain Survey (2009)
[13] Tidal & Wave power – a diversification opportunity: SSE Renewables (2011) - http://www.subseauk.org/documents/2011-02%20subseauk%20-%20ian%20innes%20presentation%20%28issued%29.pdf
[14] Source: MeyGen

Timescale construction phase	Minimum	Maximum	Median
Confirmed Survey Responses			
Total Supply Chain Population			
Temporary Jobs supported	139	179	158
Total temporary GVA	£6.25m	£8.09m	£7.11m

Table 21.16: Caithness area absorption capacity: temporary employment & GVA[15]

21.104 It is evident that even the maximum job numbers available (66) within the local level supply chain are considerably less than the potential construction job requirement of the Project (860), and the local Caithness area would only be able to absorb some 7.7% of the available labour requirement at this level.

21.105 Given this capacity relates to 36.8% of the supply chain business population, even were these job figures to be pro-rated to 100%, this would represent a maximum of 179 local temporary jobs or 20.9% of the temporary construction labour force requirement.

21.106 The conclusion is that while there is substantial 'headroom' and potential to attract further business investment in the construction sector into the local economy to satisfy this requirement, this would only be on a temporary basis during the construction period and such new investment would require this and other projects to sustain permanent operational capacity. More likely the Project will be required to attract a substantial number of temporary construction capacity and workers from outside the Caithness area during the course of the construction and installation phase, potentially from the wider Highlands area and elsewhere.

Impact significance

21.107 In terms of levels of significance the potential creation of a maximum of 860 temporary jobs would be assessed as of major positive impact (and hence significant) at a study area / local level, where the existing potential local 'absorption capacity' is likely to be able to accommodate between 66-179 temporary jobs, and the impact is assessed as being of 'greater than local scale or which exceed recognised standards.' In addition, this is assessed as a minor impact at an all Highlands level the impacts being 'limited or very localised raised as a local issue'.

Impact title	Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Construction Employment 860 temp jobs £38.9m temp GVA	N/A	Major positive	Major positive	Positive

MITIGATION IN RELATION TO IMPACT 21.1

- There are a number of national, regional and local initiatives involving the Scottish Government, regional and local development agencies and the Caithness and North Sutherland Regeneration Partnership with the aim to work towards enhanced skills training, supply chain enhancement, and support for business improvement working in the marine renewables industry, including Caithness. These will assist in realising and maximising the opportunities in the local and wider areas and where appropriate MeyGen will support these initiatives.

[15] Source: GVA at a Scottish Highlands Council level (2009) - GVA per Employee per annum: Manufacture of Basic and Fabricated metals, Machinery, Motor Vehicles and Other transport equipment (£37,356); Construction / Civil engineering (£52,876); and average for activities (£45,116)

21.6.3 Impact 21.2: Wider qualitative economic benefits during construction

21.108 It is considered feasible that during the construction process there will be opportunities where those employed would develop skills that will be of benefit to the local economy in the longer term, and indeed would be transferrable to other projects in the area. Examples might include the development of project management skills, which could be beneficial in terms of ensuring that local companies or individuals are much better placed to compete for future construction work in the wider area, or increasing the number of new starts and supporting small businesses that can benefit from work related to the Project in establishing a business. Once established, these firms or individuals will be in a stronger position to survive and prosper from ongoing work elsewhere.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
N/A	Moderate positive	Moderate positive	Positive

MITIGATION IN RELATION TO IMPACT 21.2

- There are a number of national, regional and local initiatives involving the Scottish Government, regional and local development agencies and the Caithness and North Sutherland Regeneration Partnership with the aim to work towards enhanced skills training, supply chain enhancement, and support for business improvement working in the marine renewables industry, including Caithness. These will assist in realising and maximising the opportunities in the local and wider areas and where appropriate MeyGen will support these initiatives.

21.6.4 Impact 21.3: Local tourism business impacts during construction

21.109 In terms of local tourism business impacts and effects (that is where the impacts and effects are experienced by individual tourism businesses within the local area), these generally only relate to the construction phase of the Project, with the general view that permanent operation & maintenance will have negligible adverse impacts upon tourism in the area. The business community are aware of the potential benefits which might accrue from the temporary construction labour force requirements for accommodation and for other related goods and services, and through the course of consultation this is an issue which has been raised and recognised widely. A substantial proportion (38%) of the tourism business respondents to the tourism survey of 251 such businesses across the local area, considered there to be a major positive benefit, and given the low sensitivity of the local accommodation provider receptors, with relatively limited numbers of visitors and visitor capacity, the impact significance of such impacts is assessed as moderate positive.

Impact significance

Impact title[1]	Magnitude of impact from survey response	Likelihood	Impact magnitude	Sensitivity of receptor	Consequence	Significance
6% of businesses	Minor	Possible	Minor	Low	Minor	Not Significant
2% of businesses	Major	Possible	Moderate	Low	Moderate	Significant
38% of businesses	Major positive	Possible	Positive	Low	Moderate positive	Positive

Note: [1]The '% of businesses' is the percentage of the businesses surveyed who considered the impact to be of that magnitude.

MITIGATION IN RELATION TO IMPACT 21.3
▪ Consultation with local businesses to manage traffic flows during major events. ▪ During the temporary HDD activities, screening measures may be implemented to reduce impacts on passing visitors. ▪ For the potential positive construction impacts there are a number of national, regional and local initiatives involving the Scottish Government, regional and local development agencies and the Caithness and North Sutherland Regeneration Partnership with the aim to work towards enhanced skills training, supply chain enhancement, and support for business improvement working in the marine renewables industry, including Caithness. These will assist in realising and maximising the opportunities in the local and wider areas and where appropriate MeyGen will support these initiatives.

Residual impact

Impact title[1]	Magnitude of impact from survey response	Likelihood	Impact magnitude	Sensitivity of receptor	Consequence	Significance
2% of businesses	Major	Unlikely	Minor	Low	Minor	Not Significant
Note: [1]The '% of businesses' is the percentage of the businesses surveyed who considered the impact to be of that magnitude.						

21.6.5 Impact 21.4: Wider tourism impacts during construction

21.110 For wider tourism across the area (that is where impacts and effects are experienced not by individual businesses but generally across the study area), there is a small proportion of the respondents to the tourism business survey, which consider the construction phase to result in adverse impacts. While the 2% of business respondents, which consider there to potentially be a major adverse impact as a result of the works. This is similarly the case with the 1% who consider there to be a moderate adverse impact.

21.111 There are a very substantial proportion of business respondents (72%) which consider that there would be a major positive benefit as a result of the Project. This is also set in the context of a healthy tourism sector in the local area, with 74% being satisfied with current trading performance, 64% having experienced stable or increasing trade over the past 3 years, and 83% anticipating stable or increasing trading conditions in the future.

Impact significance

Impact title	Magnitude of impact from survey response	Likelihood	Impact Magnitude	Sensitivity of receptor	Consequence	Significance
9% of businesses	Minor	Possible	Minor	Medium	Minor	Not Significant
1% of businesses	Moderate	Possible	Moderate	Medium	Moderate	Significant
2% of businesses	Major	Possible	Major	Medium	Major	Significant
72% of businesses	Major positive	Possible	Positive	Medium	Major positive	Positive

MITIGATION IN RELATION TO IMPACT 21.4
▪ Consultation with local businesses to manage traffic flows during major events. ▪ During the temporary HDD activities, screening measures may be implemented to reduce impacts on passing visitors. ▪ For the potential positive construction impacts there are a number of national, regional and local initiatives involving the Scottish Government, regional and local development agencies and the Caithness and North Sutherland Regeneration Partnership with the aim to work towards enhanced skills training, supply chain enhancement, and support for business improvement working in the marine renewables industry, including Caithness. These will assist in realising and maximising the opportunities in the local and wider areas and where appropriate MeyGen will support these initiatives.

Residual impact

Impact title	Magnitude of impact from survey response	Likelihood	Impact Magnitude	Sensitivity of receptor	Consequence	Significance
1% of businesses	Minor	Unlikely	Negligible	Medium	Negligible	Not Significant
2% of businesses	Moderate	Unlikely	Minor	Medium	Minor	Not Significant

21.6.6 Impact 21.5: Recreation impacts during construction

21.112 In terms of recreation impacts and effects these generally relate to the onshore construction phase of the Project, with the assessment taking the view that permanent operation & maintenance will have negligible adverse impacts upon recreational resources / receptors in the area. Potential adverse impacts and effects would result from construction works interrupting recreational routes and paths, and noise or congestion similarly causing inconvenience to recreational users of routes, facilities and activities in the local area.

21.113 In terms of offshore impacts these relate to the disruption of recreational traffic moving through the Inner Sound. The Inner Sound is known as the preferred route through the Pentland Firth for sailing craft however transits are estimated as 1-2 per month (Section15).

Impact significance

21.114 The majority of recreational receptors even those which are in close proximity to the PCC or make use of offshore waters close to the array itself are assessed as only experiencing minor or negligible impacts. The Sustrans National Cycle Route 1 due to their heightened sensitivity as a result of their national or regional status and their number of users is assessed as having a moderate significant impact.

Impact title	Sensitivity of receptor	Magnitude of impact	Consequence	Significance
John o' Groats	Medium	Minor	Minor	Not Significant
A99	Medium	Minor	Minor	Not Significant
A836	Medium	Minor	Minor	Not Significant

Impact title	Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Duncansby Head	Medium	Minor	Minor	Not Significant
Puffin Express (tours)	Low	Minor	Minor	Not Significant
Nordwall Farm	Low	Minor	Minor	Not Significant
Duncansby Head to John o' Groats promoted path	Low	Minor	Minor	Not Significant
Dunnet Head promoted path	Low	Minor	Minor	Not Significant
St Johns Point promoted path	Low	Minor	Minor	Not Significant
Duncansby Head and Stacks CP207.009	Low	Minor	Minor	Not Significant
Tresdale Track CP207.018	Low	Minor	Minor	Not Significant
Canisbay Roadside CP207.019	Low	Minor	Minor	Not Significant
Freswick to Duncansby Head promoted path	Low	Minor	Minor	Not Significant
Black Hill Peat Track CP207.005	Low	Minor	Minor	Not Significant
John o' Groats Shore CP207.013	Low	Minor	Minor	Not Significant
John o' Groats Roadside Footway CP207.015	Low	Minor	Minor	Not Significant
Old Road CP207.020	Low	Minor	Minor	Not Significant
Sustrans Cycle NR1	High	Minor	Moderate	Significant
Brough to Canisbay Circular cycle route	Low	Minor	Minor	Not Significant
Thurso to Inverness cycle route	Medium	Minor	Minor	Not Significant
Offshore				
John o' Groats Wildlife Cruises	Low	Minor	Minor	Not Significant
Sailing routes	Low	Minor	Minor	Not Significant
Kayaking routes	Low	Minor	Minor	Not Significant

MITIGATION IN RELATION TO IMPACT 21.5

- Consultation with local businesses to manage traffic flows during major events.
- Temporary interruption of recreation routes during construction will be carefully managed and any diversions clearly sign-posted; information on construction works circulated to recreational businesses and public notices distributed.
- During the temporary HDD activities, screening measures may be implemented to reduce impacts on passing recreational users or from recreational focal points.
- Marine Safety Information broadcasts will be issued by HM Coastguard to inform mariners of the activity at the MeyGen site.
- The Project will be depicted on Admiralty Charts produced by UKHO.
- Navtex and Notice to Mariners will be issued including details of MeyGen works.
- Information on the work activity at the site will be circulated directly to local ports, ferry operators and recreational clubs and businesses.

Residual impact

Impact title	Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Sustrans Cycle NR1	High	Negligible	Minor	Not Significant

21.7 Impacts during Operation and Maintenance

21.7.1 Impact 21.6: Local employment and GVA impacts during O&M

21.115 Data are available from MeyGen for the estimated operation & maintenance (O&M) employment required by the tidal array. The estimated employment for the O&M employment onshore is approximately 27-30 jobs, with a further 20-22 jobs offshore; a total of 47-52 jobs (or a median of approximately 50 jobs).

21.116 To estimate net additional direct employment impacts, a series of factors must be applied to the base direct employment figure. These rates are as follows:

- Dead-weight - 0%;
- Leakage - 10%; and
- Displacement - 10%.

21.117 There would be no dead-weight effect in the local labour market as without the Project no equivalent employment would be created through other means. The 'leakage' is taken to be at a low level, given that the nature of the labour market is such that permanent high value employment of this type is in short supply in Caithness and Sutherland, and in the Northern Isles, and therefore few of these permanent jobs would pass outside the local or wider labour market to elsewhere. Equally, the 'displacement' effect would be limited given the nature of the supply chain and its ever increasing development (addressed in more detail below).

21.118 There is currently no agreed multiplier for marine energy type power generation. However, it is considered that the Scottish Government's established Type II multiplier for mechanical power transmission equipment of 1.714 is appropriate for application as a proxy to estimate indirect employment.

Using this method, direct and indirect employment generated from operation and maintenance is estimated to be approximately 69.4 FTE local jobs.[16]

21.119 The GVA generated through these 69.4 FTE local jobs would be approximately £3.67million per annum, as shown in Table 21.17 below.

Factor	Factor value	Total
Total estimated direct jobs	-	50
Dead-weight factor	0%	0
Leakage factor	-10%	-5
Displacement factor	-10%	-4.5
Total local direct jobs	-	40.5
Employment Multiplier (Type II)	x1.714	-
Total local direct and indirect jobs	-	69.4
Total GVA	£52,876	£3.67m

Table 21.17: Total operation & maintenance impacts (Jobs and GVA)

21.120 For the purposes of understanding the 'absorption capacity' of the industry's supply chain and its capability in benefiting from these O&M project outputs, Table 21.18 shows the levels of capacity and capability available in the post-construction phase. These figures have been derived from the supply chain survey.

Timescale post-construction phase	Minimum	Maximum	Median
Responses			
Jobs supported (FTEs)	55	69	62
Total GVA	£2.91 m	£3.65 m	£3.28 m
Total Supply Chain Population			
Total Jobs supported (FTEs)	149	188	168
Total GVA	£7.9m	£9.9m	£8.9m

Table 21.18: Caithness area absorption capacity: direct FTE employment and GVA[17]

21.121 Within the local Caithness industry supply chain there is sufficient capacity to accommodate the potential O&M job requirements of the Project, it representing approximately all of the local maximum capacity. Given this capacity relates to 36.8% of the supply chain business population, were these job figures to be pro-rated to 100%, this would represent between 149-188 local FTE jobs capacity.

21.122 There would also be an additional pool of a further 361-486 FTE job capacity within the wider Highlands labour market area upon which to draw. In addition, there will be a pool of highly skilled labour available from Dounreay as the process of decommissioning that site continues to its conclusion. These skills will potentially be available to the Project and other marine projects in the Pentland Firth and Orkney Waters area. Thus the conclusion is that there is available capacity within the local labour market to satisfy the Project's requirements, during the O&M phase.

Impact significance

21.123 In terms of levels of significance the potential creation of some 69.4 FTE jobs would be assessed as of moderate impact (and hence significant) at a study area / local level, with the impact being assessed as 'noticeable and judged to be important at a local scale;' and assessed as a minor impact at an all Highlands level being of 'limited or very localised raised as a local issue'.

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
N/A	Moderate positive	Moderate positive	Positive

MITIGATION IN RELATION TO IMPACT 21.6

- There are a number of national, regional and local initiatives involving the Scottish Government, regional and local development agencies and the Caithness and North Sutherland Regeneration Partnership with the aim to work towards enhanced skills training, supply chain enhancement, and support for business improvement working in the marine renewables industry, including Caithness. These will assist in realising and maximising the opportunities in the local and wider areas and where appropriate MeyGen will support these initiatives.

21.7.2 Impact 21.7: Wider qualitative economic benefits during operation and maintenance

21.124 The Project will also provide opportunities for the involvement of local, regional and Scottish suppliers in a range of activities, including research and development, design, project management, civil engineering, component fabrication/manufacture, installation and maintenance. The Project will have positive spin-off effects in terms of the development of the renewables sector in Caithness and the Northern Isles as well as the Highlands, and more generally in Scotland.

21.125 Demand resulting from development of the Project would further support production and employment in Scotland, providing a boost to Scottish industry and Scotland's production capacity. Strengthening Scotland's industrial base, particularly in an industry where global demand is growing, improves the ability of Scottish firms to compete in world markets, in turn boosting Scotland's economy.

21.126 With an increasing number of marine energy projects either under development, or passing through the consenting process in Scotland, the commercial viability and with it job prospects amongst Scottish firms improve. Cluster benefits in the industry increase where firms are supported by final demand and intermediate demand. The net effect is to increase business and employment opportunities within both the local and regional renewable energy sector, boosting the performance of local and national economies. The majority of marine array developers in Scotland have expressed an intention to source from local suppliers where possible, and would welcome increased capacity on the supply side.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
N/A	Moderate positive	Moderate positive	Positive

MITIGATION IN RELATION TO IMPACT 21.7

- There are a number of national, regional and local initiatives involving the Scottish Government, regional and local development agencies and the Caithness and North Sutherland Regeneration Partnership with the aim to work towards enhanced skills training, supply chain enhancement, and support for business improvement working in the marine renewables industry, including Caithness. These will assist in realising and maximising the opportunities in the local and wider areas and where appropriate MeyGen will support these initiatives.

[16] It should be recognised that this estimate is based on the assumption that operations and maintenance staff are available locally; it may be the case that a higher leakage rate is appropriate if specialist staff are required from outside the area.

[17] Source: GVA at a Scottish Highlands Council level (2009) - GVA per Employee per annum: Manufacture of Basic and Fabricated metals, Machinery, Motor Vehicles and Other transport equipment (£37,356); Construction / Civil engineering (£52,876); and average for activities (£45,116)

21.7.3 Impact 21.8: Tourism and recreation impacts during operations and maintenance

21.127 The assessment concludes that impacts upon tourism and recreation, where these occur, are likely only during the construction and / or decommissioning phases of the Project (see Impact 21.5 above). Responses to the tourism business survey indicate an expectation that any benefits would be generated through these phases, as would any potential adverse impacts. During the ongoing operation and maintenance phase such businesses do not expect notable impacts – either adverse from the presence of the Project offshore or onshore – or positive, due to the limited scale of permanent employment and also limited requirements for accommodation.

21.128 The visual impact of the PCC on the tourist attractions and tourist routes that pass near to the two sites has been assessed in the LSVIA section (Section 19). The LSVIA concludes that while there are some significant impacts on the landscape and seascape and significant visual impacts, these are generally contained within a localised area, with no extensive impacts on tourist attractions.

21.129 Viewpoint 9, 11, 14, and 27 (Section 19) are reflective of transient receptors along the key tourist route of the A836. The visual impact is only assessed as significant when you are close to the PCC site (e.g. viewpoint 11 for Ness of Quoys).

21.130 Key tourist attractions, John o' Groats, St John's Point and Duncansby Head (viewpoint 17, 23 and 25 section19.6.5) are all assessed as not having significant visual impacts from either PCC site, with only Canisbay Kirk (viewpoint 11) considered as significant based on the proximity to the Ness of Quoys site.

21.131 The impact of the operating turbines on offshore access and indirect impacts on recreational resource has been assessed in Section 15 (Navigation) and Section 9 (Physical Environment and Sediment Dynamics).

21.132 In terms of recreational craft using the Inner Sound it is considered that these are vessels of typically shallow draft so transiting the site would not be impacted by the presence of the turbines, albeit in significant weather and waves conditions when recreational craft are very unlikely to transit the Inner Sound. Section 5 concluded that there was a low (broadly acceptable) risk for all traffic using the Inner Sound.

21.133 Sea kayaking trips along the coast and around Stroma are considered to have no physical impact from the presence of turbines. Whilst the modelling completed in Section 9 concluded that there would be only minor spatial changes to the tidal and wave patterns in the Inner Sound which are not expected to have any perceived impact on sea kayaking or the surfing in the area.

Impact significance

Impact title	Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Recreational craft	Medium	Minor	Minor	Not Significant
Sea kayaking	Low	Minor	Minor	Not Significant
Surfing	Medium	Minor	Minor	Not significant

MITIGATION IN RELATION TO IMPACT 21.6

- No mitigation measures proposed as no significant impact predicted.

21.8 Impacts during Decommissioning

21.8.1 Impact 21.9: Local employment and GVA impacts during decommissioning

21.134 Estimates of the scale of jobs involved in the onshore decommissioning component of the Project extend to a total of some 4 years[18] of temporary employment or equivalent to 0.4 FTE jobs.

21.135 In terms of the offshore component, the following activities may be undertaken during the decommissioning phase: project management, rigging, turbine removal, foundation removal, cutting activities, port activities, disposal of environmentally sensitive material, and sub-sea survey on completion

21.136 The most recent research as to values relating to the decommissioning of marine devices[19] estimates the cost per MW to be in the range of £25,000-100,000, and assuming that costs will reduce from the higher points in the range as commercialisation of marine arrays is achieved. Hence the assessment has taken the median point of this cost range at £62,500 per MW to estimate decommissioning employment impacts.

21.137 At 86MW the estimated offshore decommissioning cost of the Project would be approximately £5.375 million. This would result in an estimated 119 years of temporary employment.

21.138 Thus the combined economic benefit generated through the decommissioning phase would be a total of 123 years of temporary employment or equivalent to 12.3 FTE jobs. In terms of levels of significance the potential creation of some 123 years of temporary employment or 12.3 FTE jobs would be assessed as of moderate impact at a study area / local level, with the impact being assessed as 'noticeable and judged to be important at a local scale'; and assessed as a minor impact at an all Highlands level being of 'limited or very localised raised as local issues'.

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
N/A	Moderate positive	Moderate positive	Positive

MITIGATION IN RELATION TO IMPACT 21.9

- There are a number of national, regional and local initiatives involving the Scottish Government, regional and local development agencies and the Caithness and North Sutherland Regeneration Partnership with the aim to work towards enhanced skills training, supply chain enhancement, and support for business improvement working in the marine renewables industry, including Caithness. These will assist in realising and maximising the opportunities in the local and wider areas and where appropriate MeyGen will support these initiatives.

21.8.2 Impact 21.10: Wider qualitative economic benefits during decommissioning

21.139 It is considered feasible that during the decommissioning process there will also be opportunities where those employed would develop skills that will be of benefit to the local economy in the longer term, and indeed would be transferrable to other projects in the area. Examples might include the development of project management skills, which could be beneficial in terms of ensuring that local companies or individuals are much better placed to compete for future decommissioning (and construction) work in the wider area, or increasing the number of new starts and supporting small businesses that can benefit from work related to the Project in establishing a business. Once established, these firms or individuals will be in a stronger position to survive and prosper from ongoing work elsewhere.

[18] Based upon 10 jobs for 3months, plus 6 jobs for 2months, plus 2 jobs for 1month; a total of 44months or approximately 4years of temporary employment. HM Treasury guidance indicates this to represent 0.4FTE jobs.

[19] It is assumed that 1 temporary job is equivalent to approximately £164,427. This value is derived from the average sales per employee in the economy construction sub-sector inflated to 2010 prices. Source: UK PLC, A Financial Analysis of Corporate Britain (2005).

Impact significance

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
N/A	Moderate positive	Moderate positive	Positive

MITIGATION IN RELATION TO IMPACT 21.10

- There are a number of national, regional and local initiatives involving the Scottish Government, regional and local development agencies and the Caithness and North Sutherland Regeneration Partnership with the aim to work towards enhanced skills training, supply chain enhancement, and support for business improvement working in the marine renewables industry, including Caithness. These will assist in realising and maximising the opportunities in the local and wider areas and where appropriate MeyGen will support these initiatives. These initiatives will contribute to enhancing the likelihood of these construction employment and output impacts occurring.

21.8.3 Impact 21.11: Local tourism business impacts during decommissioning

21.140 It is assumed that the impacts and effects experienced during the decommissioning phase will be similar in scale and type to that of the construction phase.

Impact significance

Impact title[1]	Magnitude of impact from survey response	Likelihood	Magnitude of impact	Sensitivity of receptor	Consequence	Significance
6% of businesses	Minor	Possible	Minor	Low	Minor	Not Significant
2% of businesses	Major	Possible	Major	Low	Moderate	Significant
38% of businesses	Major positive	Possible	Positive	Low	Moderate positive	Positive

Note:
[1]The '% of businesses' is the percentage of the businesses surveyed who considered the impact to be of that magnitude.

MITIGATION IN RELATION TO IMPACT 21.11

- Consultation with local businesses to manage traffic flows during major events.
- For the potential positive decommissioning impacts there are a number of national, regional and local initiatives involving the Scottish Government, regional and local development agencies and the Caithness and North Sutherland Regeneration Partnership with the aim to work towards enhanced skills training, supply chain enhancement, and support for business improvement working in the marine renewables industry, including Caithness. These will assist in realising and maximising the opportunities in the local and wider areas and where appropriate MeyGen will support these initiatives.

Residual impact

Impact title[1]	Magnitude of impact from survey response	Likelihood	Magnitude of impact	Sensitivity of receptor	Consequence	Significance
2% of businesses	Moderate	Unlikely	Minor	Low	Minor	Not Significant

21.8.4 Impact 21.12: Wider tourism impacts during decommissioning

21.141 It is assumed that the impacts and effects experienced during the decommissioning phase will be similar in scale and type to that of the construction phase.

Impact significance

Impact title	Magnitude of impact from survey response	Likelihood	Magnitude of impact	Sensitivity of receptor	Consequence	Significance
9% of businesses	Minor	Possible	Minor	Medium	Minor	Not Significant
1% of businesses	Moderate	Possible	Moderate	Medium	Moderate	Significant
2% of businesses	Major	Possible	Major	Medium	Major	Significant
72% of businesses	Major positive	Possible	Positive	Medium	Major positive	Positive

MITIGATION IN RELATION TO IMPACT 21.12

- Consultation with local businesses to manage traffic flows during major events.
- For the potential positive decommissioning impacts mitigation as above for economic impacts will increase the likelihood of occurrence.

Residual impact

Impact title	Magnitude of impact from survey response	Likelihood	Magnitude of impact	Sensitivity of receptor	Consequence	Significance
1% of businesses	Minor	Unlikely	Minor	Medium	Minor	Not Significant
2% of businesses	Moderate	Unlikely	Minor	Medium	Minor	Not Significant

21.8.5 Impact 21.13: Recreation impacts during decommissioning

21.142 It is assumed that the impacts and effects experienced during the construction phase will be similar in scale and type to that of the decommissioning phase.

Impact title	Sensitivity of receptor	Magnitude of impact	Consequence	Significance
John o' Groats	Medium	Minor	Minor	Not Significant
A99	Medium	Minor	Minor	Not Significant
A836	Medium	Minor	Minor	Not Significant
Duncansby Head	Medium	Minor	Minor	Not Significant
Puffin Express	Low	Minor	Minor	Not Significant
Nordwall Farm	Low	Minor	Minor	Not Significant
Duncansby Head to John o' Groats promoted path	Low	Minor	Minor	Not Significant
Dunnet Head promoted path	Low	Minor	Minor	Not Significant
St Johns Point promoted path	Low	Minor	Minor	Not Significant
Duncansby Head and Stacks CP207.009	Low	Minor	Minor	Not Significant
Tresdale Track CP207.018	Low	Minor	Minor	Not Significant
Canisbay Roadside CP207.019	Low	Minor	Minor	Not Significant
Freswick to Duncansby Head promoted path	Low	Minor	Minor	Not Significant
Black Hill Peat Track CP207.005	Low	Minor	Minor	Not Significant
John o' Groats Shore CP207.013	Low	Minor	Minor	Not Significant
John o' Groats Roadside Footway CP207.015	Low	Minor	Minor	Not Significant
Old Road CP207.020	Low	Minor	Minor	Not Significant
Sustrans Cycle NR1	High	Minor	Moderate	Significant
Brough to Canisbay Circular cycle route	Low	Minor	Minor	Not Significant
Thurso to Inverness cycle route	Medium	Minor	Minor	Not Significant
Offshore				
John o' Groats Wildlife Cruises	Low	Minor	Minor	Not Significant
Sailing routes	Low	Minor	Minor	Not Significant
Sea kayaking routes	Low	Minor	Minor	Not Significant

21.143 Mitigation will be put in place to minimise and reduce the potential disruption caused by onshore and offshore decommissioning works.

MITIGATION IN RELATION TO IMPACT 21.13

- Consultation with local businesses to manage traffic flows during major events.
- Temporary interruption of recreation routes during construction will be carefully managed and any diversions clearly sign-posted; information on construction works circulated to recreational businesses.
- During the temporary HDD activities, screening measures may be implemented to reduce impacts on passing recreational users or from recreational focal points.
- Marine Safety Information broadcasts will be issued by HM Coastguard to inform mariners of the activity at the MeyGen site.
- The Project will be depicted on Admiralty Charts produced by UKHO.
- Navtex and Notice to Mariners will be issued including details of MeyGen works.
- Information on the work activity at the site will be circulated directly to local ports, ferry operators and recreational clubs and businesses.

Residual impact

Impact title	Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Sustrans Cycle NR1	High	Negligible	Minor	Not Significant

21.9 Potential Variances in Environmental Impacts

21.144 The assessment has considered two alternative location options for the PCC, one at Ness of Quoys and the other at Ness of Huna. These two options have slightly different catchments of recreation resources/receptors and marginally different impacts and effects. As only one PCC location will be developed, impacts identified from a recreational perspective will reduced from those presented in this assessment.

21.145 Socio economic and tourism and recreation impacts are not influenced by the potential project alternatives.

21.10 Cumulative Impacts

21.10.1 Introduction

21.146 MeyGen has in consultation with Marine Scotland and THC identified a list of other projects (MeyGen, 2011) which together with the Project may result in potential cumulative impacts. The list of these projects including details of their status at the time of the EIA and a map showing their location is provided in Section 8; Table 8.3 and Figure 8.1 respectively.

21.147 Having considered the information presently available in the public domain on the projects for which there is a potential for cumulative impacts, Table 21.19 below indicates those with the potential to result in cumulative impacts from a socio economic perspective. The consideration of which projects could result in potential cumulative impacts is based on the results of the project specific impact assessment together with the expert judgement of the specialist consultant.

Project title	Potential for cumulative impact	Project title	Potential for cumulative impact	Project title	Potential for cumulative impact
MeyGen Limited, MeyGen Tidal Energy Project, Phase 2	✓	SHETL, HVDC cable (onshore to an existing substation near Keith in Moray)	×	OPL, Ocean Power Technologies (OPT) wave power ocean trial	×
ScottishPower Renewables UK Limited, Ness of Duncansby Tidal Energy Project	✓	Brough Head Wave Farm Limited, Brough Head Wave Energy Project	✓	MORL, Moray Offshore Renewables Ltd (MORL) offshore windfarm	✓
Pelamis Wave Power, Farr Point Wave Energy Project	✓	SSE Renewables Developments (UK) Limited, Costa Head Wave Energy Project	✓	SSE and Talisman, Beatrice offshore Windfarm Demonstrator Project	×
Sea Generation (Brough Ness) Limited, Brough Ness Tidal Energy Project	×	EON Climate & Renewables UK Developments Limited, West Orkney North Wave Energy Project	✓	BOWL, Beatrice Offshore Windfarm Ltd (BOWL) offshore windfarm	✓
Cantick Head Tidal Development Limited, Cantick Head Tidal Energy Project	✓	EON Climate & Renewables UK Developments Limited, West Orkney South Wave Energy Project	✓	Northern Isles Salmon, Chalmers Hope salmon cage site	×
SSE, Caithness HVDC Connection - Converter station	×	ScottishPower Renewables UK Limited, Marwick Head Wave Energy Project	✓	Northern Isles Salmon, Pegal Bay salmon cage site	×
SSE, Caithness HVDC Connection - Cable	×	SSE Renewables Developments (UK) Limited, Westray South Tidal Energy Project	✓	Northern Isles Salmon, Lyrawa salmon cage site	×
RWE npower renewables, Stroupster Windfarm	✓	EMEC, Wave Energy test site (Billia Croo, Orkney)	×	Scottish Sea Farms, Bring Head salmon cage site	×
SSE, Gills Bay 132 kV / 33 k V Substation Phase 1: substation and overhead cables (AC)	✓	EMEC, Tidal energy test site (Fall of Warness, Orkney)	×	Northern Isles Salmon, Cava South salmon cage site	×
SSE, Gills Bay 132 kV / 33 k V Substation Phase 2: HVDC converter station and new DC buried cable	✓	EMEC, Intermediate wave energy test site (St Mary's Bay, Orkney)	×	Scottish Sea Farms, Toyness salmon cage site	×
SHETL, HVDC cable (offshore	×	EMEC, Intermediate tidal energy	×	Northern Isles Salmon, West	×
Moray Firth)		test site (Head of Holland, Orkney)		Fara salmon cage site	

Table 21.19: Summary of potential cumulative impacts

21.148 The following sections summarise the nature of the potential cumulative impacts for each potential project phase:

- Construction and installation;
- Operations and maintenance; and
- Decommissioning.

21.10.2 Potential cumulative impacts during construction and installation

21.149 While there is limited data available on the timescales for these projects, it is not considered likely that the MeyGen Tidal Energy Project, Phase 1 together with any of these projects would result in significant negative impacts either in terms of economic, tourism or recreation during the construction and installation phase.

21.150 The only project likely to be in construction at the same time as the Project is the SSE Gills Bay 132kV/33kV substation, Phase 1 as this is required to provide increased grid capacity for the MeyGen Project. The cumulative disruption of construction works are not considered to be significant for the area and both projects will provide positive opportunities for local businesses to be directly involved in the construction works or indirectly with accommodation and secondary effects.

21.151 When construction timescales are better understood, MeyGen will ensure that any potential simultaneous works will be managed appropriately to minimise disruption to the local area.

21.10.3 Potential cumulative impacts during operations and maintenance

21.152 While there are limited data and information on these projects, it is not considered likely that the MeyGen Tidal Energy Project, Phase 1 together with any of these projects would result in a significant negative impact either in terms of economic, tourism or recreational impact during operation and maintenance.

21.153 In terms of the landscape, seascape and visual impact of other projects, in combination and cumulatively with the MeyGen Project, Phase 1 and the impacts that could have on key tourist attractions, these are considered in Section 19.

21.154 However, while the level of assessed impact from the Project is limited in tourism and recreational terms, the economic impact of the other marine and offshore wind projects in total are likely to provide considerable opportunities to the local area's businesses, where they have capacity and capability to provide for these types of energy generation and transmission infrastructure projects; and also provide opportunities for the transference of engineering and related skills from the decommissioning of Dounreay to these developments.

21.155 Phase 2 of the MeyGen Tidal Energy Project will comprise the deployment of a further 312 MW offshore and associated cables to shore and onshore infrastructure. The exact geographical location, extent and nature of the onshore facilities required for Phase 2 are not yet defined and will incorporate lessons

learned from and technology advancements beyond, Phase 1 of the Project. These factors will influence the potential for, nature of and significance of any cumulative impacts. From an economic perspective the expansion of the Project could generate further economic impacts on the local and regional economies. From a tourism and recreational perspective, potential cumulative impacts will be very much dependent on the location of onshore infrastructure, but potentially may occur.

21.156 All Pentland Firth and Orkney Waters projects are engaging with national, regional and local initiatives involving the Scottish Government, regional and local development agencies and the Caithness and North Sutherland Regeneration Partnership with the aim to work towards enhanced skills training, supply chain enhancement, and support for business improvement working in the marine renewables industry, including Caithness. These will assist in realising and maximising the opportunities in the local and wider areas and where appropriate MeyGen will support these initiatives.

21.10.4 Potential cumulative impacts during decommissioning

21.157 Impacts during decommissioning are expected to be broadly similar to the construction and installation of the Project. While there are limited data and information on the other projects, it is not considered likely that the MeyGen Tidal Energy Project, Phase 1 together with any of these projects would result in a significant negative impact either in terms of economic, tourism or recreational impact during decommissioning.

21.10.5 Mitigation requirements for potential cumulative impacts

21.158 No mitigation is required over and above the Project specific mitigation.

21.11 Proposed Monitoring

21.159 No monitoring has been proposed for this section.

21.12 Summary and Conclusions

21.160 The Project offers major potential in acting as an economic driver and boost to the local Caithness and Northern Isles, and also the wider Highlands economy, in an area, which has historically been dependent upon Dounreay and tourism to a large extent. With the continuing decommissioning of the Dounreay nuclear facility it is imperative that alternative employment and economic opportunities are realised in the local area. The Project, together with other marine projects in the Pentland Firth and Orkney Waters and offshore wind projects present such an opportunity to retain both population and skills.

21.161 The nature of the Project is such that the offshore element will not result in any visual impact either during the temporary construction or decommissioning phases, or indeed once it is in permanent operation.

21.162 The onshore elements will potentially have a limited number of adverse tourism and recreational impacts but these are assessed as not being significant following the proposed mitigation.

21.163 In terms of economic impact the Project will have positive impacts at a local level during all phases of the Project. These positive impacts will occur both within the wider industry supply chain and also within the tourism business economy through the supply of accommodation, and other goods and services.

21.164 The decommissioning phase of the Project is not assessed as having any significant impacts on the local economy, although some minor positive economic impact might occur.

21.165 The overall conclusion of the socio-economic assessment is that the Project will have some positive economic impacts and no major residual significant tourism or recreation impacts on the local study area.

21.13 References

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22 ONSHORE TRANSPORTATION AND ACCESS

22.1 There were no supporting studies which directly relate to the Onshore Transportation and Access impact assessment.

22.1 Introduction

22.2 This section assesses the potential environmental impacts of the Project on the existing road infrastructure and receptors which may be sensitive to traffic associated with the proposals. This assessment has been undertaken by Xodus.

22.3 Noise, vibration and dust elements relating to transportation and access are assessed in Section 23.

22.4 Several definitions have been used in this section and are described below:

- Construction Phase / Traffic: The construction phase refers to all aspects of the development prior to it becoming operational and includes the transportation of construction staff, construction materials and plant items to the development site. As with operational traffic a worst case scenario has been assumed and assessed (defined below);
- Operational Phase / Traffic: The operational phase refers only to the day to day operation of the Project and any maintenance requirements therefore limited to control and maintenance staff visits to the Power Conversion Centre (PCC). A worst case scenario has been assumed and assessed (defined below);
- Goods Vehicles: Light Goods Vehicles (LGV) under 7.5 tonne Gross Vehicle Weight; Heavy Goods Vehicles (HGV) over 7.5 tonnes but under 44 tonnes Gross Vehicle Weight, abnormal loads (where an abnormal load is one which is over 2.9m wide, over 18.65m in length or over 80 tonnes Gross Vehicle Weight);
- Automatic Traffic Counter (ATC) data: Transport Scotland has provided historic ATC data for traffic volumes at various locations in the vicinity of the study area; and
- National Road Traffic Forecast (NRTF): NRTF growth factor (1.53%) is adopted for the purposes of this assessment to predict future traffic predictions.

22.2 Assessment Parameters

22.2.1 Rochdale Envelope

22.5 In line with the Rochdale Envelope approach, this assessment considers the maximum ('worst case') Project parameters. Identification of the worst case scenario for each receptor (i.e. Environmental Impact Assessment (EIA) topic) ensures that impacts of greater adverse significance would not arise should any other development scenario be taken forward in the final scheme design. Table 22.1 describes the detail of the Project parameters that have been used in this assessment and explains why these are considered to be worst case. The potential impacts from alternative Project parameters have been considered in Section 22.9.

22.6 Based on the information presented in Table 22.1 year 3 construction represents the worst case from an onshore transportation and access perspective.

Project parameter relevant to the assessment		'Maximum' Project parameter for impact assessment	Explanation of maximum Project parameter
Onshore Power Conversion Centre	Construction - Year 1	25 HGV trips plus 20 workers travelling to site.	Construction of 1 Power Conversion Unit Building (PCUB) and control building during year 1 of onshore construction schedule at either Ness of Quoys or Ness of Huna.
	Construction - Year 3	50 HGV trips plus 30 workers travelling to site.	Construction of 2 PCUB buildings during year 3 of onshore construction schedule at either Ness of Quoys or Ness of Huna.
	Operation and Maintenance (O&M)	No HGV trips. Eight workers and their vehicles travelling to site per day.	Assessment based on assumption that six permanent control staff are present at the same time as two maintenance vans.
Onshore cable routes between PCC and SHETL substation	Construction – Year 2	Disruption to road network with installation of cables.	Installation of 1 x 33kV underground cable. Assessment of potential impacts associated with cable installation along all potential cable corridors identified between PCC locations and SHETL substation proposed at Phillips Mains. No permanent road access (other than existing road network) required along cable routes.
	Construction – Year 3	Disruption to road network with installation of cables.	Installation of 2-3 x 33kV underground cables. Assessment of potential impacts associated with cable installation along all potential cable corridors identified between PCC locations and SHETL substation proposed at Phillips Mains. No road access (other than existing road network) required along cable routes.
Cable landfall	Horizontal Directional Drill (HDD) site construction	Up to 75 HGV trips plus 10 workers travelling to site.	Assessment of potential impacts associated with the HDD of the cable bores, during the Project construction phase. This includes: ▪ Establishment and reinstatement of the HDD site; ▪ Transport of equipment to and from site during mobilisation and demobilisation of HDD activities each year of the 3 year HDD drilling campaign; and ▪ Workers travelling to and from the HDD site. Up to 1 abnormal load associated with the HDD site construction activities.
	HDD spoil removal – Year 1	Up to 211 HGV trips plus 10 workers travelling to site.	Assessment of potential impacts associated with the HDD of the cable bores, during the Project construction phase. This includes: ▪ The transport of drill cuttings from the site to the recycling/reuse/disposal site and transport of water for mixing bentonite to the site; and ▪ Workers travelling to and from the HDD site. No abnormal loads associated with the HDD activities.
	HDD spoil removal – Year 2	Up to 422 HGV trips plus 10 workers travelling to site.	Assessment of potential impacts associated with the HDD of the cable bores, during the Project construction phase. This includes: ▪ The transport of drill cuttings from the site to the recycling/reuse/disposal site and transport of water for mixing bentonite to the site; and ▪ Workers travelling to and from the HDD site. No abnormal loads associated with the HDD activities.
	HDD spoil removal – Year 3	Up to 1,497 HGV trips plus 10 workers travelling	Assessment of potential impacts associated with the HDD of the cable bores, during the Project

Project parameter relevant to the assessment		'Maximum' Project parameter for impact assessment	Explanation of maximum Project parameter
		to site.	construction phase. This includes: ▪ The transport of drill cuttings from the site to the recycling/reuse/disposal site and transport of water for mixing bentonite to the site; and ▪ Workers travelling to and from the HDD site. No abnormal loads associated with the HDD activities.
Offshore Project components	Transport of offshore turbine and Turbine Support Structure (TSS) components to onshore assembly area	Based on 3 abnormal loads per turbine: Year 1 – 30 abnormal loads. Year 2 – 54 abnormal loads. Year 3 – 222 abnormal loads. Up to 10 workers assumed to travel to the assembly site in their vehicles on any given day.	Assessment of potential impacts associated with the assembly and installation and long term operation and maintenance of the offshore infrastructure; TSS, turbines and cables. During offshore installation the following is assumed: ▪ Transport of all TSS/turbine components to assembly site by road; ▪ The transport of TSS/turbine components to assembly site (assumed to be Scrabster) will involve up to 3 abnormal sized loads; and ▪ Workers associated with offshore installation will live on board the installation vessels and arrive at site on board the vessel(s).
	Operation and Maintenance	Delivery of components and numbers of workers travelling to site Up to 50 workers assumed to travel to Scrabster on a daily basis.	During the operational phase of the Project the impact assessment has considered workers travelling to and from maintenance vessel base (assumed to be Scrabster). There will be 50 people working on the Operations and Maintenance (O&M) phase, including offshore works and maintenance of offshore equipment and onshore, (i.e. maintaining turbines) which will all be heading to facilities around Scrabster.

Table 22.1: Rochdale Envelope parameters for the onshore transportation and access assessment

22.2.2 Area of assessment

22.7 It is also important to define the geographical extent of the assessment area. The focus of the onshore transportation and access assessment is potential impacts on the road network and receptors in the areas of the road network to be used during the onshore transport aspects of the Project.

22.8 It should be noted that this assessment was completed on a larger Project area this has since been refined to a smaller footprint at both the Ness of Quoys and Ness of Huna PCC sites and a single cable corridor to the SHETL substation option areas. The final Project is described in Section 5 and shown in Figure 5.2; the selection process for these is discussed in Section 4.

22.3 Legislative Framework and Regulatory Context

22.3.1 Legislation

22.9 The EIA Regulations are the only legislation relevant to this assessment. There is currently no statutory legislation which applies to environmental impacts of traffic generated by new developments.

22.3.2 National planning policies

22.10 In 2004 the Scottish Government published the Scottish transport white paper which set out the Government's vision for transport in Scotland. The paper documented plans for a radical reform of transport at National and Regional levels. The key objectives detailed in the paper were:

- To promote economic growth by building, enhancing, managing and maintaining transport services, infrastructure and networks to maximise their efficiency;
- To promote social inclusion by connecting remote and disadvantaged communities and increasing the accessibility of the transport network;
- Protect our environment and improve health by building and investing in public transport and other types of efficient and sustainable transport which minimise emissions and consumption of resources and energy;
- Improve safety of journeys by reducing accidents and enhancing the personal safety of pedestrians and staff; and
- Improve integration by making journey planning and ticketing easier and working to ensure smooth connection between different forms of transport.

22.11 Following from this Scotland's National Transport Strategy (2006) was released which sets out the Scottish Government's long term vision for transport including objectives, priorities and plans. The high level objectives identified in the white paper remain applicable to the Transport Strategy and in addition three key strategic outcomes were identified:

- Improve journey times and connections;
- Reduce emissions; and
- Improve quality, accessibility and affordability.

22.12 Scottish Planning Policy (Paragraphs 165 – 181) sets out the broad policies relating to transport and new or existing developments including emissions, land use, existing transport network, locations for development, development plans, parking policies, strategic transport network, airports and seaports, freight, and roadside facilities.

22.13 Planning Advice Note 75 (PAN 75) Planning for Transport (Point 41) states that "All planning applications that involve the generation of person trips should provide information covering the transport implications of the development, the level of detail will be proportionate to the complexity and scale of the impact of the proposal. This will provide an indication of whether a transport assessment should be carried out".

22.14 The same advice note (Point 37) states "Schemes in committed programmes and/or those at an advanced stage of preparation where work is expected to begin in the plan period should be included in the local plan proposals map".

22.3.3 Development plan policies

22.15 The Caithness Local Plan is a statutory document which was prepared by The Highland Council (THC) to guide decisions on planning applications[1]. The plan was adopted in September 2002 but will be replaced by the Highland-wide Local Development Plan (HWLDP)[2] (expected to be adopted in 2012).

22.16 The vision of the current is for a robust and expanding economy growing population, improved communications and services and safeguards for the environment. An overall development strategy for the county based on strategic objectives is the mechanism for achieving this vision.

22.17 Elements of the strategic objective for infrastructure relate to transport in the county. The Council will seek to:

[1] Still in force at time of EIA and ES compilation
[2] Not adopted at time of EIA and ES compilation

- Ensure key roads are brought up to an acceptable standard and fit into the natural environment as far as is practicable;
- Support measures that will maintain the Far North Rail Line, Scrabster and Wick harbours and Wick airport to encourage greater use by passengers and freight; and
- Reduce the environmental impact of traffic in settlements and larger developments through traffic calming measures and by giving priority to pedestrians and cyclists.

22.18 The plan recognises that the A3836 is a major tourist route linking John o' Groats and North Sutherland and realises that there may be opportunities to take advantage of this and derive more local benefit in association with Castlehill / Dunnet Bay area.

22.19 The draft Highland-wide Local Development Plan (already been out to consultation and expected to be adopted in 2012)[3] sets out an overarching spatial planning policy for the whole of THC's area. It will update the General Policies of the Caithness Local Plan. The vision for Caithness and Sutherland is for the area to be a connected and place.

22.20 Policy 57 – Travel states that "Development proposals that involve travel generation must include sufficient information with the application to enable the Council to consider any likely on and off site transport implications of the development" and should:

- Be well served by the most sustainable modes of travel available in the locality from the outset, providing opportunity for modal shift from private car to more sustainable transport modes wherever possible, having regard to key travel desire lines;
- Be designed for the safety and convenience of all potential users;
- Incorporate appropriate mitigation on site and/or off site, provided through developer contributions where necessary, which might include improvements and enhancements to the walking/cycling network and public transport services, road improvements and new roads;
- Incorporate an appropriate level of parking provision, having regard to the travel modes and services which will be available and key travel desire lines and to the maximum parking standards laid out in Scottish Planning Policy or those set by the Council; and
- Fit with the policies and recommendations of the Local Transport Strategy.

22.21 Policy 57- Travel also states "Where site masterplans are prepared, they should include consideration of the impact of proposals on the local and strategic transport network. In addition the Council will seek the implementation and monitoring of Green Travel Plans in support of significant travel generating developments".

22.22 The Local Transport Strategy highlights the importance of the A9 trunk road. It states that flows on the A9 were consistent with general growth patterns, with growth on all sections south of Aviemore, and at Aviemore itself, of 44% from 2000 to 2006. The stretch of the A9 at Inverness also experienced growth of 50% over the same period. The section of the A9 north of Inverness has flows of up to 33,000 vehicles per day, but further north there has been less traffic growth particularly north of Dornoch Bridge, where low daily flows are consistent with the level of population. However, with the potential for development of marine energy in the Pentland Firth and other renewable developments this route is likely to become increasingly important for commercial and business connections to the south.

[3] Not adopted at time of EIA and ES compilation

22.4 Assessment Methodology

22.23 Guidance for the assessment of the impact of the Project on transportation and access has been taken from the Institute of Environmental Assessment (IEA) Guidance Notes No.1: Guidelines for the Environmental Assessment of Road Traffic (IEA, 2003).

22.24 The increase in any traffic levels and their receptor effects have been assessed against the guidelines (IEA, 2003) which state that assessment is required where traffic movements or HGV movements increase by >30%, or more than 10% where there are sensitive receptors likely to be affected.

22.25 In addition, specific feedback on the Project from relevant stakeholders has been taken into consideration in the assessment.

22.26 This section outlines the relevant feedback on the Project, the approach to baseline characterisation and the significance criteria used in the impact assessment.

22.4.1 Scoping and consultation

22.27 Since the commencement of the Project, consultation on onshore transportation and access issues has been ongoing. Table 22.2 summarises all consultation relevant to onshore transportation and access. In addition, relevant comments from the EIA Scoping Opinion are summarised in Table 22.3, together with responses to the comments and reference to the Environmental Statement (ES) sections relevant to the specific comment.

Date	Stakeholder	Consultation	Topic/specific issue
7th April 2011	Marine Scotland and Scottish Natural Heritage (SNH)	Pre-Scoping meeting	EIA surveys and studies required and the data needs for each EIA study.
27th May 2011	Marine Scotland, statutory consultees and non statutory consultees	Submission of EIA Scoping Report	Request for EIA Scoping Opinion from Marine Scotland and statutory consultees and request for comment from non statutory consultees.
30th June – 2nd July 2011	Local stakeholders	Public Event - EIA Scoping	Public event to collate information/opinions on proposed EIA scope.
19th August 2011	THC	Telephone call	Scope of transport study.
19th August 2011	Transerv	Telephone call	Scope of transport study.
14th September 2011	THC	Meeting	Planning pre application meeting. Presentation on overall Project and results of EIA studies to date.
31st September 2011	Marine Scotland, The Highland Council, statutory consultees and non statutory consultees	Receipt of EIA Scoping Opinion	Receipt of response to EIA Scoping Report and other comments from non statutory consultees.
10th October 2011	THC	Receipt of pre application advice	Receipt of pre application advice from The Highland Council.
8th November 2011	Caithness Transport Forum	Email	Scope of transport study.
6th – 7th December 2011	Local stakeholders	Public Event – pre application consultation	Public event to communicate the findings of the EIA to local stakeholders.

Table 22.2: Consultation relevant to onshore transport and access

Name of organisation	Key concerns	Response	ES section within which the specific issue is addressed
THC	Construction traffic for the size of scheme considered to be reasonable and appropriate to the road network but would like to see further information on traffic levels presented (no responsibility for the trunk road network).	Construction traffic levels have been predicted as part of the impact assessment and are presented in this section in comparison with the existing traffic levels.	Section 22.5 Baseline Description
Transport Scotland (JMP Consultants Limited)	Impact of construction traffic on the trunk road network including preferred routes, impact on traffic levels, noise and air quality. Impact of operational traffic on the trunk road network.	Construction traffic levels are predicted in this section alongside indications of likely preferred routes of construction vehicles. Air quality issues due to traffic have been scoped out (described in this section) due to the predicted traffic levels and the criteria set out in the JMP response. Noise and vibration are considered in a separate section (Section 23). Operational traffic is likely to be minimal but is described in this section.	Section 22.5 Baseline Description, Section 23 Onshore noise and Dust, and, Section 22.6 Construction Impact Assessment
Caithness Transport Forum	The CTF recommended that the A99 needs widening both sides of Keiss village to make the carriageway suitable for two-way commercial traffic. Additionally, the CTF advised that if Gills Harbour were used for large loads the corner going down to the harbour could also be widened for ease of access.	At the present stage the EIA focuses on Project components and their interactions with the road network in its present state. The EIA is not at this stage looking at engineering aspects of the road network and issues such as road capacity and the quality of existing infrastructure will be the subject of consideration at a later date during detailed engineering design.	N/A

Table 22.3: Scoping comments relevant to onshore transportation and access

22.4.2 Desk based study

22.28 A desk study has been undertaken to characterise the road infrastructure in the area of the proposed Project and collate road traffic numbers for the main routes serving the area. This allows a comparison to be made between likely existing traffic levels and the traffic levels associated with the Project, provided by MeyGen.

22.29 In undertaking the desk based study, various data sources and documents have been reviewed including:

- Responses to consultation and the EIA Scoping Report;
- Consideration of 2010 and 2011 traffic count data provided by Transport Scotland for the A836, including classification by vehicle type; and
- Consideration of other traffic sensitive receptors in the area such as communities, busy routes and sites of particular interest e.g. important tourist destinations.

22.4.3 Field survey

22.30 Detailed recent traffic count data (up to July 2011) provided by Transport Scotland for the A836 has negated the requirement for a further manual traffic count survey, following discussion with THC in August 2011.

22.31 A site visit was undertaken in order to make a photographic record of condition of all the roads and junctions in the immediate area which may be affected by the Project. This site visit did not include the A9 trunk road which regularly supports large volumes of traffic, including haulage to and from Scrabster.

22.32 No further field survey was deemed necessary for the environmental assessment of the transportation and access requirements or implications of the Project.

22.4.4 Significance criteria

22.33 The EIA process and methodology are described in detail in Section 8. Each assessment section is, however, required to develop its own criteria for the 'sensitivity of receptor' and 'magnitude of impact' aspects since the definition of these will vary between different topics. For onshore transportation and access, the significance criteria used in this section is based on the methodology described in Section 8 but the sensitivity of the receptor and magnitude of impact are defined in Table 22.4 and Table 22.5 respectively.

22.34 The consequences of impacts are then considered by reference to the relevant criteria in the EIA Regulations. The significance of impacts in relation to the EIA Regulations is defined in Section 8, Table 8.2.

Sensitivity of receptor	Definition
Very High	▪ Receptors of greatest sensitivity to traffic flow: schools, playgrounds, accident blackspots, retirement homes, roads without footpaths that are routinely used by pedestrians.
High	▪ Receptors with a high sensitivity to traffic flow: colleges, hospitals and doctors' surgeries, shopping streets with multiple roadside frontages, roads without footpaths that are infrequently used by pedestrians.
Medium	▪ Receptors with medium sensitivity to traffic flow: recreation facilities, streets with few shops with roadside frontages, roads with narrow footpaths used by pedestrians.
Low	▪ Receptors with some sensitivity to traffic flow: places of worship, public open space, listed buildings, tourist attractions and residential areas with adequate footpath provision.
Negligible	▪ Receptors with little or no sensitivity to traffic flow and those sufficiently distant from affected roads and junctions.

Table 22.4: Definitions for sensitivity of receptor

Magnitude of impact	Definition
Severe	▪ Severe alteration to key elements / features of the baseline conditions such that the character / composition / attributes will be fundamentally changed. ▪ Guide: >100% increase in baseline conditions. ▪ Impact highly likely to occur or will have the effect of being a permanent (> 3 years) change in baseline conditions.
Major	▪ Major alteration to key elements / features of the baseline conditions such that character / composition / attributes will be fundamentally changed. ▪ Guide: 71% to 100% increase in baseline conditions. ▪ Impact likely to occur or will have the effect of being a semi-permanent (< 3 years) change in baseline conditions.

Magnitude of impact	Definition
Moderate	▪ Alteration to one or more key elements / features of the baseline conditions such that post deployment character / composition / attributes of baseline will be partially changed. ▪ Guide: 31% to 70% increase in baseline conditions. ▪ Impact will possibly occur or will have the effect of being a temporary lasting change to baseline conditions (i.e. more than a series of independent occurrences).
Minor	▪ Minor shift away from baseline conditions. Change arising from the loss / alteration will be discernible but underlying character / composition / attributes of baseline condition will be similar to pre-development circumstances / patterns. ▪ Guide: 11% to 30% increase in baseline conditions. ▪ Impact unlikely to occur or will have the effect of being a series of independent occurrences or daily short-term change to the baseline conditions over a period < 6 months.
Negligible	▪ Very slight change from baseline conditions. Change barely distinguishable, approximating to the "no change" situation. ▪ Guide: 1% to 10% increase in baseline conditions. ▪ Impact extremely unlikely to occur.
Positive	▪ An enhancement in the availability or quality of a resource.

Table 22.5: Definitions for magnitude of impact

22.4.5 Data gaps and uncertainties

22.35 This is a semi quantitative assessment that includes some professional judgement of conditions and worst case estimates regarding traffic levels associated with the Project. Much of the assessment concerns traffic levels in rural areas and on minor roads for which there is limited continuously recorded traffic flow data. However, assumptions have been made for these roads using the available continuous data for the A836.

22.36 The A836 is a single two-way carriageway whereas all the minor link roads are single-track roads with passing places.

22.5 Baseline Description

22.5.1 Introduction

22.37 This section describes the road network in its current form. It also describes the local transport network available for travel by bicycle, bus and car in the vicinity of the site.

22.5.2 Geographical area of assessment

22.38 The Project is located around a section of the A836. It is likely, however, that routes for delivery of materials of plant will utilise the trunk road network. The A9 to Thurso is an important link between Inverness and Caithness as well as Orkney and is recognised in The Highland Council Local Transport Strategy as a key route for freight. For construction traffic and transport of turbine component parts, assessment has included utilisation of the A9 trunk road. For operational traffic assessment has been made on the local road network only. Figure 22.1 shows the local road network.

22.5.3 Road network

22.39 The existing road network in the vicinity of the proposed Project comprises a local 'A' road, A836, which links the A9 at Thurso to the A99 at John o' Groats. The A836 travels through a number of small settlements on this stretch, the largest of which being Castletown, near to Dunnet. The B876 also meets the A386 at Castletown linking the town with Wick, although this is the more minor (in road status terms) of three routes between Wick and the north coast of Caithness. Castletown is home to a number of amenities as well as homes for the elderly, schools, churches and an industrial estate. The baseline traffic described later in this section includes vehicles which have either left or are travelling into Castletown.

22.40 Within the immediate vicinity of the Project the A836 provides the only access to the harbour at Gills Bay from which operates a roll on-roll off (RO-RO) ferry to Orkney. Other activity at Gills Bay includes occasional use by small fishing vessels and small survey vessels. Several more minor roads link into the A836 to provide access to dispersed settlements in the area. Potential cable routes for the MeyGen Project are located along these link roads. The only concentration of housing and services in the immediate vicinity is at Canisbay, to the south of Ness of Quoys, where there is a Primary school, post-office/shop and bus stop.

22.41 The A836 is part of the North and West Highlands National Tourist Route which is approximately 224km long. The route starts in Ullapool on the west coast, goes through mountains and the villages of Achiltibuie, Lochinver and Kinlochbervie, and Durness in the north-west of Scotland. From Durness, the route heads east to John o' Groats.

22.5.4 Cyclists

22.42 During the site visit a number of cyclists were observed along both the A836 and adjoining minor roads. John o' Groats is a popular start point or destination for cyclists travelling the length of the UK to or from Lands End. There is no official route in the area around John o' Groats but cyclists will normally choose to make use of National Cycle Route 1, as shown on Figure 22.1, or use the road network directly south along the A99 between John o' Groats and Wick. The Canisbay Loop is a local cycle route running from Brough near to Dunnet Head along minor roads and linking to the A836 near Castle of Mey before it passes through the Project area, through Gills and circling back through Canisbay and continuing on the minor roads before returning to Brough. This route is shown on Figure 22.1.

22.5.5 Other road users

22.43 No major route bus services operate in the area, however there is a local service between John o' Groats and Thurso which offers connections to Wick, Inverness and elsewhere in the Highlands. The bus stops for the local service are shown on Figure 22.1.

22.44 Cruise liners visit Scrabster each year, carrying up to 1,500 passengers each. Most of the shore excursions are in the form of half day coach tours. The passengers are split in half with half doing the tour in the morning and the other half in the afternoon. Generally this sees approximately 12 coaches in use for the larger cruise liners and six for the smaller ones. The main shore excursion from Scrabster is the Castle of Mey and normally about 75% of the tours will go there. Scenic tours including Dunnett Head, Duncansby Head and John o' Groats are also popular, accounting for approximately 20% with the remainder being made up of the Pulteney distillery in Wick and Strathnaver Museum (West of Thurso).

22.45 The cruise business in Scrabster has been growing slowly but steadily over the past few years. In 2010 there were nine cruise arrivals, in 2011 there were 10 and in 2012 there are provisional expectations of 12 vessels (Scrabster Harbour Master *pers comm.,* 2011).

22.46 Information has been gathered on examples of abnormal loads which have used the local road network. Table 22.6 describes the various sizes and weights of the loads and the routes taken.

Load Description	Weight	Width	Length	Route
Submarine Used Fuel Flask and transporter	90 tonnes (total trailer weight 120 tonnes approx).	3m approx	Approx 9m	From MoD Vulcan site (by Dounreay) to Inverness rail head via Thurso town centre (Princes Street and Thurso river bridge).
Forsse wind farm blades (steered trailor)	Approx 25 tonnes.	-	32m	A9 to Forsse (E of Thurso) via Thurso town centre.
Dounreay Fuel Movements (planned)	Estimated at 40 tonnes but not confirmed.	3m approx	No more than 15m	From Dounreay to Georgemas Junction via Thurso town centre.

Load Description	Weight	Width	Length	Route
Gordonbush Wind Farm components	110 tonnes (150 tonnes trailer weight).	4m	40 trailer + 10m tractor unit	Invergordon to Gordonbush (by Brora).
Tow Heads	220 tonnes (total trailer weight 270 approx).	6m approx	32m approx	From Wick Quayside to Bridge of Wester (East of Wick).
350 tonne mobile crane	76 tonnes approx.	3m approx	18m approx	Aberdeen via Inverness and Thurso to Scrabster and Dounreay.

Table 22.6: Examples of abnormal loads

22.5.6 Road users

22.5.7 Baseline traffic volumes

22.47 As construction activities for the Project will continue throughout the year this assessment has looked at the seasonality of vehicle trips. A component of seasonality is due to tourism so an indication of the level of change throughout the tourist season has been obtained from VisitScotland for the Thurso Information Centre which opens from April to October each year. In 2009 and 2010 the quietest months were April and October, with the busiest month being August. In 2010 the number of visitors increased between April and August by approximately 460%. The figures provided by VisitScotland represent footfall statistics and are not split according to mode of travel however they do provide a strong indication of the seasonal nature of tourism in the region.

22.48 Assuming the baseline local traffic remains consistent throughout the year, several week-long periods in 2010 and 2011 have been selected to provide the baseline traffic levels for the A836 from the data supplied by Transport Scotland (location shown on Figure 22.1), taking into account the busy month of August and the quiet months of April and October. Weeks in each month have been chosen at random to provide this snapshot. A week in February has been chosen to further understand the traffic levels outside of the normal tourist season, and a week in July 2011 has also been selected as it is the most recent data available for the A836.

22.49 Using the NRTF growth factor of 1.53% per year the potential baseline traffic levels in 2015 have been predicted. True and predicted traffic levels split by total vehicles and HGVs are presented in Table 22.7 on a per week basis during the core hours of 0800 to 1800.

22.50 The table demonstrates that the busiest month agrees with the predictions due to increased tourism activity in the month of August and with there being less vehicle activity during February, outside the tourist season.

22.51 A slight increase in the number of HGVs is seen during the summer months of July and August, but in percentage terms the number of HGV trips counted per week remains fairly consistent throughout the year. For the purposes of this assessment the NRTF growth factor has been applied to predict the number of HGV trips in 2015.

Month (2010 – 2011)	Total trips (present)	Total HGVs (present)	Total trips (2015)	Total HGVs (2015)
August	14,709	399	15,869	430
October	10,787	323	11,638	348
February	9,053	330	9,767	356
April	10,279	287	11,090	309
July	11,066	368	11,939	397

Table 22.7: Typical and predicted seasonal baseline two-way traffic flow for the A836 (Transport Scotland)

22.52 Data provided by Transport Scotland for the A9 did not include classification of vehicle type. However, the Annual Average Daily Traffic (AADT) between 01 June 2010 and 31 May 2011 has been calculated at approximately 535 vehicles (two-way flow). Based on the data supplied for the A836 it has been assumed that a similar percentage of HGVs use the A9; 3% of 535 vehicles is equivalent to approximately 16 HGVs potentially using the A9 at Thurso each day. Based on the importance of the A9 for freight, it is likely that this figure is an under-estimate. The location of this count at Thurso is shown on Figure 22.1.

22.6 Impacts during Construction and Installation

22.6.1 Impact 22.1: Road traffic congestion associated with PCC site

22.53 MeyGen has provided information on the likely HGV numbers associated with the construction phase of the proposed Project. The most intensive activity is in year 3 and relates to HGV activity for the disposal of spoil from the HDD bores and traffic associated with PCUB construction. There could also potentially be abnormal sized loads associated with HDD site establishment. It is therefore this activity which has been used as the worst case scenario in this impact assessment. It is assumed that all spoil and water for bentonite mixing for the balance of the HDD bores in 2015 will be transported evenly over an eight month period. This equates to approximately 50 HGV trips per week and is compared to predicted HGV levels in 2015 in Table 22.8.

Month (2010 – 2011)	Total trips (2015 baseline)	Total HGVs (2015)	Construction worker vehicles two-way trips per week	Const. HGVs two-way trips per week	Total vehicles (2015 baseline + const.)	Total HGVs (2015 baseline + const.)	% Increase all vehicles	% Increase HGVs
Aug	15,869	430	240	50	16,159	480	2	12
Oct	11,638	348	240	50	11,928	398	2	14
Feb	9,767	356	240	50	10,057	406	3	14
Apr	11,090	309	240	50	11,380	360	3	16
Jul	11,939	397	240	50	12,229	447	2	13

Table 22.8: Comparison of predicted weekly construction HGV trips with predicted traffic baseline

22.54 Air quality has been considered in accordance with the JMP response to the EIA Scoping Report whereby the significance of changes likely to affect air quality are judged by thresholds. The predicted change is *not* on a road with more than 10,000 annual average daily traffic (AADT) numbers (as defined in the Environmental Protection UK "Development Control: Planning for Air Quality" publication). In addition, the second set of criteria posed by JMP for air quality screening (according to the "Design Manual for Roads and Bridges") is not met by the construction aspects of this development:

- Road alignment will not change by 5m or more;
- Daily traffic flows will not change by 1,000 AADT or more;
- HGV flows will not change by 200 AADT or more;
- Daily average speed will not change by 10km/h or more; and
- Peak hour speeds will not change by 20km/h or more.

22.55 Air quality issues have therefore been scoped out and are not considered further.

22.56 Some of the HGV trips are tankers containing bentonite drilling fluid (a mixture of bentonite and water). It may be appropriate to use an alternative water supply (such as a mains water pipe) and therefore the number of trips would decrease dramatically. These figures therefore represent a true worst case scenario.

22.57 It has been assumed that the likely routes taken by construction traffic will be along the A9 to the outskirts of Thurso before turning onto the A836 through Castletown. The route is shown on Figure 22.1.

22.58 Using the traffic numbers presented in Table 22.8 calculations have been made to assess the potential increase in HGV numbers and total vehicle numbers using the A836. As a worst case (i.e. with the potential for the largest percentage increase in HGV numbers) a week in April has been selected as the comparison week. An additional 50 HGV trips per week is equivalent to an increase of approximately 16%.

22.59 Furthermore, the contribution of up to 40 construction workers, each with their own vehicle, even when combined with HGV trips results in an increase to total predicted trips in 2015 of only 3%. The influence of HGV traffic is therefore considered the worst case impact. Marine construction personnel will have a similar minimal affect on the overall traffic levels in the area.

22.60 In addition it should be noted that the Project is not introducing any new types of traffic to the region. All roads are designed for and as can be seen by the traffic figures, they will routinely carry HGV traffic.

Impact significance

22.61 Considering the definitions of sensitivity presented earlier in this section, construction traffic will travel through at least one built-up area with a number of sensitive receptors (Castletown). The sensitivity for this impact is therefore considered medium. Due to the change in baseline conditions (increased HGV traffic) of 16% and the acknowledgement that the impact is unlikely to be more than temporary independent occurrences over a constrained period of time the magnitude is considered minor.

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Medium	Minor	Minor	Not Significant

MITIGATION IN RELATION TO IMPACT 22.1

- Although no significant impact has been identified. Mitigation measures have been provided on a precautionary approach to ensure this remains the case.
- During the onshore construction phase Project contractors will preferentially use the A836.
- Liaison with the local community and users of the area regarding overall construction activities such as details of types, levels, timing and routing of traffic will help to reduce the sensitivity of the receptors to change.
- The layout of the site has a large pull in area for large vehicles to avoid blocking the road.
- The large deliveries will be planned and marshalled so they so not coincide with each other and to avoid the peak traffic times on the local roads infrastructure.
- A member of the construction management team will liaise and co-ordinate with the local community to ensure that deliveries do not coincide with significant local events.
- The construction team will publicise when deliveries using large or slow moving equipment is planned to inform local road users.

22.6.2 Impact 22.2: Alteration of Road traffic congestion during cable installation

22.62 The Project will involve cable routes from the PCC to the grid connection as well as creation of a new permanent road access point at the PCC. The permanent road access will also be used for the temporary access for HDD activities as well as for the laydown area for all cable laying works.

22.63 The maximum cable route distance for any phase of the Project is approximately 5 to 6km. Based on assumption of 0.1km per day per cable, the maximum approximate duration of installing the cables from the PCC to grid connection for the Project will take approximately 60 days.

22.64 Much of the cable routes are along or near to minor roads in the area, or cross roads in the area, therefore there will be restrictions to traffic flow during the period of installation.

Impact significance

22.65 Considering the definitions of sensitivity presented earlier in this section the installation of cables may interact with some sensitive receptors, however works will not occur in any built-up areas. Sensitivity is therefore considered to be low. Due to the change in baseline conditions (alteration of the road network) the magnitude of impact is considered minor (the attributes of the road network will only be partially changed in the case of the access road, and barely distinguishable in terms of the cable routes).

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Low	Minor	Minor	Not Significant

MITIGATION IN RELATION TO IMPACT 22.2

- Although no significant impact has been identified mitigation measures have been provided on a precautionary approach to ensure this remains the case.
- The local community will be kept informed of when and where restrictions in traffic flow during cable installation and construction of the permanent access road to the PCC will occur, and identify measures to limit restrictions.

22.6.3 Impact 22.3: Road traffic congestion associated with transport of offshore components to assembly site

22.66 MeyGen has provided information on the likely numbers of abnormal loads associated with the transport of offshore (TSSs and turbines) components to a nearby assembly site (assumed to be Scrabster). Each turbine may require up to a maximum of three abnormal load/size trips.

22.67 Over the three year duration of construction for the maximum proposed 86 turbines, this may equate to 306 abnormal load/size trips on the trunk road network over three years of which 222 will take place in year 3 assuming no more than 1 load per day this equates to 2 abnormal loads every 3 days. The manufacturing locations are unknown therefore the route assessed here assumes the start is within easy access of the A9 or a similar trunk road, and is south of the Dornoch Firth. These loads are expected to travel at speeds between 12 and 40 miles per hour dependent on gross vehicle weight and therefore below the national speed limit of the road which is set at 60 miles per hour for cars and other light vehicles and 50 miles per hour for HGVs.

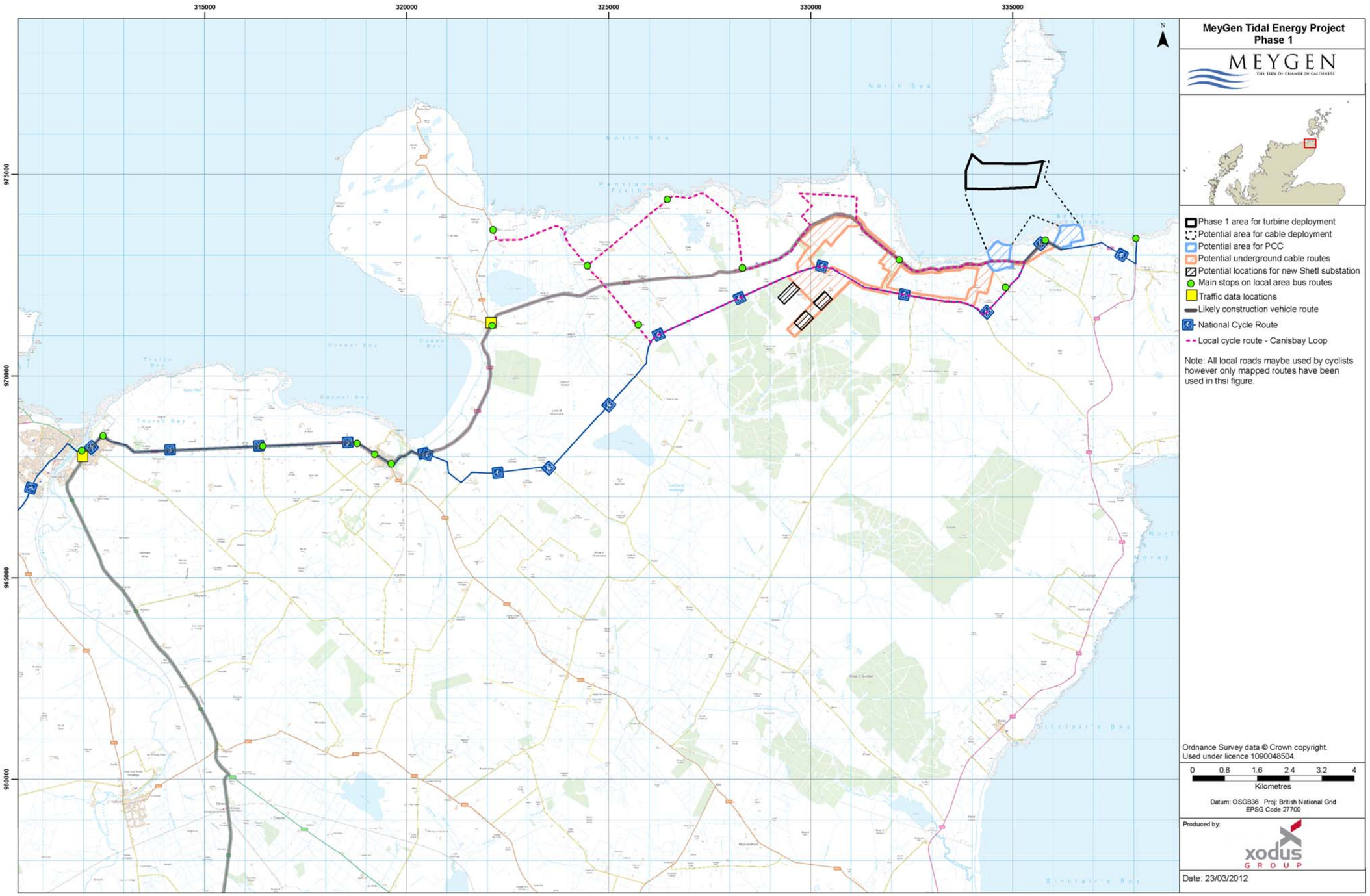

Figure 22.1: The transport network in the vicinity of the Project

22.68 The trunk road network, specifically the A9, is a priority freight route and is therefore an appropriate road for transporting components. Advice from The Highland Council is that transport of onshore wind turbine components is resulting in increased journey time for users of the A9. This sensitivity to reduction in speed (and consequent increase in congestion during busy periods) is therefore considered in the assessment of this impact.

22.69 Information on abnormal loads for the region (along the A9 and through Thurso) indicates that the road network is suitable for such loads without causing danger to other road users or users/property adjacent to the road network. Traffic lights in Thurso town centre have been altered to allow large loads to swing at the bridge end (Sir George's Street – Triall Street corner junction). This illustrates an acceptance of abnormal loads using this route providing they are appropriately managed.

Impact significance

22.70 Given that the loads may travel through several built-up areas with sensitive receptors the sensitivity is considered to be Medium. The magnitude of impact, due to abnormal loads reducing the average speed of traffic on a busy route (and potentially cause congestion), and due to the number of slow and abnormal load/size trips required, is considered to be moderate.

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Medium	Moderate	Moderate	Significant

MITIGATION IN RELATION TO IMPACT 22.3

- A range of traffic management mitigation measures will be adopted:
- If turbine components are to be transported to the Caithness area by road, a traffic management plan should be developed in discussion with Transport Scotland and Transerv who is responsible for the management of the north west Scotland trunk road network as well as the local communities along the proposed route. The traffic management plan will include provision for:
  - Deliveries using large or slow moving equipment will be planned to avoid peak traffic times
  - Deliveries using large or slow moving equipment will be planned so they do not coincide with each other.
  - The operations team will publicise when deliveries using large or slow moving equipment is planned to inform local road users and communities along the route.

Residual impact

22.71 The implementation of the proposed traffic management plan will ensure that the magnitude of impact is reduced to minor.

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Medium	Minor	Minor	Not Significant

22.7 Impacts during Operations and Maintenance

22.7.1 Impact 22.4: Traffic congestion during operation and maintenance

22.72 The only traffic associated with the operation of the Project will be for manning the PCC and infrequent maintenance activity. No operational access to onshore cable routes is required. Maintenance of the PCC will only be two or three times per year with travel to the site in the form of a small van. Ongoing operation may require up to five people once fully commissioned. It is assumed that this equates to five individual vehicles.

22.73 Marine maintenance workers associated with Scrabster or other ports in the region are the subject of a general upgrade of regional port and harbour facilities in the Pentland Firth and Orkney Waters (PFOW) area and the associated increase in traffic as part of these upgrades is not within the scope of this EIA. In total 50 workers are expected to be associated with the operations and maintenance of the Project. In the context of Dounreay (1900 current workers) this number is relatively insignificant and there is the potential that the Dounreay workforce will be decreasing. The Project may be making use of this already available workforce and so the overall workforce in the area may not increase by the full 50 workers.

22.74 In comparison to the quietest time of year, February, this equates to an increase of 2% relating to all vehicles (based on 2014 predicted traffic levels).

Impact significance

22.75 Given that traffic going to and from the PCC may be from a variety of locations and travel may be by ordinary light vehicle through one built-up area with sensitive receptors, it may be considered that the sensitivity is medium. As the magnitude of increase in vehicle numbers is 2%, the magnitude of impact may be considered to be negligible.

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Medium	Negligible	Negligible	Not Significant

MITIGATION IN RELATION TO IMPACT 22.4

- No proposed mitigation as no significant impact predicted.

22.8 Impacts during Decommissioning

22.76 Decommissioning activities for the offshore and onshore infrastructure are unlikely to require any higher numbers of abnormal load trips or HGV trips as described under the potential impacts for construction in Section 22.6. The types of impact that will be experienced and the conclusions regarding impact significance, assuming the implementation of the same mitigation, will be the same or less than during construction and installation.

22.9 Potential Variances in Environmental Impacts

22.77 There are alternative transport options associated with the Project relating specifically to different options for grid connection and for the duration of construction works. The impact assessment presented in this section has used only the worst case vehicle numbers and construction options therefore selection of alternative Project options (e.g. grid connection at the PCC for years one and two) will result in a reduced environmental impact.

22.78 Should nearby assembly of offshore components not be possible assembly may occur elsewhere with turbines and TSSs transported to the Inner Sound by sea. This would remove the identified potential impact on the trunk road network due to the transport of turbine and TSS components.

22.10 Cumulative Impacts

22.10.1 Introduction

22.79 MeyGen has in consultation with Marine Scotland and Highland Council identified a list of other projects (MeyGen, 2011) which together with the Project may result in potential cumulative impacts. The list of these projects including details of their status at the time of the EIA and a map showing their location is provided in Section 8; Table 8.3 and Figure 8.1 respectively.

22.80 Having considered the information presently available in the public domain on the projects for which there is a potential for cumulative impacts, Table 22.9 indicates those with the potential to result in cumulative impacts from a transportation and access perspective. The consideration of which projects could result in potential cumulative impacts is based on the results of the project specific impact assessment together with the expert judgement of the specialist consultant.

Project title	Potential for cumulative impact	Project title	Potential for cumulative impact	Project title	Potential for cumulative impact
MeyGen Limited, MeyGen Tidal Energy Project, Phase 2	✓	SHETL, HVDC cable (onshore to an existing substation near Keith in Moray)	×	OPL, Ocean Power Technologies (OPT) wave power ocean trial	×
ScottishPower Renewables UK Limited, Ness of Duncansby Tidal Energy Project	✓	Brough Head Wave Farm Limited, Brough Head Wave Energy Project	×	MORL, Moray Offshore Renewables Ltd (MORL) offshore windfarm	×
Pelamis Wave Power, Farr Point Wave Energy Project	×	SSE Renewables Developments (UK) Limited, Costa Head Wave Energy Project	×	SSE and Talisman, Beatrice offshore Windfarm Demonstrator Project	×
Sea Generation (Brough Ness) Limited, Brough Ness Tidal Energy Project	×	EON Climate & Renewables UK Developments Limited, West Orkney North Wave Energy Project	×	BOWL, Beatrice Offshore Windfarm Ltd (BOWL) offshore windfarm	×
Cantick Head Tidal Development Limited, Cantick Head Tidal Energy Project	×	EON Climate & Renewables UK Developments Limited, West Orkney South Wave Energy Project	×	Northern Isles Salmon, Chalmers Hope salmon cage site	×
SSE, Caithness HVDC Connection - Converter station	✓	ScottishPower Renewables UK Limited, Marwick Head Wave Energy Project	×	Northern Isles Salmon, Pegal Bay salmon cage site	×
SSE, Caithness HVDC Connection - Cable	✓	SSE Renewables Developments (UK) Limited, Westray South Tidal Energy Project	×	Northern Isles Salmon, Lyrawa salmon cage site	×
RWE npower renewables, Stroupster Windfarm	✓	EMEC, Wave Energy test site (Billia Croo, Orkney)	×	Scottish Sea Farms, Bring Head salmon cage site	×
SSE, Gills Bay 132 kV / 33 k V Substation Phase 1: substation and overhead cables (AC)	✓	EMEC, Tidal energy test site (Fall of Warness, Orkney)	×	Northern Isles Salmon, Cava South salmon cage site	×
SSE, Gills Bay 132 kV / 33 k V Substation Phase 2: HVDC converter station and new DC buried cable	✓	EMEC, Intermediate wave energy test site (St Mary's Bay, Orkney)	×	Scottish Sea Farms, Toyness salmon cage site	×
SHETL, HVDC cable (offshore	×	EMEC, Intermediate tidal energy	×	Northern Isles Salmon, West	×
Moray Firth)		test site (Head of Holland, Orkney)		Fara salmon cage site	

Table 22.9: Summary of potential cumulative impacts

22.81 The following sections summarise the nature of the potential cumulative impacts for each potential project phase:

- Construction and installation;
- Operations and maintenance; and
- Decommissioning.

22.10.2 Potential cumulative impacts during construction and installation

22.82 The Highland Council Local Transport Strategy (2010) recognises the potential for growth in the region, particularly due to the PFOW leasing round for marine energy projects. The only known construction timeline at this stage is for the proposed Gills Bay Substation (SSE Power Distribution) which is intended for construction commencing April 2013.

22.83 HDD is the most intensive construction activity. The first year of HDD work will add much fewer HGV trips to the baseline than has been assessed in this section for year 3. Other MeyGen construction activities involve smaller numbers of vehicles and whilst construction activity may overlap with construction of the substation it will not be an activity involving large numbers of trips. It is therefore expected and assuming that the principles of the Project mitigation are adopted across the SSE substation project and are insignificant that the cumulative effects of these two projects will be minimal.

22.84 Further projects identified in the region, but without construction timescales, may add to the volume of traffic predicted for the MeyGen Project, however without details of their construction it is not possible to reasonably assess the potential cumulative effect.

22.10.3 Potential cumulative impacts during operations and maintenance

22.85 During operational phase the Project adds 2% to the predicted traffic levels (of 2015). Given that the other identified terrestrial projects in the region are energy related and unlikely to be high trip-generating projects, the cumulative effect of the Project in combination with other terrestrial projects in the region is not considered significant. In terms of the Project as a whole, the terrestrial operational workforce is not expected to increase considerably.

22.86 Offshore maintenance activities will bring an increase in workforce numbers required to service the offshore components however these numbers are part of a wider strategic upgrade to port and harbour facilities in the region and are therefore not part of the scope of this EIA.

22.10.4 Potential cumulative impacts during decommissioning

22.87 Although it is possible that a number of the impacts that may occur during decommissioning (e.g. noise emissions, transport of components) could act cumulatively with other developments, there is limited scope for much of this since it is unknown at this stage if other developments offering the potential for cumulative impact would be decommissioned at the same time as this development, or that of the

MeyGen Phase 2 development (which would likely be decommissioned at the same time as the proposed development).

22.10.5 Mitigation requirements for potential cumulative impacts

22.88 No mitigation is required over and above the Project specific mitigation.

22.11 Proposed Monitoring

22.89 No monitoring required.

22.12 Summary and Conclusions

22.90 All aspects of the Project have been considered in transportation and road access terms under the relevant guidelines for the environmental assessment of road traffic.

22.91 In a multi-faceted project a series of activities have the potential for interactions with sensitive receptors on or around the local road network or the trunk road network. Construction activities all involve the use of HGVs, therefore the most intensive period and number of HGVs has been considered in the assessment (HDD works during year 3). Similarly, a worst case estimate for the number of abnormal loads required for transport of offshore components to a nearby assembly site has been assessed (although transport by sea is an alternative). Worker trips to either the onshore construction site or to a port or harbour from which offshore maintenance activities will be conducted have formed part of the revised predicted traffic levels but found to have a negligible percentage impact on overall predicted traffic levels (taking 2015 as the base year).

22.92 All potential impacts identified have been found to be manageable during the course of the Project. Principle mitigation is recommended in the form of strong communication with the local community regarding the traffic requirements of the construction phase, and for a traffic management plan covering the transport of the offshore components. This plan would enable the Project team and its contractors to work with the local authority and trunk road managers (The Highland Council and Scotland Transerv, respectively) to ensure that all potential impacts are minimised.

22.93 The operational phase is found to be of negligible significance considering the existing traffic levels in the area and taking into consideration forecasted growth in the region. The amount of operational traffic is expected to remain constant for the Project whilst the overall traffic levels in the area are expected to increase.

22.94 In conclusion it is recommended that with the implementation of mitigation measures this Project should not be rejected on transport grounds.

22.13 References

Department of Transport, (2007). Guidance on Transport Assessment.

The Highland Council, (2010). Local Transport Strategy 2010/11 – 2013/14 (Department of Transport, Environmental and Community Services).

Institute of Environmental Assessment, (2003). Guidelines for the Environmental Assessment of Road Traffic.

Scottish Executive, (2005). Transport Assessment and Implementation: A Guide.

Transport Scotland, (2011). Automatic Traffic Count Data (various locations around the Highland region).

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23 ONSHORE NOISE AND DUST IMPACTS

23.1 The table below provides a list of all supporting studies which relate to noise and dust. All supporting studies are provided on the accompanying CD.

Details of study	Location on supporting studies CD
Results of onshore noise surveys and accompanying figures (Xodus, 2011)	ONSHORE\Noise survey

23.1 Introduction

23.1.1 Overview

23.2 This section addresses the impacts due to noise and dust from onshore elements of the Project. The assessment was undertaken by Xodus including their in house acoustics team.

23.3 The assessment includes the effects of noise and dust due to:

- Construction of the Power Conversion Centre (PCC) and Horizontally Directionally Drilled (HDD) sites;
- HDD operation;
- Cable installation works;
- Construction and HDD traffic; and
- Operation of the PCC.

23.4 The Project will be located in a relatively quiet and rural location due to the location of the tidal resource. It is acknowledged that this constraint on the Project means that it will inevitably lead to some increase in noise as a result of construction and operation. The approach adopted for noise has therefore been to minimise any impacts by adopting best available techniques for noise and dust reduction and management.

23.2 Assessment Parameters

23.2.1 Rochdale Envelope

23.5 In line with the Rochdale Envelope approach, this assessment considers the maximum ('worst case') Project parameters. Identification of the worst case scenario for each receptor (i.e. Environmental Impact Assessment (EIA) topic) ensures that impacts of greater adverse significance would not arise should any other development scenario be taken forward in the final scheme design. Table 23.1 describes the detail of the Project parameters that have been used in this assessment and explains why these are considered to be worst case. The potential impacts from alternative Project parameters have been considered in Section 23.9.

Project parameter relevant to the assessment		'Maximum' Project parameter for impact assessment	Explanation of maximum Project parameter
Onshore Power Conversion Centre (PCC)	Construction and decommissioning	Ness of Quoys and Ness of Huna; daytime working for PCC construction.	Assessment of potential impacts associated with the construction of the PCC at both the Ness of Huna and Ness of Quoys. Construction of permanent access road, temporary hard standing using a light excavator, dumper truck and roller. The topsoil will be removed and scrapped down to the bedrock; some bedrock breaking (by excavator breaker) may be required to level the site for PCC foundations. PCC construction will include foundation and floor preparation, using light excavator, dumper truck and roller. Steel structure erected and external cladding fitted using a single small crane and cherry picker. Daytime working only assumed for PCC construction and decommissioning activities.
	Operation	Operating noise from the PCC at either Ness of Quoys or Ness of Huna; 24 operation of the PCC.	Assessment of potential impacts associated with the operation of the PCC at both the Ness of Huna and Ness of Quoys. PCC will be operational 24 hours a day and PCC equipment noisiest when the tide running fastest.
Onshore cable routes between PCC and SHETL substation	Construction and decommissioning	All potential cable corridors between PCC locations and SHETL substation proposed at Phillips Mains (see Figure 2.1) (at EIA commencement); daytime working for cable installation and decommissioning.	Use of a single tractor and cable plough (ploughing method) or single light excavator (cut and backfill method) to bury the cables. Daytime working only assumed for cable installation and decommissioning activities.
Cable landfall	Horizontal Directional Drill (HDD) site construction and reinstatement	Construction of temporary access road and hard standing for HDD compound at either Ness of Quoys or Ness of Huna.	Construction of temporary access off the permanent access road, temporary hard standing for the HDD compound using a light excavator and dumper truck. The topsoil will be removed and scrapped down to the bedrock; some rock breaking (by excavator breaker) may be required to level the site. The HDD compound will move to new positions to complete each different phase of drilling. A new compound area will be prepared for each phase and the previous area reinstated. Daytime working only assumed for HDD site construction and reinstatement activities.
	HDD operation	86 HDD bores drilled from either Ness of Quoys or Ness of Huna; 24 hour operation during HDD.	Assessment of potential impacts associated with the HDD of the cable bores, during the Project construction phase. ▪ 24 hour working assumed for HDD activities.
Offshore Project components		N/A	The offshore Project parameters do not influence the onshore noise and dust impact assessment.

Table 23.1: Rochdale Envelope parameters for the onshore noise and dust assessment

23.2.2 Area of assessment

23.6 It is also important to define the geographical extent of the assessment area. The focus of the onshore noise and dust assessment is concerned with potential impacts on receptors in the area of the onshore PCC installation and operation works, HDD drilling activities and onshore cable installation.

23.7 It should be noted that this assessment was completed on a larger Project area; this has since been refined to a smaller footprint at both the Ness of Quoys and Ness of Huna PCC sites and a single cable corridor to the SHETL substation option areas. The final Project is described in Section 5 and shown in Figure 5.2; the selection process for these is discussed in Section 4.

23.2.3 Acoustic terminology and concepts

23.8 This section provides an overview of the fundamentals of how sound propagates away from an industrial site.

23.9 Increasing the distance from the noise source normally results in the level of noise getting quieter, due primarily to the spreading of the sound with distance, analogous to the way in which the ripples in a pond spread after a stone has been thrown in. Another important factor relates to the type of ground over which the sound is travelling. Acoustically "soft" ground, (such as grassland, ploughed fields etc) will result in lower levels of noise with increasing distance from the industrial site as compared to acoustically "hard" surfaces (e.g. concrete, water, paved areas). The reduction in noise level depends, however, on the frequency of the sound.

23.10 It is common experience that wind affects the way in which sound propagates, with noise levels downwind of a source being louder than upwind. This is partly due to the sound "rays" being bent either upwards or downwards by the wind in a similar way that light is bent by a lens, as shown in Figure 23.1. It is less well known that varying temperatures in the atmosphere can also cause sound rays to be bent, adding to the complexity of sound propagation.

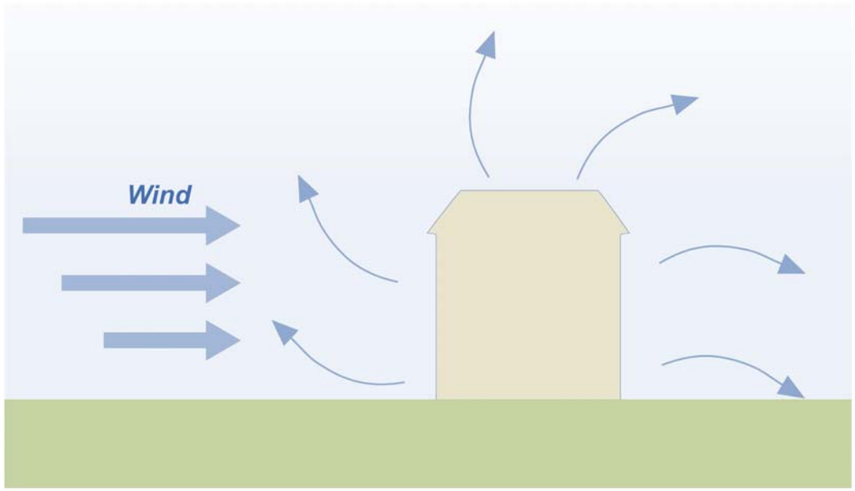

Figure 23.1: Refraction of sound waves due to wind gradients (increasing wind speed with height)

23.11 Another attenuation mechanism is due to absorption of sound by the molecules of the atmosphere. Higher pitched sounds are more readily absorbed than lower pitched sounds. The factors affecting the extent to which the sound is absorbed are the temperature and the water content of the atmosphere (relative humidity).

23.12 Because industrial noise is typically weighted towards the lower frequencies, the effect of varying temperature and humidity is minimal when compared to other factors, such as wind and ground effects. However, where high frequency sounds are encountered, there may well be a significant variation between measured sound levels on different days due to variations in temperature and humidity.

23.13 When listening to noise which occurs out in the open (e.g. from road traffic, aircraft, birds, wind in the trees etc.), it is common experience that the noise level is not constant in loudness, but is changing in amplitude all of the time. Therefore, in order to numerically describe the noise levels, it is beneficial to use statistical parameters. It has become practice to use indices which describe the noise level which has been exceeded for a certain percentage of the measurement period, and also an index which gives a form of average of the sound energy over a particular time interval. The former are termed percentile noise levels and are notated L_{A90}, L_{A50}, L_{A10} etc. and the latter is termed the equivalent continuous noise level and is notated by L_{Aeq}. It is worth noting that if the noise level does not vary with time, then all the parameters, in theory, normalise to a single value.

23.14 With regard to the percentile levels, the L_{A90} is the sound pressure level which is exceeded for 90% of the measurement time. It is generally used as the measure of background noise (i.e. the underlying noise) in environmental noise standards.

23.15 The L_{Aeq} (sometimes denoted $L_{Aeq,T}$) is the equivalent continuous noise level and is an energy averaged value of the actual time varying sound pressure level over the time interval, T. It is used in the UK as a measure of the noise level of a specific industrial noise source when assessing the level of the specific source against the background noise. It is also used as a measure of ambient noise (i.e. the "all-encompassing" sound field).

23.16 The term 'A' weighting implies a measurement made using a filter with a standardised frequency response which approximates the frequency response of the human ear at relatively low levels of noise. The resulting level, expressed in 'A' weighted decibels, or dBA, is widely used in noise standards, regulations and criteria throughout the world.

23.17 For a more detailed analysis of the frequency characteristics of a noise source, then noise measurements can be made in bands of frequencies, usually one octave wide. The resulting levels are termed octave band sound pressure levels. The standard octave band centre frequencies range from 31.5 Hz (about three octaves below middle 'C' on the piano) to 8 kHz (about five octaves above middle 'C'). This covers most of the audible range of frequencies (usually taken to be around 20 Hz to 20 kHz). Octave band noise levels are usually quoted as linear data – i.e. without an 'A' weighting filter being applied.

23.18 The term decibel is a relative quantity and should always be referenced to an absolute level. In this section, all sound pressure levels (denoted L_P) are expressed in dB ref 20 μPa. Hence, a sound pressure level of 0 dBA refers to a pressure level of 20 μPa, which is generally taken as the lowest level of sound that the human ear can detect.

23.19 Subjectively, and for steady noise levels, a change in noise level of 2 – 3 dBA is normally just discernible to the human ear. A difference of 10 dBA represents a doubling or halving of subjective loudness.

23.20 Sound power (denoted L_W) is the acoustical power radiated from a sound source. The advantage of using the sound power level, rather than the sound pressure level, in reporting noise from industrial sites is that the sound power is independent of the location of the site, distance from the measurement point and environmental conditions. If the sound power of a source is known, then it is possible to calculate the sound pressure level at a distance away from the source, accounting for the attenuation due to propagation, as discussed above. In this section, all sound power levels are expressed in dB ref 1pW.

23.3 Legislative Framework and Regulatory Context

23.3.1 Noise

Legislation and planning advice

23.21 The EIA Regulations are the only legislation relevant to this assessment.

National Planning Policy

- **Planning Advice Note 1/2011: Planning and Noise**

23.22 Scottish Government guidance is provided primarily through PAN 1/2011. The document gives guidance to local authorities in Scotland on the use of their planning powers to prevent and limit the adverse impact of noise. The PAN is intended to promote the principles of good acoustic design and a sensitive approach to the location of new development. The underlying principle of the PAN is to ensure that the quality of life is not unreasonably affected and that new development continues to support sustainable economic growth.

23.23 The PAN promotes:

- The principles of good acoustic design;
- A sensitive approach to the location of new development;
- The appropriate location of new potentially noisy development;
- A pragmatic approach to the location of new development within the vicinity of existing noise generating uses, to ensure that quality of life is not unreasonably affected and that new development continues to support sustainable economic growth; and
- Early involvement of Environmental Health Officers (EHOs) and/or professional acousticians in proposals which are likely to have significant adverse noise impacts or be affected by existing noisy developments.

23.24 More technically detailed advice for potential noise generating developments in Scotland is provided in Technical Advice Note (TAN): Assessment of Noise. The separation of the TAN allows guidance to be updated without having to review the overarching planning guidance. The TAN recommends several stages as part of a noise impact assessment, summarised as follows:

23.25 Stage 1: Initial Process

- Identification of all noise sensitive receptors (NSR); and
- Prioritise NSR according to level of sensitivity.

23.26 Stage 2: Quantitative Assessment

- Identify type of development; and
- Determine magnitude of impact.

23.27 Stage 3: Qualitative Assessment

- Consider additional features; and
- Adjust magnitude of impact where appropriate.

23.28 Stage 4: Level of significance

- Develop matrix relating receptors sensitivity to the magnitude of impacts; and
- Output results in summary table of significance of noise impacts.

Regional Planning Policy

- **Development plan policies**

23.29 Policy G2 of The Highland Structure Plan (2001), entitled 'Design for Sustainability', states that "Proposed developments will be assessed on the extent to which they… impact on individual and community residential amenity…".

23.30 There is no specific reference to noise and vibration in the Caithness Local Plan (2002).

23.3.2 Dust

Legislation and planning advice

23.31 The EIA Regulations are the only legislation relevant to this assessment.

National Planning Policy

23.32 European Union (EU) legislation on air quality forms the basis for UK air quality policy. Although this assessment specifically considers the effects of dust, the most appropriate plans and policies are held within policies associated with air quality.

23.33 The 1995 Environment Act (HMSO, 1995) required the preparation of a national Air Quality Strategy (AQS) which set air quality standards and objectives for specified pollutants. The Act also outlined measures to be taken by local planning authorities (LPAs) in relation to meeting these standards and objectives (the Local Air Quality Management (LAQM) system).

23.34 The UK AQS was originally adopted in 1997 (Department of the Environment, 1997). This document is reviewed and updated as necessary in order to take account of the evolving EU legislation, technical and policy developments and the latest information on health effects of air pollution. The strategy was reviewed and reissued in 2000 as the AQS for England, Scotland, Wales and Northern Ireland (DETR, 2000). This was subsequently amended in 2003 (DETR, 2003) and was updated in July 2007 (DEFRA, 2007).

23.35 The EU Limit Values (as set out in the EU Council Directives 96/62/EC 'Air Quality Framework Directive' and its daughter directives), the new 'Air Quality Directive' 2008/50/EC and the Air Quality Standards Regulations 2010 laid down statutory air pollutant concentration limits, and the 2000 Regulations (as amended in 2002) effectively implement the AQS objectives. The limit values in most cases are the same, although the achievement dates differ. These values inform regional planning policy against which the assessment of dust is made.

Regional Planning Policy

23.36 Part IV of the Environment Act 1995 introduced a system of LAQM under which Local Planning Authorities (LPAs) are required to review and assess the future quality of the air in their area by way of a staged process. Should this process indicate that any of the AQS objectives will not be met, the LPA must designate that area as an Air Quality Management Area (AQMA) and prepare an Air Quality Action Plan (AQAP) to improve the air quality in that area in order to work towards the objectives. The Highland Council has not declared any AQMAs (The Highland Council, 2010).

23.37 Neither the Caithness Local Plan (2002) nor the Highland Structure Plan (2001) make detailed reference to, or provide guidance on air quality issues in the region[1]. The proposed Highland-wide Local Development Plan (HwLDP)[2] (2011) notes that in certain areas of the Highlands there are some issues with air quality, which will be the subject of ongoing monitoring under the AQS. These areas do not overlap with the Project

23.38 Policy 73 of the proposed HwLDP asks that development proposals which may individually or cumulatively have an adverse affect on local air quality, which could cause harm to human health, be accompanied by appropriate information or assessment and details of how such effects would be mitigated.

23.3.3 Standards and guidance relevant to noise

British Standard 4142

23.39 As recommended in PAN 1/2011, British Standard 4142: 1997, 'Method for rating industrial noise affecting mixed residential and industrial areas' is used, where appropriate, to assess noise from proposed industrial and commercial developments as it affects a dwelling. The prime purpose of this standard is to determine the likelihood of complaints about noise from industrial and commercial installations. The foreword to the standard states that it may also be helpful in certain aspects of environmental planning

[1] Still in force at time of EIA and ES compilation
[2] Not adopted at time of EIA and ES compilation

and may be used in conjunction with recommendations on noise levels and methods of assessment published elsewhere.

23.40 The method is based upon a comparison between the noise from the specific source being considered, measured as a time-average ($L_{Aeq,T}$) noise level, with the background noise level (measured as an L_{A90}) in the absence of the specific source. For rating purposes, the noise level measured with the source operating is increased by 5 dBA if the source has any distinctive characteristics (such as whines, hums or bangs), or if it is irregular enough to attract attention. For daytime operations (defined as between 07:00 and 23:00 hours) BS 4142 states that an assessment period of 1 hour should be used, whereas a period of 5 minutes should be used at night.

23.41 The standard specifies that, if the rating level of the noise exceeds the background noise by around 10 dBA or more, complaints about noise are 'likely'. A difference of +5 dBA is of 'marginal significance' with respect to the likelihood of complaints, whilst a difference of -10 dBA or less indicates that 'complaints are unlikely'.

23.42 The foreword to the standard recognises that it is necessarily general in character and may not cover all situations. The likelihood that an individual will complain depends on individual attitudes and perceptions in addition to the noise levels and acoustic features present. Although in general there will be a relationship between the incidence of complaints and the level of general community annoyance, quantitative assessment of the latter is beyond the scope of the standard, as is the assessment of nuisance.

23.43 The standard is not suitable for use when the background noise level is below about 30 dBA and the rating level is below about 35 dBA.

23.44 BS 4142 does not provide guidance relating to the absolute level of noise and, for this, reference can be made to BS 8233.

British Standard 5228

23.45 British Standard 5228-1:2009 "Code of practice for noise and vibration control on construction and open sites. Noise" is the most relevant standard relating to construction noise. The standard was revised in 2009.

23.46 The standard notes that for some large infrastructure projects that require an EIA, construction noise is sometimes assessed by comparing the predicted construction noise (plus pre-construction ambient noise) with the pre-construction ambient noise. However, it notes that a greater difference might be tolerated than for a permanent industrial source.

23.47 For dwellings, times of site activity outside of normal working hours will need special consideration. It suggests that evening noise limits might have to be as much as 10 dBA below the daytime limit and that very strict noise control targets might need to be applied for night-time working.

23.48 Annex E (informative) of the standard provides examples of criteria that can be used for the assessment of the significance of effects due to construction noise. It notes three main reasons for undertaking such an assessment:

- For Environmental Impact Assessments (EIAs);
- Assessments for developments that do not require EIA; and
- Control of Pollution Act (CoPA) Section 61 applications.

23.49 Annex E describes two main approaches for assessing the significance of effects, as follows:

- Significance based upon fixed (absolute) limits and eligibility for noise insulation and temporary re-housing. This is primarily based on guidance given in Advisory Leaflet 72 and is described below; and
- Significance based upon noise change. The standard notes that this assessment method reflects more conventional EIA methodologies for noise.

23.50 With respect to noise change, the standard gives two examples of assessment techniques; the first being the "ABC" method and the latter being the 5 dB change method.

23.51 The ABC method criteria are based on a comparison of the predicted L_{Aeq} level due to construction works with the pre-existing L_{Aeq} before the construction works, rounded to the nearest 5 dB. If the rounded pre-existing L_{Aeq} level is less than the values listed in Category A, then the noise levels listed in the Category A column should be used as the threshold level for significance of construction noise. If the pre-existing L_{Aeq} level is equal to the values listed in Category A, then the noise levels listed in the Category B column should be used as the threshold level for significance. Finally, if the pre-existing L_{Aeq} level is greater than the values listed in Category A, then the noise levels listed in the Category C column should be used.

23.52 The 5 dB change method is based upon a significant effect being deemed to occur where noise from construction activities exceeds pre-construction ambient levels by 5 dBA or more, subject to lower cut-off values of 65, 55 and 45 dB $L_{Aeq,period}$ for the daytime, evening and night-time periods respectively.

23.53 Annex E also includes guidance on setting noise limits for construction activities which will involve long-term earth moving activities (as is the case for the temporary HDD and onshore construction aspects of the Project). It states that this type of activity is more akin to surface mineral extraction sites and that the guidance contained within Mineral Policy Statement (MPS) 2 needs to be taken into account when setting criteria for acceptability. The standard suggests that a limit of 55 dB $L_{Aeq,1h}$ is adopted for these types of activities but only where the works are likely to occur for a period in excess of six months.

23.54 The standard also includes criteria for assessing the requirement for provision of sound insulation or temporary re-housing where, in spite of the mitigation measures applied and any Section 61 consents under the Control of Pollution Act, noise levels at some properties exceed particular trigger levels.

British Standard 8233

23.55 BS 8233 "Sound Insulation and Noise Reduction for Buildings - Code of Practice" provides general guidance on acceptable noise levels within buildings. In sleeping areas the recommended maximum indoor ambient noise levels range from 30 dB L_{Aeq} (good conditions) to 35 dB L_{Aeq} (reasonable conditions). These internal levels correspond to external façade noise levels of 40 - 50 dB L_{Aeq} with windows partially open to allow for ventilation (assuming a 10 – 15 dBA level difference, as recommended in Table 10 of the standard). If the noise of concern contains distinctive characteristics, then these levels may need to be lower.

23.56 As noted in the Standard, the criteria for good and reasonable resting conditions are for "anonymous" and steady noise, such as that from road traffic or continuously running plant. Consequently, these criteria may not always be directly applicable for unsteady noise or for noise which can be attributed to a particular source, such as an industrial development.

23.57 The standard also notes that, for a reasonable standard in bedrooms at night, individual noise events should not normally exceed 45dB L_{AFmax}. This corresponds to an external façade noise level of 55 – 60 dB L_{AFmax} with windows partially open.

23.58 For the daytime, the standard recommends maximum indoor ambient noise levels in living rooms range from 30 dB L_{Aeq} (good conditions) to 40 dB L_{Aeq} (reasonable conditions). These internal levels correspond to external façade noise levels of 40 - 55 dB L_{Aeq} with windows partially open.

23.59 As well as protection for inside the building, the standard makes recommendations for maximum external noise levels in gardens and balconies etc. The standard states that it is desirable that "the steady noise level does not exceed 50 $L_{Aeq,T}$ dB and 55 $L_{Aeq,T}$ dB should be regarded as the upper limit".

World Health Organisation guidance

23.60 In 2009 a report was published presenting the conclusions of a WHO working group responsible for preparing guidelines for exposure to noise during sleep entitled "Night Noise Guidelines for Europe". The document can be seen as an extension to the original 1999 WHO Guidelines for Community Noise. Various effects are described including biological effects, sleep quality, and well-being. The document gives threshold levels for observed effects expressed as $L_{max, inside}$ and $L_{night, outside}$. The L_{night} is a year long average night-time noise level, not taking into account the façade effect of a building. In an exposed population a noise exposure of 40 dB $L_{night, outside}$ is stated as equivalent to the lowest observed adverse effect level (LOAEL) for night noise. Above this level adverse health effects observed are self-reported sleep disturbance, environmental insomnia and increased use of somnifacient drugs and sedatives. Above 55 dB $L_{night, outside}$ cardiovascular effects become the major public health concern. Threshold levels for waking in the night, and / or too early in the morning are given as 42 dB $L_{Amax, inside}$. Lower thresholds are given that may change sleep structure.

23.61 It is relevant to note that taking into account typical night to night variation in noise levels that will often occur due to meteorological effects and the effects of a façade, the night noise guidelines are similar to those previously given in the 1999 WHO report (an external noise level of 45 dB L_{Aeq}), although defined in a different way.

23.62 The major concern in Europe is with respect to noise from transportation systems, and most of the studies on which these guidelines are based relate to this type of noise source. There can be no certainty that the same effects will be observed from noise of an industrial nature, but in the absence of any more detailed information some weight should be attached to the WHO guidance when assessing industrial noise as well.

IOA / IEMA guidance

23.63 A draft guidance document was published jointly in 2002 by the Institute of Environmental Management and Assessment (IEMA) and the Institute of Acoustics (IOA). The document is intended to provide guidance on all aspects of noise impact assessment and was produced to ensure a consensus of the requirements of good practice across the acoustics, as well as environmental impact assessment professions. Following a period of consultation, some amendments were proposed for the guidance, as detailed in a paper presented to the Institute of Acoustics in 2006 by Mr Turner of Bureau Veritas. Although the final document has not yet been formally issued, it is still relevant to this study.

23.64 The 2002 draft guidance document notes that there is currently no guidance on how to undertake a noise assessment for EIA and, although standards and guidance on noise are available, they have not been specifically developed for use in EIA and, as a result, many are used out of context.

23.65 The draft guidance defines noise change as "the difference in acoustic environment before and after the implementation of proposals" and defines the noise impact as "the consequence of a noise change. This may be in the form of annoyance caused or a change in the degree of intrusion or disturbance."

23.66 The Institute of Acoustics paper in 2006 provided a summary of the proposed changes to the original draft document. The 2006 paper includes guidance on setting noise impact criteria for impacts on people which are reproduced in Table 23.2. This table presents the scale of effects of noise on humans correlated to suggested semantic descriptors and significance criteria.

Perception	Impact	Semantic descriptor	Significance
Not noticeable	None	No impact	Not significant
Noticeable	Non-intrusive Noise can be heard, but does not cause any change in behaviour or attitude, e.g. turning up volume of TV, speaking more loudly, closing windows. Can slightly affect the character of the area but not such that there is a perceived change in the quality of life.	Slight	Not significant
Noticeable	Intrusive Noise can be heard and causes small changes in behaviour and/or attitude, e.g. turning up volume of TV, speaking more loudly, closing windows. Potential for non-awakening sleep disturbance. Affects the behaviour such that there is a material change in the quality of life.	Moderate	Significant
Noticeable	Disruptive Causes a material change in behaviour or attitude, e.g. avoiding certain activities during periods of intrusion. Potential for sleep disturbance resulting in difficulty getting to sleep, premature awakening and difficulty in getting back to sleep. Quality of life diminished due to change in character of the area.	Substantial	Significant
Noticeable	Physically Harmful Significant changes in behaviour and/or inability to mitigate effect of noise leading to psychological stress or physiological effects, e.g. regular sleep deprivation/ awakening, loss of appetite, significant medically definable harm, e.g. noise induced hearing loss.	Severe	Significant

Table 23.2: Generic scale of noise impacts on people

23.67 The 2006 paper notes that "one of the key conclusions reached by the working party following consultation was that the guidelines should more strongly emphasise its recommendation of a shift away from the common practice of relying on simple decibel change semantic scales as the key indicator of impacts and their significance. The guidelines promote a more sophisticated approach of weighing up all the objective and subjective factors (including decibel change where appropriate) to reach a reasoned judgement of the impacts and their significance."

Department of Environment Advisory Leaflet 72

23.68 Guidelines for noise from construction activities were given in the old Department of Environment Advisory Leaflet 72, 'Noise Control on Building Sites' [Ref. 0]. The leaflet states that, for rural, suburban and urban areas away from main road traffic and industrial noise, noise levels between 07.00 and 19.00 measured outside the nearest window of the property should not exceed 70 dBA. The recommended maximum level increases to 75 dBA in urban areas near main roads in heavy industrial areas.

23.69 The leaflet does not specify a measurement parameter but it does state that the limit is as "measured using a simple sound level meter". Given that the leaflet was published before integrating sound level meters were commonplace, this implies that the limit should be based on the instantaneous sound pressure level as opposed to a long term average such as $L_{Aeq,12h}$.

23.70 The leaflet also states that building work should not be allowed to disturb people sleeping nearby, although it does not quantify what levels of noise are likely to disturb sleep.

23.71 This leaflet is now over thirty years old (the last version was 1976), is out of print and has been superseded by guidance provided in other, more recent, guidance and standards, such as BS 5228 and MPS 2. There is some doubt regarding whether that Advisory Leaflet is still current (BS 5228 is silent on the matter), although it is still regularly referred to when assessing the impact due to construction activities.

Design Manual for Roads and Bridges (DMRB)

23.72 The Design Manual for Roads and Bridges (DMRB) Volume 11 (Highways Agency, 2011) sets out the overall assessment process for new or altered highways. DMRB Section 3 Part 7 relates to the assessment of noise and vibration. Whilst it is principally concerned with the assessment of increased noise due to new or altered roads, it is nevertheless considered reasonable to use its methodology as a guide to the significance of increased traffic noise levels from intensification of use of an existing highway.

23.73 In the UK, use is made of the $L_{A10,18h}$ noise index based on the categorised annual average weekday traffic flow, in relation to the determination of eligibility under the Noise Insulation Regulations for new or altered highways. For the assessment of the suitability of a site for residential development adjacent to an existing road use is made of the daytime and night-time L_{Aeq} noise indices.

23.74 It is generally accepted that increased road traffic noise can have both a short and long-term effect, in that a sudden change in noise will create a greater impact in the shorter term than over a longer period time. (The same phenomenon may also apply to other sources of noise, such as continuously operating industrial sites, although this is less well documented). Table 23.3 gives the DMRB classification of noise impacts in the short term and Table 23.4 for the long term impacts. These are based on the $L_{A10,18h}$ noise index but changes to the L_{Aeq16h} index would be expected to give similar results.

Noise change, dB $L_{A10,18\,h}$	Adverse / beneficial	Significance of any effect
0	Adverse	No change
0.1 – 0.9	Adverse	Negligible
1 – 2.9	Adverse	Minor
3 – 4.9	Adverse	Moderate
5+	Adverse	Major

Table 23.3: Significance criteria for road traffic noise changes – short term

Noise change, dB $L_{A10,18\,h}$	Adverse / beneficial	Significance of any effect
0	Adverse	No change
0.1 – 2.9	Adverse	Negligible
3 – 4.9	Adverse	Minor
5 – 9.9	Adverse	Moderate
10+	Adverse	Major

Table 23.4: Significance criteria for road traffic noise changes – long term

Mineral Policy Statement (MPS) 2

23.75 Landmark appeal decisions have utilised the guidance contained within Minerals Policy Statement (MPS) 2 (or its predecessor, MPG 11) where the construction works involve long-term earth-moving activities. This approach is now included in BS 5228.

23.76 It is worth noting that the equivalent to MPS 2 in Scotland is PAN 50 (as referenced in paragraph 35 of PAN 1/2011). Furthermore, MPS 2 has now been revoked in England and replaced by the new National Planning Policy Framework and the accompanying Technical Guidance. However, reference is made in this section to MPS 2 due to its inclusion in BS 5228, in an informative Annex E.

23.77 Guidance given in MPS2 suggests that a noise limit of 70 dB $L_{Aeq,1h}$ for up to 8 weeks per year is appropriate in mineral extraction sites for the essential construction of baffle mounds. For longer term noisier activities, a lower limit should be considered. The guidance suggests that noise should not exceed the background level by more than 10 dBA, subject to a maximum of 55 dB $L_{Aeq,1h}$. Evening limits should not exceed background by more than 10 dBA and night-time limits should not exceed 42 dB $L_{Aeq,1h}$.

23.78 It is unlikely that construction of the PCC or HDD sites would count as long-term earth moving activities. Nevertheless, it is considered relevant to pay heed to the guidance in light of its inclusion in the British Standard and like mineral extraction, the development of tidal stream energy is limited by the resource location. The location of the HDD and PCC is therefore geographically linked to the resource of the Inner Sound.

23.3.4 Summary of guidance for use in assessing noise

23.79 Table 23.5 summarises the relevant criteria adopted to assess the impact of noise from the Project for each type of operation.

Type of receptor	Type of noise	Type of assessment	Relevant guidance / standards	Assessment
Residential (construction phase)	All-encompassing construction noise.	Absolute noise level assessment.	PAN 1/2011, BS 5228 / MPS 2 / AL72.	Comparison to limits in MPS 2 / AL72.
	All-encompassing construction noise.	Noise change.	PAN 1/2011, BS 5228.	Assessment of noise change in terms of ambient noise and any other relevant parameters.
	Construction and drilling traffic noise.	Noise change.	PAN 1/2011, DMRB.	Assessment of noise change.
Residential (operational phase)	All-encompassing ambient noise.	Absolute noise level assessment.	PAN 1/2011, BS 8233 / WHO.	Comparison to guideline limits for annoyance and sleep disturbance.
	All-encompassing noise.	Noise change.	PAN 1/2011, IEMA Guidelines for noise impact assessments.	Assessment of noise change in terms of ambient noise and any other relevant parameters.
	Noise from industrial premises.	Level difference.	PAN 1/2011, BS 4142.	Assessment of specific noise rating level compared to background noise.

Table 23.5: Summary of relevant guidelines for assessing impact of noise

23.3.5 Guidance relevant to dust

23.80 No specific guidance (such as thresholds) exist for the impact assessment of dust, however the following guidance documents assist in managing dust emissions at construction sites and are therefore deemed relevant to this assessment.

Scottish Environment Protection Agency guidance

23.81 The Scottish Environment Protection Agency (SEPA) has been involved in the production of guidelines relevant to dust and air quality issues. This guidance document, Pollution Prevention Guidelines 6 (PPG6) – *Working at construction and demolition sites* – has been prepared in conjunction with the Environment Agency and Northern Ireland Environment Agency (NIEA) (Environment Agency (2010). This guidance recommends and refers to a best practice document by the Greater London Authority and London Councils (2006), discussed below.

Greater London Authority and London Councils best practice guidance

23.82 This document, '*The control of dust and emissions from construction and demolition*', provides best practice guidance for construction and demolition sites. It sets out the potential effects of air quality issues as well as suggesting relevant mitigation and control measures for sites with different risk ratings and specifically relating to dust emissions.

23.4 Assessment Methodology

23.4.1 Scoping and consultation

23.83 Since the commencement of the Project, consultation on onshore noise issues has been ongoing. Table 23.6 summarises all consultation relevant to onshore noise. In addition, relevant comments from the EIA Scoping Opinion are summarised in Table 23.7, together with responses to the comments and reference to the Environmental Statement (ES) sections relevant to the specific comment.

Date	Stakeholder	Consultation	Topic/specific issue
7th April 2011	Marine Scotland and SNH	Pre-Scoping meeting	EIA surveys and studies required and the data needs for each EIA study.
27th May 2011	Marine Scotland, statutory consultees and non statutory consultees	Submission of EIA Scoping Report	Request for EIA Scoping Opinion from Marine Scotland and statutory consultees and request for comment from non statutory consultees.
30th June – 2nd July 2011	Local stakeholders	Public Event - EIA Scoping	Public event to collate information/opinions on proposed EIA scope.
9th August 2011	The Highland Council (THC)	Telephone conversation with EHO	Baseline survey planning and assessment methodology.
14th September 2011	THC	Meeting	Planning pre application meeting. Presentation on overall Project and results of EIA studies to date.
31st September 2011	Marine Scotland, THC, statutory consultees and non statutory consultees	Receipt of EIA Scoping Opinion	Receipt of response to EIA Scoping Report and other comments from non statutory consultees.
10th October 2011	THC	Receipt of pre application advice	Receipt of pre application advice from THC
18th November 2011	THC	Telephone conversation with EHO	Discussion of criteria for noise impact assessment.
5th December 2011	THC	Telephone conversation with EHO	Discussion of criteria for noise impact assessment.
6th – 7th December 2011	Local stakeholders	Public Event – pre application consultation	Public event to communicate the findings of the EIA to local stakeholders.

Table 23.6: Consultation undertaken in relation to onshore noise and dust

Organisation	Key concerns	Response	ES section within which the specific issue is addressed
SEPA	The local authority is the responsible authority for local air quality management under the Environment Act 1995, however we recommend that this development proposal is assessed alongside other developments that are also likely to contribute to an increase in road traffic. This increase will exacerbate local air pollution and noise issues, particularly at busy junctions and controlled crossing points. Consideration should therefore be given to the cumulative impact of all development in the local area in the ES or supporting information. Further guidance regarding these issues is provided in NSCA guidance (2006) entitled Development Control: Planning for Air Quality.	The Highland Council's environmental health department was consulted prior to undertaking the noise assessment to seek their views. It was the view of the council that the main concern was likely to be the 24/7 drilling operations, particularly at night. The Council requested that noise surveys should be undertaken under light wind conditions to reflect the "worst case" scenario for assessing the impact from the Project. The generation of dust is also considered in this section.	Sections 23.6.5 Baseline Description and 23.6 Construction Impact Assessment
	Excavation works, particularly through drilling and blasting, may cause nuisance to adjacent land users due to the generation of dust and noise. Comments from the local authority environmental health officers should be sought on the potential nuisance to adjacent land users during the construction and decommissioning phases of the Project.		
	Where borrow pits are proposed, information should be provided regarding their location, size and nature including the depth of the borrow pit floor and the final reinstated profile. The impact of such facilities (including dust, blasting and impact on water) should be appraised as part of the overall impact of the scheme. Information should cover, in relation to water, at least the information set out in PAN 50 Controlling the environmental effects of surface mineral workings (Paragraph 53) and, where relevant, in relation to groundwater (Paragraph 52).	No borrow pits will be required for the Project and therefore have not been considered in the impact assessment.	N/A
JMP	Impacts to sensitive receptors associated with noise and vibration arising from the proposed development during the construction and operational phases should be considered. Operational traffic noise and construction traffic noise should be assessed by considering the increase in traffic flows and following the principles of CRTN. Design Manual for Roads and Bridges (DMRB) Vol 11 states: "in the period following a change in traffic flow, people may find benefits or disbenefits when the noise changes are as small as 1dB(A) - equivalent to an increase in traffic flow of 25% or a decrease in traffic flow of 20%. These effects last for a number of years".	DMRB is geared towards motorways and trunk roads. Although the document suggests that the nuisance criteria can be used even in cases where the traffic is not free flowing, it is questionable whether the criteria should be used for assessing traffic noise due to an industrial development where there will be no changes to the road network itself. Nevertheless, there is a need to assess the impact due to construction traffic noise.	Section 23.6 Construction Impact Assessment
	PAN 56 advises that a change of 3 dBA is the minimum perceptible under normal conditions, and a change of 10 dBA corresponds roughly to halving or doubling the loudness of a sound.	PAN 56 has now been replaced by PAN 1/2011, which is referenced in the assessment.	Section 23.3 Standards and Guidance
	Therefore, the ES should consider potential impacts to identified trunk road receptors, in terms of: 1) Predicted noise levels from construction traffic; and 2) Any increases to road traffic attributed to the Proposed Development.	Operational traffic is not likely to have a significant impact on noise levels and has been scoped out of this assessment. Construction traffic noise has been assessed.	Section 23.6 Construction Impact Assessment
The Highland Council	The Highland Council's EHO was consulted by phone on 9th August 2011. The EHO highlighted HDD noise as a potential concern and stated, if possible, that any particularly noisy activities should be undertaken during the daytime. He requested that noise monitoring should be undertaken during light wind conditions due to variability in the weather for the location.	Baseline noise measurements were subsequently undertaken during unusually calm conditions for the region.	Sections 23.5 Baseline Description

Table 23.7: Scoping comments relevant to onshore noise

23.4.2 Desk based assessment

Noise

23.84 In order to assess the noise impact associated with HDD activities and the construction and operation of the PCC, it is necessary to predict the likely noise levels which will be generated by the Project. A computer based noise model (using CadnaA software) has been developed to predict the noise levels. The detailed terrain model for the development area was based on digital mapping data from Ordnance Survey.

23.85 The source term levels (i.e. the calculated sound power levels of equipment) were entered into CadnaA to calculate the expected sound pressure levels in and around the site and in particular at the community receptors. CadnaA uses the propagation method described in ISO 9613-2:1996, "Acoustics -- Attenuation of sound during propagation outdoors -- Part 2: General method of calculation".

23.86 The ISO 9613 methodology uses correction terms, applied to the source term level, for various factors affecting the propagation of noise from the source, to calculate a sound pressure level under meteorological conditions favourable to propagation (i.e. light downwind or under a moderate temperature inversion). The standard includes terms for geometrical divergence, atmospheric absorption, ground effects, reflections and screening due to obstacles.

23.87 Noise modelling scenarios have been developed for the potential construction and HDD operations at Ness of Huna and Ness of Quoys and for operational PCC noise at both potential sites.

23.88 Expected sound pressure levels due to construction have been predicted using the methodology defined in BS 5228 and utilising information on the construction method, size, vehicle access route and the type and quantity of plant required to construct the new PCC site, access track and cable routes. This information was used to calculate the range of noise levels likely to be encountered at each of the noise sensitive receptors as well as typical noise levels for each phase of construction. Increases in traffic noise have been calculated, where appropriate, using the methodology defined in the Calculation of Road Traffic Noise (CRTN).

23.89 The HDD noise models are based on noise data provided to Xodus by potential drilling contractors for the drilling rigs and on noise data from previous measurements undertaken on ancillary equipment. It should be noted that the HDD contractor has not yet been chosen so further modelling and specification of noise control measures may be required later in the development. The principal noise sources will be the HDD drilling rig, generators, mud pumps and shale shakers. It should be noted that the equipment noise data provided by the potential drilling contractors was very basic and it is not known, for example, whether the noise measurements near the rig were affected by extraneous noise from other sources. It is considered that this represents a "worst case" scenario because any extraneous noise affecting the measurements would result in a higher estimation of the sound power level of the rig than used in this assessment.

23.90 The operational noise levels for the PCC are based on noise data supplied by manufacturers for typical equipment that might be installed. The equipment, including transformers and air blast coolers, will be housed in three Power Conversion Unit Buildings (PCUBs) which are currently proposed to be clad using an acoustic cladding system. The system is likely to comprise an external cladding layer (e.g. trapezoid steel or polycarbonate), a 150mm layer of mineral wool (of nominal density $90kgm^{-3}$) and an inner perforated liner. The primary noise source will be the Thermal Exchange AF500 air blast coolers which produce a sound pressure level of 56 dBA at 10m for free-standing, unenclosed units.

23.91 Ventilation louvers will be provided along the top of the long side walls on opposing walls. This will provide a through draft for normal use. In addition, a back up ventilation system will be provided using a duct within the apex of the roof, with an outlet on the north façade (facing out away from residential properties), with a louver inlet at low level on the opposing south facing walls. All louvers will be of the acoustic type and it has been assumed that they will be approximately 300mm in depth.

Dust

23.92 A desk study has been undertaken in order to evaluate the Project activities which have the potential to generate airborne dust, including PM_{10}[3] which could affect human health, vegetation and local air quality.

23.4.3 Field survey

Baseline noise survey locations

23.93 For the purpose of determining the baseline noise level, seven locations were chosen to represent the most likely affected areas in terms of the potential noise impact from construction and operation of the Project. The monitoring locations are described in Table 23.8 and are shown in Figure 23.2.

Location No.	Description	Comments
1	Norwin	Representative of baseline noise levels for locations bordering the HDD and PCC site at Ness of Huna and near the potential cable route between the Ness of Huna and Ness of Quoys.
2	Quoys	Representative of baseline noise levels for locations bordering the HDD and PCC site at Ness of Quoys and near potential cable route options from the Ness of Quoys.
3	The Cottage	Representative of baseline noise levels for properties in and around Gills Bay, close to the A836 road and potential cable routes east along the coast from Ness of Quoys and through the Gills area.
4	East Mey	Representative of baseline noise levels for properties in East Mey close to the A836 road and potential cable routes.
5	Hill of Rigifa	Representative of baseline noise levels for properties around Hill of Rigifa and near to potential cable routes and potential SHEPD substations sites in this area.
6	Roadside	Representative of baseline noise levels for properties near to potential cable routes south of Gills.
7	Highfield, Warse	Representative of baseline noise levels for properties in Warse and near potential cable routes in this area.

Table 23.8: Baseline noise measurement locations

Baseline survey equipment and methodology

23.94 Unattended continuous long-term noise monitoring equipment was installed at two locations – location 1 (Norwin, near Ness of Huna) and location 2 (Quoys). They represent the nearest and most sensitive receptors in order to determine the background and the ambient noise levels within the vicinity of the two proposed HDD and PCC sites. Attended noise monitoring was also carried out at these two locations and five other locations.

23.95 Type 1 Larson Davies 820 sound level meters (SLM) fitted with weatherproof windshields were used for the unattended continuous measurements taken at locations 1 and 2. The meters were powered by dry cell batteries and stored inside weatherproof security cases. The meters were left on site to log noise levels over the period of 23rd – 26th August 2011. The instrumentation was calibrated before and after the measurement period using a calibrator. No significant drift in calibration occurred. Overall $L_{Amax,F}$, $L_{Aeq,T}$, $L_{A10,T}$, $L_{A50,T}$, $L_{A90,T}$ percentile levels were measured over consecutive 5 minutes periods.

23.96 A Type 1 Larson Davis 824 sound level analyser, fitted with a windshield, was used for the short-term attended measurements. The SLM was calibrated before and after each measurement by using a hand held calibrator. Overall L_{Amax}, $L_{Aeq,T}$, $L_{A10,T}$, $L_{A50,T}$ and $L_{A90,T}$ percentile levels were measured over pre set intervals of 5 minutes. The microphone was mounted on a tripod at a height of 1.5m above ground level. In order to minimise the influence of reflections, the measurement points were chosen to be at least 3.5m from any reflecting surface other than the ground.

[3] Particle matter of size less than or equal to 10 micrometers.

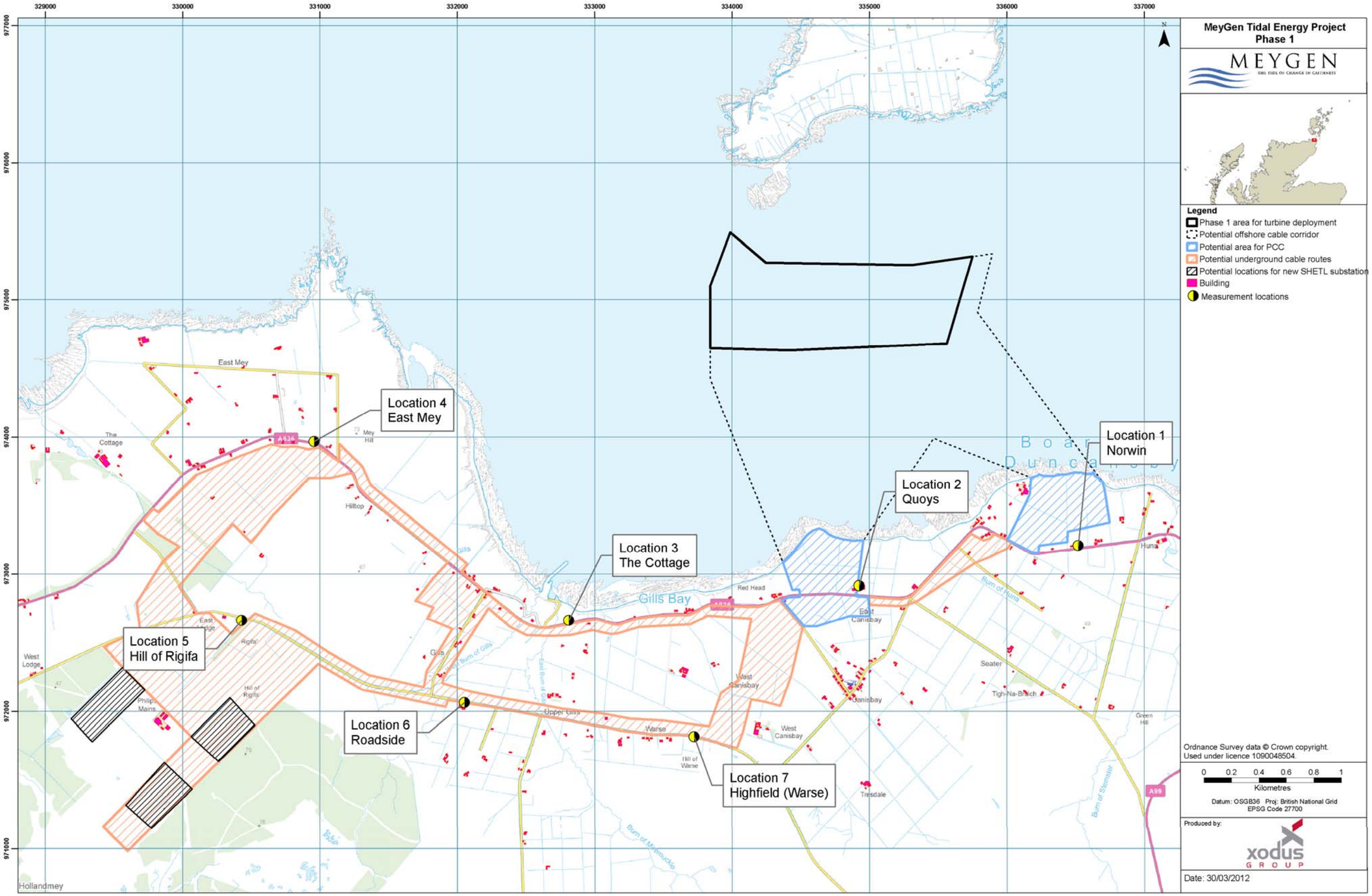

Figure 23.2: Noise monitoring locations

23.97 These attended measurements were taken at locations 1 - 7. The measurements at locations 3 – 7 were undertaken during the daytime period only (because these locations are representative of those which will be primarily affected by cable route construction, which will take place in the daytime). An additional attended survey was undertaken at Locations 1 and 2 during the night-time to obtain observations about meteorological conditions and sources of noise contributing to the overall noise level. For this survey, the data from the unattended noise monitor was used.

23.98 Observations of local meteorological conditions were made during the attended noise monitoring. These observations included wind speed, relative humidity and temperature. The survey was undertaken under light wind conditions, this therefore represents a "worst case" scenario in terms of assessing the impact of the Project.

Baseline survey results analysis

23.99 Noise levels will vary over the course of the day and night and on different days, primarily due to differences in meteorological conditions and varying levels of anthropogenic activity. However, it is useful to determine single numbers for use in assessing the effects of a development. BS 4142 does not define a robust measurement method for determining the background noise level based on long-term monitoring results. For the purposes of this Project, the arithmetic average of the ambient and background noise levels has been taken, minus one standard deviation, to provide an indication of the baseline noise. Work on previous projects has shown this method to give a reasonable measure of background noise levels in rural environments. It is recognised that the derived baseline noise levels will be, by necessity, a simplification of the real noise environment. However, it is considered that by subtracting one standard deviation from the data this will result in an assessment which is robust for the majority of situations encountered. It is considered that this assessment represents a 'worst case' scenario as the noise monitoring was undertaken during unusually calm meteorological conditions for the region. Detailed results of the noise monitoring are provided on the supporting studies CD (Xodus, 2011).

23.100 Average wind speeds for Kirkwall between 1971–2000 are presented in Table 23.9, based on information from the Met Office website. It is worth noting that average wind speeds are very high in comparison to the range of wind speeds encountered during the survey. This reinforces the view that the baseline noise levels presented in this report are unusual and that noise levels under even average conditions will be significantly higher.

Month	Average wind speed at 10 m height, ms^{-1}
January	8.6
February	8.1
March	8.0
April	6.8
May	6.2
June	5.8
July	5.6
August	5.5
September	6.6
October	7.5
November	7.8
December	8.0
Year	7.0

Table 23.9: Average wind speed per month 1971 – 2000

23.4.4 Significance criteria

23.101 Where appropriate the methodology used follows that outlined in Section 8. Variations from this are explained below.

Noise

23.102 The impact and significance criteria used to assess operational and construction and installation noise have been developed taking into account the sensitivity of the receiver and the potential magnitude of the impact (in terms of noise change, absolute levels and the likelihood of occurrence (i.e. whether continuous or temporary)). The magnitude and sensitivity are combined to evaluate the consequence and significance of the impact, as detailed in Table 8.2 (significance rankings) in Section 8. Those impacts rated as moderate, major or severe are considered potentially significant under the EIA Regulations.

23.103 Table 23.10 summarises the definitions of the sensitivity of receiver sensitivities used for this Project, adopted from PAN 1/2011 and the accompanying TAN. It should be noted that the noise sensitive receiver locations in the vicinity of the Project are primarily residential in nature, although there is a church near the proposed PCC/HDD site at Quoys. Other types of receptor do exist in the area, but they are much further away from the development area, so will be much less affected by noise. As a consequence, the impact criteria for onshore noise impacts have been developed assuming high sensitivity of the receptors.

Sensitivity of receptor	Definition	Examples of receiver
High	Receptors where people or operations are particularly sensitive to noise	▪ Residential properties, including gardens. ▪ Quiet outdoor areas used for recreation. ▪ Schools. ▪ Hospitals. ▪ Residential care homes. ▪ Places of worship.
Medium	Receptors moderately sensitive to noise, where it may cause some distraction or disturbance	▪ Offices. ▪ Bars, cafes, restaurants where external noise may be intrusive. ▪ Sports grounds where spectator noise is not a normal part of the event and where external noise may be intrusive.
Low	Receptors where distraction or disturbance from noise is minimal	▪ Buildings not occupied during working hours. ▪ Factories and working environments with existing high noise levels. ▪ Sports grounds where spectator noise is a normal part of the event. ▪ Night clubs.

Table 23.10: Definitions for sensitivity of receptor

23.104 The significance of impacts on the receptors has been defined in Table 23.11, taking into account both the absolute ambient noise level and the change in ambient noise. The rationale for this is based on the assumption that a given change in noise level would have a greater impact if the end absolute noise level exceeds the criteria in WHO Guidance and BS 8233 for annoyance or sleep disturbance. Thus, if the end noise level is less than the absolute noise level criteria for onset of sleep disturbance and the change in noise will not be noticeable (i.e. less than 3 dBA change) then it seems logical that the impact of the development would be negligible. Likewise, it is unlikely that even a large change in ambient noise would result in a severe impact unless the criteria for sleep disturbance or annoyance were also exceeded. These assumptions are based on the philosophy described in the generic scale for assessing impacts on people, as summarised previously in Table 23.2. It should be noted that, for operational noise, the impact will be continuous once the PCC is operational. As a consequence, the impact criteria for operational noise have been assigned using lower values than would be used to assess the impact due to temporary noise, such as due to construction and installation.

Ambient noise level with PCC operation	Noise change, dBA	Consequence
Any	0	Negligible
≤ 55 dB $L_{Aeq,1h}$ (day) ≤ 45 dB $L_{Aeq,1h}$ (night)	< 3	Negligible
	3 - 4.9	Minor
	5 - 9.9	Moderate
	≥ 10	Major
> 55 dB $L_{Aeq,1h}$ (day) > 45 dB $L_{Aeq,1h}$ (night)	< 3	Minor
	3 - 4.9	Moderate
	5 - 9.9	Major
	≥ 10	Severe

Table 23.11: Definitions of consequence for operational noise (high sensitivity receptors)

23.105 In addition to the above impact criteria, a BS 4142 assessment has also be undertaken, where appropriate, to determine the likelihood of complaints due to the PCC in the short term (i.e. within the first year or so following the commencement of operation of the Project).

23.106 For drilling and construction noise, which will be temporary in nature, it is considered (based on the guidance in BS 5228) that residents will be willing to tolerate both higher absolute noise levels and higher changes in noise if they know that the impact will not be permanent. The proposed impact criteria take into account the guidance provided in BS 5228, Advisory Leaflet 72 and MPS 2. The premise on which the criteria are based is that a temporary impact would not be significant if the relevant absolute noise criterion for that period is not exceeded. Thus, impacts become more substantial for a given change in noise level once 45 dBA is exceeded at night (i.e. the onset of sleep disturbance effects) and 55 dBA for the daytime (based on the lower range of proposed limits in BS 5228 / MPS2 and to avoid the onset of annoyance). The night-time level of 55 dBA used in the table is based on the WHO interim target. These criteria relate to activities lasting for more than 8 weeks and it would be reasonable to relax them for shorter-term activities, if they occur, subject to the use of best practicable means to reduce noise.

Ambient noise level with HDD / construction	Noise change, dBA	Consequence
Any	0	Negligible
≤ 55 dB $L_{Aeq,1h}$ (day / weekend) ≤ 50 dB $L_{Aeq,1h}$ (evening) ≤ 45 dB $L_{Aeq,1h}$ (night)	0.1 – 4.9	Negligible
	≥ 5	Minor
> 55 dB $L_{Aeq,1h}$ (day) > 50 dB $L_{Aeq,1h}$ (evening / weekend) > 45 dB $L_{Aeq,1h}$ (night)	0.1 – 4.9	Minor
	≥ 5	Moderate
> 75 dB $L_{Aeq,1h}$ (day) > 65 dB $L_{Aeq,1h}$ (evening / weekend) > 55 dB $L_{Aeq,1h}$ (night)	0.1 – 4.9	Moderate
	5 – 9.9	Major
	≥ 10	Severe

Table 23.12: Definitions of consequence for construction and drilling noise (high sensitivity receptors)

Dust

23.107 The significance criteria relating to any changes in air quality due to dust have been established through consideration of the following factors:

- Duration of activity;
- Exceedence of standards (such as the AQS objectives which differ for each type of pollutant);
- Geographical extent;
- Magnitude of change; and
- Permanence.

23.108 The significance of potential impacts is assessed with reference to Section 8 of this ES and considers the magnitude of impact against the sensitivity of receptors. The sensitivity of receptor is defined in terms of the quality of the local air resource and its susceptibility to change in conditions (Table 23.13) and the magnitude is considered in terms of deviation from the baseline and the sensitivity of receptors (Table 23.14)

Sensitivity of receptor	Definition
Very High	Environment is easily subject to major changes due to dust. Sites contain features of international or national conservation or cultural designation, or permanent reduction of anthropogenic activity.
High	Environment is subject to large changes due to dust. Sites contain features of international or national conservation or cultural designation, or long-term or permanent reduction of anthropogenic activity.
Medium	Environment clearly responds to effects in a quantifiable and/or qualifiable manner. Sites contain features of national or regional conservation or cultural designation, long term or permanent modification of anthropogenic activity.
Low	Environment responds in a minimal way to effects such that only minor changes are detectable. Sites of local nature conservation or cultural value, or temporary modification of anthropogenic activity.
Negligible	Environment responds in a minimal way such that only minor changes are detectable. Sites of local interest with little or no change to anthropogenic activity.

Table 23.13: Definitions for sensitivity of receptor

Magnitude of impact	Definition
Severe	An extreme change to the baseline condition of the receptor, exceeding AQS standards.
Major	A fundamental change to the baseline condition of the receptor, exceeding AQS standards.
Moderate	A detectible change resulting in the non-fundamental temporary or permanent condition of a receptor, may temporarily exceed AQS standards.
Minor	A minor change to the baseline condition of the receptor (or a change that is temporary in nature).
Negligible	An imperceptible and/or no change to the baseline condition of the receptor.

Table 23.14: Definitions for magnitude of impact for dust

23.4.5 Data gaps and uncertainties

23.109 This assessment includes some professional judgement of conditions and worst case estimates regarding noise and dust levels associated with the proposed development.

23.110 The assessment of impacts relating to dust is discussed qualitatively in the context of existing activities. No field measurements have been taken.

23.5 Baseline Description

23.5.1 Noise

23.111 The results of the attended and unattended noise monitoring are summarised in Table 23.15. It should be noted that the large difference between the ambient noise levels during the daytime and night-time at locations 1 and 2 is because attended measurements were taken at the front of the property, near to the road, whereas unattended measurements were taken in the rear garden of the property, further from and partially screened from the road. Therefore, the attended measurements form a useful baseline for

assessing the effects of development traffic on residential premises along the A836, whereas the unattended measurements will be a more useful indicator of baseline noise affected by HDD / PCC noise.

Location		Ambient dB L_{Aeq}		Background dB L_{A90}	
		Average	Standard deviation	Average	Standard deviation
Attended survey results					
1	Daytime	64	±3	37	±2
2	Daytime	55	±2	38	±3
3	Daytime	62	±2	38	±3
4	Daytime	60	±4	37	±3
5	Daytime	46	±4	38	±3
6	Daytime	57	±8	36	±3
7	Daytime	56	±1	36	±3
Unattended survey results					
1	Daytime	45	±7	33	±6
	Night-time	33	±6	28	±4
2	Daytime	40	±5	30	±5
	Night-time	29	±6	24	±3

Table 23.15: Baseline noise survey results summary

23.112 Based on the results of the baseline noise measurements, Table 23.16 details the baseline noise levels that have been used in assessing the effects of noise due to operations of the site and HDD operations on the two closest residential receivers to the proposed HDD / PCC sites at Ness of Huna and Ness of Quoys.

Location	Daytime		Night-time	
	Ambient dB L_{Aeq}	Background dB L_{A90}	Ambient dB L_{Aeq}	Background dB L_{A90}
1 - Norwin	38	27	27	24
2 - Quoys	35	25	23	21

Table 23.16: Baseline noise levels used in assessment of operational noise

23.113 Table 23.17 details the baseline noise levels which have been used to assess the effects of HGV traffic and construction noise on the noise sensitive receiver locations. As development traffic and construction activities will only occur during daytime hours, only the daytime values are quoted.

Location	Daytime	
	Ambient dB L_{Aeq}	Background dB L_{A90}
1 - Norwin	61	35
2 - Quoys	53	35
3 - The Cottage	60	35
4 - East Mey	56	34
5 - Hill of Rigifa	42	35
6 - Roadside	49	33
7 - Highfield, Warse	55	33

Table 23.17: Baseline noise levels used in assessment of traffic noise

23.5.2 Dust

23.114 The construction area is located within the jurisdiction of The Highland Council who have a statutory duty to periodically review air quality in the area under the Environment Act 1995. The Highland Council published an Air Quality Progress Report (The Highland Council, 2010) which considers new monitoring data and identifies new development that needs to be included in the next update and screening assessment (USA) report which is to be submitted in 2012.

23.115 Monitoring reported in the progress report demonstrates that the air quality objectives are being met or are likely to be met where the target date is still in the future (relative to the publication of the report). The Project does not lie within or in close proximity to an Air Quality Management Area (The Highland Council, 2010).

23.116 Qualitatively, the site is located in a rural coastal area which is frequently exposed to strong winds. The majority of airborne dust in the area is therefore likely to be formed through mechanical generation, for example erosion of agricultural soils. The nearest sensitive receptors to the site are farm buildings and single dwellings spread throughout the study area, and the small village at Canisbay.

23.6 Impacts during Construction and Installation

23.6.1 Impact 23.1 - PCC/HDD site and cable route construction noise

Impact assessment

23.117 The predicted range of noise levels for each of the major phases of construction is given in Table 23.18. The reason for presenting a range of levels is that noise levels will vary depending on where equipment is operating at any one time. The lower end of the range represents the case where all of the equipment is operating at a point furthest from the receiver whereas the higher number represents a scenario where all equipment is operating at the closest point to the receiver. In reality, it is unlikely that these extremes will be encountered for significant periods of time. The noise model assumes that all equipment will be operating for 100% of the time, which is also unlikely. The higher numbers therefore represent an extreme worst case scenario which, even if it was to be encountered, would be for a very limited period of time. As an example, it is possible that the higher levels for construction of the access track and cable route would only be encountered whilst the equipment was operating at the closest point to each receiver. This scenario is rather similar to normal road works where higher levels of noise can be encountered for a short time before moving on down the road. These higher levels are therefore only likely to be encountered for a period of up to a few hours.

23.118 Whilst these activities may be clearly audible outside the properties, it is anticipated that undue disturbance will not be caused, given that it is for a relatively short period and would only occur during normal working hours. Even the highest noise levels are well below the guideline limit in Advisory Leaflet 72 and below the suggested MPS 2 limit of 70 dBA for temporary works lasting less than eight weeks.

Task	Predicted sound pressure level, dB $L_{Aeq,1h}$						
	Construction of access road	Construction of access road (including use of breaker)	PCC foundations	Erect PCC steel structure	Bury cables (plough method)	Bury cables (cut and back fill method)	Cable Landfall
Location 1 - Norwin	44 - 53	40 - 48	39 - 44	30 - 35	37 - 43	30 - 36	41 - 42
Location 1b - Huna House / The Bungalow	48 - 57	44 - 52	47 - 50	38 - 41	44 - 52	37 - 45	50 - 63
Location 2 - Quoys	40 – 47	43 - 51	41 - 44	33 - 35	38 - 43	31 - 36	43 - 44
Location 2b - Canisbay Kirk / Kirkstyle	41 – 54	45 - 58	41 - 44	32 - 34	39 - 43	32 - 36	42 - 43
Location 2c - Canisbay	40 – 56	44 - 60	40 - 43	31 - 35	38 - 42	31 - 35	41 - 43

Table 23.18: Predicted range of specific noise levels due to construction

23.119 Predicted typical ambient noise levels for construction are presented in Table 23.19. The predicted ambient levels include the baseline ambient noise level added to the predicted typical ambient noise during each phase of the works. Table 23.20 shows the predicted change in ambient noise during each phase of construction and Table 23.21 shows the resultant consequence rankings. It should be noted that, as described in paragraph 23.106, the criteria are strictly for impacts lasting more than eight weeks. It is considered highly unlikely that these higher levels will be experienced for this long and some relaxation should therefore be applied when interpreting the moderate impacts.

Task	Predicted typical ambient noise level with construction, dB L_{Aeq}						
	Construction of access road	Construction of access road (including use of breaker)	PCC foundations	Erect PCC steel structure	Bury cables (plough method)	Bury cables (cut and back fill method)	Cable Landfall
Location 1 - Norwin	51	47	43	39	43	39	43
Location 1b - Huna House / The Bungalow	55	50	49	42	50	44	60
Location 2 - Quoys	45	49	44	38	42	38	45
Location 2b - Canisbay Kirk / Kirkstyle	51	55	44	37	42	38	44
Location 2c - Canisbay	53	57	43	37	41	37	43

Table 23.19: Predicted typical worst case ambient noise levels due to construction

Task	Predicted change in ambient noise level due to construction, dB L_{Aeq}						
	Construction of access road	Construction of access road (including use of breaker)	PCC foundations	Erect PCC steel structure	Bury cables (plough method)	Bury cables (cut and back fill method)	Cable Landfall
Location 1 - Norwin	+13	+9	+5	+1	+5	+1	+5
Location 1b - Huna House / The Bungalow	+17	+12	+11	+4	+12	+6	+22
Location 2 - Quoys	+10	+14	+9	+3	+7	+3	+10
Location 2b - Canisbay Kirk / Kirkstyle	+16	+20	+9	+2	+7	+3	+9
Location 2c - Canisbay	+18	+22	+8	+2	+6	+2	+8

Table 23.20: Predicted change in ambient noise levels due to construction

Task	Consequence ranking for construction noise						
	Construction of access road	Construction of access road (including use of breaker)	PCC foundations	Erect PCC steel structure	Bury cables (plough method)	Bury cables (cut and back fill method)	Cable Landfall
Location 1 - Norwin	Minor	Minor	Minor	Negligible	Minor	Negligible	Minor
Location 1b - Huna House / The Bungalow	Minor	Minor	Minor	Negligible	Minor	Minor	Moderate
Location 2 - Quoys	Minor	Minor	Minor	Negligible	Minor	Negligible	Minor
Location 2b - Canisbay Kirk / Kirkstyle	Minor	Minor	Minor	Negligible	Minor	Negligible	Minor
Location 2c - Canisbay	Minor	Moderate	Minor	Negligible	Minor	Negligible	Minor

Table 23.21: Consequence rankings due to construction

23.120 In addition to the above analysis, Table 23.22 shows the number of buildings along the cable route which will be subject to noise levels above the indicated level at some point during the construction period. It should be noted that it is only anticipated that these noise levels will be reached for a very short period whilst the equipment passes the closest point to the building (perhaps only a few hours) and that noise levels at other times will be much lower. It should also be noted that the number of buildings includes a number of outhouses etc and therefore not all buildings will be inhabited.

Maximum sound pressure level to which building will be exposed to, dB $L_{Aeq,1h}$	Number of buildings exposed	
	Bury cables (plough method)	Bury cables (cut and back fill method)
> 70 dBA	11	4
> 60 dBA	32	20
> 50 dBA	70	46

Table 23.22: Number of buildings exposed to various noise levels during cable laying activities

23.121 It is acknowledged that a moderate impact may be encountered at Huna House, The Bungalow and at Canisbay for some activities due to the close proximity of the properties to the PCC/HDD sites and access tracks. However, as stated previously, this is for the worst case assumption of all equipment operating at the same time at the closest point to the receptor and will be for a very limited duration, perhaps only a few hours. Nevertheless, in recognition of the potential for a major impact at these locations, typical mitigation measures which represent best practice for construction sites are discussed in the following section.

23.122 The impact of construction noise on wildlife is examined separately in Section 18.

Mitigation

23.123 The principal contractor will be required to submit a detailed Construction Environmental Management Plan (CEMP) giving construction plant schedules, working hours, proposals to minimise noise emissions and predicted noise levels at houses, along with a programme of sample monitoring. This will be formulated in liaison with The Highland Council prior to commencement of construction. The principal contractor will be expected to:

- Reduce noise to a minimum using the best practicable means at all times and in agreement with The Highland Council;
- Fit exhaust silencers wherever possible;
- Maintain plant regularly, ensure it is accurately adjusted and that noise abatement measures (e.g. covers) are fully operational and used correctly; and
- Work to keep local residents and groups informed of the proposed working schedule, where appropriate, including the times and duration of any abnormally noisy activity that may cause concern.

23.124 In order to minimise the impact of construction noise, it is also proposed to confine noisy construction activity (excluding HDD activities) to the following times:

- Mondays to Fridays (excluding public holidays): 07:00 to 19:00;
- Saturdays: 07:00 to 13:00; and
- No noisy work on bank holidays and Sundays.

23.125 A noise monitoring procedure and schedule will be prepared and agreed with The Highland Council prior to commencement of work. It will cover critical phases of the site construction and plant commissioning. Typically the procedure would include noise measurements in the vicinity of the noise source(s) and the nearest housing.

MITIGATION IN RELATION TO IMPACT 23.1
▪ Submission of CEMP detailing predicted construction noise levels and mitigation measures to be used.
▪ Limit construction working times to minimise noise during sensitive periods.

Residual impact

23.126 Assuming that the above mitigation measures can be implemented in full, it is anticipated that the impact due to construction of the HDD site, PCC and cable routes can be kept to a minimum, especially when it is taken into account that the impacts will be transient in nature. The principal contractor will need to provide further information as part of the CEMP to quantify the level and duration of impact once more detailed construction information becomes available. It is anticipated that the character of sound due to normal construction works will be similar in nature to noise from tractors and other farm machinery currently prevalent in the area.

23.127 Assuming that a reduction of 5 - 10 dBA could be achieved through use of the mitigation methods described above, including the use of localised screening and hoardings where necessary, all of the predicted significance rankings would reduce to minor.

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
High	Minor	Minor	Not Significant

23.6.2 Impact 23.2 - Construction and drilling traffic noise

Impact assessment

23.128 Based on the results of the traffic assessment in Section 22, the results of the construction and drilling traffic noise assessment are shown in Table 23.23.

Month	Total trips (present)	Total HGVs (present)	Total trips (2014)	Total HGVs (2014)	Construction HGVs	Total HGVs (2014 + construction)	% increase HGVs	Increase in HGV noise, dBA	Increase in total traffic noise, dBA
Aug	14,709	399	15,395	418	135	553	32	+1.2	+0.4
Oct	10,787	323	11,290	338	135	473	40	+1.5	+0.5
Feb	9,053	330	9,475	345	135	480	39	+1.4	+0.6
Apr	10,279	287	10,758	300	135	435	45	+1.6	+0.5
Jul	11,066	368	11,582	385	135	520	35	+1.3	+0.5

Table 23.23: Traffic noise impact assessment

23.129 Comparing to the impact criteria in DMRB, it is considered that the maximum increase in noise due to HGVs would result in a minor impact and is therefore not significant but requires ongoing management to ensure the impact remains within acceptable limits. It should also be bourne in mind that the increase in traffic noise will be temporary and levels will revert to normal once construction and drilling has ceased.

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
High	Minor	Minor	Not Significant

MITIGATION IN RELATION TO IMPACT 23.2
▪ Although no significant impact has been identified, mitigation has been considered to ensure this remains the case. ▪ The local community should be kept informed of overall construction activities including details of types, levels and routes of traffic.

23.6.3 Impact 23.3 - Horizontal Directional Drilling noise

Impact assessment

23.130 The predicted noise contours for the HDD operations are shown in Figure 23.3 and Figure 23.4 and summarised in Table 23.24.

Location	Predicted specific noise level, dBA	
	Ness of Quoys site	Ness of Huna site
Location 1 - Norwin	27	41
Location 1b - Huna House / The Bungalow	24	49
Location 2 - Quoys	42	21
Location 2b - Canisbay Kirk / Kirkstyle	42	26
Location 2c - Canisbay	46	26
Location 3 - The Cottage	31	20
Location 4 - East Mey	19	15
Location 5 - Hill of Rigifa	17	13
Location 6 - Roadside	23	17
Location 7 - Highfield (Warse)	28	21

Table 23.24: Predicted noise levels from HDD operations

23.131 It should be noted that the precise location of the drilling equipment within the HDD site is not yet known and, consequently, the predicted noise levels could differ depending on the final configuration, although it is known that this will be a 24 hour operation. Furthermore, the drilling contractor has not yet been appointed so there is further uncertainty about the type of equipment that will be used. Nevertheless, it is considered that the modelling has considered a worst case scenario as there is considerable scope for mitigation of noise from the rig if required.

23.132 The impact of HDD operations has been assessed against the significance criteria for construction activities and this is presented in Table 23.25 for the daytime and Table 23.26 for the night-time.

Location	Ambient noise assessment, dBA				Consequence	Significance
	Baseline ambient	Specific noise	New ambient	Change		
Assessment for Ness of Huna site						
Location 1 - Norwin	38	41	43	+5	Minor	Not Significant
Location 1b - Huna House / The Bungalow	38	49	49	+11	Minor	Not Significant
Location 2 - Quoys	35	21	35	0	Negligible	Not Significant
Location 2b - Canisbay Kirk / Kirkstyle	35	26	36	+1	Negligible	Not Significant
Location 2c - Canisbay	35	26	36	+1	Negligible	Not Significant
Assessment for Ness of Quoys site						
Location 1 - Norwin	38	27	38	0	Negligible	Not Significant
Location 1b - Huna House / The Bungalow	38	24	38	0	Negligible	Not Significant
Location 2 - Quoys	35	42	43	+8	Minor	Not Significant
Location 2b - Canisbay Kirk / Kirkstyle	35	42	43	+8	Minor	Not Significant
Location 2c - Canisbay	35	46	46	+11	Minor	Not Significant

Table 23.25: Impact assessment for HDD noise – daytime

Location	Ambient noise assessment, dBA				Consequence	Significance
	Baseline ambient	Specific noise	New ambient	Change		
Assessment for Ness of Huna Site						
Location 1 - Norwin	27	41	41	+14	Minor	Not Significant
Location 1b - Huna House / The Bungalow	27	49	49	+22	Moderate	Significant
Location 2 - Quoys	23	21	25	+2	Negligible	Not Significant
Location 2b - Canisbay Kirk / Kirkstyle	23	26	28	+5	Minor	Not Significant
Location 2c - Canisbay	23	26	28	+5	Minor	Not Significant
Assessment for Ness of Quoys Site						
Location 1 - Norwin	27	27	30	+3	Negligible	Not Significant
Location 1b - Huna House / The Bungalow	27	24	29	+2	Negligible	Not Significant
Location 2 - Quoys	23	42	42	+19	Minor	Not Significant
Location 2b - Canisbay Kirk / Kirkstyle	23	42	42	+19	Minor	Not Significant
Location 2c - Canisbay	23	46	46	+23	Moderate	Significant

Table 23.26: Impact assessment for HDD noise – night-time

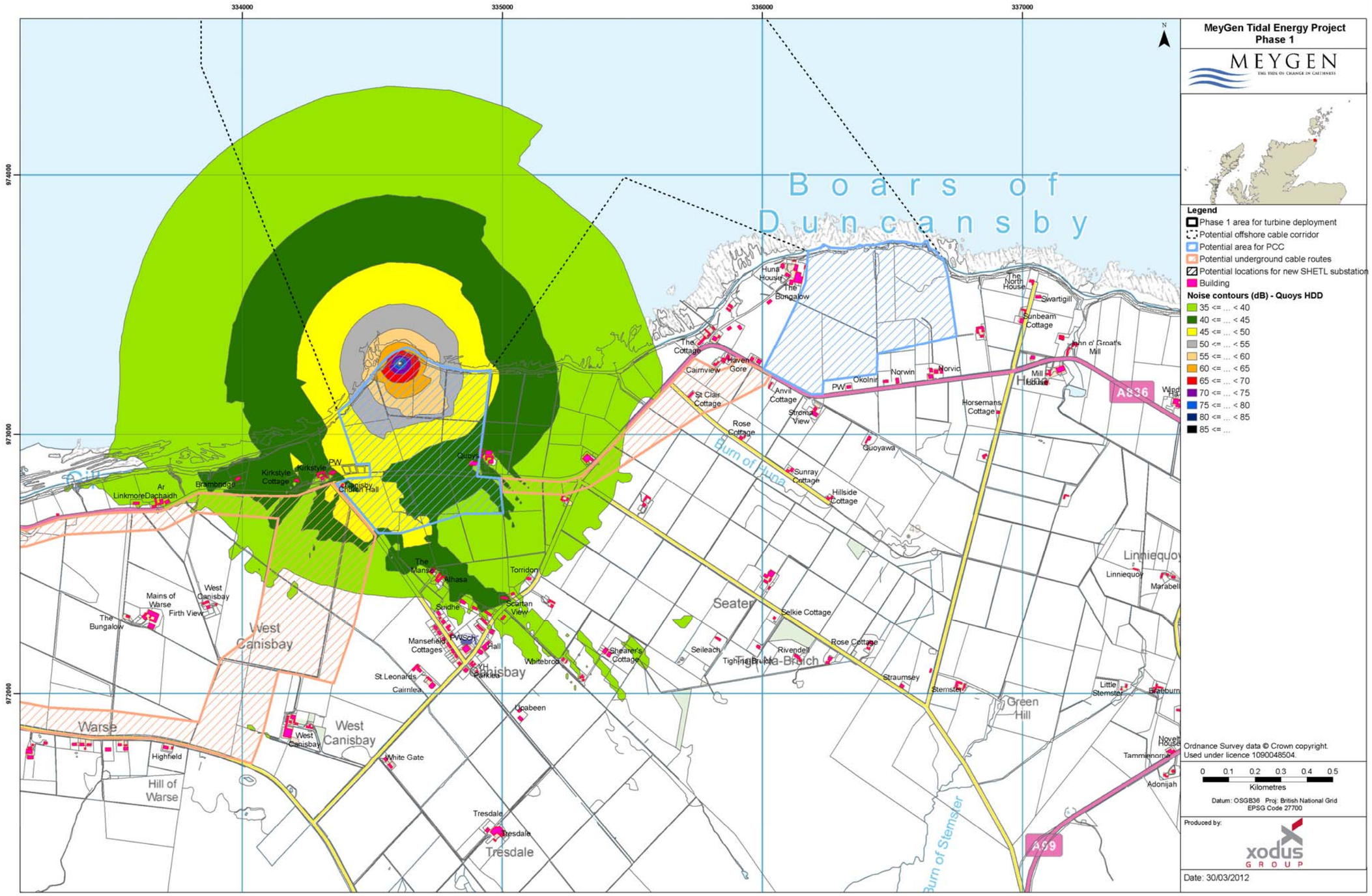

Figure 23.3: Noise contours for HDD activity at Ness of Quoys

Figure 23.4: Noise contours for HDD activity at Ness of Huna

Mitigation

23.133 Although the precise rig and specification has not been selected for the Project yet, it is possible to specify potential mitigation measures based on experience of undertaking noise control on other drilling rigs. It is recommended that mitigation measures contain a combination of some or all of the following, if required:

- Erection of noise barriers or baffle mounds between the rig and noise sensitive receiver locations;
- Erection of acoustic enclosure around the drilling rig;
- Installation of up-rated silencers to the rig generator exhaust;
- Installation of attenuators to air intakes and outlets;
- Installation of acoustic cladding to noise generating components; and
- Use of acoustic dampening materials.

23.134 Although it is difficult to estimate the likely benefit of such measures without a detailed understanding of the relative contribution of each noise source on the rig, it is considered likely that considerable reductions of between 10 - 20 dBA could be achieved.

23.135 It is proposed that a night-time noise limit of 45 dB $L_{Aeq,1h}$ and 60 dB L_{AFmax} at the nearest residential premises could be specified for HDD operations as part of any planning consent in order to ensure that noise from the operations does not result in sleep disturbance. The specification for mitigation measures will be dependent on the drilling rig equipment to be used and will be implemented if the rig is likely to exceed the proposed 45 dBA night-time noise limit.

MITIGATION IN RELATION TO IMPACT 23.3
▪ Submission of CEMP detailing predicted HDD noise levels and mitigation measures to be used. ▪ Installation of noise control engineering measures to rig and ancillary equipment. ▪ Use of enclosures, barriers and baffle mounds. ▪ Noise limit of 45 dB L_{Aeq} and 60 dB L_{AFmax} for night-time drilling operations at the nearest noise sensitive receptor.

Residual impact

23.136 Table 23.27 shows the residual impact assessment for HDD noise at night assuming that a reduction of 15 dBA can be achieved by installation of noise control measures to the drilling rig. The table shows the residual impact at the closest properties to each site during the night-time, which is the most critical time period.

23.137 Although there will be a change in night-time ambient noise levels at the closest properties to the HDD site during the drilling period, the impact will only be minor because the predicted noise levels are all below the WHO criterion for onset of sleep disturbance effects. As the overall significance of this impact will be minor it is therefore not significant but will require ongoing management to ensure the impact remains within acceptable limits.

Location	Ambient noise assessment, dBA				Consequence	Significance
	Baseline ambient	Specific noise	New ambient	Change		
Assessment for Ness of Huna Site						
Location 1b – Huna House / The Bungalow	27	34	34	+7	Minor	Not Significant
Assessment for Ness of Quoys Site						
Location 2c - Canisbay	23	31	32	+9	Minor	Not Significant

Table 23.27: Residual impact assessment for HDD noise – night-time

23.6.4 Impact 23.4 – Impacts due to airborne dust during construction

23.138 Construction dust emissions due to excavation and preparation of the PCC and HDD site, as well as transport of materials such as aggregate have the potential to transport dust throughout the construction area. Due to the high energy winds regularly experienced in the area airborne dust would easily be carried quickly over large distances. However, during such times when the wind transports large quantities of dust in the air, airborne dust is also likely to be dispersed rapidly.

23.139 Potential air quality impacts associated with the construction phase of the Project have been assessed qualitatively in terms of dust impacts on adjacent sensitive receptors. Examples of relative sensitivities of different receptors are listed in Table 23.28. No receptors have been identified as having Very High sensitivity or Negligible Sensitivity, based on the document *Minerals Policy Statement 2* (HMSO, 2005).

High sensitivity	Medium sensitivity	Low sensitivity
Hospitals and Clinics	Schools	Farms
Retirement Homes	Residential Areas	Light and Heavy Industry
Hi-Tech Industries	Food Retailers	Outdoor Storage
Food Processing	Offices	

Table 23.28: Dust sensitive receptors

23.140 The most sensitive receptor in the construction area has been identified as Canisbay which has dwellings, a school and a food retailer. This location is therefore taken as the worst case scenario as there is potential for construction activities to take place nearby (e.g. cable route) or for the wind to transport dust in the air to the village.

23.141 Construction dust has the potential to effect nearby receptors through soiling of surfaces or in fine particle form (which some of the dust may be) may have an adverse impact on human health. Construction dust emissions may also have an impact on short term PM_{10} concentrations in close proximity to the dust generating activities however all concentrations of pollutants are below air quality objectives in The Highland Council jurisdiction so a permanent or long term change to the concentrations of PM_{10} is not expected.

23.142 Assuming good construction management practices are put in place for all phases of construction it is considered that the magnitude of any impact due to dust would be minor and any changes will be temporary in nature. The sensitivity, as described above, is considered to be medium. The frequency of dust emissions, at a worst case, may be considered to be either regular over less than three years or intermittent over more than three years; therefore fitting into likelihood category three, Intermittent. This results in an overall impact of Minor and therefore not significant providing management ensures effects remain within acceptable limits.

Sensitivity of receptor	Magnitude of impact	Consequence	Significance
Medium	Minor	Minor	Not Significant

Mitigation: Construction Environmental Management Plan

23.143 A Construction Environmental Management Plan (CEMP) will be submitted detailing measures to ensure dust emissions are kept to a minimum. Such a document may include some of the following:

- Summary and timetable of all dust generating activities;
- List of dust and emission control methods to be used such as;
- Erection of effective barriers around dusty activities or the site boundary;
- Locating machinery or dust generating activities away from boundaries or sensitive receptors;
- Use of hard standing on site and for access track to limit dust generation during vehicle/plant movement;
- Dampening down of site area during dust generating activities and during particularly dry and windy conditions;
- Wheel washing of vehicles prior to leaving the site;
- Vehicles carrying dusty materials may be covered prior to leaving the site;
- Limiting the size of stockpiles/storage mounds and the duration they are there. These should be sited taking into account predominant wind direction; and
- Re-use of excavated hardcore material to avoid unnecessary vehicle trips.

23.144 The most appropriate measures for the Project at different stages will be applied, as recommended in the best practice guidance (Greater London Authority and London Councils, 2006).

MITIGATION IN RELATION TO IMPACT 23.4
▪ Submission of CEMP detailing measures to ensure dust emissions are kept to a minimum as described above.

23.7 Impacts during Operations and Maintenance

23.145 As there are no dust emissions associated with the O&M phase of the Project it has been scoped out and is not considered further.

23.7.1 Impact 23.4 – PCC operational noise

Impact assessment

23.146 Noise contours for PCC operations are shown in Figure 23.5 and Figure 23.6 and the predicted community noise levels due to operation of the PCC site are presented in Table 23.29. It should be noted that a negative decibel number means that the sound pressure is less than the reference pressure of 20 µPa.

Location	Predicted specific noise level, dBA	
	Ness of Quoys site	Ness of Huna site
Location 1 - Norwin	8	26
Location 1b - Huna House / The Bungalow	7	32
Location 2 - Quoys	26	8
Location 2b - Canisbay Kirk / Kirkstyle	26	9
Location 2c - Canisbay	28	11
Location 3 - The Cottage	13	4
Location 4 - East Mey	1	-3
Location 5 - Hill of Rigifa	-1	-5
Location 6 - Roadside	7	2
Location 7 - Highfield (Warse)	14	4

Table 23.29: Predicted noise levels due to PCC

23.147 The potential impact due to the operational phase of the Project will be principally due to the 24 hour operation of the PCC. The noise is likely to be steady in nature. The impact assessment for PCC operational noise during the daytime is detailed in Table 23.30. The table shows that the impact will be negligible at all of the locations and therefore not significant.

Location	Ambient noise assessment, dBA				Consequence (daytime)	Significance
	Baseline ambient	Specific noise	New ambient	Change		
Assessment for Ness of Huna site						
Location 1 - Norwin	38	22	38	0	Negligible	Not Significant
Location 1b - Huna House / The Bungalow	38	26	38	0	Negligible	Not Significant
Location 2 - Quoys	35	6	35	0	Negligible	Not Significant
Location 2b - Canisbay Kirk / Kirkstyle	35	5	35	0	Negligible	Not Significant
Location 2c - Canisbay	35	6	35	0	Negligible	Not Significant
Assessment for Ness of Quoys site						
Location 1 - Norwin	38	8	38	0	Negligible	Not Significant
Location 1b - Huna House / The Bungalow	38	7	38	0	Negligible	Not Significant
Location 2 - Quoys	35	26	36	+1	Negligible	Not Significant
Location 2b - Canisbay Kirk / Kirkstyle	35	26	35	0	Negligible	Not Significant
Location 2c - Canisbay	35	28	36	+1	Negligible	Not Significant

Table 23.30 Impact assessment for PCC noise – day-time

Figure 23.5: Noise contours for PCC operations at Ness of Quoys

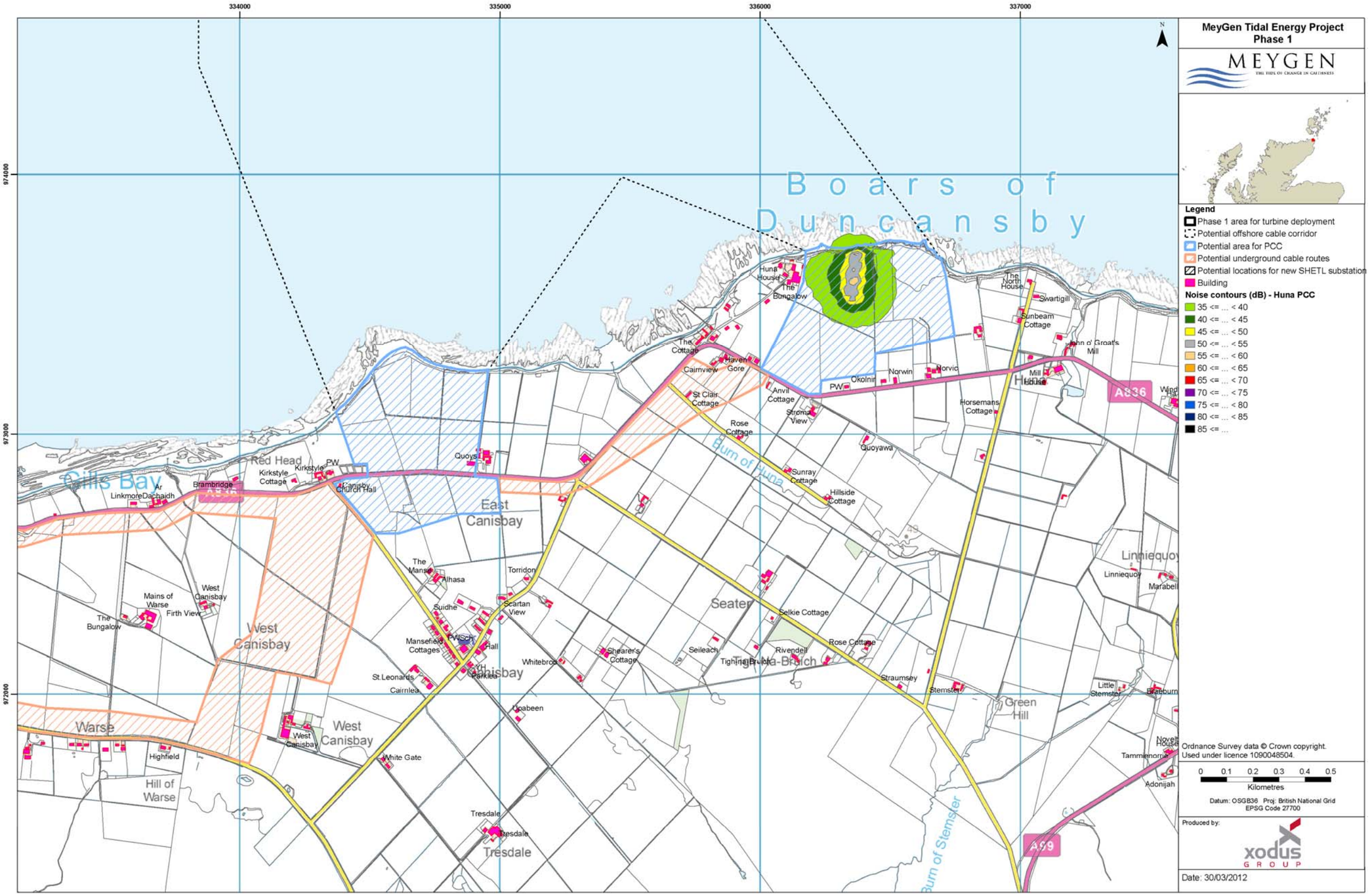

Figure 23.6: Noise contours for PCC operations at Ness of Huna

23.148 As well as examining the effect of the Project on ambient noise levels, it is also helpful to examine the likely short-term reaction of local residents to noise from the PCC site. A BS 4142 assessment can be useful in predicting the likely reactions of people to a new noise source before they have become accustomed to it. Table 23.31 shows a BS 4142 assessment for the daytime. However, it should be taken into account that the background noise level used in the assessment is very low (less than 30 dB LA90, as defined by BS 4142) and the specific noise level due to the Project is also very low (below about 35 dBA, as defined by BS 4142). The standard cannot therefore be applied robustly in this situation.

Location	BS4142 assessment, daytime			
	Background dB L_{A90}	Specific noise, dBA	Difference, dBA	Assessment
Assessment for Ness of Huna site				
Location 1 - Norwin	27	26	-1	Background noise level and rating level classified as very low and BS4142 not applicable.
Location 1b - Huna House / The Bungalow	27	32	5	Background noise level and rating level classified as very low and BS4142 not applicable.
Location 2 - Quoys	25	8	-17	Background noise level and rating level classified as very low and BS4142 not applicable.
Location 2b - Canisbay Kirk / Kirkstyle	25	9	-16	Background noise level and rating level classified as very low and BS4142 not applicable.
Location 2c - Canisbay	25	11	-14	Background noise level and rating level classified as very low and BS4142 not applicable.
Assessment for Ness of Quoys site				
Location 1 - Norwin	27	8	-19	Background noise level and rating level classified as very low and BS4142 not applicable.
Location 1b - Huna House / The Bungalow	27	7	-20	Background noise level and rating level classified as very low and BS4142 not applicable.
Location 2 - Quoys	25	26	+1	Background noise level and rating level classified as very low and BS4142 not applicable.
Location 2b - Canisbay Kirk / Kirkstyle	25	26	+1	Background noise level and rating level classified as very low and BS4142 not applicable.
Location 2c - Canisbay	25	28	+3	Background noise level and rating level classified as very low and BS4142 not applicable.

Table 23.31: BS 4142 assessment – PCC, day-time

23.149 The impact assessment for PCC operational noise during the night-time is detailed in Table 23.32. With the exception of the properties in the immediate vicinity of the PCC site, the impact will be negligible for all residential premises. For the few properties immediately adjacent to the PCC site, it is possible that a moderate impact could occur.

Location	Ambient noise assessment, dBA				Consequence (night-time)	Significance
	Baseline ambient	Specific noise	New ambient	Change		
Assessment for Ness of Huna site						
Location 1 - Norwin	27	26	30	+3	Minor	Not Significant
Location 1b - Huna House / The Bungalow	27	32	33	+6	Moderate	Significant
Location 2 - Quoys	23	8	23	0	Negligible	Not Significant
Location 2b - Canisbay Kirk / Kirkstyle	23	9	23	0	Negligible	Not Significant
Location 2c - Canisbay	23	11	23	0	Negligible	Not Significant
Assessment for Ness of Quoys site						
Location 1 - Norwin	27	8	27	0	Negligible	Not Significant
Location 1b - Huna House / The Bungalow	27	7	27	0	Negligible	Not Significant
Location 2 - Quoys	23	26	28	+5	Moderate	Significant
Location 2b - Canisbay Kirk / Kirkstyle	23	26	28	+5	Moderate	Significant
Location 2c - Canisbay	23	28	29	+6	Moderate	Significant

Table 23.32: Impact assessment for PCC noise – night-time

23.150 The BS 4142 assessment for the night-time is presented in Table 23.33. It is important to note that the background noise levels and specific noise levels from the site are both classified as very low according to BS4142 and the standard cannot therefore be robustly applied. The predicted specific and ambient noise levels as a result of the Project are all below the WHO / BS 8233 criteria for onset of sleep disturbance and well below the levels for onset of annoyance during the daytime. It is considered extremely unlikely that the noise produced by the PCC plant would result in a loss of amenity to residents at these levels.

Location	BS4142 assessment, night-time			
	Background dB L_{A90}	Specific noise, dBA	Difference, dBA	Assessment
Assessment for Ness of Huna site				
Location 1 - Norwin	24	26	+2	Background noise level and rating level classified as very low and BS4142 not applicable.
Location 1b - Huna House / The Bungalow	24	32	+8	Background noise level and rating level classified as very low and BS4142 not applicable.
Location 2 - Quoys	21	8	-13	Background noise level and rating level classified as very low and BS4142 not applicable.
Location 2b - Canisbay Kirk / Kirkstyle	21	9	-12	Background noise level and rating level classified as very low and BS4142 not applicable.

Location	BS4142 assessment, night-time			
	Background dB L_{A90}	Specific noise, dBA	Difference, dBA	Assessment
Location 2c - Canisbay	21	11	-10	Background noise level and rating level classified as very low and BS4142 not applicable.
Assessment for Ness of Quoys site				
Location 1 - Norwin	24	8	-16	Background noise level and rating level classified as very low and BS4142 not applicable.
Location 1b - Huna House / The Bungalow	24	7	-17	Background noise level and rating level classified as very low and BS4142 not applicable.
Location 2 - Quoys	21	26	+5	Background noise level and rating level classified as very low and BS4142 not applicable.
Location 2b - Canisbay Kirk / Kirkstyle	21	26	+5	Background noise level and rating level classified as very low and BS4142 not applicable.
Location 2c - Canisbay	21	28	+7	Background noise level and rating level classified as very low and BS4142 not applicable.

Table 23.33: BS 4142 assessment – PCC, night-time

Mitigation

23.151 Extensive mitigation measures have already been incorporated into the design of the PCC site, and are summarised as follows:

MITIGATION IN RELATION TO IMPACT 23.4

- Use of acoustic materials to clad the PCC buildings.
- Acoustically absorbent lining on inner façade of building.
- Installation of acoustic louvers for building ventilation.
- Orientation of PCC buildings so that any vent extracts point away from noise sensitive properties.

23.152 The precise mitigation measures incorporated in the final design will depend on several factors, including safety issues, ventilation requirements and structural considerations. It is proposed that a night-time noise limit of 35 dB $L_{Aeq,1h}$ at the nearest residential premises could be specified as part of any planning consent in order to ensure that noise from the operations does not result in sleep disturbance or significant loss of amenity.

Residual impact

23.153 It is worth noting that the baseline noise levels used in the assessment were taken during unusually calm meteorological conditions for the area, as requested by The Highland Council. Consequently, the impact assessment can be considered a worst case scenario. It is likely that background noise due to the wind would be much higher for the majority of the time, meaning that the impacts reported in this section would be less than predicted.

23.154 A BS 4142 assessment is not appropriate in assessing the residual noise levels because both the background noise levels and the rating levels for all of the locations are below the values considered by BS 4142 to be very low. In this regard, it is important to note that the absolute noise levels resulting from permanent operations will be well below the WHO criterion for onset of sleep disturbance effects at night or annoyance during the daytime.

23.155 With respect to the impact on quality of life (amenity, enjoyment of property etc.), it has been established that the development will result in, at most, a 6 dBA increase in ambient noise during the quietest period of the night during the quietest nights of the year for the properties closest to the PCC site. It is unlikely that noise from the PCC site would be perceptible in properties with the windows closed at night (above household sounds such as fridges and boilers). Internal noise levels are likely to be in the order of 18 dBA or less at night with windows partially open. Thus, even if windows were left open at night to allow for ventilation when sleeping, the noise is unlikely to have an adverse effect, even if it is audible.

23.156 Baseline ambient noise levels in the day are relatively high compared to the calculated specific noise from the plant. Consequently, the proposed development is unlikely to influence ambient noise levels during the daytime when amenity is the primary concern. In terms of the absolute noise level assessment, noise from plant will be significantly less than the 50 dB L_{Aeq} guideline limit in BS 8233 for amenity areas (e.g. gardens) during the daytime. Thus, taking both the change in noise level and absolute assessment into consideration, it is considered that the proposed development will not result in a significant adverse impact to quality of life.

23.157 It is also worth noting that the predicted change in ambient noise used in the assessment would not occur overnight. In reality, the development is being staged over a number of years. People would be able to become gradually more accustomed to the change in the noise environment in smaller steps rather than being exposed to a larger change overnight.

23.158 Consequently, and taking all of these factors into account, it is concluded that operational noise will not result in a significant loss of amenity or health impact at residential properties, even during the calmest nights.

23.8 Impacts during Decommissioning

23.159 Decommissioning activities are unlikely to substantially differ from the activities as described under the potential impacts for construction in Section 23.6. The conclusions regarding significance will therefore remain the same or lower.

23.9 Potential Variances in Environmental Impacts

23.160 There is scope for the environmental impacts predicted for onshore noise to vary depending on the final site, configuration, design and specification chosen for the construction and operation of the PCC and cable routes and the HDD site. It is difficult to quantify the potential variance at this stage of the Project, but any increase in impact at one property would likely to be offset against a reduction in impact at another property. Thus, it is likely that the overall impacts and conclusions would remain unchanged, and only the location of the residential property affected by that impact would change. It is proposed that the potential for significant variance in impact (for the worse) could be avoided by relevant use of planning noise limits to keep noise levels to within acceptable values.

23.161 It is considered unlikely that any other options selected for construction would change the conclusions drawn on the potential impacts of airborne dust as the most sensitive receptor in the vicinity of the development has been selected for assessment.

23.10 Cumulative Impact

23.10.1 Introduction

23.162 MeyGen has in consultation with Marine Scotland and The Highland Council identified a list of other projects (MeyGen, 2011) which together with the Project may result in potential cumulative impacts. The list of these projects including details of their status at the time of the EIA and a map showing their location is provided in Section 8; Table 8.3 and Figure 8.1 respectively.

23.163 Having considered the information presently available in the public domain on the projects for which there is a potential for cumulative impacts, Table 23.34 below indicates those with the potential to result in cumulative impacts from a noise and dust perspective. The consideration of which projects could result in potential cumulative impacts is based on the results of the project specific impact assessment together with the expert judgement of the specialist consultant.

Project title	Potential for cumulative impact	Project title	Potential for cumulative impact	Project title	Potential for cumulative impact
MeyGen Limited, MeyGen Tidal Energy Project, Phase 2	✓	SHETL, HVDC cable (onshore to an existing substation near Keith in Moray)	×	OPL, Ocean Power Technologies (OPT) wave power ocean trial	×
ScottishPower Renewables UK Limited, Ness of Duncansby Tidal Energy Project	×	Brough Head Wave Farm Limited, Brough Head Wave Energy Project	×	MORL, Moray Offshore Renewables Ltd (MORL) offshore windfarm	×
Pelamis Wave Power, Farr Point Wave Energy Project	×	SSE Renewables Developments (UK) Limited, Costa Head Wave Energy Project	×	SSE and Talisman, Beatrice offshore Windfarm Demonstrator Project	×
Sea Generation (Brough Ness) Limited, Brough Ness Tidal Energy Project	×	EON Climate & Renewables UK Developments Limited, West Orkney North Wave Energy Project	×	BOWL, Beatrice Offshore Windfarm Ltd (BOWL) offshore windfarm	×
Cantick Head Tidal Development Limited, Cantick Head Tidal Energy Project	×	EON Climate & Renewables UK Developments Limited, West Orkney South Wave Energy Project	×	Northern Isles Salmon, Chalmers Hope salmon cage site	×
SSE, Caithness HVDC Connection - Converter station	✓	ScottishPower Renewables UK Limited, Marwick Head Wave Energy Project	×	Northern Isles Salmon, Pegal Bay salmon cage site	×
SSE, Caithness HVDC Connection - Cable	✓	SSE Renewables Developments (UK) Limited, Westray South Tidal Energy Project	×	Northern Isles Salmon, Lyrawa salmon cage site	×
RWE npower renewables, Stroupster Windfarm	×	EMEC, Wave Energy test site (Billia Croo, Orkney)	×	Scottish Sea Farms, Bring Head salmon cage site	×
SSE, Gills Bay 132 kV / 33 k V Substation Phase 1: substation and overhead cables (AC)	✓	EMEC, Tidal energy test site (Fall of Warness, Orkney)	×	Northern Isles Salmon, Cava South salmon cage site	×
SSE, Gills Bay 132 kV / 33 k V Substation Phase 2: HVDC converter station and new DC buried cable		energy test site (St Mary's Bay, Orkney)		salmon cage site	
SHETL, HVDC cable (offshore Moray Firth)	×	EMEC, Intermediate tidal energy test site (Head of Holland, Orkney)	×	Northern Isles Salmon, West Fara salmon cage site	×

Table 23.34: Summary of potential cumulative impacts

23.164 The following sections summarise the nature of the potential cumulative impacts for each potential project phase:

- Construction and installation;
- Operations and maintenance; and
- Decommissioning.

23.10.2 Potential cumulative impacts during construction and installation

23.165 For noise, there is a possibility that there could be a cumulative impact for construction of the cable routes and other infrastructure for some of the other energy projects in the area where such projects will come within close proximity to the MeyGen cable routes. However, without details of the construction schedule or defined routes/locations it is difficult to quantify the potential effect at this time.

23.166 It is possible that the Gills Bay 132 kV / 33 kV Substation and cable route could result in a cumulative impact. Construction is likely to start in April 2013 so there is likely to be overlap for the construction period.

23.167 Further projects identified in the region, but without construction timescales, may have an effect on air quality, however without details of their construction it is not possible to reasonably assess the potential cumulative effect.

23.10.3 Potential cumulative impacts during operations and maintenance

23.168 With respect to operational noise, it is highly unlikely that there would be a cumulative effect with any other development unless it was located immediately adjacent to the MeyGen PCC.

23.169 During the operational phase the Project has very little terrestrial activity. Given that the other identified terrestrial projects in the region are energy related and unlikely to be high dust-generating projects, the cumulative effect of both noise and dust the Project in combination with other terrestrial projects in the region is considered negligible and therefore not significant.

23.170 In terms of MeyGen Phase 2, the exact geographical location and nature of the onshore facilities required are not yet defined and will incorporate lessons learned from and technology advancements beyond Phase 1 of the Project. These factors will influence the potential for, nature of and significance of any cumulative impact. From a noise and dust perspective, the requirement for additional onshore infrastructure has the potential for cumulative impacts.

23.10.4 Potential cumulative impacts during decommissioning

23.171 There are no predicted cumulative impacts for noise during decommissioning.

23.10.5 Mitigation requirements for potential cumulative impacts

23.172 No mitigation is required over and above the Project specific mitigation.

23.11 Proposed Monitoring

23.173 It is proposed to undertake surveys during construction and operational phases of the Project to monitor noise emissions against consented levels.

23.12 Summary and Conclusions

23.174 This section has considered the noise and dust impacts from onshore elements of the Project, including the two possible PCC and HDD site locations at Ness of Quoys and Ness of Huna, construction of the PCC and HDD sites, cable installation works and construction and drilling traffic.

23.175 A noise model of construction, HDD and PCC noise has been developed based on available information from equipment manufacturers and from other, similar, developments.

23.176 The noise assessment has considered both long-term and short-term effects of noise and has assessed both the change in ambient noise as well as the absolute level of noise.

23.177 For construction and installation noise, good practice noise mitigation measures have been recommended, in addition to potential construction noise limits, in order to ensure that noise levels are kept below a level that would be considered to be a significant impact.

23.178 For HDD noise, which will operate through the day and night, it is likely to be necessary to install mitigation measures to the drilling rig and consider use of enclosures or baffle mounds. The predicted residual noise levels are all below the WHO criterion for onset of sleep disturbance effect and, although there will be an increase in night-time ambient noise levels at the closest properties to the HDD site during the drilling period, the impact will only be minor and therefore not significant.

23.179 In terms of dust, the only dust generating activities are associated with construction activities (excavation, HDD and transport of materials e.g. aggregate). Airborne dust has been assessed qualitatively using a worst case estimate of magnitude and sensitivity and found not to have a significant impact providing good construction practices are put in place. Air quality issues associated with vehicles during any phase of the Project are discussed and scoped out in Section 22.

23.180 During operation of the site, noise levels will be much lower than for the construction and HDD activities. Residual noise levels will all be well below the WHO criterion for onset of sleep disturbance or annoyance and would be classified by BS 4142 as being “very low”. Although the change in noise levels might be discernable outside during the quietest period of the calmest nights, it is unlikely to be audible during the daytime or inside the properties during the night. The design will incorporate significant mitigation measures to minimise noise levels to the lowest practicable level. It is therefore concluded that it is unlikely that the Project will result in a significant loss of amenity to residents.

23.13 References

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24 ACCIDENTAL EVENTS

24.1 There were no supporting studies which directly relate to the Accidental Events impact assessment.

24.1 Introduction

24.2 This section assesses the potential for accidental events related to the Project and potential impacts associated with these events. The Environmental Impact Assessment (EIA) process is concerned with "likely significant effects". Accidental events are by their nature not likely. However, although unlikely they have been considered as part of this EIA process as they may have a significant effect. The probability or likelihood of such as event must be taken into account when assessing the significance of an accidental event in the context of EIA. It covers all stages of the Project from installation to operations and maintenance through to decommissioning. After detailing the nature and potential occurrence for these events, mitigation and management is identified which will remove or reduce the identified impacts. This assessment has been undertaken by Xodus.

24.2 Assessment Parameters

24.2.1 Rochdale Envelope

24.3 In line with the Rochdale Envelope approach, this assessment considers the maximum ('worst case') Project parameters in relation to a specific receptor or group of receptors. However, given the nature of an accidental event i.e. non routine and the fact that an accidental event will have effects on all receptors considered the Rochdale Envelope for Accidental Events covers all the potentially extreme events that may occur. Some of these have been considered in individual sections (Table 24.1). Major events in terms of pollution and fire which may affect a number of different receptors are considered in this section and are outlined in Table 24.1. Further descriptions of the volume of substances involved are provided in the relevant impact. The potential impacts associated with alternative Project parameters have been considered in Section 24.9.

24.4 Accidental and non routine events that are relevant to this Project are detailed in Table 24.1 and were identified during the Environmental Issues Identification (ENVID) process (Section 8). Some events have been detailed in other sections of this Environmental Statement (ES) and are therefore not repeated in this section. However, the section in which these aspects are dealt with is provided in Table 24.1.

Accidental or non routine event	Section the event is covered
All events that are deemed to pose a navigational hazard, relating to installation, maintenance and decommissioning. Vessel collision. Loss of equipment including parts of the turbine.	Shipping and Navigation (Section 15)
Pollution events associated with onshore construction resulting from the loss of leakage of potential pollutants including fuel, lubricants, oils, chemicals, unset concrete, grout and drilling fluids.	Geology, Hyrdrogeology and Hydrology (Section 17)
Oil spills from vessels.	Sections 24.6.1 and 24.7.1 Marine Mammals (Section 11) Ornithology (Section 12) Fish Ecology (Section 13) Commercial Fisheries (Section 14) Terrestrial Habitats and Ecology (Section 18)
Fluid leaks during support structure installation.	Section 24.6.2
Vehicle collision.	Section 24.6.3
Fluid leaks from turbines.	Section 24.7.2
Fire risk at the Power Conversion Centre (PCC).	Section 24.7.3

Table 24.1: Accidental and non routine events applicable to the Project

24.5 The focus of the accidental events impact assessment is potential impacts on the ecology of the offshore and onshore Project areas and adjacent sea, coastal and land areas.

24.3 Legislative Framework and Regulatory Context

24.6 There is no specific legislation or published guidance regarding accidental and non routine events associated with marine renewable energy developments. However the following apply to the Project:

- The International Convention for the Prevention of Pollution from ships (MARPOL) covers pollution of the marine environment by ships from operational or accidental causes;
- Regulation 37 of Annex I of MARPOL requires that all ships of 400 gross tonnage (GT) or more carry an approved Shipboard Oil Pollution Emergency Plan (SOPEP);
- Scottish Environment Protection Agency (SEPA) Pollution Prevention Guidelines (PPG) 1 covers general guidance on the prevention of Pollution, PPOG 5 provides guidelines for construction and maintenance work, on, in or near water, PPG 21 For producing emergency pollution incident response plans to deal with accidents, spillages and fires and PPG 22 for incident response and dealing with spills; and
- The Fire Safety (Scotland) Regulations 2006.

24.4 Assessment Methodology

24.4.1 Scoping and consultation

24.7 Since the commencement of the Project, consultation on accidental events issues has been ongoing Table 24.2 summarises all consultation relevant to accidental events. In addition, relevant comments from the EIA Scoping Opinion are summarised Table 24.3 together with responses to the comments and reference to the ES sections relevant to the specific comment.

Date	Stakeholder	Consultation	Topic/specific issue
7th April 2011	Marine Scotland and Scottish Natural Heritage (SNH)	Pre-Scoping meeting	EIA surveys and studies required and the data needs for each EIA study.
27th May 2011	Marine Scotland, statutory consultees and non statutory consultees	Submission of EIA Scoping Report	Request for EIA Scoping Opinion from Marine Scotland and statutory consultees and request for comment from non statutory consultees.
30th June – 2nd July 2011	Local stakeholders	Public Event - EIA Scoping	Public event to collate information/opinions on proposed EIA scope.
14th September 2011	The Highland Council (THC)	Meeting	Planning pre application meeting. Presentation on overall Project and results of EIA studies to date.
31st September 2011	Marine Scotland, THC, statutory consultees and non statutory consultees	Receipt of EIA Scoping Opinion	Receipt of response to EIA Scoping Report and other comments from non statutory consultees.
10th October 2011	THC	Receipt of pre application advice	Receipt of pre application advice from The Highland Council.
6th – 7th December 2011	Local stakeholders	Public Event – pre application consultation	Public event to communicate the findings of the EIA to local stakeholders.

Table 24.2: Consultation relevant to accidental events

Name of organisation	Key concerns	Response	ES section within which the specific issue is addressed
Marine Scotland	SEPA's Pollution Prevention Guidelines should be used in the ES preparation and during Project development Developers should be aware of available Construction Industry Research and Information Association (CIRIA) guidance on the control of water pollution from construction sites and environmental good practice	Relevant SEPA Guidelines have been consulted throughout the development of the ES. Relevant CIRIA guidance has been considered	Geology, Hydrogeology and Hydrology (Section 17) Section 24.6.2 Impact Assessment
SEPA	The ES should systematically identify all aspects of site work that might impact upon the environment, potential pollution risks and should identify the principles of preventative measures and mitigation.	All potential pollution risks have been considered	Sections 24.6, 24.7 and 24.8 Impact Assessment

Table 24.3: Scoping relevant to accidental and non routine events

24.4.2 Desk based study

24.8 Identification of potential accidental events focussed on a detailed study of the Project Description for the Project (Section 5) and discussion with the Project team.

24.4.3 Significance criteria

24.9 Where appropriate the methodology used follows that outlined in Section 8. Variations from this are explained below.

24.10 The sensitivity of the receptor and magnitude of impact are defined in Table 24.4 and Table 24.5. There is not one standard receptor that can be impacted by accidental events, therefore definitions refer generally to all possible receptors.

Sensitivity of receptor	Definition
Very high	▪ Very sensitive receptors with very little ability to absorb change caused by an accidental event without fundamentally altering its present character and or receptor is of very high environmental value or of international importance.
High	▪ Receptor has little ability to absorb change caused by an accidental event without significantly altering its present character and or receptor is of high environmental value or national importance.
Medium	▪ The receptor has moderate ability to absorb change caused by an accidental event without significantly altering its present character and or receptor is of moderate environmental value or of regional importance.
Low	▪ The receptor is tolerant of change caused by an accidental event with only minor detriment to its present character and or receptor is of low environmental importance or of local importance.
Negligible	▪ The receptor is tolerant of change caused by an accidental event without perceptible detriment to its present character and or receptor is of negligible environmental value.

Table 24.4: Definitions for sensitivity of receptor

Magnitude of impact	Definition
Severe	▪ Severe alteration to key elements or features of the baseline conditions resulting in a fundamental change in character/composition or other attributes.
Major	▪ Major alteration to key elements or features of the baseline conditions resulting in a major change in character/composition or other attributes.
Moderate	▪ Alteration to one or more key elements or features of the baseline conditions such that post event character/composition or other attributes will be partially changed.
Minor	▪ Minor alteration in baseline conditions. Change arising from the loss or alteration will be discernible but underlying character/ composition or other attributes of baseline conditions will be similar to pre event circumstances and patterns.
Negligible	▪ Very slight change from baseline conditions. Change barely distinguishable, approximating to the no change situation.

Table 24.5: Definitions for magnitude of impact

24.4.4 Frequency / probability of events

24.11 For the assessment of accidental events the application of frequency / probability is not applied to the magnitude of an impact but is applied after the consequence of an impact has been assessed. This allows the consequence of the impact to be fully understood before the likelihood of the event occurring is applied to the impact. This is particularly important for impacts where the consequence is very high but the probability of such an event occurring is extremely low (i.e. a major oil spill is a high consequence event which has a very low probability of occurrence). In this instance, the magnitude considers the duration, timing, scale and size of an impact. This is then combined with the sensitivity of receptor in the same manner as in Section 8 to provide an environmental consequence.

24.12 In order to assess the overall impact significance, the consequence is combined with a frequency/probability of the impact occurring as defined in Table 24.6.

Frequency / likelihood category	Accidental event (probability)
Continuous / Likely	▪ 10^{-1} to >1 events per year ▪ Event likely to occur more than once on the facility.
Regular / Possible	▪ 10^{-2} – 10^{-1} events per year ▪ Could occur within the lifetime of the development.
Intermittent / Unlikely	▪ 10^{-3} – 10^{-2} per events per year ▪ Event could occur within the life of 10 similar facilities. Has occurred at similar facilities.
One off Event / Remote	▪ 10^{-5} – 10^{-3} events per year ▪ Similar even has occurred somewhere in industry or similar industry but not likely to occur with current practices and procedures.
One off Event / Extremely remote	▪ <10^{-5} events per year ▪ Has never occurred within industry or similar industry, but theoretically possibly.

Table 24.6: Probability and/or frequency definitions

24.13 The overall impact significance ranking is derived by combining consequence and likelihood via the matrix presented in Table 24.7.

Consequence	Likelihood / frequency					
	Continuous / likely	Regular / Possible	Intermittent / Unlikely	One off Event / Remote	One off Event / Extremely Remote	Will not occur
Severe	Severe	Severe	Major	Moderate	Minor	Negligible
Major	Severe	Major	Moderate	Minor	Negligible	Negligible
Moderate	Major	Moderate	Minor	Minor	Negligible	Negligible
Minor	Moderate	Minor	Minor	Negligible	Negligible	Negligible
Negligible	Minor	Negligible	Negligible	Negligible	Negligible	Negligible
Positive	Positive	Positive	Positive	Positive	Positive	Positive

Table 24.7: Significance rankings

24.4.5 Data Gaps and uncertainties

24.14 Given the nature of an accidental event (i.e. non routine) there are a number of uncertainties associated with assessing the impact of these events. There are data available on the frequency of certain events (i.e. vessel collisions) and the consequences of such events to the environment. Where these data are available they have been used in assessing the impact of an accidental event. In addition available project data on the inventory of vessels that may be used during Project installation and maintenance activities and the inventory of the turbines themselves have also been used to provide suitable information on what volumes might be spilled in the event of an accident. Similar data sources where available have been used to quantify potential impacts from fire at the PCC. Where uncertainty remains over an impact this has been accounted for in the likelihood of an event occurring. However, for most impacts the measures in place to prevent accidents from happening and the frequency of such accidents is well understood.

24.5 Baseline Description

24.15 The Project is located within the Inner Sound of the Pentland Firth, with the associated onshore infrastructure situated on the coastal section of Caithness immediately south of the offshore area. Details of the Project and the local environment are provided in Sections 5 and 7 respectively.

24.6 Impacts during Construction and Installation

24.6.1 Impact 24.1: Oil spills from vessels

24.16 Oil spills can have a number of environmental impacts. Actual effects will vary depending on a wide range of factors including the volume and type of oil spilt and the sea and weather conditions at the time of the spill. Effects will also be dependant on the presence of environmental sensitivities in the path of the spill. In a highly dynamic environment such as that within the Inner Sound, oil spills will be rapidly dispersed although a spill will never be far from the coast and therefore beaching could occur. Sources of data on offshore support vessels are few (i.e. the types of vessel that will be used for installation and operation). However the best available data 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 (UKOOA, 2006). This type of loss is likely to result in 10's of litres being lost to the receiving environment.

24.17 The total oil inventory for large dynamic positioning (DP) installation vessels is likely to be in the region of 6,000,000 to 8,000,000 litres of marine diesel stored in a number of separate tanks. The worse case spill from a single tank rupture is likely to be in the region of 600,000 litres of marine diesel released into the marine environment.

Impact significance

24.18 The sensitivity of the marine environment (sea and coast) is described as high. The magnitude of impact is considered minor for a total loss of inventory and negligible for a small loss of oil. The likelihood of the loss of a small (10's of litres) amount of oil being leaked from a vessel associated with the Project is described as unlikely. The likelihood of a large oil spill from a vessel associated with the Project is even less, based on best available data for offshore installation and support vessels gives the incidence rate as one per 13,067 vessel years (DETR, 1999). Therefore the likelihood is described as extremely remote. A total loss of inventory is considered to have a moderate and therefore significant impact, whereas loss of a small amount of oil is considered to have a minor impact and therefore not significant impact.

Impact	Sensitivity of receptor	Magnitude of impact	Consequence	Likelihood / frequency	Impact significance	Significance (EIA Regs)
Oil spill from vessel (total inventory)	High	Severe	Severe	Extremely remote	Minor	Significant
Oil spill from vessel (small loss of 10s litres)	High	Minor	Moderate	Unlikely	Minor	Significant

MITIGATION IN RELATION TO IMPACT 24.1

- Despite no significant impact being identified, mitigation measures are still proposed due to the potential consequence of events.
- Vessels associated with all Project operations will comply with IMO/MCA codes for prevention of oil pollution and any vessels over 400GT will have onboard SOPEP's.
- Vessels associated with all Project operations will carry onboard oil and chemical spill mop up kits.
- Where possible vessels with a proven track record for operating in similar conditions will be employed.
- Vessel activities associated with installation, operation, routine maintenance and decommissioning will occur in suitable conditions to reduce the chance of an oil spill resulting from the influence of unfavourable weather conditions.

24.6.2 Impact 24.2: Leaks/pollution during support structure installation

24.19 A decision is yet to be made on which support structure will be used, therefore consideration is given to potential impacts associated with the drilled support structure types which require grout and where there is potential for a fluid leak.

24.20 Both the monopile and pin piled TSSs will involve drilling during the installation phase of the Project. The drilling equipment used will have a relatively small inventory of oil used for lubricating purposes. For pin pile drilling equipment the oil inventory will be approximately 60 litres and for monopile drilling equipment approximately 150 litres.

24.21 High strength cement will be used to grout the piles in place. The cement is stored in dry form in large bags with an approximate capacity of 1 ton. The worst case scenario for the amount of cement that will be carried onboard a vessel at any one time is a maximum of 100 tons (enough for the installation of one monopile). There is the potential dry cement could be lost overboard.

24.22 In addition, there is the potential during the pile installation operations that liquid cement could be lost to the marine environment. A conductor casing will separate the liquid cement from the open sea. If the

coupling were to fail this could result in an approximate maximum loss of cement to the marine environment of 500 litres.

24.23 A loss of oil from the drilling equipment will have a localised impact, and be rapidly dispersed in the dynamic conditions of the Inner Sound. The potential loss of cement into the marine environment will also have a localised impact but would also be expected to be rapidly diluted and dispersed in the dynamic conditions of the Inner Sound.

24.24 The sensitivity of the receptor is considered high. Due to the relatively small inventories, the magnitude of impact is considered minor. Given the novel nature of this technology and therefore the relatively limited experience of using pin piling and monopiling in relation to this type of installation, the likelihood of a leak from the drilling equipment is considered possible. The likelihood of a total loss of cement inventory either overboard or during drilling operations, is however considered remote.

Impact significance

Impact	Sensitivity of receptor	Magnitude of impact	Consequence	Likelihood / frequency	Impact significance	Significance (EIA Regs)
Leaks during installation – loss of oil inventory from pile drilling equipment	High	Minor	Moderate	Possible	Moderate	Significant
Leaks during installation - loss of cement inventory	High	Minor	Moderate	Remote	Minor	Not Significant

MITIGATION IN RELATION TO IMPACT 24.2

- Operations will only take place during suitable weather windows.
- Vessels over 400GT will have onboard SOPEP's that will be activated in the event of any pollution incident.
- Only recognised marine standard fluids and substances will be used in the drilling equipment.
- Consideration will be given to CIRIA guidance on the use of concrete in maritime engineering – a good practice guide.
- A fibre optic cable will be used to monitor the level of cement, when the cement reaches seabed level pumping of cement will cease immediately.
- During cementing operations the cement will be separated from the open sea conductor casing which is only removed once the cement has reached sufficient strength to withstand current forces.
- Dry cement will be stored in strong bags made of appropriate material to avoid loss of any kind; empty bags will be stored in an appropriate container and disposed of accordingly onshore.

Residual impact

24.25 Although the receiving environment is considered to be sensitive, the mitigation measures proposed will ensure impacts are minimised and therefore the residual impact is considered to be negligible.

Impact	Sensitivity of receptor	Magnitude of impact	Consequence	Likelihood / frequency	Impact significance	Significance (EIA Regs)
Leaks during installation – loss of oil inventory from pile drilling equipment	High	Negligible	Minor	Possible	Minor	Significant

24.6.3 Impact 24.3: Vehicles associated with onshore construction

24.26 A number of vehicles will be involved with the onshore construction and installation phase of the Project. Accidental events associated with vehicle activity could include collision and loss of fluid. The direct impact on watercourses is covered in the Geology, Hydrogeology and Hydrology section (Section 17) and is therefore not considered here. Other potential receptors include onshore habitats and ecology and other road users.

Impact significance

24.27 The sensitivity of the potential receptors is considered the same i.e. they all have a moderate ability to withstand change caused by an accidental collision event and associated loss of fluid. No vehicle will be carrying a large amount of fuel/oil or other harmful fluid therefore the magnitude of impact is considered minor. The likelihood is considered to be remote.

Sensitivity of receptor	Magnitude of impact	Consequence	Likelihood / frequency	Impact significance	Significance (EIA Regs)
Medium	Minor	Minor	Remote	Negligible	Not Significant

MITIGATION IN RELATION TO IMPACT 24.3

- Although no significant impact has been identified mitigation will be put in place to ensure this remains the case.
- All vehicles used will have up to date MOTs and will be operated by suitably qualified personnel.
- Due attention will be given to weather conditions and appropriate action will be taken i.e. vehicles will not be used when the weather is deemed to present dangerous conditions e.g. severe ice and snow.
- The plan for the construction phase will take into the account the capacity of the local road network.

24.6.4 Impact 24.4: Total loss of inventory from Horizontal Direction Drill boreholes

24.28 The majority of drill cuttings generated from the drilling of the Horizontal Directional Drill (HDD) bores will be returned to shore and not discharged to sea. It is estimated that the contents of the last 10m of each bore could be discharged to sea at the seabed breakthrough. During normal operations it is expected that the greatest potential discharge to sea at breakthough will result in a total volume of 82m^3 of drill cuttings. However, in the event that the entire inventory of a bore was lost the total volume of drill cuttings that could be discharged to sea is 141m^3 per bore. The inventory of a bore is considerably less than the volume generated during normal drilling operations for the monopile foundations (which is 17,200m^3) and based on the assessment of the potential impacts from these discharges (Section 10) significant impacts

are not expected. The dynamic environment will ensure that any cuttings are dispersed rapidly so that any increases in suspended sediment concentrations are likely to be short lived. In addition it is unlikely that drill cuttings will settle where they are discharged and the strong currents in the area will redistribute the cuttings rapidly away from the Project area.

Impact significance

24.29 The sensitivity of the marine environment is described as medium (see Section 10). Although increased turbidity/suspended sediment levels may occur in the localised area of the drilling operations the impact is not expected to extend outwith the immediate footprint of the wider Project area and recovery is expected to be rapid. Due to the potential inventories of releases involved; the magnitude of impact is considered negligible for loss of the inventory of a single bore. The likelihood of the loss of drill cuttings is considered unlikely.

Impact	Sensitivity of receptor	Magnitude of impact	Consequence	Likelihood / frequency	Impact significance	Significance (EIA Regs)
Loss of single bore inventory	Medium	Negligible	Negligible	Unlikely	Negligible	Not Significant

MITIGATION IN RELATION TO IMPACT 24.4

- In the event of any unplanned discharge to sea during HDD activities, the drilling contractor would activate its emergency response plan to ensure discharges were minimised.

24.7 Impacts during Operations and Maintenance

24.7.1 Impact 24.5: Oil spills from vessels

24.30 Vessels will be used for the maintenance of the turbines. These vessels will be the same size or smaller than those used for installation and will therefore have similar oil inventories. Likelihood of event, residual impact and mitigation measures are the same as for spills from vessels during installation (Section 24.6.1).

24.7.2 Impact 24.5: Leak of fluid from turbines

24.31 The tidal turbines will contain an inventory of fluids including oil, hydraulic fluid and coolant. The impact from loss of fluids from the tidal turbines will be limited. Leaks will be localised to the immediate vicinity of the turbine and will be rapidly dispersed in the tidal conditions present in the Inner Sound. The quantities and types of fluids to be used will also be a limiting factor to the overall impact, based on the candidate technologies being considered largest turbine inventories will be 645 – 1,500 litres. The fluids will be mostly water based, biodegradable and have low aquatic toxicity.

Impact significance

24.32 The sensitivity of the receptor is considered high. Due to the limited inventories involved, even in the event of a loss of the entire inventory from a single turbine, the magnitude of the impact is considered negligible. Given the novel nature of this technology a leak from a turbine is considered possible.

Sensitivity of receptor	Magnitude of impact	Consequence	Likelihood / frequency	Impact significance	Significance (EIA Regs)
High	Negligible	Minor	Possible	Minor	Not Significant

MITIGATION IN RELATION TO IMPACT 24.5

- Although no significant impact has been identified, given the novel technology involved and the high sensitivity of the receptor, mitigation is detailed to ensure that the impact remains not significant.
- Only recognised marine standard fluids and substances will be used in the turbine hydraulic systems.
- Hydraulic fluids will be mostly water based, biodegradable and be of low aquatic toxicity.
- Turbine sensors will detect loss of fluid pressure and leaks; enabling maintenance operatives to reduce the risk of further leaks.

24.7.3 Impact 24.6: Fire risk at PCC

24.33 The PCC will contain a significant amount of electrical infrastructure including 33Kv transformers, power converters and back up batteries. The presence of this amount of electrical infrastructure and the potential for some fuel to be on site presents the potential for a fire hazard. Careful consideration will be given to fire safety in the design of the PCC. In the event of a fire, early detection and mitigation is key to reducing the potential impact. The presence of sensitive alarms will ensure that any fire is dealt with quickly and efficiently.

24.34 In the event of a fire potential impacts include fire chemical release and atmospheric pollution, however even if the fire was major, given the scale of the PCC this would be limited. Potential receptors include terrestrial habitats and ecology, watercourses, the atmosphere and anyone present at the PCC at the time of a fire.

Impact significance

24.35 The potential receptors have varying levels of sensitivity which are indicated below. Any fire impact will be short lived and is extremely likely to be contained within the PCC boundary, in addition the likelihood associated with a fire at the PCC is extremely remote, therefore impact significance is considered as minor or below.

Sensitivity of receptor	Magnitude of impact	Consequence	Likelihood / frequency	Impact significance	Significance (EIA Regs)
Low (atmosphere, terrestrial habitats and ecology)	Minor	Minor	Extremely remote	Negligible	Not Significant
Medium (Water courses and ground)	Minor	Minor	Extremely remote	Negligible	Not Significant
Very high (people present at the PCC)	Severe	Severe	Extremely remote	Minor	Not Significant

MITIGATION IN RELATION TO IMPACT 24.6

- Despite no significant impact being identified, mitigation measures are still proposed due to the potential consequence of events.
- The design of the building which be such to allow good ventilation.
- Due regard will be given to the Fire Safety Scotland (Regulations) 2006 and Part 3 of the Fire Scotland Act 2005 which details the provision for fire safety in non domestic premises.

- Alarms and fire detection measures will be included in the design of the PCC.
- A fire risk assessment should be carried out for the PCC.
- In regard to the storage of fuel, SEPA PP2 'above ground storage tanks' will be followed. In particular the fuel tank will be chosen and positioned with fire risk in mind and will be located with sufficient space around it or a physical fire barrier. The base will also be suitably designed as to minimise fire risk.
- The power conversion equipment will be water or air cooled to avoid overheating and will contain very little combustible material. The equipment will be self-extinguishing and a fire/smoke alarm system will be installed in each power conversion container.
- Industry standard switches will be used to turn off source of energy in the event of fire detection and there will be a container provided fire and smoke containment.
- The transformer is F1 certified and meets standard IEC 60076-11. A vacuum cast dry type transformer (significantly lower risk of fire compared to oil filled transformers) will be used. The transformers will be self-extinguishing.
- The gas insulated switch gear (virtually no fire risk) meets requirements of standard IEC 60694.

24.8 Impacts during Decommissioning

24.36 Impacts during decommissioning are considered to be the same as for some of the impacts considered for installation and construction, namely oil spills from vessels and vehicle collision risk. The same likelihood, mitigation and residual impacts are therefore predicted and reference should be made to Sections 24.6.1 and 24.6.3 for the details of these impacts.

24.9 Potential Variances in Environmental Impacts

24.37 The assessment has identified all potential accidental events associated with the installation, construction, operation, maintenance and decommissioning of the Project. Although project design is ongoing and contractors still to be appointed (e.g. vessels, onshore construction) and therefore details of oil/fluid inventories etc may vary to those quoted here, any variances are not expected to significantly influence the impact predictions made in this assessment.

24.10 Cumulative Impacts

24.38 MeyGen has in consultation with Marine Scotland and The Highland Council identified a list of other projects (MeyGen, 2011) which together with the Project may result in potential cumulative impacts. The list of these projects including details of their status at the time of the EIA and a map showing their location is provided in Section 8; Table 8.3 and Figure 8.1 respectively.

24.39 Having considered the information presently available in the public domain on the projects for which there is a potential for cumulative impacts, Table 24.8 below indicates those with the potential to result in cumulative impacts from an Accidental Events perspective. The consideration of which projects could result in potential cumulative impacts is based on the results of the Project specific impact assessment together with the expert judgement of the specialist consultant.

Project title	Potential for cumulative impact	Project title	Potential for cumulative impact	Project title	Potential for cumulative impact
MeyGen Limited, MeyGen Tidal Energy Project, Phase 2	✓	SHETL, HVDC cable (onshore to an existing substation near Keith in Moray)	✗	OPL, Ocean Power Technologies (OPT) wave power ocean trial	✗
ScottishPower Renewables UK Limited, Ness of Duncansby Tidal Energy Project	✓	Brough Head Wave Farm Limited, Brough Head Wave Energy Project	✗	MORL, Moray Offshore Renewables Ltd (MORL) offshore windfarm	✗
Pelamis Wave Power, Farr Point Wave Energy Project	✗	SSE Renewables Developments (UK) Limited, Costa Head Wave Energy Project	✗	SSE and Talisman, Beatrice offshore Windfarm Demonstrator Project	✗
Sea Generation (Brough Ness) Limited, Brough Ness Tidal Energy Project	✓	EON Climate & Renewables UK Developments Limited, West Orkney North Wave Energy Project	✗	BOWL, Beatrice Offshore Windfarm Ltd (BOWL) offshore windfarm	✗
Cantick Head Tidal Development Limited, Cantick Head Tidal Energy Project	✓	EON Climate & Renewables UK Developments Limited, West Orkney South Wave Energy Project	✗	Northern Isles Salmon, Chalmers Hope salmon cage site	✗
SSE, Caithness HVDC Connection - Converter station	✗	ScottishPower Renewables UK Limited, Marwick Head Wave Energy Project	✗	Northern Isles Salmon, Pegal Bay salmon cage site	✗
SSE, Caithness HVDC Connection - Cable	✗	SSE Renewables Developments (UK) Limited, Westray South Tidal Energy Project	✗	Northern Isles Salmon, Lyrawa salmon cage site	✗
RWE npower renewables, Stroupster Windfarm	✗	EMEC, Wave Energy test site (Billia Croo, Orkney)	✗	Scottish Sea Farms, Bring Head salmon cage site	✗
SSE, Gills Bay 132 kV / 33 k V Substation Phase 1: substation and overhead cables (AC)	✓	EMEC, Tidal energy test site (Fall of Warness, Orkney)	✗	Northern Isles Salmon, Cava South salmon cage site	✗
SSE, Gills Bay 132 kV / 33 k V Substation Phase 2: HVDC converter station and new DC buried cable	✓	EMEC, Intermediate wave energy test site (St Mary's Bay, Orkney)	✗	Scottish Sea Farms, Toyness salmon cage site	✗
SHETL, HVDC cable (offshore Moray Firth)	✗	EMEC, Intermediate tidal energy test site (Head of Holland, Orkney)	✗	Northern Isles Salmon, West Fara salmon cage site	✗

Table 24.8: Summary of projects with potential cumulative impacts

24.40 Given the nature of an accidental event i.e. non routine, the likelihood for cumulative impacts caused by accidental events (i.e. an accidental event occurring in the same time period as one or more projects and this Project) is considered to be extremely remote. However, given that operations may be ongoing simultaneously there will be a slight increase in the risk of some events occurring (e.g. oil spills). Other projects will also have management and mitigation in place to reduce the likelihood of an accidental event and have emergency plans which will be activated to ensure impacts are minimised.

24.11 Proposed Monitoring

24.41 None is required as part of routine operation of the Project, however in the unlikely event of a pollution incident, appropriate post incident monitoring will be implemented as required and agreed with the regulator and their advisors.

24.12 Summary and Conclusions

24.42 An assessment has been carried out into the potential accidental and non routine events that may occur as a result of the Project. The assessment covered all stages of the Project from installation and construction through to operations and maintenance and finally decommissioning. The worst case scenarios were considered for all potential impacts. The events covered in this section were:

- Oil spills from vessels;
- Fluid leaks from turbine support structure installation;
- Vehicle collision;
- Leaks from the turbines; and
- Fire risk at the PCC.

24.43 A number of mitigation measures and management plans have been put in place to minimise the potential for these impacts to occur and in the event they do occur, measures to minimise impacts.

24.13 References

CIRIA (2010). The use of concrete in maritime engineering. A good practice guide.

DETR (1999). Identification of Marine Environmental High Risk Areas (MEHRAs) in the UK. Draft issued for consultation December 1999.

UKOOA (2006). Report on the analysis of DTI UKCS oil spill data from the period 1975 – 2005. A report prepared by TINA consultants.

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25 ENVIRONMENTAL MANAGEMENT AND MONITORING

25.1 Introduction

25.1 The purpose of this section is to provide a summary of mitigation, monitoring and management measures proposed within the Environmental Statement (ES).

25.2 The Project will use tidal power to produce sustainable electricity through the deployment of tidal turbines in the marine environment. The electricity is exported to shore where it is converted at the Power Conversion Centre (PCC) prior to export to the grid. This type of project has the potential to impact on the environment and other users of the area. The potential effects have been assessed through the Environmental Impact Assessment (EIA) and Navigation Risk Assessment (NRA) and the results presented in the ES and accompanying NRA report. The EIA and NRA have indicated that it is necessary to manage the Project and implement mitigation to ensure the Project is sustainable and to minimise or mitigate any ongoing effects on the environment resulting from the Project.

25.2 Environmental Management Plan

25.3 Environmental assessment, including consultation with stakeholders, is an iterative process and will continue beyond ES submission. The primary mechanism for ensuring environmental assessment continues and that all environmental issues are addressed is through the Project Operational Management System. This management system will ensure that ES mitigation commitments, consent conditions and environmental monitoring requirements are taken through to implementation.

25.4 A full Environmental Management Plan (EMP) will be implemented in agreement with the relevant regulators following the successful award of project consents. The EMP will consist of a working document which details consent conditions, the commitments outlined in the ES and compliance monitoring requirements (i.e. monitoring required to assess the performance of mitigation measures). It will also highlight the parties responsible for the implementation of the contents of the EMP.

25.5 The EMP will include details on the proposed mitigation and compliance monitoring.

25.2.1 Mitigation

25.6 Where the EIA has identified potentially significant impacts (i.e. those ranked moderate or higher) that cannot be avoided, mitigation measures have been proposed. Such measures should remove, reduce or manage the effect to a point where the residual significance of that impact is reduced to an acceptable level. Mitigation has also been recommended in order to ensure impacts remain insignificant.

25.7 All mitigation measures committed to during the EIA and detailed in topic specific ES sections are summarised in the table overleaf (Table 25.1).

25.8 These commitments will be implemented as part of the Project through communication with the Project team and any contractors with whom MeyGen engages. Details of mitigation can be found in Table 25.1. The EMP will be included in the overall Construction Environment Management Document (CEMD). Contractors will implement the requirements of the CEMD through their own Construction Environment Management Plan (CEMP).

25.2.2 Compliance monitoring

25.9 A monitoring program will be designed to enable MeyGen to track and assess the performance of the mitigation measures, ensuring MeyGen meets its regulatory and corporate requirements and to update and improve the program if necessary.

ES section / topic	Commitment
Physical environment and sediment morphology	▪ Minimise as far as practicable the depth and diameter of the turbine foundation piles (without compromising technical performance); ▪ Minimise as far as practicable the volume of drill cuttings released into the marine environment during breakthrough of Horizontal Direction Drill (HDD) bores, by implementing a closed loop recycling system to return drill cuttings and fluid from the HDD to shore.
Benthic ecology	▪ The area of kelp that may need cleared will be restricted to as small as practicable around the cable and only larger plants will be removed if possible; and ▪ Installation layout will be clearly defined and communicated to any personnel involved in kelp clearance. ▪ Minimise as far as practicable the depth and diameter of the turbine foundation piles (without compromising technical performance); ▪ Lubricant used in the compressor to drive air into the drilled piles will be non-toxic and seawater will be used as a drilling fluid, negating the need for any additional chemical input; and ▪ Minimise as far as practicable the volume of drill cuttings released into the marine environment during breakthrough of HDD bores, by implementing a closed loop recycling system to return drill cuttings and fluid from the HDD to shore. ▪ All vessels involved in all stages of the project will adhere to all relevant guidance (including the IMO guidelines) regarding ballast water and transfer on non-native marine species. ▪ Where cables are not within boreholes attempts will be made to lay cables within natural crevices and cracks in the seabed to reduce cable wear. This will ensure that the majority of the cable is not exposed; ▪ The voltage of the cables will be up to 6.6kV (as opposed to the 132kV) which will considerably reduce the electromagnetic fields (EMF) emitted by the cables; ▪ The length of the drilled boreholes for the cable will be maximised (as far as technically and commercially practicable) to increase the length of cable under the seabed, and ▪ Ongoing research by Marine Scotland and their advisors will be monitored for potentially successful mitigation strategies.
Marine mammals	▪ The principles of the JNCC guidance on protection of marine European protected species from injury and disturbance (JNCC, 2010) and of relevant guidelines on minimising the risk of injury to marine mammals will be adopted as necessary (for example, reducing the duration of noise emitting activities). ▪ MeyGen commit to undertaking frequent reviews of the literature regarding spiral injuries in seals and ducted propellers and to regularly discuss advances in understanding of this topic with relevant regulatory and advisory bodies. MeyGen will apply appropriate mitigation, as deemed necessary in consultation with Marine Scotland and SNH, should vessels with ducted propellers be used, to avoid any significant impacts. ▪ All vessels associated with Project operations will comply with IMO/MCA codes for prevention of oil pollution and any vessels over 400 GT will have onboard SOPEPs. ▪ All vessels associated with Project operations will carry onboard oil and chemical spill mop up kits. ▪ Where possible vessels with a proven track record for operating in similar conditions will be employed. ▪ Vessel activities associated with installation, operation, routine maintenance and decommissioning will occur in suitable conditions to reduce the chance of an oil spill resulting from the influence of unfavourable weather conditions. ▪ Operational monitoring will be implemented in order to confirm the assessment of noise and physical barriers to movement (see Section 25.3.6). ▪ MeyGen propose, in line with the Scottish Government Survey, Deploy and Monitor Policy that the monitoring of the deployments in years 1 and 2. This will allow for a better definition collision risk and avoidance rates and to better understand the possible impact of the full 86 turbine array. It will also inform the potential requirement for future mitigation and ensure no significant impacts on marine mammals.
Ornithology	▪ All vessels associated with Project operations will comply with International Maritime Organisation (IMO)/Maritime and Coastguard Agency (MCA) codes for prevention of oil pollution and any vessels over 400 GT will have onboard Ship Oil Pollution Emergency Plans (SOPEPs). ▪ All vessels associated with Project operations will carry onboard oil and chemical spill mop up kits. ▪ Where possible vessels with a proven track record for operating in similar conditions will be employed. ▪ Vessel activities associated with installation, operation, routine maintenance and decommissioning will occur in suitable conditions to reduce the chance of an oil spill resulting from the influence of unfavourable weather conditions. ▪ Only recognised marine standard fluids and substances will be used in the turbine hydraulic systems. ▪ Hydraulic fluids will be mostly water based, biodegradable and be of low aquatic toxicity. ▪ Project specific emergency response procedures will be implemented and include contingency arrangements in the unlikely event of a pollution incident. ▪ Once specific onshore Project areas are known, further, targeted investigation will be undertaken to ascertain the status, distribution and habitat use of birds within the Project footprint and surrounding environment. The results of the survey will be used to confirm the impact assessment.
Fish ecology	▪ Where possible the use of soft start (gradual ramping up) of operations that will emit noise into the Project area will be used. ▪ MeyGen accepts that there is some uncertainty over the noise generated during drilling and turbine operation and as a result commits to conducting noise monitoring for the initial turbines installed and candidate turbine technology to validate the noise modelling. ▪ Minimise as far as possible the amount of material that will be deposited at the seaward end at breakthrough locations of directional drilling holes. ▪ Minimise as far as possible the depth and diameter of the turbine foundation piles (without compromising technical performance) in order to minimise the volume of drill cutting discharges. ▪ Minimise as far as possible the amount of material that will be deposited at the seaward end at breakthrough locations of directional drilling holes. ▪ All vessels associated with Project operations will comply with IMO/MCA codes for prevention of oil pollution and any vessels over 400 GT will have onboard SOPEP's. ▪ All vessels associated with Project operations will carry onboard oil and chemical spill mop up kits. ▪ Where possible vessels with a proven track record for operating in similar conditions will be employed. ▪ Vessel activities associated with installation, operation, routine maintenance and decommissioning will occur in suitable conditions to reduce the chance of an oil spill resulting from the influence of unfavourable weather conditions.

ES section / topic	Commitment
	▪ Lubricant used in the compressor to drive air into the drilled piles will be non-toxic and seawater will be used as a drilling fluid, negating the need for any additional chemical input; and ▪ Minimise as far as practicable the volume of drill cuttings released into the marine environment during breakthrough of HDD bores, by implementing a closed loop recycling system to return drill cuttings and fluid from the HDD to shore. ▪ All vessels involved in all stages of the project will adhere to all relevant guidance and legislation (including the IMO guidelines and the International Convention for the Prevention of Pollution from Ships (MARPOL)) regarding ballast water and transfer on non-native marine species. ▪ Where cables are not within boreholes they will be laid where possible within natural crevices and cracks within the seabed ensuring that the majority of the cable is below the seabed. ▪ The length of the drilled boreholes for the cable will be (as far as technically and commercially possible) to increase the length of cable under the seabed. ▪ Cables will be bundled into groups of three minimising the magnetic field by placing the cables close together, allowing the field vectors to cancel each other out. ▪ In addition ongoing research by Marine Scotland and their advisors which will be monitored for further indications of successful mitigation strategies. ▪ MeyGen accepts that there is uncertainty about some potential impacts from the Project and is committed to undertaking a post installation monitoring programme in order to determine the nature of those impacts. Appropriate monitoring will be agreed with Marine Scotland. ▪ To the extent further mitigation is required over and above the first mitigation proposed for Impact 13.15, MeyGen is committed to working with the regulator to identify reasonable measures to mitigated against this impact. ▪ As a result no specific mitigation measures for this impact have been identified but ongoing research by Marine Scotland and their advisors which will be monitored for further indications of successful mitigation strategies.
Commercial fisheries	▪ Ensure consultation with fishermen, which may involve the appointment of a Fisheries Liaison Officer (FLO) to ensure fishermen are informed in advance of installation plans and to promptly answer any queries from fishermen. ▪ Details of the Project will be included in updated Kingfisher fishermen's awareness charts and FishSAFE ▪ Ensure consultation with fishermen, which may involve the appointment of a Fisheries Liaison Officer to ensure fishermen are informed in advance of installation plans, and to promptly answer any queries from fishermen. ▪ All vessels associated with Project operations will comply with IMO/MCA codes for prevention of oil pollution and any vessels over 400 GT will have onboard SOPEPs. ▪ All vessels associated with Project operations will carry onboard oil and chemical spill mop up kits. ▪ Where possible vessels with a proven track record for operating in similar conditions will be used. ▪ Vessel activities associated with installation, operation, routine maintenance and decommissioning will occur in suitable conditions to reduce the chance of an oil spill resulting from the influence of unfavourable weather conditions. ▪ Further consultation with the local fishing fleet to ensure the safe continuation of fishing effort in the cable deployment area once cables are installed. ▪ Consultation with the local fishing fleet, to ensure fishermen are aware of turbine locations. ▪ Provision of offshore Project area location data to local fishermen and Kingfisher Information Services (marine safety authority), to enable incorporation of offshore Project area location data into plotters. ▪ Despite the overall likelihood of an accidental spill being an extremely remote one-off event, an accidental spillage management plan will be employed to ensure emergency response systems and procedures are in place should an accidental spillage occur. ▪ Ensure fishermen are aware of decommissioning activities and schedule.
Navigation	▪ Experience and lessons learned from other marine renewables projects will be taken into account. ▪ Workshops will be held before the activity takes place involving the Construction company and maritime stakeholders to review the hazards and plan how the work can be safely conducted. ▪ Marine Safety Information broadcasts will be issued by HM Coastguard to inform mariners of the activity at the Project area (8 broadcasts per day covering Fair Isle, Cromarty and Hebrides Areas). ▪ Navtex and Notices to Mariners will be issued including details of the MeyGen work. ▪ Information on the work activity at the site will be circulated directly to local ports, ferry operators (e.g., Pentland Ferries), fishermen and recreational clubs. ▪ Details of the Project will be included in updated Kingfisher fishermen's awareness charts and FishSAFE. ▪ Details of the Project will be included in updated Sailing Directions. ▪ There will be liaison with local Harbour Masters to ensure they are aware of the activity and can notify visitors to their port. ▪ A working VHF channel will be provided to local users. ▪ Safety zone of appropriate dimensions will be applied for to protect working vessels on the site when restricted in manoeuvrability. ▪ Operating procedures will be established to ensure work vessels do not block the channel when they are not actively working on the site. If it is not practicable for the work vessel to depart from the site they will use AIS and marks to indicate that any safety zone is not operational if they are not restricted in manoeuvrability. ▪ Collision risk management procedures will be developed to be used by working vessels specifying traffic monitoring and emergency response procedures. ▪ An Emergency Response Cooperation Plan (ERCoP) will be prepared for the Project following the template provided by the MCA in Marine Guidance Note (MGN) 371. This will be submitted to the MCA for comment and approval. Emergency response would include informing HM Coastguard, Royal National Lifeboat Institution (RNLI), Harbours and local users (e.g., Pentland Ferries) so that vessels in the area are alerted to the potential hazard. ▪ There will be a dedicated watchkeeper onboard working vessel(s) or onshore. ▪ Local knowledge will be used during the work whenever possible.

ES section / topic	Commitment
	▪ Local harbours will be used for the work where practicable. ▪ Radio broadcasts will be given as necessary to warn approaching vessels about the work activity. ▪ Further consultation will be carried out on the safety zone dimensions with Marine Scotland, the MCA, Department Energy and Climate Change (DECC), the appointed contractor and local stakeholders prior to the application being made to DECC. ▪ Safety zones will be established on a 'rolling' basis, covering only the area of the site in which activity is taking place at a given time. Once that activity has been completed in that specific location, the safety zone will then 'roll on' to cover the next specific location (not the whole Project area). ▪ Work vessels will indicate their status on Automatic Identification System (AIS) and using appropriate marks/lights, e.g., if restricted in manoeuvrability. This will signify to passing traffic whether a Safety Zones is in place or not. ▪ Working vessels are selected and audited based on suitability for the job and the conditions in the Pentland Firth. ▪ Marine operating procedures are developed specifying allowable wave, tide and weather criteria. ▪ Procedures specify that work vessels should seek shelter (or return to base) when not working at the site. ▪ Working personnel are trained in offshore survival and have suitable Personal Protective Equipment (PPE). ▪ The Construction company operates a Safety Management System. ▪ Passage plans are developed for vessels routeing between the Project area and the onshore base. ▪ Work vessel movements are monitored from an onshore control centre, e.g., on AIS and VHF (Very High Frequency). ▪ The turbines will have a minimum under water clearance of 8m relative to Lowest Astronomical Tide (LAT) which means a proportion of vessels will not need to re-route as they will have safe under keel clearances when passing over the turbines. ▪ Marking and lighting of the site will be decided by Northern Lighthouse Board (NLB) once they have reviewed the NRA and consulted as appropriate. Discussions to date have indicated that they consider the Project area is effectively marked by the southern part of the island of Stroma and the whole coastline is conspicuous on radar. Therefore, they do not foresee a need for additional marking and lighting. Floating aids to navigation are not considered suitable given the strong tides. ▪ Deploy and monitor strategy, i.e., turbines will be installed over a number of years which allows the effect on vessel navigation to be monitored. ▪ Turbines could be stopped to maximise under water clearance. ▪ Vessels will have increased awareness of the Project area due to the notification measures carried out before and during Installation (described under the mitigation of Impact 15.1). ▪ The turbines have been subjected to engineering design and third-party verification to ensure they are suitable for deployment in the Inner Sound. ▪ The Project will be using tried and tested equipment and techniques to minimise the risks associated with the high tidal flow environment. ▪ Most parts will be negatively buoyant. ▪ Turbine nacelle designs that use buoyancy as part of the installation and maintenance strategy have failsafe locking systems for the connection between the nacelle and the Turbine Support Structures (TSSs) to prevent accidental release. ▪ On-site monitoring via SCADA (Supervisory Control and Data Acquisition) will alert the 24-hour control room operations team of turbine failure or an object hitting the turbine. ▪ Project area will be depicted on charts. Turbine and cables areas will be depicted on appropriate scale charts. ▪ Cables will be grouped (where feasible) to minimise the overall footprint area on the seabed. ▪ Horizontal Directional Drilling (HDD) bores will provide protection for at least part of the cable length from shore. ▪ Natural crevices will be used to avoid exposed cables being on the seabed surface as far as practicable. ▪ Additional material weighting will be used where necessary to ensure cable stability on the seabed. ▪ Cable route coordinates will be circulated to Kingfisher and the local skippers. ▪ Cables will be grouped (where feasible) to minimise the overall footprint area on the seabed. ▪ In addition to the Project-specific mitigation, the following measures have been identified to minimise potential cumulative impacts: o Liaison with ScottishPower Renewables UK Limited should installation or decommissioning activities overlap at the Ness of Duncansby site. o Consultation with stakeholders and development of appropriate procedures should MeyGen Phase 1 and 2 be decommissioned simultaneously resulting in increased work vessel activity in the Inner Sound.
Marine cultural heritage	▪ The following mitigations are proposed if practicable for sites of moderate and major impact significance within 100m of the development. o Avoidance. o ROV survey of the geophysical anomalies by Remote Operated Vehicle (ROV) in an appropriate manner by specialists in marine archaeology so they can be positively identified. o Detailed wreck survey and salvage. If the ROV survey reveals cultural heritage, plans/elevations will be made with a full photographic record prior to impact. Wrecks should be recorded in an appropriate manner by specialists in marine archaeology. Attempts will be made to retrieve and conserve representative examples of the fabric. If the feature is of high archaeological potential the strategies below may be implemented. o Intrusive archaeological assessment. This response will be implemented for all sites and wrecks with high archaeological potential and where there will be intrusive works. Intrusive assessments would groundtruth geophysical survey results and assess the nature, extent and preservation of identified remains. o Full archaeological excavation. This level of mitigation may be deemed necessary as a result of evidence gathered by other levels and should be conducted by specialists in marine archaeology. Provision should be made for the examination and possible conservation of any artefacts recovered. Provision should be made for post-excavation work bringing the results together in a report of publication standard.

ES section / topic	Commitment
	o Further documentary research and archiving. This response includes further detailed examination of unusual archival sources that would not routinely be consulted. o No recommendations are made for anomalies of low potential. This is due to them being interpreted as natural features. o A reporting protocol will be instigated for the accidental discovery of marine cultural material during development, maintenance and monitoring. o Avoidance. Should cultural material be accidentally discovered, it is proposed that the site be avoided. ▪ If it is not practicable to avoid the material a detailed wreck survey will be undertaken. If the ROV survey reveals cultural heritage, plans/elevations will be made with a full photographic record prior to impact. Wrecks will be recorded in an appropriate manner by specialists in marine archaeology. Attempts will be made to retrieve and conserve representative examples of the fabric. If the feature is of high archaeological potential the strategies below may be implemented. ▪ Full archaeological excavation. This level of mitigation may be deemed necessary as a result of evidence gathered by other levels and should be conducted by specialists in marine archaeology. Provision should be made for the examination and possible conservation of any artefacts recovered. Provision should be made for post-excavation work bringing the results together in a report of publication standard. ▪ Further documentary research and archiving. This response includes further detailed examination of unusual archival sources that would not routinely be consulted. ▪ Avoid placing the turbines on the sandy substrate on the northeast corner of the proposed turbine deployment area.
Geology, hydrology and hydrogeology	▪ All infrastructure will be located 50m or more from surface watercourses or waterbodies where possible. ▪ Concrete will not be batched on site. ▪ Use of wet concrete near watercourses will be minimised and carefully controlled. ▪ Water-based lubricants and drill fluid will be used where possible and drill fluid will be recycled throughout the drilling process to minimise total volume required. Any surplus drill fluid will be disposed of as controlled waste at the end of construction. ▪ Waste water and sewage will be disposed of in accordance with Pollution Prevention Guidelines (PPG) 4. Where ground conditions permit, disposal to ground will be considered as the preferred option. Locations of existing private septic tanks and associated pipework will be identified prior to undertaking any ground moving activity and will be avoided as far as possible to minimise the risk of damaging this infrastructure. ▪ Waste materials including drill cuttings generated during HDD (apart from the final 5-10m which will be discharged to sea), will be reused or recycled, and where this is not possible will be disposed of appropriately. A Construction Waste Management Plan will be produced by the appointed principal contractors and will follow guidelines similar to the ones set out in Scottish Environment Protection Agency (SEPA) (2006). ▪ All equipment, materials and chemicals will be stored well away from watercourses, with at least a 50m separation. Chemical, fuel and oil stores will be stored safely in accordance with PPG2. ▪ Machinery standing for several days or longer will have drip trays placed underneath to prevent oil and fuel leaks causing pollution. ▪ Where practicable, refuelling of vehicles and machinery will be carried out in a designated area, on an impermeable surface and well away from any watercourse. ▪ Only emergency maintenance will be carried out within the project area, on an impermeable surface and well away from watercourses. If vehicles have broken down, necessitating maintenance at the point of breakdown, special precautions will be taken. ▪ Construction traffic movements will be limited as far as practicable, to reduce the risk of accidental spillage. ▪ Washing-out of vehicles used to transport concrete, grout or drilling fluid will not be undertaken on site. ▪ Contingency plans will be in place to ensure that emergency equipment, such as spill kits and absorbent materials, is available on site and will include advice on actions to be taken and personnel to be informed in the event of a pollution incident. ▪ All relevant staff and site personnel will be trained in normal operating and emergency procedures and will be made aware of highly sensitive areas on site. ▪ All activity occurring within the Burn of Horsegrow catchment will be undertaken with particular care to minimise pollution risk to the Loch of Mey Site of Special Scientific Interest (SSSI)/Ramsar site and its tributary watercourses. Additional protection measures will be installed if necessary to ensure the site is adequately safeguarded. ▪ A suitably qualified Environmental Clerk of Works will be appointed who will have responsibility for ensuring mitigation measures are in place and are operating effectively. ▪ All earth-moving operations will be undertaken in compliance with British Standards Institution (BSI) Code of Practice for Earthworks, BS 6031:2009. This will include halting of all earthworks during and immediately after heavy rainfall events. ▪ All heavily sediment-laden discharges will be routed through balancing tanks and one or more suitable filters or silt-busters in series as necessary, to reduce the sediment load. ▪ Water with light sediment load and supernatant water following treatment to remove heavy sediment load will be discharged onto vegetated surfaces and directed away from surface watercourses and ditches to avoid direct entry into the surface water system. ▪ In areas where it is necessary to run cable trenches and working width parallel to and within 20m of roadside or field drainage ditches, additional sediment control measures may be required to ensure the existing drainage network continues to operate at its current level. Additional control measures may take the form of silt fences, bunds, straw bales or other suitable barrier as appropriate to local conditions. ▪ Measures to control surface water runoff will be instigated prior to topsoil stripping. These may include retention of vegetation cover on watercourse banks, installation of straw bales or alternative barrier to intercept runoff or the installation of new land drains. ▪ Sediment control measures and temporary drainage will remain in place until vegetation cover has been re-established on the working width, to prevent reinstated soils being carried into nearby watercourses. ▪ Where open-cut cable crossings of watercourses are proposed, preference will be given to isolated open-cut techniques to minimise any potential release of sediment to the watercourse. Watercourse bed and bank material will be fully reinstated prior to the restoration of flow in the channel. ▪ All activity occurring within the Burn of Horsegrow catchment will be undertaken with particular care to minimise the risk of sediment release to the Loch of Mey SSSI/Ramsar site and its tributary watercourses. Additional protection measures will be installed if necessary to ensure the site is adequately safeguarded. ▪ Vehicle movements on site will be restricted as far as practicable, especially on temporary tracks and within the working width, to restrict soil compaction. ▪ Specialist low ground pressure vehicles will be considered for construction work, to minimise the requirement for temporary tracks. ▪ For the working width and cable trenches, topsoil will be stripped on a field-by-field basis and stored in a mound running alongside the working width on unstripped land. Where possible, topsoil will be stripped in reasonably dry conditions and stored in a mound no more than 2m high.

ES section / topic	Commitment
	▪ Stored topsoil will be kept free from the passage of vehicles and will be prevented from intermixing with other materials. Erosion protection will be placed around stockpiles if required to minimise soil loss to surface runoff. ▪ Subsoils removed from the cable trenches will be stored on the opposite side of the working width from stored topsoil and will be laid on undisturbed subsoil. ▪ Topsoil reinstatement will be carried out under suitably dry conditions in order to limit compaction. Soil loosening may be required in areas where compaction is a problem, such as under the running track or under temporary track routes. ▪ All temporary tracks and hardstanding areas will be removed and fully reinstated upon completion of the construction work. ▪ All temporary excavations associated with excavations will be fully reinstated upon completion of the construction work once vegetation has been re-established on previously stripped ground. ▪ Where permanent modifications to land drainage are required, such as around the Power Conversion Centre (PCC) site, alternative drainage will be installed prior to construction to provide continuity of flow capacity in the affected area. ▪ All crossings will be constructed taking account of guidance and good practice detailed in SEPA's *Engineering in the Water Environment Good Practice Guide: River Crossings* (2010) and Scottish Executive's *River crossings & migratory fish: Design guidance* (2000). ▪ Ground levels around temporary and permanent watercourse crossings and along the line of the cable trench will not be raised and care will be taken to ensure that bed reinstatement above cable trench crossings does not impede water flow within the channel. ▪ Permanent infrastructure will be located outwith the 1-in-200 year flood risk area and at least 5 m AOD to minimise risk from coastal flooding. ▪ Where possible, siting of the PCC and associated infrastructure will avoid the existing field drainage network. If this is not possible, alternative field drainage will be installed prior to construction work to provide continuity of flow capacity in the affected area. ▪ Track crossings of watercourses, including field and roadside drainage ditches, will be sized appropriately to ensure flow is not restricted. A programme of inspection and maintenance will be put in place to ensure their continued effective operation throughout the lifetime of the project. ▪ Should excess spoil arise from engineering works, this will be disposed of outwith the floodplain area to avoid loss of flood storage capacity. ▪ Cable trench backfill will be compacted to an appropriate degree to minimise along-trench groundwater flow without compromising the required technical performance. ▪ Where the cables are required to be seated on sand, use of cement-bound sand or appropriate alternative impermeable barrier will be considered to divert groundwater from the trench. ▪ If groundwater discharges are identified during construction, cable trenches and infrastructure will be microsited where possible to avoid the identified discharge location. ▪ In the event that the cable route running from Upper Gills to the Hill of Rigifa' is selected as the preferred option, cables will be located as close to the road as possible in order to minimise disruption to the identified groundwater dependent terrestrial ecosystem in this corridor. Consideration will be given to locating the cable trenches across the road from the identified habitat area to avoid further disruption to groundwater flow. ▪ Excavated material from road surface and sub-base may need appropriate disposal as hazardous waste. Testing will be required to determine if this is required. Disposal would be subject to agreement and licensing by The Highland Council (THC) and SEPA. ▪ Water ingress to the excavation may contain contaminants and would require collection and appropriate treatment to remove contaminant prior to discharge. This may be subject to agreement and licensing by SEPA. ▪ It has been assumed that all operations and maintenance activity will be undertaken in accordance with the good practice and mitigation measures set out above with relation to Impact 17.1. ▪ A programme of regular inspection and maintenance for all permanent drainage features will be put in place and carried out regularly. ▪ Excavation and ground-disturbing work will be kept to a minimum as far as practicable, to minimise the potential for mobilising sediment.
Terrestrial ecology	▪ Employment of best working practices during construction works, including restoration of affected habitats to an original condition, where conditions allow. ▪ Submission of Construction Environmental Management Plan (CEMP), including details of measures to reduce construction disturbance to terrestrial habitats and species where possible. ▪ Further ecological investigation in relation to otter and water vole status (once onshore Project specifics are confirmed), to ascertain protected species licensing requirements. ▪ Application for a European Protected Species (EPS) licence in relation to disturbance of otter habitat and application for a water vole habitat disturbance licence, if either licensing requirement is deemed necessary. ▪ Where ecologically sensitive habitat loss does occur, compensatory measures (such as replanting of lost tress) will be considered as part of completion of construction and restoration of habitats to an original condition (where project operations allow). ▪ Where otter habitat is disturbed (particularly in the vicinity of the PCC location where long term disturbance may occur), application for a EPS Licence will be undertaken and a programme of relevant mitigation will be implemented where necessary. ▪ Once specific Project details are known, further targeted investigation will be undertaken to ascertain the status, distribution and habitat use of otters within the Project footprint and surrounding environment. ▪ Where it is ascertained that disturbance to otters will be likely, application for a European Protected Species licence will be made. ▪ As part of the licence, implementation of on otter management plan may be necessary; this will outline best industry practices to minimise disturbance to otters where possible. ▪ Where increased otter road fatality risk is identified, specific mitigation measures will be put in place; this may include otter culverts (for new access tracks), steering fences and wildlife reflectors. It is recognised that installation of such measures may comprise a condition of (European Protected Species) licence, if deemed necessary and should be implemented as part of the CEMP. ▪ Once specific Project details are known, further ecological investigation will be undertaken to ascertain the status of water vole within the onshore Project footprint and surrounding environment. ▪ Should water vole be present within the Project footprint, application for a relevant licence will be necessary and habitat protection measures will be implemented during the construction phase to prevent causing disturbance to water voles and water vole habitat. This will likely be included as part of a water vole mitigation plan and / or CEMP. ▪ Should water vole habitat be impacted by construction, affected areas will be restored to an original condition to minimise long term impacts on the local water vole population. ▪ Should sensitive habitats (i.e. otter holts and resting sites) be located in close proximity to where onshore maintenance and operational activities are taking place (including near shore vessel activities), best industry practices and relevant mitigation measures will be implemented, to avoid causing unnecessary disturbance.

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	▪ Where disturbance impacts from small scale construction activities involved in the operations and maintenance of the PCC cannot be avoided, acquisition of a EPS licence will be undertaken to ensure potentially disturbing works are legally permitted. ▪ Employment of industry best practise during decommissioning works, including restoration of affected terrestrial habitats to an original condition. ▪ Adherence to the Environmental Management Plan (and where relevant, working method statements) throughout the decommissioning phase, aiming to reduce disturbance to terrestrial habitats where possible. ▪ Should sensitive habitats (i.e. otter holts and resting sites) be located in close proximity to where onshore and inshore decommissioning activities are taking place, best working practices and relevant mitigation measures will be implemented to avoid causing unnecessary disturbance to otters where practicably possible. ▪ Where disturbance impacts to otters from decommissioning activities cannot be avoided, acquisition of an EPS licence will be undertaken, to ensure potentially disturbing works are legally permitted. ▪ Long term mitigation against increased risk of otter road fatality will likely be in place from the construction phase onwards; it is anticipated that mitigation measures such as otter culverts (for new access tracks), steering fences and wildlife reflectors will remain effective at deterring otters from crossing roads, throughout the duration of the Project and beyond.
Landscape, seascape and visual	▪ Reduction of overall site footprint to minimise loss of physical landscape and seascape elements. ▪ Limiting PCUB height and lowering the buildings by taking away superficial soil layers. ▪ Siting of main Power Conversion Unit Buildings (PCUBs), Control Building, and other physical infrastructure within the PCC use natural topographic screening to minimise visibility – in terms of both overall visual envelope (Zone of Theoretical Visibility (ZTV)) and actual visibility from key viewpoints. ▪ Building orientation designed to minimise impact in key viewpoints: e.g. orientation of the main PCUBs has been harmonised with the open vistas when viewed from both the Canisbay Kirk and from the ferry route between Gills Bay and Orkney. ▪ Siting, non-alignment and spacing of PCUBs to minimise additional visual confusion and avoid conflict with existing adjacent historic features and buildings. ▪ Building scale designed to be compatible with scale of landscape and seascape character of site and wider context. ▪ Distinctive building form creates strong identity and clear rationale relating to renewable marine energy source. ▪ A curved roof to reflect the surrounding landscape. ▪ Building form and finishes, include use of natural materials, designed to reflect aesthetic qualities associated with landscape and seascape character of site and wider context. ▪ Use of local stone walling in harmony with existing uses to help screen control building .
Onshore cultural heritage	▪ *Avoidance.* All sites of major significance will be avoided and the cable route will be designed to avoid most cultural heritage assets. Assets in the Ness of Quoys and Ness of Huna will be avoided where possible by the design and layout of the development. ▪ *Targetted geophysical survey* has already been conducted to identify the presence / absence and extent of archaeological remains at the Ness of Quoys and Ness of Huna in order to manage potential impact. The design will avoid these where possible and intrusive evaluations will be conducted as the next step where it is not. Further survey is recommended at the east end of the Gills to Kirkstyle cable route to identify whether remains extend into it from the prehistoric mound (54) below Canisbay Kirk. ▪ *Survey.* A detailed topographic / photographic and / or standing building survey of an appropriate level will be conducted for earthworks or vernacular buildings if they cannot be avoided. ▪ *Intrusive archaeological evaluation* will be conducted if appropriate on remains that cannot be avoided, including those identified by geophysical survey, or to assess the nature and significance of sites that may be of archaeological importance so that appropriate action can be taken. ▪ *Archaeological Watching Brief.* This will be conducted during ground-breaking construction works if there is a significant potential for but no conclusive proof of archaeological remains, or as a precautionary measure if a site has been identified nearby. The works will allow opportunity for salvage excavation on remains that cannot be avoided. ▪ *Archaeological Excavation* may be necessary as a result of evidence gathered by other mitigation strategies if archaeological remains cannot be avoided and if required by THC Historic Environment Team (HET). Agreement should be made with HC HET on the standards and extent of excavation and the provisions for post-excavation work and reporting. ▪ A *Reporting Protocol* for the accidental discovery of archaeological remains will be instated, the nature of which will be agreed with THC HET. ▪ MeyGen will ensure that construction contractors have cultural heritage site maps and lists so that they know what is to be avoided; that the construction teams have a cultural heritage induction, especially if reporting protocols are to be used; and that the construction works manager or Environmental Clerk of Works marks off all sites within or close to edge of the development areas to ensure that they are avoided and not accidentally run over or otherwise impacted. ▪ Reduction of overall site footprint to minimise loss of setting of cultural heritage assets ▪ Siting of main PCUBs, Control Building, and other physical infrastructure within the PCC use natural topographic screening to minimise visibility – in terms of both overall visual envelope (ZTV) and actual visibility from key heritage assets. ▪ Building orientation designed to minimise impact in key view: e.g. orientation of the main PCUBs has been harmonised with the open vistas when viewed from both the Canisbay Kirk and from Stroma. ▪ Siting, non-alignment and spacing of PCUBs to minimise additional visual confusion and avoid conflict with existing adjacent historic features and buildings. ▪ Building scale designed to be compatible with scale of landscape and seascape character of site and wider landscape setting. ▪ Distinctive building form creates strong identity and clear rationale relating to renewable marine energy source. ▪ Building form and finishes, include use of natural materials, designed to reflect aesthetic qualities associated with landscape and seascape character of site and wider landscape setting. ▪ Use of local stone walling in harmony with existing uses to help screen buildings. ▪ Design ensures that the prominence of Canisbay Kirk and its dominance of the local landscape is not challenged by the size and height of the buildings and ensuring that the buildings do not break the horizon when looking to them from the sea. ▪ Design ensures that the key view between the kirk and the manse is not interrupted.
Socio-economics, tourism and	▪ There are a number of national, regional and local initiatives involving the Scottish Government, regional and local development agencies and the Caithness and North Sutherland Regeneration Partnership with the

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recreation	aim to work towards enhanced skills training, supply chain enhancement, and support for business improvement working in the marine renewables industry, including Caithness. These will assist in realising and maximising the opportunities in the local and wider areas and where appropriate MeyGen will support these initiatives. ▪ Consultation with local businesses to manage traffic flow during major local events. ▪ During the temporary HDD activities, screening measures may be implemented to reduce impacts on passing visitors. ▪ For the potential positive construction impacts there are a number of national, regional and local initiatives involving the Scottish Government, regional and local development agencies and the Caithness and North Sutherland Regeneration Partnership with the aim to work towards enhanced skills training, supply chain enhancement, and support for business improvement working in the marine renewables industry, including Caithness. These will assist in realising and maximising the opportunities in the local and wider areas and where appropriate MeyGen will support these initiatives. ▪ Temporary interruption of recreation routes during construction will be carefully managed and any diversions clearly sign-posted; information on construction works circulated to recreational businesses and public notices distributed ▪ During the temporary HDD activities, screening measures may be implemented to reduce impacts on passing recreational users or from recreational focal points. ▪ Marine Safety Information broadcasts will be issued by HM Coastguard to inform mariners of the activity at the MeyGen site. ▪ The Project will be depicted on Admiralty Charts produced by UKHO. ▪ Navtex and Notice to Mariners will be issued including details of MeyGen works. ▪ Information on the work activity at the site will be circulated directly to local ports, ferry operators and recreational clubs and businesses. ▪ For the potential positive decommissioning impacts mitigation as above for economic impacts will increase the likelihood of occurrence.
Onshore transport and access	▪ During the onshore construction phase Project contractors will preferentially use the A836. ▪ Liaison with the local community and users of the area regarding overall construction activities such as details of types, levels, timing and routing of traffic will help to reduce the sensitivity of the receptors to change. ▪ The layout of the site has a large pull in area for large vehicles to avoid blocking the road. ▪ The large deliveries will be planned and marshalled so they so not coincide with each other and to avoid the peak traffic times on the local roads infrastructure. ▪ A member of the construction management team will liaise and co-ordinate with the local community to ensure that deliveries do not coincide with significant local events. ▪ The construction team will publicise when deliveries using large or slow moving equipment is planned to inform local road users. ▪ The local community will be kept informed of when and where restrictions in traffic flow during cable installation and construction of the permanent access road to the PCC will occur, and identify measures to limit restrictions. ▪ If turbine components are to be transported to the Caithness area by road, a traffic management plan should be developed in discussion with Transport Scotland and Scotland Transerv who is responsible for the management of the north west Scotland trunk road network. The traffic management plan will include provision for: o Deliveries using large or slow moving equipment will be planned to avoid peak traffic times o Deliveries using large or slow moving equipment will be planned so they do not coincide with each other. o The operations team will publicise when deliveries using large or slow moving equipment is planned to inform local road users and communities along the route.
Noise and dust	▪ Submission of CEMP detailing predicted construction and HDD noise levels and mitigation measures to be used and detailing measures to ensure dust emissions are kept to a minimum. ▪ Limit construction working times to minimise noise during sensitive periods. ▪ Noise limit of 65 dB $L_{Aeq,1h}$ for construction noise. ▪ Implementation of noise monitoring scheme to verify compliance with noise limits. ▪ The local community should be kept informed of overall construction activities including details of types, levels and routes of traffic. ▪ Installation of noise control engineering measures to rig and ancillary equipment. ▪ Use of enclosures, barriers and baffle mounds. ▪ Noise limit of 45 dB L_{Aeq} and 60 dB LA_{Fmax} for night-time drilling operations at the nearest noise sensitive receptor. ▪ Use of acoustic materials to clad the PCC buildings. ▪ Acoustically absorbent lining on inner façade of building. ▪ Installation of acoustic louvers for building ventilation. ▪ Orientation of PCC buildings so that any vent extracts point away from noise sensitive properties.
Accidental events	▪ Vessels associated with all Project operations will comply with IMO/MCA codes for prevention of oil pollution and any vessels over 400 GT will have onboard SOPEP's. ▪ Vessels associated with all Project operations will carry onboard oil and chemical spill mop up kits. ▪ Where possible vessels with a proven track record for operating in similar conditions will be employed. ▪ Vessel activities associated with installation, operation, routine maintenance and decommissioning will occur in suitable conditions to reduce the chance of an oil spill resulting from the influence of unfavourable weather conditions. ▪ Only recognised marine standard fluids and substances will be used in the pin pile drilling equipment. ▪ Consideration will be given to CIRIA guidance on the use of concrete in maritime engineering – a good practice guide.

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	▪ Operations will only take place during suitable weather windows. ▪ A fibre optic cable will be used to monitor the level of cement, when the cement reaches seabed level pumping of cement will cease immediately. ▪ During cementing operations the cement will be separated from the open sea conductor casing which is only removed once the cement has reached sufficient strength to withstand current forces. ▪ Dry cement will be stored in strong bags made of appropriate material to avoid loss of any kind; empty bags will be stored in an appropriate container and disposed of accordingly onshore. ▪ In the event of any unplanned discharges to sea during HDD activities the drilling contractor would activate its emergency response plan to ensure discharges were minimised. ▪ All vehicles used will have up to date MOTs and will be operated by suitably qualified personnel. ▪ Due attention will be given to weather conditions and appropriate action will be taken i.e. vehicles will not be used when the weather is deemed to present dangerous conditions e.g. severe ice and snow. ▪ The plan for the construction phase will take into the account the capacity of the local road network. ▪ Only recognised marine standard fluids and substances will be used in the turbine hydraulic systems. ▪ Hydraulic fluids will be mostly water based, biodegradable and be of low aquatic toxicity. ▪ Turbine sensors will detect loss of fluid pressure and leaks enabling maintenance operatives to reduce the risk of further leaks. ▪ The design of the building which be such to allow good ventilation. ▪ Due regard will be given to the Fire Safety Scotland (Regulations) 2006 and Part 3 of the Fire Scotland Act 2005 which details the provision for fire safety in non domestic premises. ▪ Alarms and fire detection measures will be included in the design of the PCC. ▪ A fire risk assessment should be carried out for the PCC. ▪ In regard to the storage of fuel, SEPA PP2 'above ground storage tanks' will be followed. In particular the fuel tank will be chosen and positioned with fire risk in mind and will be located with sufficient space around it or a physical fire barrier. The base will also be suitably designed as to minimise fire risk. ▪ The power conversion equipment will be water or air cooled to avoid overheating and will contain very little combustible material. The equipment will be self-extinguishing and a fire/smoke alarm system will be installed in each power conversion container. ▪ Industry standard switches will be used to turn off source of energy in the event of fire detection and there will be a container provided fire and smoke containment. ▪ The transformer is F1 certified and meets standard IEC 60076-11. A vacuum cast dry type transformer (significantly lower risk of fire compared to oil filled transformers) will be used. The transformers will be self-extinguishing. ▪ The gas insulated switch gear (virtually no fire risk) meets requirements of standard IEC 60694.

Table 25.1: MeyGen Tidal Energy Project, Phase 1 commitments

25.3 Environmental Monitoring Strategy

25.3.1 Survey, Deploy and Monitor

25.10 Due to the emerging nature of the tidal energy industry there are some potential impacts that have yet to be verified by operational monitoring in the industry. Where single turbines have been installed and potential environmental impacts monitored, MeyGen has made use of the available data. However, MeyGen recognises that there is little data currently available and its application to the assessment of a commercial array of turbines is limited. MeyGen therefore propose to implement a Survey, Deploy and Monitor strategy to reduce the uncertainty around particular impacts with the installation and operation of the first small array installed within the Project.

25.11 The Survey, Deploy and Monitor strategy is recognised by the Scottish Government as an important mechanism for the development of marine renewable energy in Scotland. Marine Scotland has produced guidance for Survey, Deploy and Monitor strategies and MeyGen has, and will continue to, consult with the regulatory body to ensure the project strategy is properly aligned.

25.12 MeyGen will develop an appropriate monitoring and reporting programme to cover the installation, operations and maintenance of the Project.

25.13 As the MeyGen Tidal Energy Project will be developed in a series of phases, which supports the Scottish Government policy, the initial small array of turbines will be monitored to provide information on the interactions between the turbines and the environment. This will increase the knowledge and reduce assessment uncertainty for subsequent build out of the Project and for future consent applications.

25.14 Based on the installation program outlined in Section 5, monitoring of the year 1 turbines will be used to verify the conclusions of the impact assessment, which will inform the year 3 installation and also provide information for the subsequent consent applications and EIA for future phases of the project.

25.15 The overall length of the monitoring program will be dependent on the success of monitoring strategies used and whether the data gathered is able to answer the questions posed with a given level of confidence.

25.16 Monitoring will be designed to be appropriate to the scale of the Project and will take into account what is feasible at this level. MeyGen will use best available practices to monitor potential impacts, but recognises that at the present time, for certain impacts, there are no established and/or recognised standard monitoring protocols.

25.17 It is proposed that an advisory group is set up to oversee the monitoring program involving the relevant regulators and stakeholders, including Marine Scotland and Scottish Natural Heritage (SNH). The monitoring advisory group would review the objectives, outputs and timescales of the program and ultimately have the ability to amend the program based on how successful it is.

25.18 Where monitoring indicates that additional mitigating measures may be reasonably required, MeyGen is committed to put these in place.

25.3.2 Project and strategic research and monitoring

25.19 Through the environmental impact assessment (EIA) process, MeyGen has recognised that being the first application for a commercial scale tidal stream project in Scotland and the first from The Crown Estate's Pentland Firth and Orkney Waters (PFOW) leasing round, means there is some uncertainty with the impact assessment due to the nascent status of the industry and in some cases a lack of data on a particular receptor at a regional, national or international scale.

25.20 For example, the potential collisions between bird, marine mammal and fish species and tidal turbines represents the single greatest knowledge gap in the industry. These uncertainties encompass ones which need to be addressed across the industry and are not regarded as something individual developers are able to adequately resource.

25.21 The current situation means that MeyGen has identified two approaches to monitoring:

- Where MeyGen identifies a monitoring requirement for a Project specific issue, monitoring protocols will be developed in consultation with the regulators and stakeholders.
- Where uncertainties in the assessment are identified that are considered of strategic importance to the development of the tidal steam industry, MeyGen would look to a collaborative effort between the Project, wider industry, regulatory and stakeholders to reduce the uncertainty in this area. In the monitoring program MeyGen would wish to engage the wider community and industry in discussions in how best to take this forward in the most efficient way for the interest of the Project and future projects elsewhere in Scotland and the UK.

25.22 The monitoring program will be closely linked to the strategic research currently being carried out and proposed for the future by regulators and academia.

25.3.3 Current government/PFOW strategic research

25.23 Marine Scotland (either on its own or in partnership with other organisations e.g. SNH has a significant research programme which it considers is required to inform further development of offshore renewable energy in Scotland's seas. The research is specifically investigating potential impacts between seabirds, marine mammals, habitats and marine renewables, as well as generic research into the potential effects on the marine environment as a whole.

25.24 The current research programme for 2011/12 includes:

- A significant research programme for marine renewables through the Scottish Government Marine Energy Spatial Planning Group (MESPG) Environmental Research sub-group. SNH's involvement in the Marine Scotland research programme is directly linked their own Research Strategy (2010-2013), Theme 5 'Working with Renewable Energy' and Theme 12 'Coasts and Seas';
- There are also a number of projects being undertaken to inform the Pentland Firth Marine Spatial Plan pilot project and the development of a Sectoral Plan for Marine Renewables, including projects on shipping and navigation, tourism and recreation and fishing; and
- The Crown Estate (TCE) is also involved in Marine Scotland research for the marine renewables. TCE Pentland Firth and Orkney Waters Enabling Actions Fund has been set up to accelerate and de-risk development of the marine renewables projects including research into potential environmental impacts in conjunction with Marine Scotland's strategy.

25.25 Strategic research includes the following areas:

- Develop guidance on survey and monitoring;
- Supporting monitoring of deployed devices;
- Commissioning or contributing to resource surveys, to inform site selection and subsequent assessments;
- Supporting development of techniques or technologies to detect and record species present around turbines;
- Supporting the development of locational guidance;
- Understanding the significance of potential impacts upon species and habitats and their conservation status; and

- Identifying approaches for device management and operation that will minimise or avoid environmental impacts.

25.3.4 Other research

25.26 Monitoring programs could include highly specialised research techniques. There is therefore likely to be an opportunity to involve universities and research institutes in some aspects of monitoring.

25.27 There are a number of research projects currently investigating the tidal stream environment and the potential environmental impacts of marine renewables. The most applicable to the Project is Environmental Research Institute's (ERI) Marine Renewable Energy and the Environment (MaREE) project. MeyGen holds a position on the MaREE project advisory board and has an interest in the existing research and the potential to take it forward to look at environmental monitoring of array scale projects.

25.28 Other relevant university research projects include:

- MReds (Marine Renewable Energy Development in Scotland), led by Heriot Watt University and the University of the Highlands and Islands (UHI), which includes a theme on environmental and ecological impacts;
- SUPERGEN, now in its third phase this project has a core consortium which now consists of the University of Edinburgh, the University of Strathclyde, Queen's University Belfast and the University of Exeter. Work Pack 12 investigates The Economic, Environmental and Social Impact of New Marine Technologies for the Production of Electricity; and
- PRIMaRE (The Peninsula Research Institute for Marine Renewables Energy) research to understand and quantify and mitigate the environmental and biodiversity impacts of marine renewables energy extraction.

25.29 A new funding opportunity has also been jointly announced by the Natural Environmental Research Council (NERC), Technology Strategy Board (TSB) and Scottish Enterprise. The £10.5M funding round for industry led research titled 'Marine energy: Supporting array technologies'.

25.30 The funding is designed to overcome new technical barriers at commercial array scale projects that are common across the industry.

25.31 NERC is keen to facilitate working collaborations between industry and environmental scientists to help 'design out' environmental impacts early on and will provide funds for the 'translation' of previous NERC-funded environmental science into industry-led projects.

25.32 MeyGen will look for opportunities to collaborate with research institutes in designing and implementing the monitoring program.

ReDAPT

25.33 TGL, one of the candidate tidal turbines for the MeyGen project, is planned as a vehicle for environmental monitoring through ReDAPT (Reliable Data Acquisition Platform for Tidal) project. The ReDAPT project is commissioned and funded by the ETI and aims to install and test a 1MW tidal turbine at the European Marine Energy Centre (EMEC) in Orkney, delivering detailed environmental and performance information never before achieved at this scale in real sea conditions. The performance data will be used to validate a variety of models include detailed Computational Fluid Dynamics (CFD) for the turbine, near field models of the turbulent water flow near the turbine and far field models of the EMEC test site. The project will provide substantial data on tidal resource and environmental assessment, tidal device performance, as well as supply chain assessment.

25.3.5 Pre-installation surveys

25.34 MeyGen will build on the baseline data surveys conducted for the EIA, producing a program for pre-installation surveys. The survey program will be designed as part of the proposed installation and operational monitoring. It will be important that the pre-installation surveys are designed to target the specific requirement of the monitoring and allow for the robust analysis of monitoring data and the power to detect potential change in the environment.

25.35 Surveys are also likely to be required onshore prior to construction to identify areas being actively used by particular species. Construction work will be planned to avoid or minimise disturbance.

25.3.6 Proposed monitoring for MeyGen Tidal Energy Project, Phase 1

25.36 The following summarises the proposed monitoring for the MeyGen Tidal Energy Project Phase 1. Monitoring is summarised on a topic by topic basis.

Physical Environment and Sediment Dynamics
MeyGen propose to deploy at least 1 ADCP with the initial turbines. Data collected will be used to validate the hydrodynamic modelling undertaken to inform the physical environment and sediment dynamics impact assessment. The sediment erosion/deposition and bedload transport results produced during this modelling study are directly dependant on the quality of the hydrodynamic and wave models, so by validating those underlying models, the morphology results will be partially validated by proxy.
Benthic Habitats and Ecology
Monitoring of benthic habitats and ecology is proposed in order to confirm impact predictions made in the ES; in particular in relation to: ▪ Dispersion of drill cuttings from potential TSS pile installation and HDD bore breakthrough; and ▪ To detect any significant changes in habitats due to the presence of the turbines. Surveys are expected to be required post installation and post decommissioning. Based on current knowledge of the site (extensive baseline surveys and hydrodynamic modelling) and building on the pre installation surveys, it is likely that the benthic monitoring programme would be based primarily on drop down video upstream / downstream of the project such that potential changes to the biotope mosaic in the area could be detected. Reference areas to either side of the turbine array and cable routes could also be sampled.
Marine Mammals
Potential impacts on marine mammals have been assessed as being negligible or minor. Although the results conclude that the Project does not pose a significant risk to marine mammals, MeyGen recognises that due to the emerging nature of the tidal energy industry there is uncertainty about some potential impacts especially where these have yet to be verified by operational monitoring. Where impacts cannot be fully quantified (e.g. turbine collision risk). MeyGen is committed to developing a marine mammal monitoring program. This program will be based on the 'Survey, Deploy and Monitor' strategy in accordance with Scottish Government policy (currently available in draft). MeyGen has recognised that being the first application for a commercial scale tidal stream project in Scotland and the first from The Crown Estate's Pentland Firth and Orkney Waters leasing round, has meant that there is potential for the Project to form part of an industry wide strategic monitoring program that will benefit future projects as well. Where strategic monitoring is appropriate, MeyGen would look to a collaborative effort between the Project, wider industry, regulators and stakeholders to take this forward in the most efficient way for the interest of the Project and future projects elsewhere in Scotland and the UK. As part of this EIA and the MeyGen commitment to post-installation monitoring, the draft SNH survey and monitoring guidance (MacLeod *et al*., 2011; Sparling *et al*., 2011) has been reviewed. Although this guidance does not, and cannot, give specific details of what marine mammal monitoring should take place, based on the general approaches described and on current knowledge of the site (obtained from the extensive baseline surveys), it is likely that the monitoring programme could include some or all of the following: <u>Disturbance and displacement</u> ▪ Targeted observations of all marine mammals to determine how area use or behaviour may have changed over time; ▪ Acoustic monitoring of harbour porpoise (and incidentally other echo-locating species) using static loggers to assist with determining area use; and ▪ Collection of underwater noise measurements of the candidate prototype tidal turbines. The data collected will be used to validate the underwater noise modelling completed to inform the impact assessment. <u>Collision risk</u> MeyGen believes that understanding marine mammal behaviour around tidal turbines and the risk of collisions occurring is fundamental for the industry to progress. It is therefore proposed that this potential impact is considered as strategic research and therefore monitoring development in cooperation with regulators, stakeholders and other developers. This impact

assessment has indicated seals as the species group of most concern. Monitoring could include::

- Continuation of ongoing seal tagging programme in the Inner Sound;
- Installation of one or more active monitoring systems on one or more tidal device to better understand the near-field response of marine mammals (and other marine species) to operating tidal devices, and
- Shoreline monitoring for marine mammal carcases and subsequent necropsy to determine if interaction between marine mammals and turbines/ducted propellers is occurring.

MeyGen will work with the regulator (Marine Scotland) and its advisory bodies (e.g. SNH) to agree the details of appropriate monitoring and will ensure that the monitoring programme is aligned with industry best practice. Methods for assessing disturbance and displacement impacts (including underwater noise) and collision risk can potentially be linked with similar effort required for Ornithology and Fish Ecology.

Where monitoring indicates that additional mitigation measures may be reasonably required, MeyGen is committed to put these in place.

Ornithology

Potential impacts on birds have been assessed as being negligible or minor. Although the results conclude that the Project does not pose a significant risk to birds, MeyGen recognises that due to the emerging nature of the tidal energy industry there is uncertainty about some potential impacts especially where these have yet to be verified by operational monitoring in the industry.

Where impacts cannot be fully quantified (e.g. turbine collision risk). MeyGen is committed to developing a bird monitoring program. This program will be based on the 'Survey, Deploy and Monitor' strategy in accordance with Scottish Government policy (currently available in draft).

MeyGen has recognised that being the first application for a commercial scale tidal stream project in Scotland and the first from The Crown Estate's Pentland Firth and Orkney Waters leasing round, has meant that there is potential for the Project to form part of an industry wide strategic monitoring program that will benefit future projects as well.

Where strategic monitoring is appropriate, MeyGen would look to a collaborative effort between the Project, wider industry, regulators and stakeholders to take this forward in the most efficient way for the interest of the Project and future projects elsewhere in Scotland and the UK.

As part of this EIA and the MeyGen commitment to post-installation monitoring, the draft SNH survey and monitoring guidance (MacLeod *et al*., 2011; Sparling *et al*., 2011) has been reviewed. Although this guidance does not, and cannot, give specific details of what ornithology monitoring should take place, based on the general approaches described and on current knowledge of the site (obtained from the extensive baseline surveys), it is likely that the monitoring programme could include some or all of the following:

Disturbance and displacement (birds at sea)

- Targeted boat or land-based observations of all bird species to determine how area use or behaviour may have changed over time. Critical periods of the year are the breeding season; and,
- Collection of underwater noise measurements of the candidate prototype tidal turbines. The data collected will be used to validate the underwater noise modelling completed to inform the impact assessment.

Collision risk (birds at sea)

MeyGen believes that understanding diving bird behaviour around tidal turbines and the risk of collisions occurring is fundamental for the industry to progress. It is therefore proposed that this potential impact is considered as strategic research and therefore monitoring approaches should be developed in cooperation with regulators, stakeholders and other developers. Monitoring could include:

- Installation of one or more active monitoring systems on one or more tidal device to better understand the near-field response of bird species) to operating tidal devices; and,
- Other strategic research such as expanding current research on the extent of connectivity between the site and local breeding colonies. Fitting individual birds with geo-locating tags and dive data loggers will provide information on this and would also contribute to collision risk monitoring.

MeyGen will work with the regulator (Marine Scotland) and its advisory bodies (e.g. SNH) to agree the details of appropriate monitoring and will ensure that the monitoring programme is aligned with industry best practice. Methods for assessing disturbance and displacement impacts and collision risk can potentially be linked with similar effort required for Marine Mammals and Fish Ecology.

Where monitoring indicates that additional mitigation measures may be reasonably required, MeyGen is committed to put these in place.

With regards to the onshore aspects of the Project, once the final onshore development areas are known, a pre construction bird survey will be undertaken, the scope of which will be agreed with SNH.

Fish Ecology

The majority of potential impacts on fish have been assessed as being not significant. The potential impact of EMF impact was assessed to be potentially significant before mitigation. Although the results conclude that the Project does not pose a significant risk to fish, MeyGen recognises that due to the emerging nature of the tidal energy industry there is uncertainty about some potential impacts especially where these have yet to be verified by operational monitoring in the industry.

Where impacts cannot be fully quantified (e.g. turbine collision risk). MeyGen is committed to developing a fish monitoring program. This program will be based on the 'Survey, Deploy and Monitor' strategy in accordance with Scottish Government policy (currently available in draft).

MeyGen has recognised that being the first application for a commercial scale tidal stream project in Scotland and the first from The Crown Estate's Pentland Firth and Orkney Waters leasing round, has meant that there is potential for the Project to form part of an industry wide strategic monitoring program that will benefit future projects as well.

Where strategic monitoring is appropriate, MeyGen would look to a collaborative effort between the Project, wider industry, regulators and stakeholders to take this forward in the most efficient way for the interest of the Project and future projects elsewhere in Scotland and the UK.

With particular regard to diadromous (migratory routes and behaviour) and elasmobranch (behaviour) fish species, there is overarching lack of scientific data. MeyGen is aware of the strategic research being carried out by the Scottish Government and academic institutions will help reduce that knowledge gap which will help verify this EIA and give greater confidence in future assessments. However, based on the prohibitively high level of effort required and the non-site-specific nature it is not believed that this is something that an individual developer should be actively involved in.

As part of this EIA and the MeyGen commitment to post-installation monitoring, the draft SNH survey and monitoring guidance (MacLeod *et al*., 2011; Sparling *et al*., 2011) has been reviewed. Although this guidance does not, and cannot, give specific details of what fish monitoring should take place, based on the general approaches described and on current knowledge of the site (obtained from the extensive baseline surveys), it is likely that the monitoring programme could include the following:

Disturbance and displacement

- Collection of underwater noise measurements of the candidate prototype tidal turbines. The data collected will be used to validate the underwater noise modelling completed to inform the impact assessment.

Collision Risk

MeyGen believes that understanding fish behaviour around tidal turbines and the risk of collisions occurring is fundamental for the industry to progress. It is therefore proposed that this potential impact is considered as strategic research and therefore monitoring development in cooperation with regulators, stakeholders and other developers. Monitoring could include:

- Installation of one or more active monitoring systems on one or more tidal device to better understand the near-field response of fish species) to operating tidal devices.

The EIA has concluded that the project could have a potentially significant impact on elasmobranch species. The effect of EMF on these species is being researched by the Scottish Government and it is understood that this will give greater confidence in the assessment and the mitigation outlined. MeyGen does not propose any site-specific monitoring for EMF impacts.

MeyGen will work with the regulator (Marine Scotland) and its advisory bodies (e.g. SNH) to agree the details of appropriate monitoring and will ensure that the monitoring programme is aligned with industry best practice. Methods for assessing disturbance and displacement impacts and collision risk can potentially be linked with similar effort required for Marine Mammals and Ornithology.

Where monitoring indicates that additional mitigation measures may be reasonably required, MeyGen is committed to put these in place.

Commercial Fisheries

No monitoring specific to commercial fisheries is proposed. However, consultation with local fishermen will be ongoing throughout the duration of the Project to aid assessment of any long term project impacts, in addition to helping inform the decommissioning phase, ensuring disruption to the local fishing fleet is minimised where possible.

Vessel traffic behaviour will be monitored as described for Shipping and Navigation (see below).

Shipping and Navigation

Traffic will be monitored on AIS during construction and operation of the devices to assess the effect the Project has on passing traffic and the proportion of vessels that re route either within the Inner Sound or via the Outer Sound. Any other changes in vessel behaviour compared to the baseline traffic data will be reviewed, e.g. transit times relevant to tide.

Marine Cultural Heritage

A reporting protocol will be put in place in the event of discovery of previously unknown marine cultural heritage material. Depending on the significance of the find there may be a requirement for further investigation and recording in line with the mitigation proposed.

Geology, Hydrology and Hydrogeology

Monitoring is proposed of any surface water courses that could be affected by the Project, to provide baseline water quality prior to any construction and to provide reassurance that mitigation measures are effective.

Surface water monitoring will include regular visual inspections of identified locations, plus regular but less frequent water quality sampling.

The monitoring will include control sites outwith affected watercourse catchments and/or upstream of all proposed activity as well as areas within the MeyGen Project area and downstream of the proposed activity. The construction contractors Environmental Clerk of Works (or equivalent) will monitor the construction team to avoid any accidental damage to surface water courses.
Terrestrial Habitats and Ecology
Once specific onshore development areas are known, further investigation of potential species, specifically otter and water vole will required to ascertain the status of these protected species within the Project footprint and immediate surrounding environment. Targeted species surveys will be undertaken to determine otter and water vole presence and distribution to inform protected species licensing and monitoring requirements (should monitoring be deemed necessary), throughout the duration of the Project. The construction contractors Environmental Clerk of Works (or equivalent) will monitor the construction team to avoid any accidental damage to protected species.
Landscape, Seascape and visual amenity
No monitoring required.
Onshore Cultural Heritage
The construction contractors Environmental Clerk of Works (or equivalent) will monitor the construction team to avoid any accidental damage to identified cultural heritage assets. A reporting protocol will be put in place in the event of discovery of previously unknown marine cultural heritage material. Depending on the significance of the find there may be a requirement for further investigation and recording in line with the mitigation proposed.
Socio Economics, Tourism and Recreation
No monitoring required.
Onshore Transportation and Access
No monitoring required.
Onshore Noise and Dust
It is proposed to undertake surveys during construction and operational phases of the project to monitor noise emissions against consented levels.
Accidental Events
None required as part of routine operation of the project, however in the unlikely event of a pollution incident, appropriate post incident monitoring will be implemented as required and agreed with the regulator and their advisors.

25.4 Interface with Contractors

25.37 Contractor management is an important element of the Project and MeyGen expect contractors to demonstrate a high level of environmental awareness, including suitable management.

25.38 The EMP and responsibilities for environmental standards and procedures will be included as part of all contract invitations to tender. The EMP will be incorporated into an overall CEMD which the contractor will need to adhere to.

25.39 Pre mobilisation audits will be carried out as standard for any vessels, vehicles or equipment that will be used in the Project. This will ensure appropriate procedures, documentation is in place to meet measures identified during the EIA process and MeyGen's statutory obligations.

25.40 Environmental commitments, objectives and targets identified for the Project through the EIA process will be communicated to all contractors through contractual conditions. Contractor performance will be measured against these commitments.

25.5 Environmental Awareness and Training

25.41 MeyGen understand that trained and knowledgeable staff can help to prevent or reduce potential environmental impacts and are therefore committed to ensuring that all personnel who perform or manage Project work that may have the potential to have a significant impact on the environment are trained appropriately.

25.42 Any contractors appointed by MeyGen to undertake work which has the potential to impact on the environment are audited and monitored to ensure they have procedures in place to manage their environmental responsibilities.

25.6 Summary

25.43 Mitigation and environmental management is an iterative process and has been informed by the EIA process, consultation with stakeholders including regulators. Mitigation measures will be monitored to enable MeyGen to track and assess the performance of the EMP, ensuring improvements can be made if necessary.

25.44 With regards to environmental monitoring, MeyGen will use a Survey, Deploy and Monitor strategy to reduce the uncertainty around particular impacts with the installation and operation of the first small array installed within the Project. The monitoring program will be overseen by the proposed advisory board to ensure the objectives and outputs of the program are met.

25.45 Where monitoring indicates that further specific mitigating measures may be reasonably required, MeyGen is committed to put these in place.

25.7 References

Macleod, K., Lacey, C., Quick, N., Hastie, G. and Wilson J. (2011). Guidance on survey and monitoring in relation to marine renewables deployments in Scotland. Volume 2. Cetaceans and Basking Sharks. Unpublished draft report to Scottish Natural Heritage and Marine Scotland.

Sparling, C., Grellier, K., Philpott, E., Macleod, K., and Wilson, J. (2011). Guidance on survey and monitoring in relation to marine renewables deployments in Scotland. Volume 3. Seals. Unpublished draft report to Scottish Natural Heritage and Marine Scotland.

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26 CONCLUDING STATEMENT

The Environmental Impact Assessment (EIA) has been carried out by MeyGen in accordance with relevant EU, UK and Scottish regulations and has robustly assessed the potential environmental impacts of the proposed Project.

The EIA has assessed the worst-case scenario that would have the greatest effect on the environment. This approach results in a maximum impact assessment, giving security and confidence to the regulatory bodied that the environmental impact will be no greater that that which is set out within the Environmental Statement and in fact may be considerably less.

Due to the novel nature of the tidal energy industry there are some uncertainties related to impact predictions that have yet to be verified by operational monitoring. MeyGen therefore propose to follow the Scottish Government's Survey, Deploy and Monitor Strategy where appropriate. MeyGen will deploy the Project in a series of phases. The initial array will provide information on the interactions between the array and the environment, increasing the knowledge for the remaining phases of the Project and the tidal stream industry as a whole.

If successful in attaining the required consents for construction, the Project is likely to be one of the world's first and largest arrays of tidal turbines. The MeyGen Tidal Energy Project Phase 1 represents an important development step for tidal stream technology in terms of the scale of development and in the transition from prototype technology to full development. The development of marine renewables is a key objective for Scotland and the Project represents a key part of the Scottish and UK renewable energy strategies.

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