Lewis Wave Power Limited

40MW Oyster Wave Array

North West Coast, Isle of Lewis

Environmental Statement

Volume 1: Non-Technical Summary; and

Volume 2: Environmental Statement

March 2012

40MW LEWIS WAVE ARRAY: ENVIRONMENTAL STATEMENT

VOLUME 1 AND 2 OF 3: NON-TECHNICAL SUMMARY AND ENVIRONMENTAL STATEMENT

TABLE OF CONTENTS

The following Non-Technical Summary and Environmental Statement constitutes Volume 1 and 2 of the 40MW Lewis Wave Array Environmental Statement.

It is supported by Volume 3: Technical Appendices.

ACRONYMS

Abbreviation	Full Name
AA	Appropriate Assessment
AfL	Agreement for Lease
ALARP	As Low as Reasonable Practicable
AOD	Above Ordnance Datum
ASCOBANS	Agreement on Conservation of Small Cetaceans of the Baltic and North Seas
ASFB	Association of Salmon Fisheries Boards
BATNEEC	Best Available Technology Not Entailing Excessive Costs
BBPP	Breeding Bird Protection Plan
BoCC	Birds of Conservation Concern
BS	British Standards
CA	Cruising Association
CAR	Controlled Activities and Regulations
CD	Chart Datum
CDM	Construction Design Management
CEFAS	Centre for Environment Fisheries and Aquaculture Studies
CEMP	Construction Environmental Management Plan
CIRIA	Construction Industry Research and Information Association
CNES	Comhairle nan Eilean Siar
COWRIE	Collaborative Offshore Wind Research Into The Environment
CRTN	Calculation of Road Traffic Noise
CWS	Countryside Wildlife Status
dB	Decibel
DECC	Department for Energy and Climate Change
DMRB	Design Manual for Roads and Bridges
DOC	Dissolved Organic Carbon
DWR	Deep Water Route
EIA	Environmental Impact Assessment
EMEC	European Marine Energy Centre
EMP	Environmental Management Plan
EPS	European Protected Species

Abbreviation	Full Name
EQS	Environmental Quality Standards
ERCoP	Emergency Response Cooperation Plan
ES	Environmental Statement
EU ETS	European Union Emissions Trading System
FCE	Forestry Civil Engineering
FCS	Forestry Commission Scotland
FRP	Fibre Reinforced Polymer
GIS	Geographical Information Systems
GLVIA	Guidelines for Landscape and Visual Impact Assessment
GPS	Global Positioning System
GWDTEs	Ground Water Dependent Terrestrial Ecosystems
HDD	Horizontal Directional Drilling
HGV	Heavy Goods Vehicle
HIE	Highlands and Islands Enterprise
HRA	Habitats Regulations Appraisal
HVDC	High Voltage Direct Current
IALA	International Association of Marine Aids
ICES	International Council for Exploration of the Sea
ICOMOS	International Council on Monuments and Sites
IEEM	Institute of Ecology and Environmental Management
IEMA	Institute of Environmental Management and Assessment
IFG	Inshore Fisheries Group
IPIECA	The International Petroleum Industry Environmental Conservation Association
IUCN	International Union for Conservation of Nature
JNAPC	Joint Nautical Archaeology Policy Committee
JNCC	Joint Nature Conservation Committee
LBAP	Local Biodiversity Action Plans
LDP	Local Development Plan
LNR	Local Nature Reserve
LSA	Local Study Area
MAIB	Marine Accident Investigation Board
MarLIN	Marine Life Information Network

Abbreviation	Full Name
MAROL	International Convention for the Prevention of Pollution from Ships
MCA	Marine Coastguard Agency
MCA	Marine Conservation Area
MCAA	Marine and Coastal Access Act
MEHRAs	Marine Environmental High Risk Areas
MGN	Marine Guidance Note
MLWS	Mean Low Water Springs
MMO	Marine Management Organisation
MoD	Ministry of Defence
MPA	Marine Protected Area
MSL	Mean Sea Level
MS-LOT	Marine Scotland Licensing and Operations Team
MSP	Member of Scottish Parliament
MW	Megawatt
NBN	National Biodiversity Network
NCI	Nature Conservation Importance
NLB	Northern Lighthouse Board
NNR	National Nature Reserve
NPF	National Planning Framework
NPPG	National Planning Policy Guidance
NRA	Navigational Risk Assessment
NRP	National Research Projects Limited
NSP	Noise Sensitive Properties
NTM	Notice to Mariners
NTS	Non Technical Summary
OHFT	Outer Hebrides Fisheries Trust
OHSA	Outer Hebrides Surfing Association
OS	Ordnance Survey
OSPAR	Convention for the Protection of the Marine Environment of the North-East Atlantic
PAC	Pre-Application Consultation
PAN	Planning Advice Note
PBR	Potential Biological Removal

Abbreviation	Full Name
PMF	Priority Marine Feature
PPV	Peak Particle Velocity
RBMP	River Basin Management plan
REZ	Renewable Energy Zone
RNLI	Royal National Lifeboat Institution
RoW	Receiver of Wrecks
RSA	Regional Study Area
RSPB	Royal Society for the Protection of Birds
RYA	Royal Yachting Association
SAC	Special Area of Conservation
SCADA	Supervisory Control And Data Acquisition
SCANS II	Small Cetaceans in the European Atlantic and North Sea
SCOS	Special Committee On Seals
SEA	Strategic Environmental Assessment
SEPA	Scottish Environment Protection Agency
SLVIA	Seascape, Landscape and Visual Impact Assessment
SNH	Scottish Natural Heritage
SNIFFER	Scottish and Northern Ireland Forum For Environmental Research
SOPEP	Shipboard Oil Pollution Emergency Plan
SPA	Special Protection Area
SPP	Scottish Planning Policy
SSSI	Sites of Special Scientific Interest
TA	Transport Assessment
TS	Transport Statement
TAC	Total Allowable Catch
TCE	The Crown Estate
UK BAP	United Kingdom Biodiversity Action Plan
UKHO	United Kingdom Hydrographic Office
UNESCO	United Nations Educational, Scientific and Cultural Organisation
VMS	Vessel Monitoring System
VP	Vantage Point
WCA	The Wildlife and Countryside Act 1981
WCS	Worst Case Scenario

Abbreviation	Full Name
WDCS	Whale and Dolphin Conservation Society
WEC	Wave Energy Convertor
WFD	Water Framework Directive
WIC	Western Islands Council
WIDSFB	Western Isles District Salmon Fisheries Board
ZTV	Zone of Theoretical Visibility

GLOSSARY OF TERMS

Term	Description
Accropode	Concrete units designed to interlock with other accropode units to form a layer and resist wave action
Anadromous fish	Fish which spend most of their lives in the sea and migrate to fresh water to breed.
Anthropogenic factors	Factors related to human activities.
Antifouling	Prevention of biofouling growth on structures.
Cathodic protection	Use of sacrificial material, such as zinc, in anodes fixed to metal structures in the marine environment to reduce corrosion damage.
Common pipeline	Pipelines (one low and one high pressure) that run the length of the Oyster Wave Array connecting the Oyster devices together
dB re 1 Pa	Sound pressure measurement for underwater noise levels
Drilling fluid	Lubrication for the horizontal directional drill bit.
Environmental Impact Assessment	Assessment of the potential positive or negative impacts of a proposed project on the environment.
Environmental Management Plan	A plan outlining measures to ensure construction and operation of a project minimises environmental impacts, fulfilling commitments made during an EIA and consent conditions.
Gap fillers	Structure to be placed underneath the Oyster device which will compose of either a wire cages or bags filled with rocks, or accropodes (see above).
Geotechnical analysis	The analysis of ground conditions and sediment composition.
Grilse	A young salmon that returns to fresh water after one winter in the sea.
Grouting	Polymer based concrete used to fill cavities within and surrounding foundations.
Horizontal directional drilling	Horizontal directional drilling (HDD) is a steerable trenchless method of installing underground pipes, conduits and cables using a drilling rig.
Hydro electric	Generation of electricity through water movement.
ICES rectangle	A reporting unit used for reporting landings of fisheries. The unit consists of a rectangle, 0.5^{O} latitude by 1^{O} longitude. At UK latitudes they measure approximately 30 x 30 nautical miles.
Jack up barge	A floating mobile platform that is able to stand still on the sea floor, resting on a number of supporting legs which can be lowered to the seabed / raised as required.

Term	Description
Landing platform	Platform which will located on the landward side of each Oyster device which will support an accumulator module, hydraulic pipelines and provide a landing area for dedicated handling equipment.
Mean sea level	Average tidal level, taking into account high and low tides over a time period
Monopile	Hollow steel tube that is inserted into the seabed to create a stable build foundation
Mooring anchors	Anchors which will be used for mooring the Oyster devices. They will each comprise of three rock anchors arranged in a ‘V’ formation, which hold an anchor plate in place on or near the seabed
Natal River	The river that an individual fish originates from and for many species the river to which they will return to breed
Ovoviviparous	Gives birth to live young
Pelamis Wave Power	Wave energy generation device consisting of a floating attenuator made of jointed tubes, with hydraulic connections at the joints.
Permanent Threshold Shift	The permanent loss of hearing in some or all frequencies.
Poor ground conditions	Ground or seabed which will not support building works or structures
Potential Biological Removal	The potential mortality level that a population can sustain before it is unsustainable
ROC	Renewable Obligation Certificates - A government subsidy for all renewable generation devices
Rochdale envelope	An approach to consenting, named after a UK planning law case, which allows a project description to be broadly defined, within a number of agreed parameters for the purpose of consent application.
Rock anchor	A metal pole inserted into the seabed via a pre-drilled hole and fixed in place via grouting.
SCADA	Control and operation mechanism for a device – stands for supervisory control and data acquisition.
Shore pipeline	Pipelines (one low and one high pressure) that connect the common pipeline to the shore
Smolt	Term used to describe salmon that are entering the sea from their natal river for the first time.
Stabilisation anchor	Anchor connecting hydraulic pipelines to the seabed. This consists of a collar surrounding the pipeline which is pinned to the seabed using rock anchors. Grout bags may be placed under the pipeline where required, to prevent spanning of large gaps.
Temporary Threshold Shift	The temporary loss of hearing on some frequencies.

Term	Description
Voith Hydro WaveGen development at Siadar	Breakwater system incorporating oscillating water column to drive a unidirectional air turbine to generate power. A 4 megawatt project at Siadar has been awarded consent, however, and construction is yet to begin
Wave energy converter (WEC)	Device which converts wave energy into electrical energy
Wave energy converter pipeline	Pipelines (one low and one high pressure) that connect each individual Oyster device to the common pipeline
Wet storage	Storage (normally temporary) of equipment or structures in the water.

1. INTRODUCTION

1.1.1 Lewis Wave Power Limited (hereafter referred to as 'Lewis Wave Power') wishes to construct a wave energy array off the north-west coast of the Isle of Lewis, Western Isles, Scotland, with associated infrastructure, to facilitate export of power to the electricity transmission system. The installation will hereafter be referred to as 'the development'. This document constitutes the Environmental Statement (ES) for the project, and presents the findings of the Environmental Impact Assessment (EIA) process. The ES comprises the information provided in this report (the main text) along with all the supporting appendices.

1.2 Background

1.2.1 Lewis Wave Power is a wholly owned subsidiary of Edinburgh based Aquamarine Power Limited (hereafter referred to as 'Aquamarine Power'), the technology developer of the Oyster wave power technology, which captures energy from nearshore waves and converts it into clean sustainable electricity. Aquamarine Power installed the first full scale 315 kilowatt (kW) Oyster at the European Marine Energy Centre (EMEC) in Orkney, which began producing power to the National Grid for the first time in November 2009. That device has withstood two winters in the harsh Atlantic waters off the coast of Orkney in northern Scotland. Aquamarine Power recently installed the first of three next-generation 800kW Oyster devices at Billia Croo, Orkney, which, when all installed, will be the first Oyster array, consisting of an 800, an 801 and 802 device. The devices installed at the Lewis development will be similar to Oyster 801 and 802 in both design and appearance, but will include further design improvements based on lesson learnt from the Billia Croo project. Further details on the technology are presented in Chapter 5 *Project description*.

1.2.2 The Crown Estate granted Lewis Wave Power two seabed lease options for the north-west coast of Lewis on 19 May 2011 (Figure 4.1 *Chapter 4 Site selection*). Lewis Wave Power is seeking to develop a 40 megawatt (MW) wave energy array, and the development will deploy between 40 and 50 Oyster devices with an installed capacity of approximately 800 kW to 1MW each.

1.2.3 The Lewis Wave Power development will help the Scottish and UK Governments to meet their 2020 electricity generation targets from renewable sources. This includes the development of some of the newer renewable technologies including wave and tidal renewables, for which Scotland has significant portion of Europe's resource (http://www.scotland.gov.uk/News/Releases/2011/05/18093247)

1.2.4 Lewis Wave Power's development off the west coast of Lewis will have a total installed capacity of 40MW, enough energy to power up to 38,000 homes .

1.3 Brief description of the development site and its setting

1.3.1 The west coast of Lewis, where Atlantic swells arrive at the coast having been uninterrupted by any land mass for thousands of miles, has been identified as one of the best locations in Western Europe for the deployment of an Oyster array. *Chapter 4: Site Selection*, provides a detailed description of how the site was identified and selected. The development itself is described in further detail in *Chapter 5: Project Description*.

1.4 The development

1.4.1 The array will consist of between 40 and 50 Oyster devices, depending on the final power rating of the devices used. These devices will be positioned according to the best understanding of available wave resource, water depth, seabed gradient and seabed protrusions.

1.4.2 The devices installed in north-west Lewis will be similar to Oyster 801 and 802 in both design and appearance, but will include further design improvements based on lesson learnt from the Billia Croo project.

Oyster technology

1.4.3 The Oyster device is a buoyant, hinged flap, attached to the seabed in depths of 10 to 15 metres (m) by a monopile (see *Chapter 5: Project Description*). As waves pass the flap it pitches backward and forwards with the motion of the wave. This movement drives two hydraulic pistons, which in turn push water, at high pressure, through a pipe connection to an onshore hydro electric turbine generator. Onshore, high-pressure water is converted to electrical power using proven, conventional Pelton wheel hydro electric generators. The flow from the Pelton wheel discharges to a header tank and returns to the device via a low pressure return pipeline.

1.4.4 Oyster has a number of major advantages:

- Environmental considerations are paramount in Oyster design, development, installation, operation and maintenance. The system is a closed loop via an offshore device(s) with minimal seabed footprint.
- All electro-mechanical power generation equipment is located onshore, reducing the cost of maintenance and increasing availability.
- Multiple devices can be manifolded to a single pipeline and hydro electric power conversion plant, allowing the concept to take full advantage of potential economies of scale.
- The device is located in the nearshore region where wave energy is more predictably directional. The water depth and wave breaking environment reduce the occurrence of extreme wave heights when compared to offshore, but without any significant reduction in the overall wave energy available.

1.5 Renewable energy targets

1.5.1 Global climate change is seen as being one of the greatest environmental challenges facing the world today. One of the primary reasons for the current rate of temperature increase is the higher concentrations of greenhouse gasses in the atmosphere. One of the principal gasses is carbon dioxide (CO_2) primarily produced through our dependence on the burning of fossil fuels to generate our electricity.

1.5.2 Renewable energy is an integral part of the UK Government's longer-term aim of reducing CO_2 emissions by 60% by 2050. In 2000 the UK Government set a target to produce 10% of electricity supply from renewable energy by 2010, and in 2006 announced its aspiration to double that level to 20% by 2020. In August 2011, the Scottish Government announced a new target to generate the equivalent of 100% of Scotland's own electricity demand from renewable sources by 2020, which equates to 16GW of installed capacity (Scottish Government 2011).

1.5.3 The Future Generation Group Report 2005: "Scotland's Renewable Energy Potential: Realising the 2020 Target", published by the Scottish Executive on behalf of the Forum for Renewable Development in Scotland (FREDS – a Government/Industry forum) in June 2005, identified for the first time that an installed capacity of 6,000MW is required to meet this 2020 target.

1.5.4 The energy produced from the installation of the proposed development would contribute to meeting the Scottish Government's target. The development has been proposed, in part, to respond to these requirements for renewable energy production.

1.6 Scotland's wave resource

1.6.1 Scotland's potential to produce marine renewable energy is vast, with the total wave resource in Scotland estimated at 14GW.

1.6.2 The UK and Scottish Governments are committed to increasing the proportion of electricity produced through marine renewable sources. Costs remain high at the moment for both wave and tidal projects; however, this is a new industry sector and costs are likely to fall as they have done within the wind sector over the last decade. The experience of early projects will play a key role in promoting cost reduction.

1.7 Benefits in reduced emissions of carbon dioxide

1.7.1 Oyster devices are designed to produce clean, renewable energy. The predicted carbon saving based on the design of Oyster 1 is approximately 500 tonnes per year, while subsequent generations of the Oyster device are designed to produce more power without significantly increasing in size, greatly increasing carbon saving per device.

1.8 Planning policy context

1.8.1 The footprint of the terrestrial components of the development lies within the local authority area of Comhairle nan Eilean Siar (The Western Isles Council), whilst the footprint for the marine components is leased by The Crown Estate and controlled by Marine Scotland Licensing Operations Team. See Figure 5.2 (*Chapter 5 Project description*) for the development footprint.

1.8.2 The planning policy context of the development is described in *Chapter 6*: *Planning Policy Context.*

1.9 Environmental Statement (ES) structure

1.9.1 The Environmental Statement will be submitted in 3 volumes:

- **Volume I**: Non Technical Summary (NTS) - This presents a separate summary, providing an overview of the Proposed Development, environmental impacts and proposed mitigation measures. This volume will be provided in both English and Gaelic.
- **Volume II**: Environmental Statement (ES) – This is the main report, and ES is divided into a number of background and technical chapters detailing the various studies that have been carried out throughout the EIA process.
- **Volume III**: Technical Appendices - Appendices are provided, giving appropriate additional information to support the chapters. A list of the appendices is provided in Table 2.4 (Chapter 2: *Scoping and assessment methodology*).

1.10 Project team

1.10.1 The ES has been compiled by Lewis Wave Power and Royal Haskoning (UK) Ltd and presents the results of the assessment of environmental effects undertaken by a number of specialist consultants. These consultants are presented in Table 1.1, along with their respective disciplines and contribution to the ES.

Table 1.1 EIA and design team	
Organisation	**Expertise / ES input**
Lewis Wave Power Limited	Wholly-owned subsidiary of Aquamarine Power - developer of Oyster wave power technology.
Royal Haskoning (UK) Ltd	Environmental consultancy responsible for the overall ES production, and technical chapters on terrestrial ecology, hydrology, coastal processes, onshore noise, traffic and access, marine mammals and basking sharks, tourism and recreation, fish and shellfish, commercial fisheries, benthic ecology, shipping and navigation, socio economics and water quality.
Natural Research Projects Ltd	Ornithological studies and report writing as well as marine mammal data gathering.
Envision Ltd	Benthic survey of array footprint.
Aspect Land and Hydrographic Surveys	Multi-beam bathymetric and sub-bottom profiling surveys and report writing.
Headland Archaeology Ltd	Cultural heritage assessment and report writing.
Anatec Ltd	Navigational and safety risk assessment and report writing.
Carol Anderson Landscape Architect	Landscape, seascape and visual impact assessment and report writing.
Kongsberg Maritime Ltd	Underwater noise assessment and report writing.

2. SCOPING AND ASSESSMENT METHODOLOGY

2.1 Introduction

2.1.1 This chapter of the Environmental Statement (ES) is designed to provide the reader with an overview of the Environmental Impact Assessment (EIA) process, and in particular the EIA requirements as set in place by The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2000 (the "Regulations"; Scottish Executive (2000)), The Marine Works (Environmental Impact Assessment) Regulations 2007 and the Town and Country Planning (Scotland) Act 1997 (as amended).

2.1.2 This chapter has one technical appendix (Appendix 2.1) containing the Scoping Opinion from by Marine Scotland in response to the Scoping Report (Lewis Wave Power, 2011).

2.2 General approach

2.2.1 The above EIA Regulations state that any development likely to have a significant effect on the environment must be subject to an EIA with the resulting ES submitted alongside the appropriate Section 36 consents application.

2.2.2 Schedule 1 of the Regulations lists all of the developments for which an EIA is mandatory. Schedule 2 describes those projects for which an EIA is determined on a case-by-case basis by the Scottish Ministers.

2.2.3 As the development is over 1MW and requires Section 36 consent, it is considered to be a Schedule 2 development under The Electricity Works (EIA)(Scotland) Regulations 2000; defined as *"a generating station, the construction of which (or the operation of which) will require a section 36 consent but which is not Schedule 1 development".* To ensure full compliance with the regulations, Lewis Wave Power will provide an Environmental Impact Assessment to accompany its Section 36 consent application.

2.2.4 Under the EIA Regulations, an applicant may submit a "Request for Scoping Opinion". Lewis Wave Power sought a "scoping opinion" regarding the Lewis wave array development from the Scottish Executive on the 20th May 2011 under Regulation 7. This asked the Scottish Executive to provide their opinion on what information needs to be provided within the main text of the ES. This "scoping opinion" was received on the 4th August 2011 and the ES has been prepared on the basis of that advice. Appendix 2.1 contains the Scoping Opinion.

2.2.5 Following consultation with both Marine Scotland and the Western Isles Council as part of the formal Scoping Opinion and additional discussions, it was confirmed the Lewis Wave Power development would seek consent for offshore components through the Marine (Scotland) Act 2010, and for onshore components through outline planning under the Town and Country (Scotland) Planning Act 1997 (as amended). This are outlined below, and discussed *in Chapter 6 Regulatory and Policy Context*. This ES supports both applications.

Offshore to Mean High Water Springs

2.2.6 In March 2010 the Marine (Scotland) Act was enacted. It provides a framework for the sustainable management of Scotland's seas and one of its key aims is to streamline and simplify the consenting process for offshore renewable energy projects.

2.2.7 Projects have historically been required to gain consent under several pieces of legislation before development can proceed. Prior to the introduction of the Act, developers would submit applications for consent to a number of authorities under various pieces of legislation. However, with the introduction of the Act, co-ordinated applications for a number of consents (under the Electricity Act, the Coastal Protection Act, and the Food and Environment Protection Act) can now be made via a single contact, the Marine Scotland Licensing Operations Team (MS-LOT), as part of a unified consenting process.

2.2.8 Under the Marine (Scotland) Act 2010, a Marine Licence is required for the placement of structures on the seabed. This Environmental Statement will provide the information required to support the Lewis Wave Power Marine Licence application.

Onshore to Mean Low Water Springs

2.2.9 Lewis Wave Power will apply for outline planning consent to cover the onshore works from Comhairle nan Eilean Siar (Western Isles Council) under the Town and Country Planning Act 2007 (as amended). This application will incorporate the following legal requirements:

- Planning permission in principle for the development through The Town and Country Planning (Development Management Procedure) (Scotland) Regulations 2008;
- Consideration of the Town and Country Planning (Hierarchy of Developments) (Scotland) Regulations 2009;
- Completion of pre application consultation as set out in Part 2 of The Town and Country Planning (Development Management Procedure) (Scotland) Regulations 2008; and
- Consideration and satisfaction of The Environmental Impact Assessment (Scotland) Regulations 2011.

2.2.10 Comhairle nan Eilean Siar (the planning authority) has 4 months to consider a planning application for an EIA development.

2.3 Approach to Rochdale Envelope

2.3.1 Some aspects of the detailed design of the development still require finalisation, in particular:

- The method of installing the pipeline connections between the devices and the onshore powerhouse (surface laid or Horizontal Directional Drilling: HDD);
- Depending on the outcome of the pipeline installation method, the number and exact location of the pipelines (for the surface laid method a minimum two and maximum eight; for the HDD option a maximum 36)
- The footprint of the devices and their exact location (subject to micro-siting post consent); and

- The size of the gap fillers under each device.

2.3.2 The approach to a Rochdale Envelope was discussed in consultation with MS-LOT (12th October 2011), and it was agreed that the application would apply for an envelope of potential area of search, describing the likely footprint of activity within each parcel of potential development. These footprints are further discussed within *Chapter 5 Project description*, and are discussed within each technical chapter where appropriate.

2.4 EIA methodology

2.4.1 EIA is a systematic process, for examining the possible positive and negative significant impacts of a development project on the receiving environment. This process includes an assessment of the likely impacts and the identification of a range of suitable mitigation options and management measures.

2.4.2 The assessment is carried out based on the data supplied by the developer proposing the works and the information identified from the scoping response and other consultees (statutory, stakeholders and public engagement).

2.4.3 The EIA process is designed to be as transparent as is possible, with a number of distinct stages. These include:

1. **Screening** – this stage determines whether the proposed development is likely to have a significant effect on the environment (see Section 2.2);
2. **Scoping** – this stage involves a formal process requesting an opinion on the proposed development from statutory consultees and coordinated by the Scottish Executive. The scoping process also identifies the existing environmental data present and the key issues at the site, thereby identifying any additional studies that are required for their assessment;
3. **Baseline st udies** – this stage identifies the current status of the receiving environment and carries out further desk and field studies as required and/or identified during Stage 2;
4. **Assessment of impacts** – this stage includes the assessment of the significance of the potential impacts related to the proposed development as well as the proposed mitigation and the resulting residual effects;
5. **Environmental reporting** – compilation of the ES and the supporting documentation (e.g. appendices and technical reports.); and
6. **Submission and consenting** – this stage involves the submission of the ES along with the appropriate consent applications. These then go through a determination process with the appropriate consenting body. For applications under Section 36 of the Electricity Act, or Marine Licenses under the Marine Scotland Act, the consenting body will be Marine Scotland (through Scottish Ministers), while for works under the Town and Country Planning Act, the local authority would provide consent.

2.4.4 Although the EIA process has to cover the above areas it should be noted that the process is designed to be iterative rather than a single appraisal of a finalised development design. Therefore, the EIA can then inform the project in order to ensure that the most appropriate final design is reached (see *Chapter 4 Site Selection).*

2.4.5 The Lewis Wave Array EIA followed the procedure shown in Table 2.1.

2.4.6 Table 2.1 EIA process stages undertaken for the Lewis Wave Array

Stage	Date
Request for a Scoping Opinion	20th May 2011
Receipt of Scoping Opinion	4th August 2011
Bird, Marine Mammal and Vessel Observations survey start date	September 2010
Continued consultation	Throughout
Development and finalisation of project design (see Chapter 4: Site Selection)	Throughout
Public exhibition	9th to 12th March 2012
Impact assessments, mitigation and residual impact assessment	November 2011 – February 2012
Joint consultation with Marine Scotland Licensing Operating Team (MS-LOT) and Western Isles Council regarding approach to consultation	January 2012
Completion of ES	29th February 2012
Pre-Application Consultation (PAC) submission	February 2012
Planning	2012
Statutory consultation on the ES	March – November 2012

2.5 Assessment methodology

2.5.1 The ES (the end point of the EIA process outlined in Section 2.3) is based on a number of activities. These include:

- Consultee consultation;
- Consideration of relevant local, regional and national planning policies, guidelines and legislation;
- Development of significance criteria;
- Assessment of alternatives;
- Review of available data already present and not collected directly in relation to this specific ES (e.g. previous Environmental Statements, publicly available information, etc.); and
- Surveys (desk-based and field) and monitoring.

2.5.2 The ES not only addresses the direct impacts likely to be caused by the development, but also the indirect impacts, cumulative effects, short, medium and long term impacts, those that are both permanent and temporary and those impacts that are beneficial or adverse in nature. Within each of the assessment chapters there are proposed mitigation measures, which have been designed to avoid, reduce or offset the most significant adverse impacts of the proposed development. *Chapter 23: Summary of impacts*, *mitigation, good practice and monitoring*, provides a summary of the residual impacts and mitigation measures for the development.

2.5.3 Additionally a standard approach, wherever possible, has been taken when outlining the geographical area to be considered in each of the technical chapters. This area usually termed the "study area" is of a different scale depending on the topic of the specific assessment chapter. Other terminology such as "area of interest" and "wider region area" are used to describe different geographical scales, and an explanation of these terms (if/when used) are included in each of the assessment chapters. For example in *Chapter 12*: *Fish and shellfish* this will be:

- A marine area over which relevant surveys were conducted and that contains the development as the "local Study Area" or LSA; and
- An area of sea defined by the relevant ICES Rectangle (with extension for salmon) as the "Regional Study Area or RSA".

2.5.4 The project design and EIA process follows a series of stages, which are outlined below:

- Site selection and project initiation;
- Screening – is an EIA requirement;
- Pre-application discussions;
- Scoping – consultation on the proposed scope to identify the potential effects of the project and the methodology on how these should then be assessed;
- Environmental baseline studies – an establishment of what is present on/in the vicinity of the site;
- Assessment of the potential effects of the proposed development;
- Mitigation – modify the proposal in order to integrate the mitigation measures and then re-assess the residual effects;
- Production of an ES;
- Submission of consent applications supported by the ES;
- Consultation by MS-LOT with the appropriate consultees, stakeholders and members of the public;
- Consent application consideration by the MS-LOT;
- Application decision with or without conditions; and
- Implementation and monitoring as required.

2.5.5 The process of identifying and assessing the environmental effects of the proposed development is iterative and cyclic and runs in parallel with the project design. If any of the potential impacts are identified a being adverse in nature then the design can be altered, as and if required, to mitigate these effects. Consultation is ongoing throughout the EIA process and contributes to the identification of effects as well as the mitigation measures to avoid, reduce or offset these effects.

2.6 The Site Selection and Scoping processes are detailed in *Chapter 4 Site Selection*. The results of the environmental baseline studies, the assessment of impacts and all of the mitigation measures proposed are outlined in Chapters 7 - 22 of this report, with a summary of all mitigation being outlined in *Chapter 23 Summary of impacts, mitigation, good practice and monitoring*.

2.7 Scoping and consultation

2.7.1 The purpose of the scoping process is to identify the principal environmental issues at the earliest possible stage of the development through responses from the regulators and their consultees. This assists in the appropriate targeting of the assessment studies and the identification of which elements of the development have the potential to cause significant environmental effects.

2.7.2 Consultation enables the identification of environmental aspects of concern and where practicable, views of consultees may be incorporated into the design of the project, thereby avoiding, reducing or offsetting any environmental effects. Lewis Wave Power considers the consultation process as being crucial to the success of any project and, therefore, has created a specific chapter on this topic. As a result, consultation undertaken by the project team beyond the Scoping process is detailed in *Chapter 3 Consultation*. The remainder of this chapter will only deal with responses specific to the Scoping process.

2.7.3 A formal request for a Scoping Opinion from MS-LOT was submitted in May 2011. This was provided in the form of an official Scoping Report with a supporting letter requesting opinions on the proposed scope of work and methodologies related to the Lewis Wave Array. The Scoping Report highlighted what, at this early stage in the process, were likely to be the main effects associated with the development and how these effects were proposed to be assessed. A Scoping Opinion response (i.e the Scoping Report) was received on the 4th August 2012.

2.7.4 Table 3.2 in *Chapter 3 Consultation,* lists all of the consultees whose opinion was sought during the Scoping process.

2.7.5 The Scoping Opinion sets out the views of the statutory consultees and what they felt the requirements were for the subsequent EIA, including what impact assessments should be undertaken.

2.7.6 In addition to the opinions of the statutory bodies the views and opinions of non-statutory bodies to the Scoping Report were also sought. These can also be seen in *Chapter 3 Consultation.*

2.8 Key issues

2.8.1 Following the scoping and consultation process regarding the Scoping Report, there were several key environmental concerns identified as requiring detailed assessment during the EIA process and these have been included within this ES. These were:

- Marine Mammals and basking sharks;
- Ornithology (especially diving birds);
- Marine benthic habitats;
- Terrestrial habitats;
- Otters
- Coastal processes;
- Hydrology, peat and groundwater dependant terrestrial ecosystems (GWDTE);
- Commercial fisheries;
- Underwater noise;
- Maritime Navigation;
- Construction traffic;
- Cultural Heritage;
- Landscape and Seascape;
- Fish (especially Elasmobranchs and Anadromous species); and
- Recreational sea users.

2.9 ES composition

2.9.1 The ES comprises a number of elements which include:

- A Non-Technical Summary. This is a stand-alone document, although is also included at the beginning of the main ES. It summarises in non-technical language the findings of the ES.
- The ES (this document). This comprises of two principal parts. Chapters 1 – 6 describe the project and the legal and policy framework within which the application will be determined. This includes details of the project design and consultation undertaken to seek the views of statutory, non statutory stakeholders and the local community. Chapters 7 – 22 contain the individual assessments relating to the environmental (and other) issues that were identified during the scoping process and/or by Lewis Wave Power. The likely significant effects of the development on these are contained within this portion of the document, along with the proposed mitigation and the residual effects remaining. A summary of impacts, mitigation, good practice and proposed monitoring is provided in Chapter 23. The full contents of the ES are listed in Table 2.2.

Table 2.2 Contents of the ES

Volume	Chapter	Chapter Title
I	NTS	Non Technical Summary
II		Acronyms
		Glossary of terms
	1	Introduction
	2	Scoping assessment and methodology
	3	Consultation
	4	Site selection
	5	Project description
	6	Regulatory and policy context
	7	Physical Environment and coastal processes
	8	Soils, hydrology and hydrogeology
	9	Benthic ecology
	10	Ornithology
	11	Marine mammals and basking sharks
	12	Fish and shellfish
	13	Terrestrial and intertidal ecology
	14	Seascape landscape and Visual Impact
	15	Shipping and navigation
	16	Commercial fisheries
	17	Traffic and transport
	18	Archaeology and cultural heritage
	19	Onshore noise
	20	Water quality
	21	Socio economics and local community
	22	Tourism and recreation
	23	Summary of impacts, mitigation, good practice and monitoring
		References
III	Appendices	See Paragraph 2.8.2

2.9.2 The Technical Appendix is a single volume that contains all of the supporting documentation (e.g. technical reports, survey reports, etc.) that relate to each of the individual assessments. The full list of Appendices is provided in Table 2.3.

Table 2.3: List of Appendices

Appendix Number	Appendix Title
2.1	Scoping Opinion
3.1	Scottish Natural Heritage responses to Habitats Regulations Appraisal consultation
5.1	Project footprint calculations (offshore)
5.2	Excavated material calculations
5.3	Footprint calculations (onshore)
7.1	Site Investigation Survey report
7.2	Met Ocean Data
7.3	Coastal geomorphology and physical environment survey report
8.1	Raw data from peat depth survey

Table 2.3: List of Appendices	
Appendix Number	**Appendix Title**
9.1	Benthic habitat survey report
10. 1	Lewis Wave Array Year 1 birds technical report
11.1	Year 1 marine mammal and basking shark survey report
11.2	Underwater noise impact study in support of the Oyster Wave Energy Project
12.1	International Council for the Exploration of the Sea (ICES) landings data from Regional Study Area
12.2	Fish and shellfish species present within the wider region
12.3	Complete list of species likely to be present within the Regional Study Area
13.1	Lewis Wave Array Extended Phase 1 habitat and otter survey report
13.2	Lewis Wave Array Intertidal survey report
14.1	Seascape Landscape Visual Impact figures
15.1	Navigational Risk Assessment
16.1	Minutes from Inshore Fisheries Group meeting
16.2	Fishing effort map: UK
16.3	Fisheries questionnaire issued to local fishermen.
16.4	Returned fisheries questionnaires
18.1	Archaeology and cultural heritage baseline onshore
18.2	Archaeology and cultural heritage baseline offshore

2.10 Structure of technical chapters

2.10.1 Where practicable, a standard approach has been taken to the structure of each of the technical chapters. However, there are some chapters that are not compatible with this structure (e.g. Cultural Heritage) and have therefore been treated individually.

2.11 Effect assessment and mitigation

2.11.1 The Impact Assessment section within each of the technical chapters considers the identified potential effects of the development on the baseline conditions present during the construction, operation, maintenance and decommissioning phases of the development.

2.11.2 The significance of each impact is discussed along with proposed good practice to be followed or additional mitigation measures to be implemented that are appropriate to reduce the significance level. The good practice guidance documents are listed and reference is made to particularly relevant measures to be implemented. Along with the mitigation measures these recommendations aim to avoid, reduce or offset the most significant adverse impacts of the proposed development and there is a commitment from Lewis Wave Power that they will be implemented where practicable during the appropriate phase (e.g. construction, operation (including maintenance) and decommissioning) of the development.

2.11.3 Throughout the design process a number of mitigation measures and good practice guidance have been identified and implemented to avoid, reduce or offset effects, even where these were not deemed to be significant. Therefore, some of the mitigation measures that have been identified throughout the assessment chapters do not necessarily relate to significant adverse effects, but have been included to further reduce the levels of impacts related to the Development.

2.12 Significance criteria

2.12.1 The significance of residual impacts has been assessed for each of the assessment chapters. Where possible this has been based on quantitative evidence; however, where it has not been possible to quantify these effects they have been assessed qualitatively based on the best available knowledge at the time and professional judgement.

2.12.2 The standardisation of the significance criteria generally leads to a common classification of the significance of effects. These are classified as Major, Moderate, Minor or Negligible. The effects are also described according to whether they are Adverse, Neutral or Beneficial. However, as noted in Paragraph 2.11.7 certain assessments have not married well with the defined chapter and/or significance criteria structure and, as such, have been treated individually. Each chapter provides a description of how the significance has been assessed.

2.12.3 The potential impacts for each issue related to the Lewis Demonstration Wave Array have been developed with regards the following:

- Extent and magnitude of the impact (Table 2.4);
- Duration of the impact (short, medium or long-term);
- Nature of the impact (direct or indirect; reversible or irreversible);
- Whether the impact occurs in isolation or is cumulative in nature;
- Sensitivity of the receptor (Table 2.5);
- The significance of effect, and whether the effects are beneficial or adverse; and
- The level of mitigation that can be implemented to avoid, reduce or offset the effect (where the significance of effect is noted at being low, medium or high).

Table 2.4 Magnitude of impact

Magnitude of Impact	Description
High	A fundamental change to the baseline condition of the receptor.
Medium	A detectible change resulting in the non-fundamental temporary or permanent condition of a receptor.
Low	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 2.5 Sensitivity of the receptor	
Receptor Sensitivity/Value/Importance	**Description**
High	Environment is subject to major change(s) due to impact. Or Sites contain features of international or national conservation or cultural designation, or permanent reduction of anthropogenic activity, for example, such as fish landings
Medium	Environment clearly responds to effect(s) in quantifiable and/or qualifiable manner. Or Example sites contain features of national or regional conservation or cultural designation, permanent modification of anthropogenic activity.
Low	Environment responds in minimal way to effects such that only minor change(s) are detectable. Or Sites of local conservation or cultural value or temporary modification of anthropogenic activity.
Negligible	Environment responds in minimal way to effect such that only minor change(s) are detectable. Or Sites contain features of local interest, little or no change to anthropogenic activity.

2.12.4 Sensitivity criteria can be based both on the degree of environmental response to any particular impact, as well as the 'value' of the receptor (for example; an area of international significance should be considered more sensitive to impact than an area of little or no conservation value). The sensitivity for each impact is determined by consideration of at least one of the following points:

- Comparison with Regulations or standards e.g. British Standards;
- Compliance with policy, plans and guidance documents e.g. Local Plan;
- Reference to criteria such as protected species, designated sites and landscapes;
- Consultation with stakeholders; and
- Experience and professional judgements by specialists on environmental sensitivity.

2.12.5 A detailed description of the criteria used to assess sensitivity value or importance for each receptor is provided in the relevant assessment chapter.

2.12.6 By combining the magnitude of the impact and the sensitivity of the receptor in a matrix (see Table 2.6) the final significance of the effect (prior to the implementation of mitigation measures) can be obtained. It should be noted that any residual effect (the effect after the implementation of mitigation) which remains at the level of 'Moderate' or 'Major' is still regarded by the EIA Regulations as being significant.

Table 2.6 Impact significance matrix

Magnitude of Impact	Receptor Sensitivity/Value/Importance			
	Negligible	Low	Medium	High
High	No significant effect	Moderate	Major	Major
Medium	No significant effect	Minor	Moderate	Major
Low	No significant effect	Negligible	Minor	Moderate
Negligible	No significant effect	Negligible	Negligible	Minor

2.12.7 Due to the differences between the individual technical assessments throughout this ES there is no specific definition that can be applied. Therefore, each of the individual assessments have also carried out their own impact assessment and defined the criteria levels for defining the level of residual effect. Where it has been possible to do so, this has been based upon accepted criteria (e.g. for onshore noise and vibration effects and their associated guidelines), as well as by employing expert interpretation and value judgements in order that the extent of any given effect can be established.

2.13 Cumulative effects

2.13.1 The EIA Regulations require that potential cumulative effects are taken into account within the project EIA. Cumulative effects may be understood as *"incremental effects of an action..." arising "from individually minor but collectively significant actions"*. The EIA will consider how Lewis Wave Power's proposed development may interact with other ongoing and planned projects and activities.

2.13.2 In terms of proposed developments in the vicinity of the site, Lewis Wave Power is aware of two possible onshore wind farm developments (the Stornoway Wind Warm and the Eishken Wind Farm) and of two wave energy projects – Voith Hydro WaveGen's consented 4MW wave development at Siadar (RWE group and NPower renewables, 2007) and one off the west coast of Great Bernera (Pelamis Wave Power).

2.13.3 In terms of ongoing activities, it is possible that fisheries may interact with the proposed development to result in cumulative effects.

2.13.4 The possibility of cumulative effects within Lewis and its marine areas does not exist for all of the assessment chapters. Where there is deemed to be no potential for cumulative effects to occur, then this is clearly stated.

2.14 Assumptions and limitations

2.14.1 The principal assumption, which has been made during the preparation of this ES is that:

- The information provided by third parties, including publicly available information and databases, is correct at the time of publication.

2.14.2 The EIA has been subject to the following limitations:

- Baseline conditions have been assumed to be accurate at the time of the physical surveys; however, due to the dynamic nature of the environment, conditions may change during the various phases of the development; and

- The assessment of cumulative effects has been reliant on the availability of accurate information on the proposed developments that may act in combination with the one outlined within this ES.

2.15 Project Team

2.15.1 For a full list of the Project Team see Table 1.1 in Chapter 1: *Introduction.*

3. CONSULTATION

3.1 Introduction

3.1.1 This Chapter of the Environmental Statement (ES) is designed to provide the reader with an overview of the consultations that have been undertaken by Lewis Wave Power and the project team throughout the project development and Environmental Impact Assessment (EIA) process. The following sections outline how each group of stakeholders has been involved.

3.1.2 In parallel to a Section 36 application under the Electricity Act 1989, The Electricity Works (Environmental Impact Assessment)(Scotland) Regulations 2000 and the Marine Works (Environmental Impact Assessment) Regulations 2007, Lewis Wave Power will also submit an outline planning application under the Planning (Scotland) Act 2006 for this development. As such a Pre-Application Consultation (PAC) report will be submitted with the outline planning application, in accordance with the Town and Country Planning (Development Management Procedure (Scotland) Regulations 2008 and the relevant provisions of the Town and Country Planning Application (Scotland) Act 1997 as amended. Details and dates of consultations are set out in Section 3.4.

3.1.3 Additional community consultation has, and will continue to be, undertaken in accordance with Planning Advice Note (PAN) 3/2010 Community Engagement (Scottish Government, 2010). This PAN provides advice on how communities can be engaged in the planning process and on how developers can listen to and engage with the community in order to take into account what the community would like for their area. The importance of successful consultation is underlined in the publication of best practice guidance as set out in Planning Advice Note (PAN) 81 "Community Engagement – Planning with People".

3.2 Lewis Wave Power consultation strategy

3.2.1 Lewis Wave Power believes early and ongoing consultation allows the views, potential concerns and perceptions of stakeholders and local communities to feed into the project development process. This is particularly useful in such a novel project as the Lewis Wave Array. Engaging early has enabled the project development team to determine the scope of the EIA and need for specific environmental studies based on helpful feedback from consultations.

3.2.2 The project development team have undertaken a proactive approach to consultation, with key stakeholders and the community involved in both a formal and informal manner on a non-statutory basis (with respect to the consenting process) from the project outset and prior to the Lewis Wave Power's application for a seabed lease from the Crown Estate.

3.2.3 Lewis Wave Power has consistently sought to engage on a regular basis with regulators and statutory consultees, providing quarterly update meetings on the progress of the project with Marine Scotland Licensing Operations Team (MS-LOT) and Scottish Natural Heritage (SNH). In addition regular contact has been maintained throughout the development of the project with the planning authority, Comhairle Nan Eilean Siar (Western Isles Council) planning department.

3.2.4 Wider consultation with community groups and special interest organisations has also been sought throughout the project progress. Where possible, representatives from Lewis Wave Power have attended community meetings, presented at a number of forums and met face to face with organisations who have expressed an interest in the development plans (Section 3.4).

3.2.5 In addition, Lewis Wave Power and the project team have sought to engage with the wider Outer Hebridean community in positively promoting the project. Lewis Wave Power has actively participated in public events and exhibitions to engage and explain the aims and aspirations of the Lewis Wave Power development. The local community have been regularly updated on the progress of the development through various media sources, including the dedicated Lewis Project pages on the Aquamarine Power website (http://www.aquamarinepower.com/projects/north-west-lewis).

3.2.6 Lewis Wave Power is committed to developing the 40 mega watt (MW) array working as closely as possible with the local community. Community representatives from the Galson Estate Trust have been engaged in discussions from the outset and Lewis Wave Power is determined to ensure that the local community benefits from both the environmental and socio-economic benefits of the development. This will mainly be achieved through the improvement of the local infrastructure, direct payments to the local community estate for leasing the development site and the development of local supply chain in delivering this project, enabling local companies to develop skills and knowledge to particulate and compete in the growing marine renewable industry (see *Chapter 21: Socio Economics and Local Community*). Lewis Wave Power aim to continue to actively engage with the local community in Siadar, the Galson Estate and the wider Lewis population beyond the consenting phase and into the construction and operational phase of the development.

3.3 Key project development stages

3.3.1 Table 3.1 identifies key issues consulted upon at the different stages of project development.

Table 3.1 key issues consulted upon at the different stages of project development

Project Development Stage	Key Issues Consulted Upon
Pre development	Site selection Stakeholder engagement strategy
EIA Scoping	Known environmental information sources Potential environmental studies required Identification of preliminary issues of stakeholder Interest to be addressed within the ES. Scope of environmental studies
EIA development	Site location Detailed project description Outcome of environmental baseline investigations Identification of potential environmental impacts and mitigation measures
Consent Submissions	Extent of area to be developed Construction and operation timeframes Construction Management Plans

Table 3.1 key issues consulted upon at the different stages of project development	
Project Development Stage	**Key Issues Consulted Upon**
Post Consent Award	Supply chain engagement Detailed construction activities – mitigation, management arrangements and stakeholder feedback Operational performance

3.4 Community consultation

3.4.1 Discussions with the community on Lewis began on 23 July 2010, when Aquamarine Power (on behalf of Lewis Wave Power) attended the first meeting of the Outer Hebrides Renewables Group, chaired by Western Isles Council leader Angus Campbell. Aquamarine Power also met with representatives from SNH, Highlands and Islands Enterprise and with local Member of the Scottish Parliament (MSP) Dr Alasdair Allan seeking advice on how best to engage with the local community in selecting a location for a site for the Oyster technology.

3.4.2 Lewis Wave Power recognises the importance of the marine environment to local communities in both social and economic terms. For this reason Lewis Wave Power has engaged early and actively with a number of community organisations, including the Galson Estate Trust and Outer Hebrides Inshore Fisheries Group, to ensure that community groups who may be affected by the development had the opportunity to provide feedback on the location of the development and identify key issues early on in the development process. Comments received during this process have informed the site selection and site layout design (both onshore and offshore). This positive working relationship has meant that the EIA process has benefited from these strong links to key community stakeholders and has formed an important aspect in the development of this project.

3.4.3 Formal public consultation on the development was initiated on 20th May 2011 with the submission of a Scoping Report to MS-LOT. In addition to the competent authorities and statutory consultees identified by MS-LOT, a number of community and campaign organisations were formally asked for their feedback on the Lewis Wave Power development proposals and were encouraged to direct the scoping document to any other individual, or organisation, who may be interested. The wider Lewis community were encouraged to become involved in the consultation process through coverage in the local media and on the Lewis project pages on the Aquamarine Power website.

3.4.4 The Scoping Report was for an area of search covering the Agreement for Lease areas awarded by the Crown Estate to Lewis Wave Power and the comments received from stakeholders helped inform the site selection process. Stakeholders were also invited to comment on how best to involve stakeholders in the EIA process. A list of those organisations that were sent a copy of the scoping report and request for feedback is included in Table 3.2. The Scoping Report was also made available through the Lewis Project Pages on the Aquamarine Power website.

Table 3.2 Recipients of the Lewis Wave Power Scoping Document	
Association of Salmon Fishery Boards	Royal Society for the Protection of Birds (RSPB)
British Telecom	Scottish Canoe Association
Barvas Estate	Scottish Coastal Forum
Comhairle nan Eilean Siar (Western Isles Council)	Scottish Fisherman's Federation
Chamber of Shipping	Scottish Fisherman's Organisation
Civil Aviation Authority	Scottish Enterprise
Crown Estate	Scottish Fisheries Protection Agency
Defence Estates	Scottish Government - Planning
Defence Infrastructure Organisation	Seafood Industry Authority
Department for Energy and Climate Change (DECC)	Scottish Environmental Protection Agency
Galson Estate Trust	Scottish Surfing Federation
Historic Scotland	Scottish Natural Heritage (SNH)
Health & Safety Executive	Scottish Wildlife Trust
Highlands and Islands Enterprise	Sea Mammal Research Unit
Independent Councillors (Ian Morrison, John Macky, Agnus Rennie, Kenneth Murray)	Scottish Water - Lewis
Joint Nature Conservation Committee	Stornoway Fishery Office
Joint Radio Company	Surfing GB
Local Authority	Surfers against Sewage
Marine Conservation Society	Royal National Lifeboat Institute (RNLI)
Marine Safety Forum	Truck Roads and Bus Operations
Marine Scotland	Transport Scotland
Marine Scotland – Fisheries Compliance (Stornoway)	Ports and Harbours
Maritime and Coastguard Agency	Western Isles District Salmon Fisheries Board & Outer Hebrides Fisheries Trust
Ministry of Defence (MoD)	Western Isles Fisheries Association
National Air Traffic Services (NATS)	Western Isles Fisheries Trust
Northern Lighthouse Board (NLB)	Western Isles Member of Parliament (Angus MacNeil)
Outer Hebrides Surf Association	Western Isles Member of Scottish Parliament (Dr Alisdair Allan)
Royal Yachting Association	Whale and Dolphin Conservation Society

3.4.5 Contact has been initiated and maintained with a number of specific interest groups on Lewis including the Outer Hebrides Surf Association, Bragar Common Grazings Committee, Siadar Common Grazings Committee, and the local branch of the Institute of Engineering and Technology.

3.4.6 Since first engaging with the Western Isles community, Lewis Wave Power has supported a number of local community initiatives, including providing a manned information stand at the Stornoway Wind Farm Public Exhibition in March 2011 and providing support to the annual Hebridean Science Festival in 2011 and 2012 with a series of primary school visits and public information displays (see Photograph 3.1).

Photograph 3.1 Schools Visit as part of the Hebridean Science Festival

3.4.7 In addition Lewis Wave Power's parent company, Aquamarine Power, is the lead industry partner in the Hebridean Marine Energy Futures project alongside the lead academic partner Lews Castle College (See Photograph 3.2). This collaborative project aims to accelerate marine energy development in the Outer Hebrides, through a programme of industry-academic knowledge exchange activities that will build a significant skills base in resource characterisation and mapping, site surveying, grid integration design and pre-development consent planning. The project also enjoys the support from a number of other academic institutes and renewable energy companies.

Photograph 3.2 Aquamarine Power's collaboration with University of the Highlands and Islands

3.4.8 Throughout the production of the EIA, there has been ongoing consultation and engagement with the local community through, consultation with local groups. A public exhibition will be held on 9th and 10th March in Galson and 12th March in Stornoway. This exhibition will be interactive and manned by two to three members of the Lewis Wave Power project team and provide an opportunity for the local communities to view and discuss the complete project plans (offshore and onshore elements of the project).

3.4.9 Throughout the development of the project, Lewis Wave Power has sought to engage with the local and national press. One principle driver for this approach has been to maximise opportunities to raise awareness of the project locally and nationally. Key press articles and events are summarised in Table 3.3 below.

Table 3.3 Community consultation and media events

Date	Description
23rd July 2010	Attendance at the Outer Hebrides Renewables Group
23rd July 2010	Introductory meetings with Highlands and Islands Enterprise and Dr. Alastair Allan
10th August 2010	Aquamarine Power Press Release about visit on the 23rd July
18th March 2011	Aquamarine Power visit to Bayble and Shawbhost schools as part of the Hebridean Science Festival
19th March 2011	Information Display and wave tank at the Hebridean Science Festival hall.
23rd March 2011	BBC News *"Project to identify wave power sites off Western Isles."*
15th April 2011	Meeting with Comharile Nan Eilean Siar local councillors (Agnes Rennie, Ken Murray and Iain Morrison) to discuss forthcoming seabed lease announcement and development plans for North West Lewis.
21st April 2011	The Stornoway Gazette *"Arnish capitalises on Marine Energy boom."*
25th April 2011	The Press and Journal Newspaper *"Jobs safe as Lewis yard wins energy contract."*
18th May 2011	Aquamarine Power Press Release "*Aquamarine Power secures seabed rights for potential 40MW Lewis wave energy sites"*
19th May 2011	The Scotsman Newspaper " *Capturing Power of the Waves*"
19th May 2011	BBC Scotland "*Aquamarine Project sparks new Western Isles Call Link*"
14th July 2011	Outer Hebrides Renewables Group Meeting, Stornoway

Table 3.3 Community consultation and media events	
Date	**Description**
13th September 2011	Presentation on the Oyster Technology and the Crown Estate Seabed lease granted to Lewis Wave Power at general public information event organised by the Institute of Engineering and Technology (IET) at Greenspace, Lews Castle College, Stornoway.
13th September 2011	Presentation to the Bragar Common Grazing Committee, about the environmental baseline investigation work being undertaken by the Lewis Wave Power and the potential development options.
7th December 2011	Meeting with the Stornoway Harbour Assistant Harbour Master to discuss port and harbour facilities.
9th and 10th March 2012	Public Stakeholder Event, Galson Estate Trust Business Centre
12th March 2012	Public Stakeholder Event, Stornoway
15th March 2012	Renewable Energy School Workshop at Lionel School, Ness
15th March 2012	Renewable Energy School Workshop at Back School, Back.
16th March 2012	Attendance at the Hebridean Science Festival
June 2012 (date TBC)	Attendance at Energy North Supply Chain Event in Stornoway

3.5 Government local authority and environmental groups consultation

3.5.1 Lewis Wave Power followed best practice and implemented an engagement programme with the Western Isles Council, public bodies and environmental groups directly on the progress of the project development plans. Therefore local elected and public representatives, council officials, Scottish Government and agency officials as well as campaign groups were met face to face on a number of occasions to discuss the development of the Lewis Wave Array.

3.5.2 Direct consultation took place with SNH and the Royal Society for Protection for Birds (RSPB) to discuss the proposed methodology for bird and marine mammal surveys. As the project developed, and following direct feedback on the scoping report, further meetings were held with the Whale and Dolphin Conservation Society (WDCS). SNH and MS-LOT have been in continual dialogue with Lewis Wave Power as the project progressed. On the 23rd and 25th January 2012, SNH confirmed that Habitats Regulations Appraisal (HRA) assessments for grey seals, Atlantic salmon and otters would not be required (See Appendix 3.1).

3.5.3 Lewis Wave Power met with the Scottish Environment Protection Agency (SEPA) to discuss matters raised in the Scoping Opinion, including Groundwater Dependant Terrestrial Ecosystems (GWDTEs), potential requirements of Controlled Activities and Regulations (CAR) licensing and best practice arrangement for upgrading the access road crossing across the burn.

3.5.4 Since the first initial meeting with MS-LOT in November 2010, regular joint project updates were held with MS-LOT, Western Isles Council and SNH. Their representatives were consulted on the survey methodology for the commissioned benthic habitat survey and the approach for monitoring underwater noise. To ensure maximum efficiency and consensus, whenever possible, joint consultation meetings and telephone conferences were undertaken.

3.5.5 The Maritime and Coastguard Agency (MCA) have been consulted on both a national and local basis. Key discussions took place in Southampton and Stornoway to discuss the navigational issues posed by the development in the near shore region. The outcome of these discussions is included within the Navigation Risk Assessment (*Chapter 15: Shipping and Navigation)*.

3.5.6 Following a response to the Lewis Wave Power scoping request, a meeting was held with representatives from the Outer Hebrides Surf Association (OHSA) in September 2011. Discussions centred on the Oyster technology, its impact on the waves and surfing activity at the two potential sites being considered at that stage. The feedback from the OHSA was positive and they confirmed that the two potential sites being considered were not currently used by surfers.

3.5.7 For details of consultation undertaken for the EIA please see consultation sections in each chapter of the ES. Key dates are outlines in Table 3.4.

Table 3.4 Key consultation dates

Date	Description
28th September 2010	Submission of methodology for bird and marine mammal surveys to SNH
08th November 2010	MS-LOT Meeting regarding initial development proposals
16th November 2010	Initial meeting with Western Isles Council planning department about development opportunities in Lewis
16th November 2010	SNH Meeting to discuss wildlife monitoring arrangements and vantage points.
8th February 2011	MS-LOT and SNH meeting – Project progress update meeting
23rd May 2011	MS-LOT and SNH meeting – Project progress update meeting
13th April 2011	SNH Meeting – local office project update
1st August 2011	MCA Meeting (Southampton) – initial discussions about Navigational Risk Assessment requirements
18th August 2011	Consultation with MS-LOT and SNH regarding benthic survey methodology
13th September 2011	Outer Hebrides Surf Association (OHSA) – initial discussions about the Oyster technology, impact of the devices on the wave and the potential development sites on the North West Coast of Lewis.
14th September 2011	SEPA Meeting – initial meeting to discuss potential CAR licence issues and to discuss initial results from onshore ecology surveys

Table 3.4 Key consultation dates	
Date	**Description**
14th September 2011	Western Isles Council Planning Department – initial meeting to discuss development proposals at Siadar.
16th September 2011	Submission to MS-LOT and SNH regarding underwater noise scope of works
12th October 2011	MS-LOT and SNH Meeting – Project progress update meeting, including discussions on underwater noise.
24th November 2011	MCA Meeting (Southampton) – meeting to discuss navigational issues specific to Siadar location and approach to Navigational Risk Assessment workshop
5th December 2011	Submission to MS and SNH regarding coastal geomorphology report and approach to the coastal processes assessment
15th December 2011	MCA Meeting (Stornoway) - Navigational Risk Assessment Workshop. Inshore Fisheries Group, Marine Scotland, Stornoway Port Authority and Western Isles Harbour Master also in attendance
15th December 2011	SEPA Meeting – meeting to discuss project layout and SEPA requirements for burn road crossing.
19th December 2011	Submission of first year's bird and marine mammal data to MS-LOT and SNH
26th January 2012	Confertel with Western Isles Council and MS-LOT – discussion on the consent application strategy, submission dates and joint working between the council and MS-LOT to ensure consistency in regulation.
16th February 2012	Meeting with MS-LOT and SNH – discussion on Section 36 application process and final Lewis Wave Power project description.

3.6 Landowner consultation

3.6.1 The development will be located within an area of land owned by a local community organisation, the Galson Estate Trust. The Trust was formed 8 years ago and successfully led a community buy-out of the Estate in February 2006. Aquamarine Power (on behalf of Lewis Wave Power) first met with the representatives from the Galson Estate Trust in September 2010. Since then, a series of meetings have been held to agree terms for a land lease and to identify a suitable location for the development. Continued dialogue has also been maintained with the Galson Estate Trust through regular phone call and e-mails.

3.6.2 Key landowner consultation meetings and contact are outlined in Table 3.5.

Table 3.5 Key Landowner Consultation Meetings	
Date	**Description**
September 2010	Initial meeting with Galson Estate Trust to present technology and development opportunities
16th November 2010	Project Update meeting with the Galson Estate Trust
15th April 2011	Meeting with the Galson Estate Trust to identify potential areas of development within the Galson Estate
26th July 2011	Response to the Lewis Wave Power Scoping request submitted the Galson Estate Trust
14th September 2011	Meeting with the Galson Estate Trust to identify areas of Crofting land and Common Land around Siadar. Site visit and discussion on initial site design and layout.
24th October 2011	Project update meeting with the Galson Estate Trust
6th December 2011	Presentation to the Galson Estate Trust Board on the detailed site layout, build out plan and technology development.
2nd February 2012	Commercial terms agreed for leasing the onshore development land

3.7 Commercial fisheries consultation

3.7.1 From the outset the importance of a clear channel of communication between the fishing industry and Lewis Wave Power Limited was recognised. Arising from early discussions, the secretary for the local Outer Hebrides Inshore Fisheries Group (IFG) has provided a key communication link between Lewis Wave Power and the local inshore fishing community. The IFG secretary has been in constant communication with the local fishermen who fish off the west coast of Lewis and throughout the project area. He has collated relevant information and helped with consultation to support the EIA. In particular, questionnaires were distributed amongst the fishermen potentially working within the study area by the IFG, and the information received is considered with the ES.

3.7.2 As part of the consultation process Lewis Wave Power attended three IFG meetings, the minutes of 2 meetings are provided in Appendix 16.1 In addition to attending these meeting informal discussions have taken place with local fishermen regarding the potential impact of the development as well as potential opportunities that the development will present both for the inshore fishing industry and supply chain opportunities relating to the construction and operation of the development.

3.7.3 Key dates are outlines in Table 3.6.

Table 3.6 Key dates for commercial fisheries consultation	
Date	**Description**
15th April 2011	Initial meeting with the Outer Hebrides IFG secretary to outline technology and describe Agreement for Lease from the Crown Estate
2nd July 2011	First meeting with the Outer Hebrides Inshore Fisheries Group to present Technology and Development proposals.
31st August 2011	Meeting with the Inshore Fisheries Group secretary to discuss use of the area and plan questions for local fishermen
13th October 2011	Fisheries Questionnaires distributed by the Inshore Fisheries Group to fishing vessels with potential to fish within the area
29th October 2011	Attendance at Inshore Fisheries Group meeting – an explanation of the technology and outline of the development proposals were discussed, alongside proposals for the development of the Western Isles Hatchery programme
5th December 2011	Letter sent to Association of Salmon Fisheries Boards and the Western Isles District Salmon Fisheries Board regarding migratory salmon
12th January 2012	Letter of support provided by Aquamarine Power on behalf of Lewis Wave Power to the Western Isles Hatchery Project.

3.8 Other consultation

3.8.1 The Association of Salmon Fisheries Boards and the Western Isles District Salmon Fisheries Board were also consulted with regarding migratory salmon data within the region. The concerns raised by both these organisations have been addressed in the *Chapter 16: Commercial Fisheries.*

3.8.2 Consultation responses were also received from the Stornoway Harbour Authority and Highlands and Islands Enterprise. These comments and information have been taken into consideration, where appropriate, in this ES. A full list of consultees can be seen in Table 3.2.

4. SITE SELECTION

4.1 Introduction

4.1.1 This Chapter of the Environmental Statement (ES) describes the site selection process, design considerations, constraints and consideration of alternatives, which have led to the selection of the development site.

4.1.2 The requirement to outline the project alternatives comes from the Electricity Works (Environmental Impact Assessment) Scotland Regulations 2000 and Marine Works (Environmental Impact Assessment) Regulations 2007. This stipulates that the ES must identify the main alternatives studied by the applicant (Lewis Wave Power) and the main reasons for their choice, taking into account the environmental effects.

4.2 Location selection

4.2.1 On the basis of wave resource data Aquamarine Power has identified a number of potential development locations in Scottish waters which may be suitable for the deployment of Oyster technology.

4.2.2 A “location suitability” analysis selection process was undertaken in early 2010 to identify and assess potentially suitable sites for the deployment of Oyster devices, covering an area of search along the west coast of Lewis. A constraints mapping exercise was undertaken, leading to the identification of a number of potential development locations along the north-west coast, based on the consideration of the following criteria:

- Bathymetry suitable for the positioning and installation of Oyster devices;
- Proximity to grid infrastructure;
- Proximity to suitable harbour for Oyster storage prior to deployment;
- Road access with the potential to be upgraded;
- Suitability of onshore topography;
- Positive feedback from local stakeholders;
- Proximity to settlements and crofting land;
- Areas of existing tourism;
- Proximity to nature conservation designated sites;
- Regions of known surfing activity;
- Proximity to existing developments; and
- Proximity to military rifle ranges.

4.2.3 To provide further confidence in the suitability of the physical seabed characteristics of the area, detailed bathymetric and geophysical surveys of two sites, representative of the north-west coast of Lewis, were undertaken. The survey findings indicated that the deployment of Oyster devices is technically feasible at a number of locations along this stretch of coastline.

4.3 Area of search

4.3.1 The Crown Estate granted Lewis Wave Power two Agreement for Lease (AfL) areas for the north-west coast of Lewis on the 19th May 2011 (shown in Figure 4.1).

- The first AfL option consists of a 10 mega watt (MW) demonstration lease area to the north of Siadar; and
- The second AfL option is a commercial 30 MW lease covering an area of search stretching from Bàgh Dhail Beag in the south to Tràigh Shanndaigh in the north.

4.3.2 The Environmental Impact Assessment (EIA) Scoping Report requested opinion from consultees on an area which contained both AfL areas and was termed the "area of search" (Figure 4.1).

4.4 Detailed site selection

4.4.1 Two smaller areas within the EIA Area of Search, identified during the processes outlined above, were taken forward to consideration for development of the 40MW wave array, at Bhragar (Labost), and Siadar (Figure 4.2). Further investigations were conducted into feasibility for both offshore and onshore elements of the proposed development, looking at a number of parameters including physical suitability of the site for development, infrastructure, grid and site access, proximity to designated sites, land ownership and other users of the local area. No parameter was considered totally unsuitable for development at either site. The potential site at Siadar proved to be better for development than Bhragar at this stage, and had the added benefit of being adjacent to the 10MW agreement for lease area. Table 4.1 below summarises the comparative assessments made.

Table 4.1 Comparative assessment of Siadar and Bhragar

Parameter	Siadar (Galson Estate Trust)	Bhragar (Barvas Estate)
Bathymetry	Excellent Wide area of suitably flat rocky seabed	Good Narrow strip of irregular rocky seabed interspersed with sandbanks
Physical Site Access	Good Straight road access near to main road with minor upgrades and small number of adjacent houses	Satisfactory Single track access, ~3km from main road, a number of "pinch points" and large number of houses
Infrastructure	Good Utility services nearby	Good Utility services nearby
Grid	Needs Transmission connection. Distribution line nearby	Needs Transmission connection. Distribution line nearby
Seabed Lease Capacity	Excellent Maximum of 40MW	Good Maximum of 30MW
Existing Users	Excellent Limited recreational and/or Commercial use	Excellent Limited recreational and/or Commercial use
Proximity to Environmental designated Sites	Excellent Not within a designated site	Excellent Not within a designated site

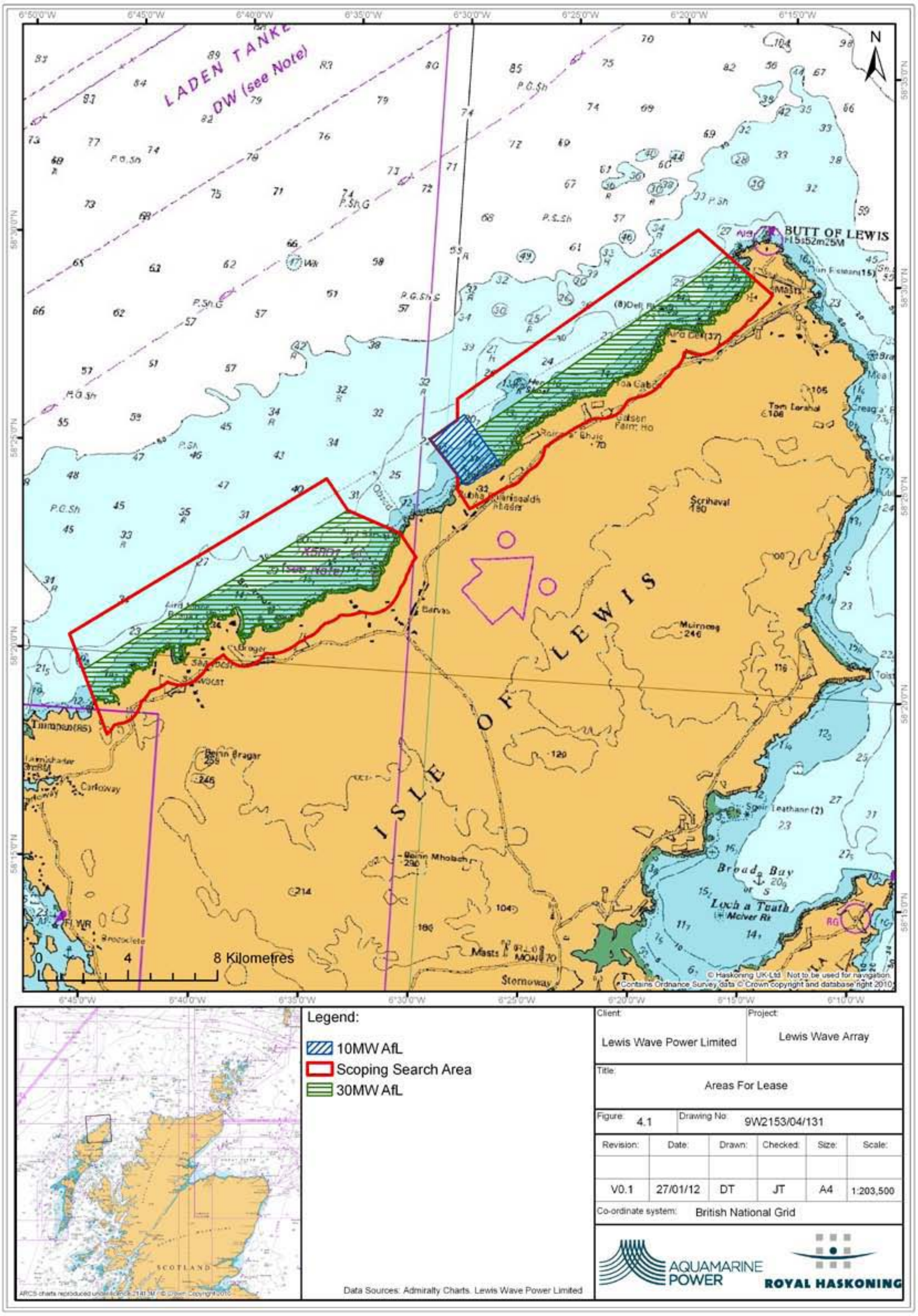


Figure 4.1 Map showing the 10 and 30MW Agreement for Lease Area (AfL) and the Area of Search used in the EIA Scoping Report

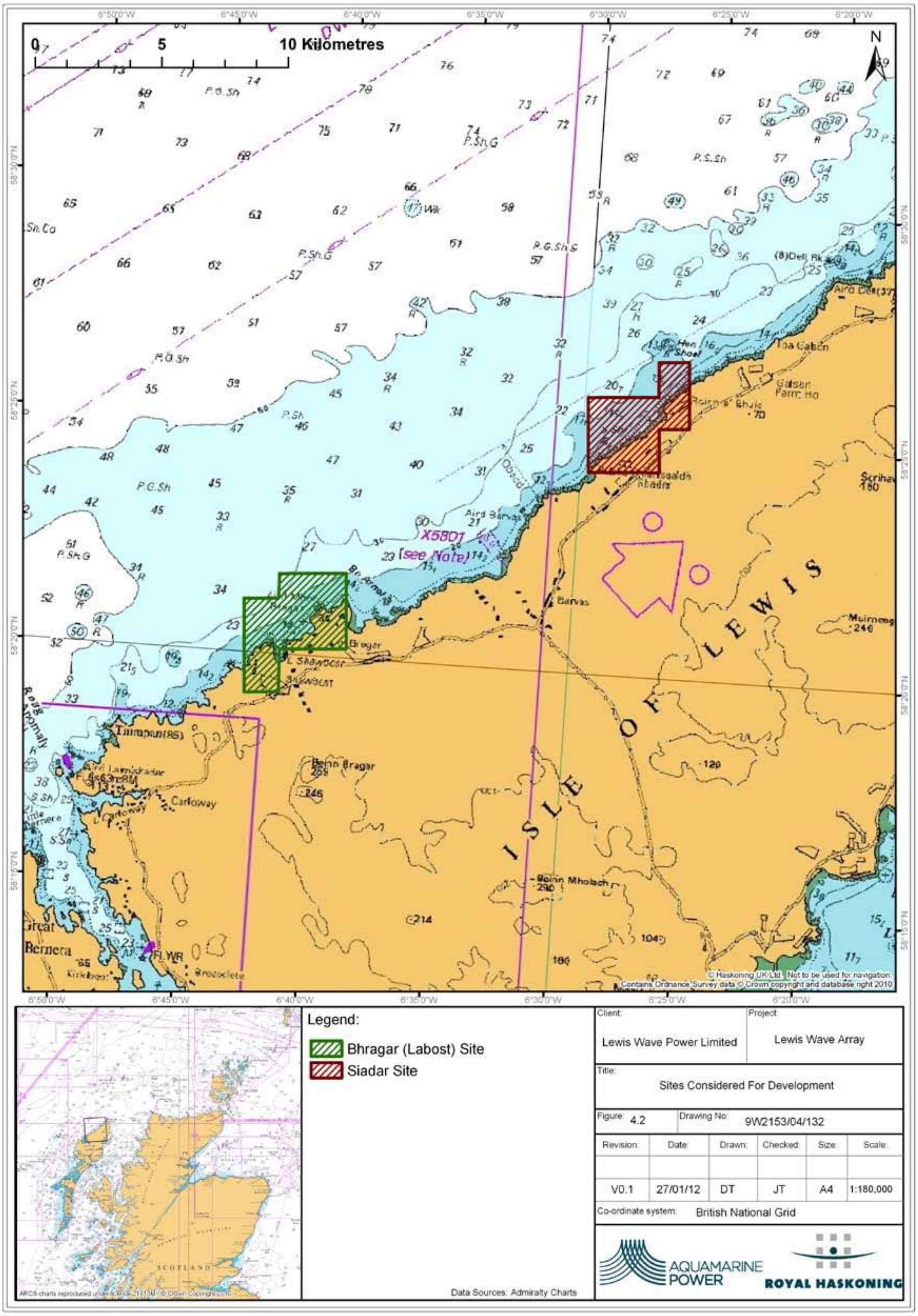


Figure 4.2Map showing the two sites that were considered in further detail for development

4.5 Development of wave energy convertor technology

4.5.1 The Oyster devices are rated at 800kW, which will require 50 devices to make up a 40MW array. Aquamarine Power is looking to further develop the technology which may lead to an increase of each Oyster rating to 1MW and therefore a reduction in the required number to 40 devices to achieve the same amount of power.

4.6 Onshore site location

4.6.1 As discussed above, initial areas in which to develop the offshore works at Siadar were identified (Figure 4.3), avoiding national and international designated sites, as well as limiting interaction with other users such as fishing and surfing activities. This focussed the area of search for the onshore portion of the development site and the landowner, the Galson Estate Trust, helped the project team to identify an onshore location at Siadar. The onshore site is on an area of common ground, avoiding areas of agricultural interest, to minimise adverse impacts to the local community.

4.6.2 Several environmental surveys were commissioned at an early stage, to inform detailed site selection. These included Phase 1 habitat, intertidal, otter and archaeology surveys and landscape and visual assessment. Ongoing consultation with Scottish Natural Heritage (SNH), Scottish Environment Protection Agency (SEPA) and the Comhairle nan Eilean Siar (Western Isles Council) also took place during this time.

4.6.3 Utilising the outputs from the environmental surveys, a hydraulics option appraisal was carried out by Aquamarine Power engineers (on behalf on Lewis Wave Power) to identify the optimal hydraulic solutions for connecting the onshore station to the offshore Oysters, whilst minimising the environmental footprint of the onshore site.

4.6.4 The final location for onshore works has taken into account the results of the survey and consultation and technical assessments. The location for the onshore construction site has been located a minimum of 125 metres (m) from the watercourses, avoiding sensitive peat habitat and blanket bog. The chosen location is also relatively sheltered from view, located between the sea and a 30m hillside. In addition, the location close to the coastline reduces the distance required for pipelines to travel between the Oyster devices and the onshore works.

4.6.5 This onshore site location was taken forward in the EIA process.

4.7 Mitigation through site selection and layout Iteration

4.7.1 The proposed wave array has gone through an iterative process refining the design taking account of site conditions, environmental sensitivities and the views of consultees all as mitigation by design. Therefore the final project design is seen as being the best solution available. The final layout and design of the project can be seen to have already incorporated adaptations to minimise impacts on features of archaeology, and ecology, as well as technical / engineering difficulties.

4.7.2 In addition to the measures to minimise impacts already built into the project design a series of additional receptor specific mitigation measures have also been developed. The details of these additional mitigation measures are outlined in the technical chapters (Chapters 7 to 22) within the main body of the ES and summarised in *Chapter 23*: *Summary of impacts*, *mitigation good practice and monitoring*.

Figure 4.3 Initial onshore and offshore areas in which to develop at the Siadar site

5. PROJECT DESCRIPTION

5.1 Introduction

5.1.1 This chapter describes the 40 megawatt (MW) wave array.

5.1.2 Lewis Wave Power will develop a wave energy array in the waters off the north-west coast of the Isle of Lewis, the Western Isles, Scotland. The array will have a generation capacity of up to 40MW of renewable power for export to the national grid. This will contribute to meeting the Scottish Government's targets of providing the equivalent of 100 per cent of Scotland's gross annual electricity consumption by 2020 (www.scotland.gov.uk) from renewable sources.

5.1.3 The array will consist of between 40 and 50 Oyster wave energy convertors (WECs) also referred to as Oyster devices, depending on the design and therefore final power rating of the Oyster devices used. These devices will be positioned according to the best understanding of available wave resource, water depth, seabed gradient and seabed protrusions.

5.1.4 The deployment will be subject to the required consents and licenses being obtained (see *Chapter 6 Regulatory and Policy Context*).

5.1.5 Lewis is the most northerly of the Western Isles and is located approximately 40 kilometres (km) west of mainland Scotland. The north-west coast of Lewis which runs from Càrlabhagh (Carloway) in the south-west to Rubha Robhanais (The Butt of Lewis) in the north-east is approximately 40km long and is directly exposed to the Atlantic Ocean (Figure 5.1). The site which is shown in Figure 5.2 lies within the local authority area of Comhairle nan Eilean Siar (The Western Isles Council).

5.1.6 The wave array will be located in waters to the north of Siadar and to the west of Bhuirgh (Figure 5.2) between the 10metres (m) and 15m depth contours. The wave array will be configured in a linear formation running roughly parallel to the coast and will cover a distance of up to 3.2km from end to end. Indicative locations for the individual devices are displayed in Figure 5.2, however, these will be subject to micro siting and the layout is indicative, and based on current understanding.

5.1.7 In addition to the Oyster devices there will be a requirement for supporting infrastructure both onshore and offshore. This will include pipework which will connect the devices to a hydro electric power station, located onshore, within an area of land to the north of Siadar village (See *Chapter 4: Site Selection*).

> This project description describes in detail the development of the 40MW wave array as shown in Figure 5.2. Consideration is also given to activities associated with the project that will occur at other locations however these are not described in detail within this ES. It should be noted that the planned activities within Loch Roag will be subject to an additional application if appropriate.

5.1.8 The reader is advised to refer to the ES glossary for clarification of terms contained within this chapter.

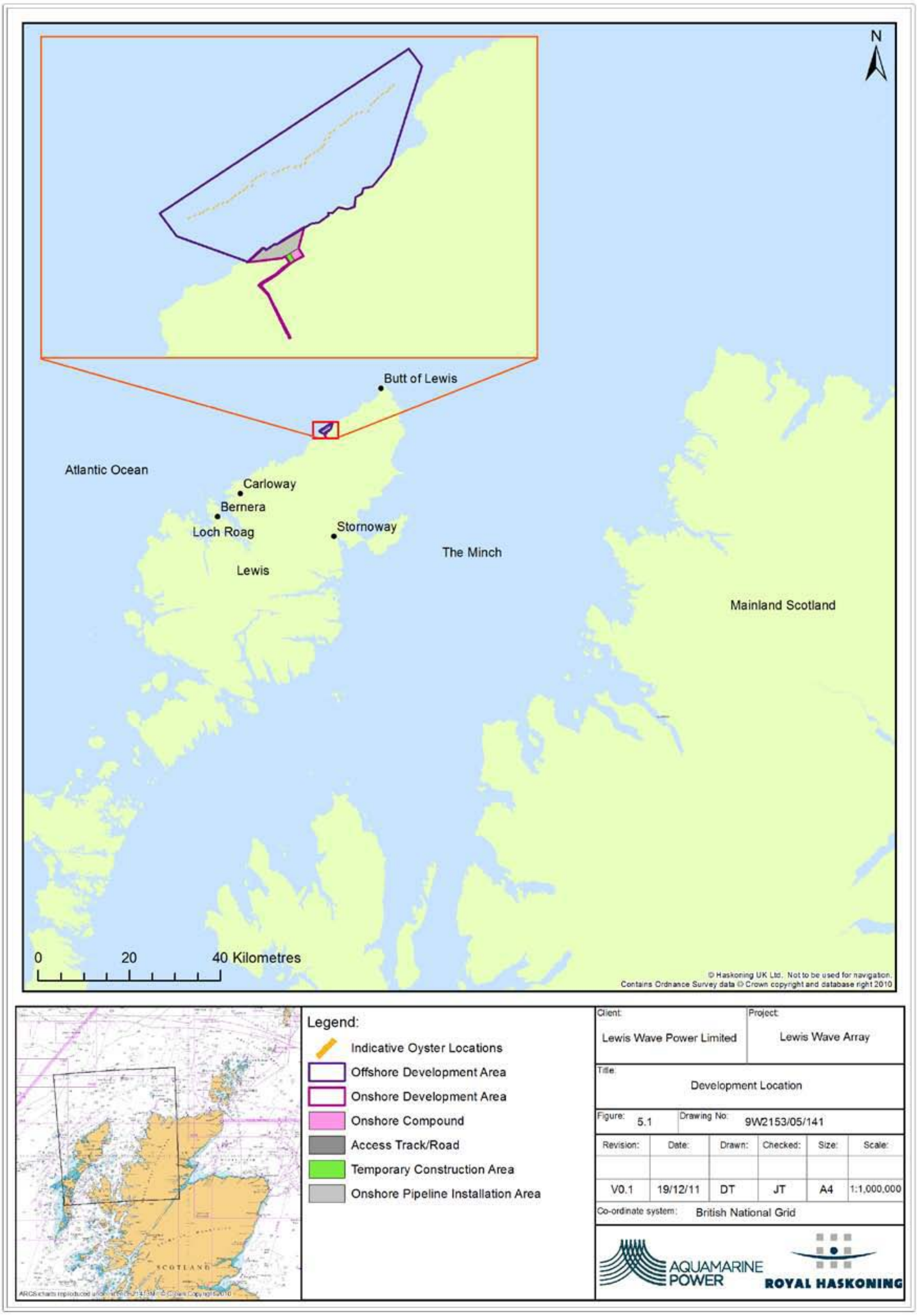


Figure 5.1 Map illustrating the location of the proposed development within Scotland

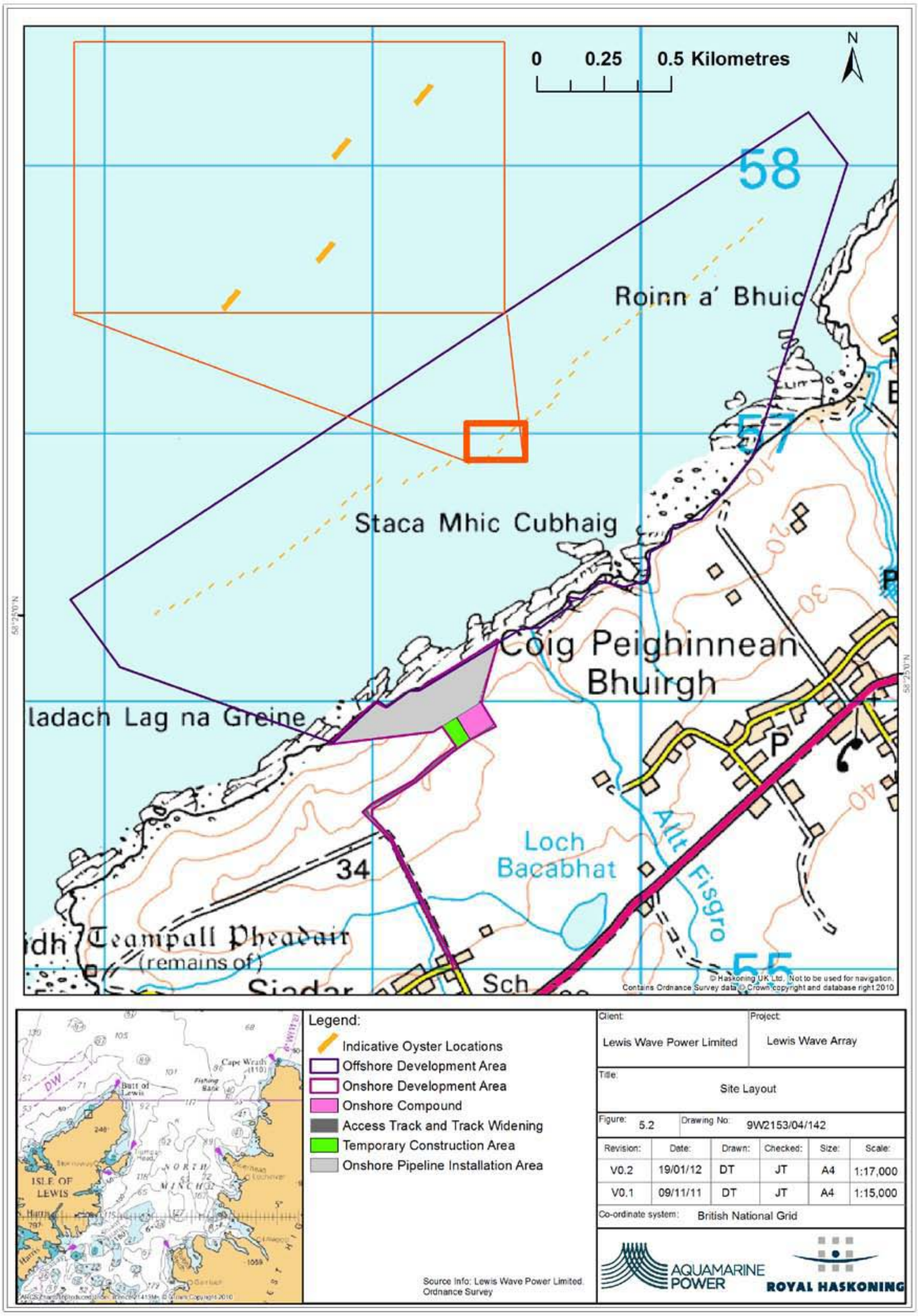


Figure 5.2 Indicative site layout

5.2 Site description

Offshore

5.2.1 The waters off the north-west coast of Lewis are shallow and, while the seabed slopes gently down towards the continental shelf, the waters remain no deeper than 50m out to a distance of 4 to 5km from the coastline. The near shore environment is generally rocky with some areas of coarse sand and gravel in pockets between rock outcrops and boulders. With greater distance offshore the seabed becomes more stable and is composed of finer sands and gravels.

5.2.2 The bathymetry within the development site ranges between 10m and 15m depth, the depth range required by the Oyster WECs. The seabed is reasonably level with few discernable anomalies. In the south and extreme north of the site some of the devices will lie on the seaward side of existing shallow trenches.

5.2.3 The west coast of Lewis is a location with abundant wave energy, Atlantic swells arrive at the coast having been uninterrupted by any land mass for thousands of miles.

Onshore

5.2.4 The west coast of Lewis is very exposed often experiencing strong onshore winds and the environment here reflects this. There are few trees, and vegetation is characteristically stunted. The underlying geology is Lewisian Gneiss, much of which is overlain with a thick layer of peat. The coastline is generally linear with a few small bays and headlands; gently sloping grasslands and heath lead up to a hinterland which is relatively flat in nature in comparison to southern parts of Lewis and the neighbouring island of Harris.

5.2.5 The onshore components of the development will be located within an area of grassland which is located to the west of the main road (A857) that runs up the west coast of Lewis (for more information please refer to *Chapter 13 Terrestrial and Intertidal Ecology*).

Land ownership

5.2.6 The land on which onshore elements of the project will be located is owned by the Galson Estate Trust. The Galson Estate Trust covers an area of 56,000 acres and is a community owned estate managed by the Galson Estate Trust. An agreement has been made with the Galson Estate Trust to construct, operate and maintain the 40MW Oyster wave farm on land under their ownership.

5.3 Project Details

A Rochdale envelope approach is used in the impact assessments within chapters 6 to 22 (See *Chapter 2 Scoping and assessment methodology* for more detail). Therefore in this chapter a range of options or values are presented (which will form the Rochdale envelope) or a maximum likely case value which will have the greatest possible impact to any given receptor is presented.

Wave energy convertors (WECs)

5.3.1 Waves have the potential to provide a sustainable source of energy which can be captured and converted into electricity by wave energy convertors (WECs). WECs are currently being developed to extract energy from a range of wave environments from the shoreline out to the deeper waters offshore (EMEC, undated). Aquamarine Power Limited's Oyster WEC technology is designed to harvest the wave energy from the near shore environment.

5.3.2 There are six different categories of wave energy conversion technology currently identified and the Oyster WEC fits into the "oscillating wave surge converter" category (EMEC undated). The power rating for each Oyster WEC which will be deployed at the Lewis site has not yet been finally determined, but will be between 800kW and 1MW.

Oyster technology

5.3.3 The Oyster WEC is a buoyant, hinged flap, attached to the seabed by a monopile Figure 5.4. As waves pass the flap it pitches backward and forwards with the motion of the wave and this movement drives two hydraulic pistons, which in turn push high pressure water through a pipe network to an onshore hydroelectric turbine as illustrated in Figure 5.3.

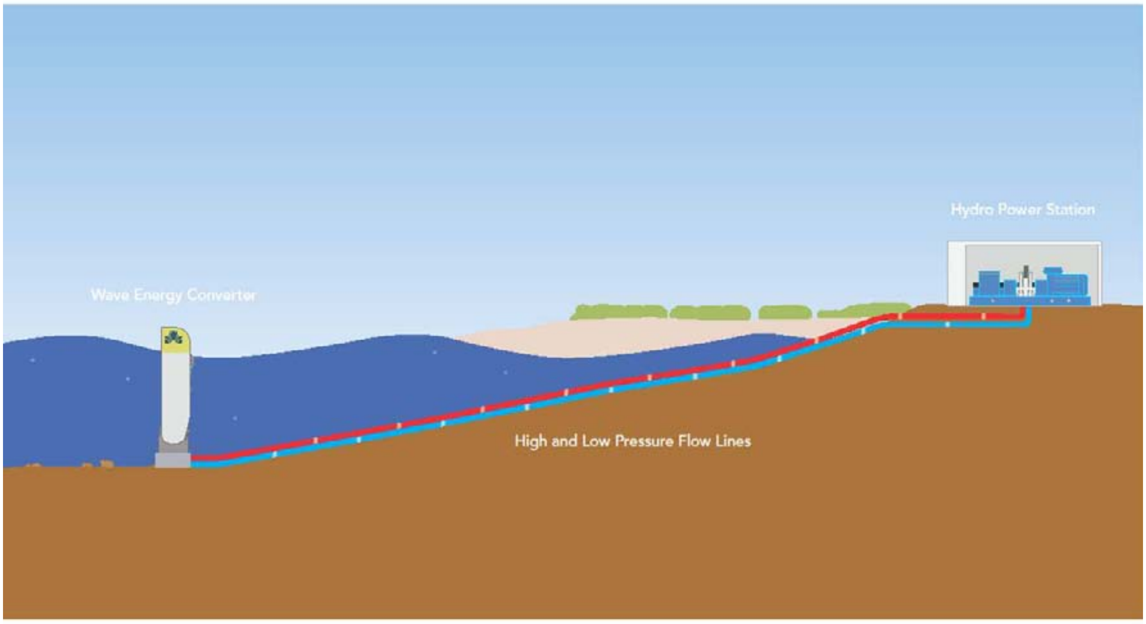


Figure 5.3 Diagram to show concept of how the Oyster WECs connect to the Hydro electric Power station.

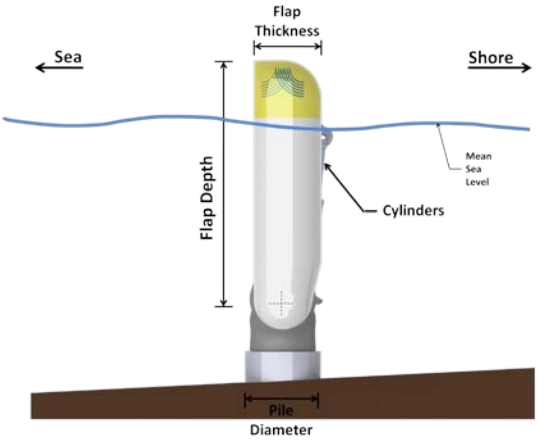
5.3.4 The first Oyster WEC (Oyster 1) was successfully deployed at the European Marine Energy Centre (EMEC)'s Billia Croo site, in Orkney, in 2009. Oyster 1 delivered over 6000 offshore operating hours and survived two winters at sea.

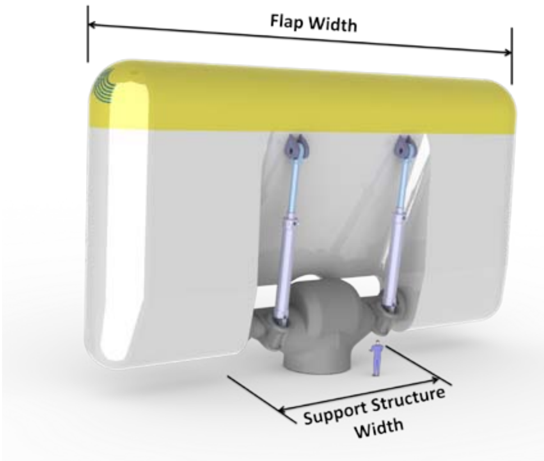
5.3.5 Aquamarine Power recently installed the next-generation Oyster device called the Oyster 800 at the Billia Croo site. The high and low pressure pipelines which connect the onshore hydro electric power station with the offshore device were installed using horizontal directional drilling which was completed in 2011. Work is currently underway to commission Oyster 800 by connecting it to the high & low pressure pipelines. Aquamarine Power also plans to install two further developments of the Oyster device, the 801 and 802 versions, in the same location creating the first Oyster array. Each Oyster WEC will have a generating capacity of approximately 800kW and all three will be connected to a single onshore hydro electric station. The maximum generating capacity of the three WECs will be 2.4MW.

5.3.6 The devices installed at the 40MW Lewis development will be similar to Oyster 801 and 802 in both design and appearance, but will include further design improvements based on lesson learnt from the Bilia Croo project.

Device specifications

5.3.7 The final specifications of the Oyster devices deployed will be determined by experience gained from previous designs. A Rochdale Envelope approach has been taken to describe the design parameters of the devices for the purposes of impact assessment. Table 5.1 details the design specifications, or range of conceivable values for specifications of the Oyster WECs to be deployed at the Lewis site and Figure 5.4 provides an illustration of the devices.





Side View **Back View**

Figure 5.4 Illustrations of the Oyster WECs

5.3.8 The Oyster WECs will be made of a combination of composites such as Fibre Reinforced Polymer (FRP), elastomers, marine grade rubber and steel and will sit on one pre-installed monopile per WEC which will be drilled and grouted into the rock seabed. The monopiles will provide a secure and level base for the WECs on the seabed at approximately 13m MSL (Mean Sea Level) water depth.

5.3.9 The WECs have a design life of 20 years and are designed in accordance with the Load and Resistance Factor Design method (LRFD) defined within Det Norske Veritas (2011). Design loads on the devices are evaluated for extreme loading and background (fatigue) loading conditions.

5.3.10 To ensure that maximum energy is extracted from the waves, the area below the WECs will be filled by “gap fillers”, these will take the form of wire cages or bags filled with rocks, or will be made of concrete accropodes. The “gap fillers” will be placed around the monopile and under the bottom of the each oyster flap after it is attached to the monopile.

Table 5.1 Design Parameters for each Oyster device to be installed at the Lewis development (See Figure 5.4 for illustration of parameters)

Parameter	Specification
WEC Flap	
Material	Fibre reinforced polymer (FRP)
Weight of FRP	140 tonnes in air
Power take off attachments	FRP or steel castings, 20 tonnes

Table 5.1 Design Parameters for each Oyster device to be installed at the Lewis development (See Figure 5.4 for illustration of parameters)	
Parameter	**Specification**
Bearings housing	FRP or steel castings, 20 tonnes
Flap width	Between 26m and 33m
Flap thickness	3.5m
Flap depth	Between 9 and 11m
Height of Flap from Hinge	12.5m
Freeboard	Between 3m and 4.5m above MSL
WEC Support Structure	
Material	Steel
Weight	300 tonnes
Pile sleeve diameter	5m
Cross head diameter	5m
Pile	
Diameter	5m
Height	17m
Installation depth	15m into seabed
Material	Steel (200 tonnes) and cement based grout (between 45-80m^3)
Gap Fillers	
Material	Rock or concrete
Size	Between 130m^2 and 953m^2

5.4 Site design and layout

<u>Offshore components</u>

WECs

5.4.1 The WECs are designed to operate in water depths of between 10 and 15m below chart datum (CD). This means that they will be located between 300m (in the north of the site) and 750m (in the south) from the coastline (Figure 5.2). The WECs will be aligned approximately parallel to the coastline with a minimum separation distance of 20m (Figure 5.5); although in the final layout the distance is likely to be larger than 20m.

5.4.2 High and low pressure pipelines will form a closed loop system with water being pumped from the WEC to the shore and back again. The fluid within the pipes will consist of: fresh water (94.9%), a hydraulic additive called Eco Stack Magic (5%) which will increase the lubricity of the working fluid and Agent 70 (0.1%) which is a defoaming agent (See Table 5.9 for more detail). Lewis Wave Power is committed to using the most environmentally friendly hydraulic additives possible whilst maintaining performance standards of the Oyster hydraulics.

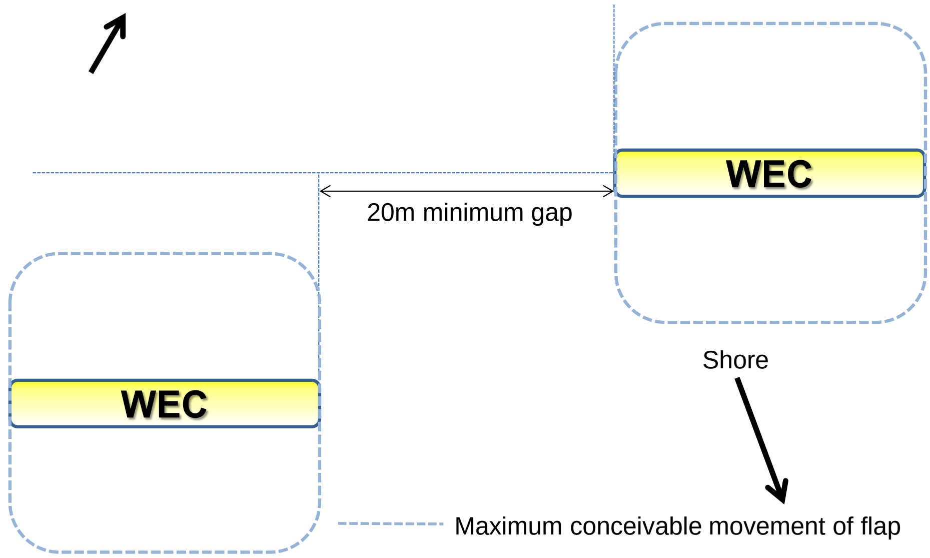


Figure 5.5 Plan of target scenario for WEC positioning in relation to nearest WEC

5.4.3 Each WEC will be connected via one high pressure pipe (which will contain water that has been pressurised by the WEC) and one low pressure (return) pipe to a “common pipeline” (containing one high and one low pressure line) shared by other WECs (Point 1 in Figure 5.6). The “common pipeline” links all the WECs together and then connects via a number of “common to shore pipelines” to the shore based electricity generator. .The WEC pipelines will either be secured to the seabed by the landing platform (see ***Landing platforms*** below for further details) or will be secured by stabilisation anchors.

Hydraulic modules

5.4.4 Each WEC will contain up to four hydraulic accumulator modules. The accumulator modules have been designed to be recovered during maintenance and repair procedures which will occur during operation (See Section **5.7. Operation** below). Each hydraulic accumulator module will contain a bank of hydraulic cylinder accumulators. The hydraulic cylinder accumulator consists of the hydraulic cylinder, check valves, a pressure relief valve and isolation valves. . Each accumulator module will also incorporate communications harnesses and junction boxes.

5.4.5 The removable modules perform independently of each other in that they contain the necessary valves and accumulators such that one module can pump high pressure fluid whilst the other is non-operational, or even removed.

Landing platforms

5.4.6 On the shore side of each WEC a landing platform will be installed which will serve a number of functions. The platform will provide an area on which dedicated handling equipment can be landed from a support vessel during maintenance. In addition the platform will also support additional (to the WEC see above) accumulator modules which will contain a bank of accumulators.

5.4.7 In addition the platform is likely to house the connection between the WEC and the common pipeline (figure 5.6).

5.4.8 The platforms will consist of a frame made from steel or composite and will be approximately 10m wide by 10m long, sitting proud of the seabed at a height of approximately 5m. The structure will be painted in glass flake epoxy protection paint. The frame structure will be open sided and potentially will support a meshed top to allow for protection of the pipes. It will be fixed on top of the pipes to hold them in place on the seabed and will be attached to the seabed using up to 20 large rock anchors (see ***Installation of rock anchors*** below and glossary for an explanation of rock anchors).

Pipelines

5.4.9 The common pipelines (Figure 5.6) will each measure a maximum of 0.9m in diameter. Each common pipeline will run the length of the array and is likely to be a maximum distance of 3.5km in length. The common pipeline will be installed in sections that join each WEC to the previous WEC (Figure 5.6). Each section will be secured at both ends under the landing platforms and will have an additional stabilisation anchor point mid-way along the section. Stabilisation anchors will consist of a collar surrounding the pipeline which will be pinned to the seabed using rock anchors (See glossary for explanation of rock anchor). A grout bag may be positioned under the pipeline which will be held in place by the rock anchors.

5.4.10 At up to eight separate locations the common pipelines (both high and low pressure) will be connected to “Shore Pipelines” (Figure 5.6) which will transport the hydraulic fluid to the shore. The Shore Pipelines will also consist of one high and one low pressure pipeline and will be installed using one of two options:

5.4.11 The pipes will either be surface laid i.e. attached to the seabed using stabilisation anchors; or

5.4.12 The pipes will be installed under the existing bedrock using a process known as horizontal directional drilling (HDD).

5.4.13 Alternatively a mixture of the two installation methods will be used.

5.4.14 An umbilical cable will connect each WEC to the onshore control room located in the hydro electric power station. This cable will be installed within a conduit next to the pipelines (Figure 5.6) and will be used to relay information regarding the performance of the devices back to the onshore hydro electric power station. The umbilical will contain a fibre optic data cable and a power cable to provide power to the sensors on the WEC.

Pipeline installation options

Option 1: Surface laid

It should be noted here that the two methods of pipeline installation will have different potential impacts on the environment. It is likely that overall the surface laid method will have greater potential for impacts to the environment than the HDD option.

5.4.15 The configuration of the pipelines should a surface laid approach be adopted is yet to be finalised. The description below is based on a buildable scenario that would result in the greatest (worst case) amount of pipeline being installed.

5.4.16 Up to eight common to shore pipelines will connect the common pipeline to either a common landing area as displayed in Figure 5.6 or between two and eight separate landing areas. This will depend upon the final engineering requirements of the array.

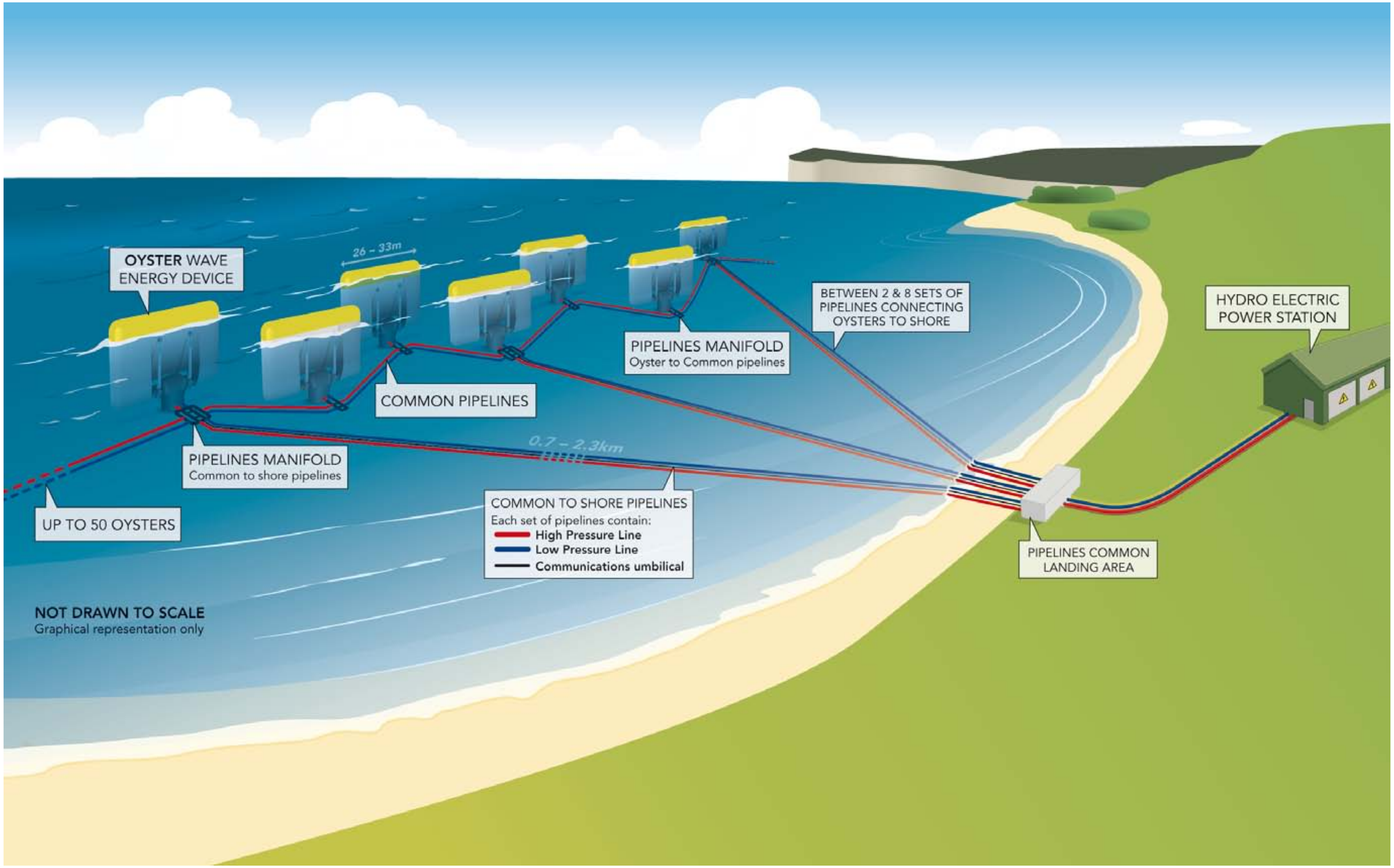


Figure 5.6 Indicative illustration of the array layout

5.4.17 Each common to shore pipeline will consist of one high pressure pipe and one low pressure pipe each of which will be 0.9m in diameter and will be between 700m and 2300m long (It is unlikely that the longest common to shore pipelines will be as long as 2300m and as the project detailed design develops this figure is likely to decrease). The shore pipelines will be secured to the seabed using stabilisation anchors (see *Pipelines* and glossary for explanation of stabilisation anchors) positioned at regular intervals of approximately 50m.

5.4.18 All surface laid pipelines will be made from steel and may be painted externally. The pipelines may be lined internally with a non-metallic liner. Aluminium alloy sacrificial anodes will also be used to protect the offshore infrastructures at approximately 1 per 50m of pipeline and one per individual steel structure. To provide protection to offshore surface laid pipes, the pipelines may be coated in concrete, or the pipelines may be made up of pre-fabricated concrete pipelines within which the high and low pressure pipelines are pushed through.

Option 2: Directionally drilled

5.4.19 The shore pipelines may be installed using a HDD method of rock boring. The boreholes through which the pipes will be pulled will be drilled from either one of two onshore locations or from an offshore location using a jack up rig.

5.4.20 If the boreholes are drilled from an onshore location several boreholes will be drilled from one or possibly two separate areas each up to 30m by 30m located within the onshore pipeline installation area shown in Figure 5.2. A maximum of 32 (16 for high pressure pipelines and 16 for low pressure pipelines) boreholes may be required to connect the common pipeline to the shore. From the point of breakthrough at the seabed the pipelines would be surface laid as described above.

5.4.21 In both cases, on completion of the pilot hole drilling and emergence at the exit point there will be some drill fluid discharge. The drill fluid comprises of seawater with a non-oil based drilling fluid such as bentonite; the safety data sheet for which indicates that the product is not considered toxic to aquatic organisms, and is a biodegradable drilling fluid. A closed loop recycling system will separate drill cuttings from reusable drilling fluids, meaning that at break-through of the seabed offshore or the land onshore there will be a limited quantity of seawater-based drill fluid and cuttings lost to the environment. Drill cuttings excavated offshore will be returned to shore and all captured cuttings will be collected for disposal by licensed contractors.

Pipelines connections

5.4.22 The junction between the individual WEC pipelines and the common pipelines is likely to be contained under the landing platform (See *Landing platforms* above). Alternatively if a WEC is located at a distance of over 10m from the common pipeline the connection between the WEC pipeline and the common pipeline will be protected by a manifold structure which will be 6m by 6m and will similar in design to the manifold described in the paragraph below.

5.4.23 At the junctions between the common pipelines and the shore pipelines (Figure 5.6) there will be a manifold structure which will link these pipelines together. This manifold will be made from steel or composite and will be a structure approximately 10m by 10m and 5m high. As with the landing platforms it will consist of an open sided frame structure possibly with a meshed top to allow for protection of the pipes. It will be fixed on top of the pipes to hold them in place and will be attached to the seabed using rock anchors. The maximum number of these manifolds will be eight and the minimum number will be two if surface laid pipeline option is used or 32 if HDD is used. All surface pipes will be fixed to the seabed using stabilisation anchors that will be pinned using rock anchors (see *Pipelines* above for explanation of a stabilisation anchor).

Temporary pontoon

5.4.24 During the construction phase a temporary floating pontoon will be connected to the shore at a location within the onshore pipeline installation area (Figure 5.2). The pontoon will facilitate rapid access for a small craft to and from the offshore development area, which will improve safety and help logistics.

5.4.25 The pontoon will be made from a mixture of plastics, steel and concrete and will be a floating structure, which will be accessible from the shore and stretch into the water. It will consist of a series of floating blocks with a metal handrail for safety. It is likely that it would be moored in place using concrete blocks on the seabed, which would attach to the pontoon via chains. It is likely that some civil engineering works will be required to support the pontoon, these would take the form of foundation works and a concrete access ramp. The pontoon itself would be temporary and would be put in place during construction of the wave array. The pontoon would be removed in winter season and during periods of bad weather.

Onshore components

Surface laid pipelines

5.4.26 If shore pipelines are surface laid they will either be bought to a common landing area as illustrated in Figure 5.6 or will come onshore at between two and eight separate locations. Once on shore the pipes will either be laid in trenches or will be laid out on the surface.

Directionally drilled

5.4.27 If the shore pipelines are installed by HDD there will be two options

Option 1 – Drill up to 32 HDD boreholes from one or two separate locations within the onshore pipeline installation area (Figure 5.2); or

Option 2 – Drill all 32 HDD boreholes from offshore locations

Hydro electric power station

5.4.28 A number of structures and buildings will be constructed within a compound of approximately 10,000m^2. A draft plan of the compound is illustrated in Figure 5.7. The greatest height of any of these structures will be 8m. As with offshore construction the onshore construction will be built in phases, with one building to house Phase 1 (3MW) built in the first year (Onshore Phase 1) followed by a larger building for Phases 2 to 4 (37MW) built in 2015 (Onshore Phase 2).

5.4.29 The proposed indicative layout of the hydro electric power station is provided in Figure 5.7. In addition to the hydro electric power station, there will be an area of approximately 6000m^2 adjacent to the compound that will be used as a temporary construction area and is therefore be considered part of the construction footprint. This area will be used to store vehicles and materials during construction.

5.4.30 In order to allow construction of the onshore components of the development an access road will be built which will connect the construction site to the A857. The access road will follow an existing minor road for 260m until the point at which the road bends left (Figure 5.2) The access road will be continue in a north westerly direction for approximately 543m by upgrading and widening of an existing track until the point at which the track turns west away from the construction area (Figure 5.2). After this point a new access road approximately 530m in length will be built to the construction site (Figure 5.2). Once complete the access road will be composed of hardcore and will consist of a single track approximately 5m wide.

5.4.31 A track will also be constructed which will be used to transport vehicles from the compound to the either the point at which the pipelines make landfall in the surface laid option or up to two separate locations where the drilling rigs would be located in the HDD option.

5.5 Installation methodology

Offshore

Timing

5.5.1 The installation will be phased over a period of 4 to 6 years with installation of the first phase of 3MWs commencing in summer 2014. The expected installation schedule for all phases is as follows:

- Phase 1 – 3MW- installation starts in 2014;
- Phase 2 – 7MW - installation starts in 2015;
- Phase 3 – 15MW – installation starts in 2016; and
- Phase 4 – 15MW – installation starts in 2017.

5.5.2 Installation of each phase will be broken down into several stages. The indicative schedule of activities for the first 3MW phase which would commence in April 2014 is shown in Table 5.2.

5.5.3 It is expected that for phases 2 to 4 a similar installation schedule will take place between the months of April and October 2015 and the end of 2018. This will be achieved through parallel working.

Table 5.2 Indicative Phase 1 offshore (3MW) installation programme

Phase 1 (3MW) installation Activity	2014										
	F	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Preparation work											
Pile installation											
Oyster WEC installation											
Pipeline installation											
Commissioning											

5.5.4 It is possible that more than 3 piles would be installed in the first year to make maximum use of the jack up barge and other specialised equipment. Up to 10 piles could be installed in the first year.

5.5.5 Once each device is installed it will start operating, pumping high pressure fluid to shore and contributing to the electricity generation, whilst other devices continue to be installed.

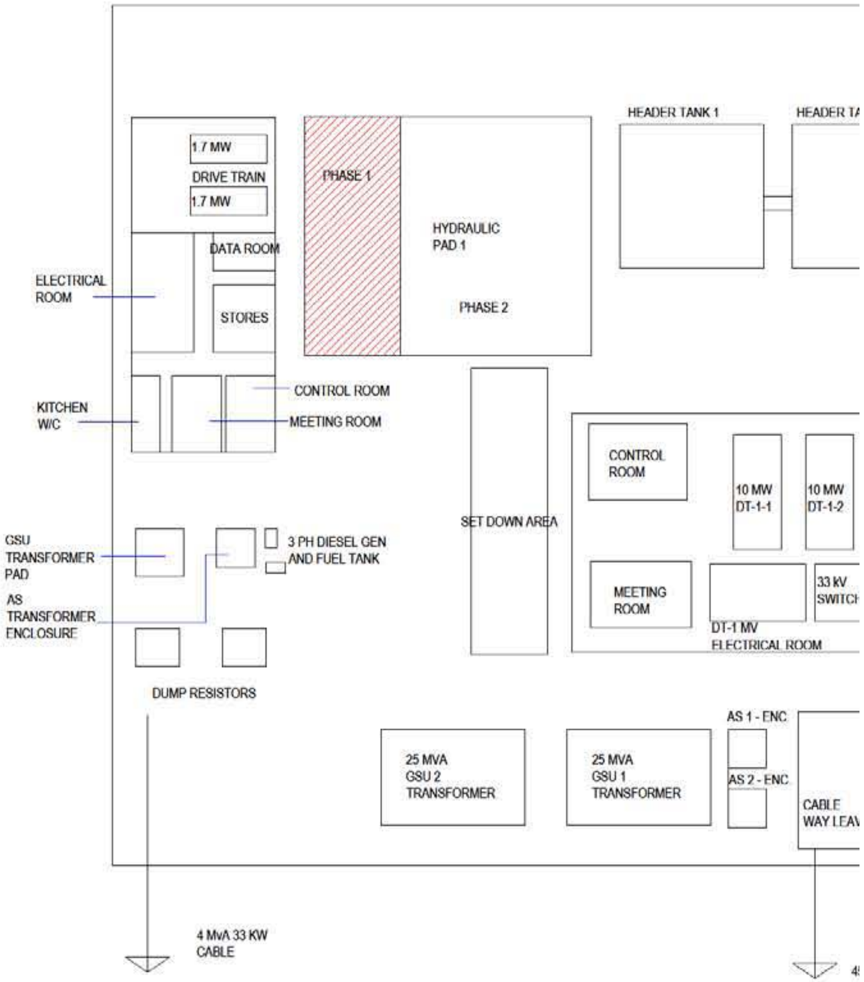


Figure 5.7 Indicative site layout of hydroelectric power station, orientation of buildings will be subject to change. Red shading highlights indicative build during Phase 1 with other buildings being constructed during Phase 2.

Vessel requirements

5.5.6 Table 5.3 below provides details of the vessel requirements for Phase 1 (3MW) of the project and the number of days each vessel is likely to be on site throughout the duration of deployment. These are approximate figures and will be subject to a number of parameters and cannot be accurately defined at this stage.

5.5.7 Pipeline preparation and installation will involve a tug, multi cat and dive boat. These vessels will be on and off site for a period of approximately two months depending on the phasing of pipeline preparation and installation in relation to the rest of the installation schedule.

Table 5.3 Vessel activities

Activity	Vessel type	Days on site (per WEC)
Pipeline preparation and Installation	Tug	3
	2 x Multi-cat	Multi-cat A - 20 Multi-cat B - 3
	Dive boat	20
Piling Operations	Jack up barge	14 (for 3 piles)
	Tug	3
Device installation	Tug	3
	2 x Multi-cat	Multi-cat A - 20 Multi-cat B - 3
	Dive boat	20
Installation of Latching Anchors	Multi-cat	20
	Dive boat	20
Routine maintenance	Multi-cat	Per 5 years - extended 20 day maintenance period
	Dive boat	10 days every 6 months
Decommissioning	Tug	3
	Multi-cat	20
	Dive boat	20

5.5.8 Installation of the sockets and monopiles will be undertaken by a jack up barge such as Seacore's Excalibur (size 60m x 32m x 3m draught). This barge will be supported by a single offshore tug (50 tonnes bollard pull or similar). Accommodation will be provided on board for all operations personnel, with shift changes at weekly intervals. Dive support will be provided by an on-board dive team. Vessel requirements for development of Phases 2 to 4 are estimated to be similar to those that are shown in Table 5.6.

Installation of monopiles

5.5.9 The jack up barge will be mobilised to site under its own power. It will use a marshalling area located in Loch Roag and/or Stornoway and then motor to the site. The legs will be lowered and deployed once on site. All eight legs of the jack-up barge will need to be on the seabed and suitable for weight bearing before operations can commence. In this position the footprint of all eight legs of the jack up barge is likely to be approximately 20m^2. There is the potential that temporary grout bags will be positioned beneath one or more of the jack-up legs to ensure the barge is stable. Once the barge is stable the drilling of the monopile socket will commence.

5.5.10 One monopile socket will be drilled into the seabed from the jack up barge for each WEC, using a single drill bit. The drilling methods to be used will make use of sea water and the drilling fluid, and all drill cuttings will be left offshore.

5.5.11 The steel pile will be then be inserted into the socket and this will be grouted into place. The grout used for this purpose is cement based grout and will be dispensed using a grout line from the jack up barge. There is a potential loss of grout to the sea during routine grouting operations and flushing out of the grout hoses. However the amount of grout being pumped into the socket will be monitored from the surface and by divers and it is predicted that approximately $1m^3$ of grout may be lost from each operation equating to a total maximum loss of $50m^3$. The socket drilling and monopole installation will take up to 100hrs.

Installation of the WECs

5.5.12 Some seabed preparation work may be required for each of the foundations. This is likely to take the form of kelp removal and seabed levelling works. Divers will remove the kelp from the area and the kelp will be discarded offshore. It is hoped that seabed levelling activities can be avoided through micro siting of each WEC but if needed it is likely to involve some rock removal/breaking operations this will be conducted using Cardox systems. If it proves necessary undertake rock breaking activities then an addendum will be submitted to accompany this ES which will investigate and assess the impacts of this activity.

5.5.13 Final assembly of the WECs will be carried out at a fabrication yard with direct access to the sea and the WECs will be towed by sea to Lewis. Following transportation of the WECs to Lewis, a facility is required where WECs can be offloaded. This is likely to be the Port of Stornoway on the east coast of Lewis. At this location the WECs will be moored against a quay wall for inspection and preparatory work for installation. The WECs will then be towed to a sheltered harbour in Loch Roag before being towed into position and installed.

5.5.14 Installation of the WECs will be achieved using one offshore tug (50 tonnes bollard pull or similar) plus two further work boats (multicats or similar) and a dive support vessel. Accommodation will be provided on these vessels for all operations personnel and two shifts will allow 24 hour working.

5.5.15 Four mooring anchors (See ***Installation of anchors*** below for more detail) will be installed on each side of the WEC. Mooring anchors will be used to assist in securely lowering each Oyster WEC onto its foundation monopile, and for maintenance operations throughout the life of the project.

5.5.16 The WECs will be towed to site by the tug vessel and will be installed one at a time. The WEC will be floated over the pile and into position using tugs and then ballasted down to the pile in combination with a winch system (using the mooring anchors) to engage with the pile. The Oyster WEC will make a mechanical connection to the pile and will not be grouted.

Installation of landing platform

5.5.17 Once the WEC has been installed a landing platform will be installed on the shoreward side of the WEC. This will be pinned to the seabed using up to 20 large rock anchors. Grout bags may be used to support the platform, and these will be held in place by the rock anchors.

Installation of pipelines

5.5.18 All pipelines to be installed in the offshore environment (shore pipelines, common pipelines, and WEC pipelines) will be manufactured at an existing facility that is yet to be determined (on either in Lewis or the mainland) and will be towed to site in one length. This is likely to involve one lead vessel and a trailing tug. The pipelines will be towed empty (air filled) and supported with additional buoyancy and chains for stabilisation. If the shore pipelines are directionally drilled these pipes will be installed from the offshore location and will be pulled through the boreholes using a leader line.

5.5.19 Divers will remove kelp from the area up to 10m wide around where the surface laid pipelines will be installed. The kelp will be left offshore. Some seabed levelling works may also be required (see *Seabed Preparation for WECs* above for methods) as well as insertion of grout bags into any gullies in the seabed over which the pipelines will be laid. Once the seabed preparations are complete the pipelines will be flooded with seawater and lowered to the seabed.

5.5.20 Prior to installation of the pipes at the common landing area (Figure 5.6) or at the separate landing areas the beach will be prepared to provide a level corridor on which to lay the pipes. The footprint for the construction corridor is 20m for each set of pipelines (a set of pipelines consist of one high and one low pressure pipeline) within the surf zone.

Installation of anchors

5.5.21 A number of different anchors will be used to secure the infrastructure to the seabed. These include:

- Rock anchors,
- Mooring anchors, and
- Stabilisation anchors,

5.5.22 Rock anchors consist of a single pin which will be driven and grouted into the rock using divers supporting rock drills. It is anticipated that two sizes of rock anchor will be used in the Lewis array:

- Small rock anchors: Approximately 25mm in diameter and 0.5m in length ; and
- Large rock anchors: Approximately 50mm in diameter and 1.5m in length.

5.5.23 Mooring anchors will be used to winch the WECs into place & for mooring vessels during installation, operations and maintenance and will consist of three large rock anchors 50mm in diameter and 1.5 long an anchor plate and a shackle (Figure 5.8). Mooring anchors are likely to be placed nearby the Oyster devices or on the seaward side of the devices. Holes for the three rock anchors will be drilled using a triangular template. The pins will then be securing in place using a Hilti concrete dispensed with a standard injection system.

5.5.24 Stabilisation anchors which are used to secure pipelines to the sea bed will comprise of a collar around the pipeline, possibly a grout bag under the pipeline and up to six small rock anchors (see above). Stabilisation anchors will be placed approximately every 50m along the all surface laid pipeline (although they may be placed at smaller intervals when the seabed is uneven).

5.5.25 The larger rock anchors (50mm in diameter and 1.5m long) will be used to hold both the landing platforms and the manifolds in place. Up to 20 rock anchors will be used for each landing platform and up to 16 will be used for each manifold structure.

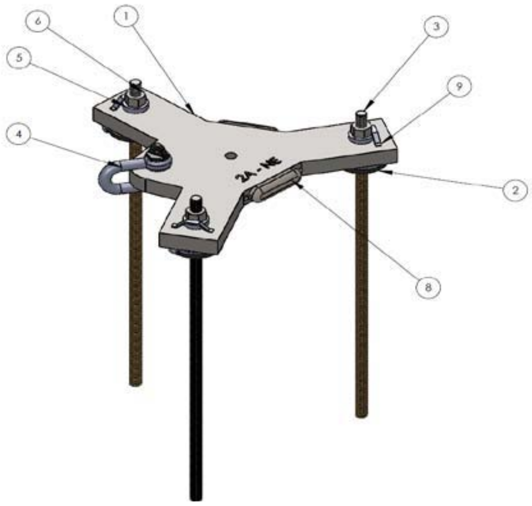


Figure 5.8 illustration of rock or stabilisation anchor consisting of three individual poles drilled and grouted into the bedrock. 1. Anchor Plate, 2. Grout seal, 3.threaded stud, 4. "D" Shackle, 5. Oversized washer, 6. Heavy hex nut, 7. Jubilee clip, 8. Anode, 9. Locking plate

Minor resupply

5.5.26 The jack up barge will remain on site for up to several weeks at a time. The tug will be used to ferry supplies and perform crew transfers to a nearby port, situated in Loch Roag.

Major resupply

5.5.27 Once the jack up barge has installed all the piles it is able to fit on its deck (probably between 2 and 6), it will need to return to shore to collect more piles and grout. This could either be a return to the mobilisation port, or may be a different port. Alternatively, the piles and grout silos could be transported by flat top barge to a sheltered anchorage in Loch Roag and the jack up could lift the equipment directly from this barge onto its deck.

5.5.28 During construction up to three WECs will be stored (wet storage) in Loch Roag at any one time. They will be anchored to the seabed using at existing designated anchorages and existing anchorage points, and the WECs will remain floating at this site. An separate application for a licence to conduct mooring activities within Loch Roag will be made if appropriate.

Onshore

Timing

5.5.29 It is currently proposed that the construction of the hydro electric power station will occur in two phases however this may change as the project develops.

Phase 1 (3MW)

5.5.30 Onshore Phase 1 will consist of the building of a 3MW hydroelectric power station and construction of this will commence in August 2013 (Table 5.4).

Table 5.4 Indicative Phase 1 (3MW) onshore installation programme

Installation activities	2013					2014												2015	
	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F
Phase 1																			
Pre civils works including works associated with upgrade & extension of the road																			
Horizontal Directional Drilling (if option is taken forward																			
Main Civils work including works associated with the construction of the hydroelectric power station																			
Phase 2 (37MW) including works associated with the construction of the second hydroelectric power station																			

5.5.31 The Phase 1 building is likely to accommodate the following elements:

- 2 x drive trains , each one consisting of 2 Pelton wheel turbines within a common enclosure, driving a shaft with 1 flywheel per drive train and 1 generator per drive train;
- 2 banks of power electronic inverters to convert generator output to grid frequency and voltage;
- Header water tank vented to the environment at ambient pressure;
- Filtration system;
- 2 x step-up transformers (1 per drive train) between the generator output and grid connection point;
- Electrical system protection to protect itself and the grid;
- Additional transformer to convert grid voltage to 'step down' to provide mains voltage to the site;
- Onshore accumulators connected to the pipelines which are used for smoothing the flow of pressurised water;
- Six Dump resistors which are used in any sort of emergency to shed power quickly (it is not confirmed whether these will be included but it is likely);
- Operator's rest/office area, workshop and switch room;
- Pipelines from the onshore facility to an exit point on the seabed near to the location of the Oyster devices;
- Diesel generator; and
- All utility (water, electrical and communications) services into the building.

Phase 2

5.5.32 Construction of phase 2 of the onshore hydro electric power station is currently scheduled to start in May 2014 (Table 5.4). Phase 2 will consist of the construction of a second building which will accommodate the equipment for the additional 37MW of power generation. The onshore infrastructure will include much the same elements as the Phase 1 building but will be scaled up to accommodate the generation of 37MW of electricity. See Figure 5.7 for further indicative information.

Foundations

5.5.33 The type of foundation that will be used depends on the depth of the poor ground conditions. If the poor ground conditions persist for more than two metres it is likely that a reinforced concrete raft foundation system will be used; or if the depth of the poor ground conditions are relatively shallow then the surface layers will be removed and the reinforced concrete foundations will bear directly onto the rock.

Pipeline installation

5.5.34 If the HDD option is taken forward for installation of the shore pipelines there will be two possible methods:

Option 1 – Drill up to 32 boreholes from either one or two separate locations within the onshore pipeline installation area (Figure 5.2).

Option 2 – Drill the boreholes from offshore locations and string and pressure test the pipelines at an alternative site and push them into the boreholes from an offshore location.

5.5.35 Drilling will be conducted using a non-oil based drilling fluid such as bentonite (See Table 5.5 for detail on this fluid) and drill cuttings will be collected onshore and disposed at a local waste site

Construction period

5.5.36 The minimum construction period for phase 1 of the onshore elements is predicted to be 12 months with a maximum period of 15 months. Working hours are most likely to consist of a 12 hour day Monday to Saturday. If the HDD option is chosen for the installation of the pipelines (See Sections **Directionally drilled** above) then operation may be required to be 24 hours a day and in this situation consultation will occur with the Western Isles Council.

5.6 Commissioning

5.6.1 Lewis Wave Power will commission the different phases of the Lewis wave array according to a written commissioning plan. The key milestones of this plan are the commissioning of sub-systems followed by commissioning of the system as a whole including:

- Pressure testing;
- Electrical component testing;
- Visual examinations and functional testing of the mechanical, electrical and instrumentation components; and
- Offshore commissioning, post-installation seabed survey and technical survey of the Oyster WECs.

5.6.2 Following successful commissioning, the commissioning contractor will submit a comprehensive documentation package confirming the system is ready to operate which Lewis Wave Power will accept once they are satisfied and operations will commence.

5.7 Operation

5.7.1 Once operational the oscillating action of the wave will move the WECs flap at approximately the same speed and timing as the passing wave. This movement will drive hydraulic pistons which will pump pressurised fluid (see below) back to the shore through the pipeline system. The onshore hydro electric power station will then convert the hydraulic pressure and flow via a pelton wheel turbine which in turn drive electrical generators.

5.7.2 The hydraulic fluid contained within the pipeline system will be fresh water that contains an additive to increase the lubricity of the working fluid. This lubricity is necessary to achieve the required sealing life and ensure maintenance is required only once every five years. Small quantities of other oils fluids and gels are also required in other systems within the Oyster device. Table 5.5 summaries the fluid inventories in the different systems for the entire wave array.

Antifouling and corrosion protection

5.7.3 Experience from the Oyster project at the Billia Croo site in Orkney is that over time an increase in algal growths and encrusting growths such as barnacles occurred on the Oyster device. Cleaning and pressure washing of the growths was required to enable some offshore maintenance operations (e.g. tightening bolts or connecting hoses). Marine growth (biofouling) has not been substantial enough to have an impact on the performance of Oyster 1, neither has it had a significant impact on the ability to maintain and operate the device. The Oyster WECs to be deployed in Lewis are constructed from fibre reinforced polymer (FRP) or composite materials (see section on Device Specifications) and no antifouling coatings will be used. Corrosion protection on sections constructed from steel will be provided by a combination of coatings and cathodic protection.

Daily operation

5.7.4 The system is designed so that the offshore components are as simple and as reliable as possible. The operation of the offshore part of the project will not rely on any electrical components or active control functions operating in the marine environment.

5.7.5 Once all four phases of the development have been installed and are operational the nominal peak output of the entire array will be approximately 40MW with a predicted average output of approximately 11.3MW. During periods of low wave action the output of the array may fall to 0MW.

Maintenance and servicing requirements

5.7.6 The Lewis development has been designed for minimum maintenance of the offshore equipment, and for easy maintenance of the onshore hydroelectric station. Both onshore and offshore equipment is designed for an operational life of 20 years.

5.7.7 The operational philosophy is to monitor the performance of the offshore equipment using Supervisory Control And Data Acquisition (SCADA) and data from the offshore controls/instrumentation system. Inspection will be performed on typically 6 month intervals, or at any other time if SCADA records indicate any anomalous behaviour which would justify an inspection. It is likely that visual inspections will be more frequent during the early operational years but will become less frequent with experience of Oyster operational performance. These inspections may lead to minor intervention or repair activity.

Table 5.5 Fluid Inventory for all components of the Lewis Wave Array

Location of Fluid	Type of Fluid	Quantity	Pathway to the environment	Risk of Leak/ Discharge
Hydraulic fluids In High and Low Pressure pipelines	**Fresh water** with Eco Stack Magic and Agent 70 (see below)	Total hydraulic fluids in the system are likely to be a maximum of 5000m^3 Lewis Wave Power are currently attempting to reduce the total system volume.*	During commissioning activities the system would experience some losses, for example during the 'hook up' of pipelines. This would be minimised as much as possible by circulating only water (with no additives) and adding the Eco Stack Magic and Agent 70 once commissioning activities have been completed. Maintenance activities are likely to be undertaken every 5 years. Maintenance activities would involve changing out of the removable hydraulic modules. This could result in the discharge of some hydraulic fluid but every effort would be taken to reduce this.	Low risk – some fluid could be discharged during maintenance activities
	Eco Stack Magic hydraulic additive to improve lubricity	5% of the Hydraulic fluid (see above)		
	Agent 70 defoaming agent	0.1% of Hydraulic fluid (see above)		
Umbilical – Fibre optic cable gel (located within pipelines	**Sepigel** – Thixotropic hydrogen scavenging gel	Estimated at 30 litres for entire system	Accidental leaks due to damage to the cable.	Low risk - this would not be discharged to the sea unless the umbilical is accidently cut/severed
Monopile socket	**Cement based grout**	80m^3 per pile (up to 4000m^3 in total)	Small amounts of grout will be lost to the environment during the grouting of piles (estimated at 1m^3 per pile). Attempts will be made to limit this by monitoring the amount of grout dispensed at each monopile and having observer divers present. In addition gout will be lost to the marine environment with the flushing the grout hoses.	High risk – low impact Approximately 50m^3 of grout will be lost to the environment during pile grouting and a further unknown quantity through flushing. The grout is considered nontoxic.
Pipelines	**Fluorescein Dye**	Unknown	It may be necessary to test for leaks in the pipelines by flushing fluorescent dye through the system. If a leak is present then quantities of this dye will be lost to the environment.	High risk- low impact If a leak is present in the system an unknown quantity of dye will be lost to the environment.
Rock Anchors	**Hilti Mortar**	1 litre (L) per large rock anchor (Maximum of 2200L)	The Hilti mortar will be in injected to secure rock anchors. The mortar dries very quickly and small amounts may be lost to the environment. Loss to the	High risk- but small amounts

Table 5.5 Fluid Inventory for all components of the Lewis Wave Array				
Location of Fluid	Type of Fluid	Quantity	Pathway to the environment	Risk of Leak/ Discharge
		0.1L per small rock anchor (maximum of 470.4L)	environment will only occur during construction	
All offshore steel infrastructure	**Interzone 954** White **Paint.**	Unknown	All offshore steel components will be painted offsite prior to installation and therefore the paint will only enter marine environment once it has set.	Low risk
Drilling Fluids	**Bentonite**	Unknown	At breakthrough with either the seabed or the terrestrial environment small quantities of drilling fluid will be lost to the environment.	High risk however Material Safety Data Sheet (MSDS) indicates that the substance is not likely to cause any negative affect to the environment

* Reduction of the total volume may be achieved by increasing the pressure in the pipelines which reduces the amount of fluids required in the system.

5.7.8 Major intervention activity is planned for every five years. The major offshore components (cylinders, check valves, accumulators) are designed for five year maintenance intervals.

5.7.9 Leak testing may need to be carried out using an environmentally friendly dye (Fluorescein Dye Liquid, used for Oyster 1 and approved for use by SEPA) which is put into the pipelines from shore to highlight where, if any, a leaks may be present offshore. Use of the dye relating to discharge into the marine environment will be discussed and agreed with MS-LOT and/or SEPA.

5.7.10 If biofouling or re-growth of kelp is proving to cause a hindrance during vital maintenance operations then cleaning and pressure washing, or small amounts of kelp clearance, in the areas of the Oyster device where maintenance is required will be carried out. This is likely to take place during planned maintenance activities.

5.7.11 Onshore equipment will be inspected and maintained according to manufacturer criteria. The onshore hydroelectric power station will consist of two or more drive trains, which can be run independently of each other. This will allow inspection and maintenance activity to proceed on one drive train while the other(s) drive train(s) are still operating. Maintenance can therefore be performed during milder weather conditions without loss of any power generation.

Decommissioning

5.7.12 Lewis Wave Power is committed to decommissioning the Lewis Wave Array at the end of its life and removing all equipment from the deployment site to a standard meeting industry best practice at the time. A Decommissioning Programme agreed with the DECC and MS-LOT will be developed pursuant to Chapter 3 of the Energy Act 2004. Decommissioning of the Lewis Wave Array will in effect be a reversal of the installation process.

Offshore

5.7.13 The phases of decommissioning, repeated for each device will be:

- Mobilisation of vessels to site;
- Secure the Oyster device;
- Cut interconnecting pipelines and retrieval to the vessel deck;
- Attachment of recovery rigging;
- Cutting of piles at seabed and allowing the Oyster device to float to the surface (with piles attached);
- Tow the Oyster device to the selected port for disassembly;
- Retrieval of all equipment and materials from the seabed onto the decommissioning vessels;
- Seabed reinstatement including cutting of piles down to seabed level where required and seabed clear up; and,
- A post decommissioning seabed survey will be carried out.

Onshore

5.7.14 All onshore infrastructure will be removed as required and the site will be returned as far as possible to the current baseline situation as described in *Chapters 8 Soils, hydrology,* *hydrogeology* and *Chapter 13 Terrestrial and intertidal ecology*. If required discrete elements such as the access road may be left insitu if these provide a benefit to the local community. This will be subject to agreements which will be finalised during the decommissioning process.

5.8 Footprint of the development

Offshore

5.8.1 The surface laid option for installation of shore pipelines discussed above will result in the largest area of disturbance to the seabed (compared to the HDD option). The total area of seabed directly affected by construction of the development will be a maximum area of 259,696m^2. A breakdown of the various elements of the project is provided in Table 5.6 and an explanation for each calculations included in Table 5.6 is provided in Appendix 5.1.

Table 5.6 Calculations of the "Area of disturbance" or "Project footprint" as a result of the construction phase

Parameter	Minimum Area (m^2)	Maximum area (m^2)
WEC and gap fillers	6,500	40,695.5
WECs Pipelines	0	2,500
Common Pipelines	20,000	35,000
Common to shore pipelines	16,000	144,000 (extremely cautious estimate)
Landing platforms	4,000	10,000
Monopiles*	785.40	981.75
WEC connector Manifold	0	1,800
Pipeline connector manifold	200	800
Mooring anchors for WECs	320	400
Jack up barge footprint	800	2,000
Total	**46,520**	**259,696**

*The calculation for the monopoles is not included in the total as this area has already been accounted for in the WEC and Gap fillers calculation.

Total volume of seabed materials excavated

5.8.2 The HDD option for installation of pipelines to shore will result in the maximum amount rock extraction (compared with the surface laid option). The maximum predicted amount extracted materials as a result of the offshore drilling operations is predicted to be 12,770m^3. A breakdown of the various elements that make up this calculation is displayed in Table 5.7 and explanations of the calculations are provided in Appendix 5.2.

Table 5.7 Calculations of the volume of excavated materials

Drilling requirement	Minimum Area (m^2)	Maximum area (m^2)
Monopiles	11781	14726
Mooring anchors	2.83	3.53
Stabilisation anchors	0.1	1.15

Table 5.7 Calculations of the volume of excavated materials		
Drilling requirement	**Minimum Area (m^2)**	**Maximum area (m^2)**
Landing platform Anchors	0.94	2.95
HDD		10,127
Total with surface laid option	**11785**	**14734**
Total with HDD option		**24860***

*The stabilisation anchors will not be required if the Shore pipelines are HDD drilled and therefore they are not included within this calculation.

5.8.3 If the HDD option for shore pipeline installation is taken calculations suggest that the 10,127m^3 (Table 5.7) will equate to a maximum weight of approximately 29,035 tonnes of rock. This would mean that the HDD option will result total weight of extracted materials of approximately 65642 tonnes (with the addition of rock extraction for monopoles, mooring anchors and landing platform anchors).

Onshore

5.8.4 The total area of land to be directly affected by the proposed development will be a maximum of 89707m^2 if the surface laid option is taken forward and 91,507m^2 if the HDD option is taken forward. A Breakdown of the various components of the onshore works for both options is displayed in Table 5.8 with and explanation of each calculation in Appendix 5.3.

Table 5.8 calculations of the total area of land "taken" by the development if the surface laid option is used for pipeline installation.		
Parameter	**Minimum Area (m^2)**	**Maximum area (m^2)**
Onshore pipeline Trench Area	3200	58400
Hydroelectric power station compound	10000	10000
Temporary construction area	6000	6000
Access road construction/widening	13879	13879
Shore access track	1600	4600
Drilling rig platforms	900	1800
Total with surface laid option	**34679**	**92879**
Total with directional drilling option	**35579**	**94679**

5.9 Health, Safety and Environmental Management

5.9.1 The design and colouring of the Oyster will be agreed with the Northern Lighthouse Board with regard to navigational safety. The suggested design and colour is for the top part of the flap and the edges of each end of the device to be coloured yellow with an Aquamarine Power logo in blue. The rest of the device to be painted white.

5.9.2 A number of requirements and recommendations have been detailed in the Navigational Safety and Risk Assessment for more information regarding these please refer to *Chapter 15 Shipping and Navigation* and the NRSA itself (Appendix 15.1).

5.9.3 Consultation with the Northern Lighthouse Board and Marine and Coastguard Agency will confirm the eventual requirements for navigational marking of the wave array. It is unlikely that there will be a requirement to light the individual Oyster WECs.

5.9.4 During the construction phase some external lighting may be required during site works to ensure the Health and Safety of Lewis Wave Power staff and its contractors. The lighting on the site will include the construction around the onshore compound (Figure 5.2) which would only be used during the construction day (which will be 12hrs long) when required. In addition lighting will also be situated around the HDD drilling rigs. The HDD operations will be carried out in 24hrs a day but will be limited either one or two small (30m by 30m) areas adjacent to the coast.

5.9.5 To comply with Health and Safety requirements for Lewis Wave Power staff and its contractors some external lighting would be required during the permanent operations of the site to ensure safe entry & exit to site. Operational external lighting would be required to light the hydroelectric power station. This would be trigger lighting, installed to operate when staff are in the area during hours of darkness. Some additional external lighting for outdoor work would also be required. This would operate on a switch on/off basis.

6. REGULATORY AND POLICY CONTEXT

6.1 Introduction

6.1.1 This chapter identifies the international and European legislative drivers and commitments in the areas of climate change, decarbonisation and renewable energy, and the corresponding UK and Scottish policies which set the objectives and targets to meet these legal obligations. This chapter also shows how the Lewis Wave Power project fits within all relevant policy frameworks and, as such, how it will make a significant contribution to meeting these targets.

6.1.2 This chapter outlines the regulatory and consenting requirements relating to the construction, operation and decommissioning of the development, including the offshore Oyster devices, associated pipelines and infrastructure and onshore generation station.

6.2 Policy context for energy generation

6.2.1 This section identifies the policy context and drivers for renewable energy developments at an International, European, UK and Scottish level.

6.2.2 With regard to the onshore elements of the project, a review of how the project fits within the planning context of the local authority is made.

<u>International energy context</u>

6.2.3 The UK plays a leading role in tackling climate change at an international level, working through the EU, G8 and UN Framework Convention on Climate Change.

6.2.4 The 1997 Kyoto Protocol set internationally agreed and binding targets for reducing emissions of greenhouse gases up to 2012. Through the Kyoto Protocol, the UK has a legally binding target to reduce emissions of greenhouse gases by 12.5% below 1990 levels in the period 2008-2012.

6.2.5 The EU Climate and Energy package, formally agreed in April 2009, builds on Kyoto and commits the EU to achieving the '20-20-20' targets: a 20% cut in emissions of greenhouse gases by 2020 compared with 1990 levels; a 20% increase in the share of renewables in the energy mix; and a 20% cut in energy consumption.

6.2.6 The EU has established an EU Emissions Trading System (EU ETS) to help meet these targets. Member states must ensure that each industrial or electricity generation plant covered by the scheme holds a greenhouse gas emissions trading permit - in effect, a licence to operate and to emit CO_2. Each permitted installation will receive an allocation of allowances, based on the Member State's National Allocation Plan. Companies that emit less CO_2 than envisaged in the cap arrangement can sell or bank surplus trading permits. However, if they exceed their cap, they will have to buy additional permits. The ETS therefore provides financial incentives for large energy users to reduce CO_2 emissions.

6.2.7 EU energy policy also sets targets for sectors not covered by the EU ETS, namely Directive 2001/77/EC of the European Parliament and Council, 27th September 2001, on the promotion of electricity from renewable energy sources in the internal electricity market, and Directive 2009/28/EC On the Promotion of the Use of Energy from Renewable Sources and Amending and Subsequently Repealing Directives 2001/77/EC and 2003/30/EC.

6.2.8 The EU is focussed on energy security issues (The EU Energy Policy: Engaging with Partners beyond Our Borders), with security and diversity of supply key threads. Renewable energy is one of a number of potential contributors to diversity of supply.

UK energy context

6.2.9 This section summarises significant UK policy developments relevant to renewable energy over the past decade, with the key legislative and policy instruments detailed in Table 6.1.

6.2.10 Increasing energy provision from renewable sources is seen as key to achieving the desired low-carbon energy future. The UK has signed up to the EU Renewable Energy Directive, which includes a UK target of 15% of energy from renewables by 2020.

6.2.11 Approaches to achieving this target have most recently been set out in the Government's UK Renewable Energy Strategy, published in 2009. The Strategy includes measures to strengthen the UK renewable industry and whilst acknowledging the importance of onshore and offshore wind in contributing to renewables targets, the strategy also recognises the potential contribution that could be made by wave and tidal energy.

6.2.12 More recently the UK Government has underpinned its long term support for marine renewables by proposing a support level of 5 Renewable Obligation Certificates (ROCs) for marine energy in the UK - a proposal which is mirrored by the Scottish Government.

Table 6.1 UK energy and climate change Policies and Acts

POLICY	KEY ELEMENTS
UK Climate Change Programme (2000)	Sets out package of policies to deliver UK's Kyoto target. Policies included stimulating new, more efficient sources of power generation.
DTI White Paper (2003)	Expressed overall priorities for UK energy policy in the first quarter of the 21st Century. Aims including cutting CO2 emissions by 60% by 2050 and maintaining the reliability of Britain's energy supplies.
Energy Review (DTI, 2006)	Proposed to strengthen the framework that supports the development of renewable technologies in the UK in order to achieve a target of 20% electricity from renewable energy by 2020.
Energy White Paper (2007)	Entitled 'Meeting the Energy Challenge', detailed how measures set out in the 2006 review were being implemented in the UK to reduce CO2 emissions and secure clean and affordable energy. The white paper identified diversity of supply and energy security as key drivers, in addition to climate drivers.
Energy Act (2008)	Implements the legislative aspects of the 2007 White Paper and reflects the availability of emerging renewable technologies.
Climate Change Act (2008)	Creates a new approach to managing and responding to climate change in the UK and sets a legally binding target of a reduction in emissions of 34% by 2020 against a 1990 baseline.
Low Carbon Transition Plan (DECC, 2009)	Sets out the UK Government's response to climate change by setting out a Transition Plan for becoming a low carbon economy. This plan will deliver emission cuts of 18% on 2008 levels by 2020 (and over a one third reduction on 1990 levels), and updates the 2003 White Paper to state that by 2020 the UK will achieve a target of 30% of its electricity from renewable sources.
UK Renewable Energy Roadmap (DECC, 2011)	The Renewables Roadmap out a comprehensive action plan to accelerate the UK's deployment and use of renewable energy. It eight technologies that either the greatest potential to help the UK meet the 2020 target in a cost-effective and sustainable way, or offer great potential for the decades that follow. These technologies include marine energy technologies.

Table 6.1 UK energy and climate change Policies and Acts	
POLICY	**KEY ELEMENTS**
Renewable Obligation (ROCS) Banding Consultation. DECC (2012)	Review of the current system of Renewable Energy Obligation Certificates (ROCS), proposing 5 ROCS for wave and tidal energy.

Scottish energy context

6.2.13 The UK is a signatory to the EU Renewable Energy Directive, which includes a UK target of 15% of energy from renewable sources by 2020. Thirty percent of this energy is expected to have to come from renewable electricity generation[1]. Scotland's potential to produce marine renewable electricity is vast, with the total wave and tidal resource in Scotland estimated at 14 GW and 7.5 GW respectively (Scottish Government, Undated).

6.2.14 The seas around Scotland have the potential to provide a sustainable, renewable energy source with:

- Up to a 25% of Europe's tidal power and 10% of its wave power
- Around 25% of the European offshore wind resource potential[2]

6.2.15 In all, Scotland is estimated at having the resource capacity to produce 12 GW of energy from marine renewable and offshore wind sources by 2020[2].

6.2.16 The Scottish Government is firmly committed to the development of a successful marine renewable energy industry in Scotland. In 2011 it committed to achieving the EU 2020 target (20% of EU's energy consumption from renewable sources by 2020) through a stated target of meeting 100% of Scotland's electricity demand from renewable sources by 2020.

6.2.17 In September 2008 The Scottish Government published its future approach to energy policy, this recognises that marine renewable energy has a part to play in future energy supply and as part of its strategy to reduce greenhouse gases and tackle global warming.

6.2.18 In 2007 the Scottish Government commissioned a Strategic Environmental Assessment (SEA) to examine the potential effects on the environment from the development of wave and tidal power. The primary objective of the SEA was to assess, at a strategic level, the effects of meeting or exceeding the Marine Energy Group's (MEG's) estimate of 1,300 Megawatt (MW) of marine renewable energy capacity around Scotland by 2020. The results of the SEA show that it may be possible to meet MEG's estimate of 1,300MW of capacity with, generally, minor effects on the environment. The SEA Environmental Report does note, however, that there are notable gaps in knowledge and that there are important exceptions to this general conclusion. Furthermore, the likelihood of the more significant effects occurring is very dependent on the particular characteristics of the projects being developed, in combination with the locations where they are being deployed.

6.2.19 The Lewis Wave Array will help towards meeting the renewables targets set by the Scottish and UK Governments. Most importantly, the project represents a significant and exciting step forwards in proving the viability of wave energy and to aiding in the development of more of these projects in the future.

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[1] http://www.decc.gov.uk/en/content/cms/meeting_energy/renewable_ener/renewable_ener.aspx
[2] http://www.scotland.gov.uk/Topics/marine/marineenergy

The Climate Change (Scotland) Act 2009

6.2.20 The Climate Change (Scotland) Act introduced binding targets on the Scottish Government to reduce net Scottish greenhouse gas emissions by 83% by 2050 from 1990 levels; with an interim target of 42% by 2020. The Scottish Governments' Renewables Action Plan published in July 2009 and most recently updated in March 2011, reiterates the targets set in 2007. Support for renewables development, including wave, is contained in National Planning Framework (NPF) 2 and Scottish Planning Policy (SPP).

6.3 Marine and terrestrial planning in Scotland

6.3.1 The Marine (Scotland) Act 2010 and the Marine and Coastal Access Act 2009 (MCAA) have introduced a marine planning regime for the UK marine area. The Scottish Government has responsibility for marine planning within both STW (0 -12nm offshore), and within the Scottish Renewable Energy Zone (REZ) (12 – 200nm offshore).

6.3.2 In accordance with the MCAA, a joint Marine Policy Statement has been prepared by the UK Government in conjunction with the Scottish Government and the devolved administrations of Wales and Northern Ireland. In March 2011 the Scottish Government published a draft National Marine Plan which covers both Scottish Territorial Waters (STW) and the Scottish REZ. The draft Plan is currently being consulted upon and is to be finalised in summer 2012. The draft Plan identifies certain key objectives for management of the marine environment. The draft Plan identifies the role offshore renewables can play in promoting economic growth and tackling climate change. The draft Plan also identifies the need for offshore renewables developments to be constructed and operated to minimise noise and collision risk to Best Available Technology Not Entailing Excessive Costs (BATNEEC) standards.

6.3.3 The Marine (Scotland) Act 2010 requires the Scottish Government to establish marine regions. The number and extent of the marine regions have yet to be established. Following creation of the marine regions, regional marine plans will be put in place with policies applicable at a local level. The Marine (Scotland) Act 2010 and MCAA also provide for the creation of Marine Protection Areas (MPAs). MPAs will be afforded particular protection on account of their nature conservation, historic or research and development value.

6.3.4 The Scottish Government's Strategic Environmental Assessment (SEA) on Marine Renewables in 2007 concluded that the deployment of new technology, particularly marine renewable devices, would carry a degree of uncertainty regarding potential associated environmental impacts. As a result, a risk-based 'Survey, Deploy and Monitor Policy' is being developed to enable efficient, sustainable deployment of wave and tidal energy devices.

6.3.5 The National Planning Framework (NPF) is prepared by the Scottish Government provides the long term strategy for development in Scotland over a 25 year period. The NPF provides an important context for renewable energy development and supporting electricity infrastructure.

6.3.6 The current NPF, NPF2, was published in June 2009. The National Planning Framework is supported and underpinned by the Scottish Planning Policy (SPP), Planning Advice Notes (PANs), and a number of Circulars. The consolidated SPP supersedes and replaces the SPPs and National Planning Policy Guidance (NPPG) series (including SPP 6 Renewable Energy). The new SPP includes policies on a range of topics, including renewable energy.

6.3.7 Development plans and statements of policy are a material consideration with regard to the authorisation of electricity generation schemes under Section 36 of the Electricity Act 1989. The draft National Marine Plan states that legislation is to be brought forward to ensure Marine Plans are a material consideration for land use planning decisions.

6.3.8 In relation to renewable energy, SPP states that it expects wave energy to form part of the renewable energy mix and encourages planning authorities to 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. Such issues are recognised as being likely to include impact on the landscape, historic environment, natural heritage and water environment, amenity and communities, and any cumulative impacts that are likely to arise.

6.3.9 The local authority, Comhairle nan Eliean Siar (Western Isles Council), adopted the statutory Western Isles Local Plan in 2008. Working with the Western Isles Structure Plan (2003), the Local Plan forms the Development Plan for the area in which the onshore components of the proposed project fall. It is used by the council to assess and determine planning applications. The Planning etc. (Scotland) Act 2006 establishes a new development planning system. In future the statutory development plan for the Outer Hebrides will comprise a single Local Development Plan (LDP). The proposed Outer Hebrides Local Development Plan was issued for consultation in September 2011, and the proposed Lewis Wave Development meets the requirements of the proposed Plan regarding renewable energy development.

6.3.10 Development Plan policy currently supports the development of renewable energy projects, including both large and small scale wave developments.

Marine (Scotland) Act 2010

6.3.11 In March 2010 the Marine (Scotland) Act received Royal Assent; it provides a framework for the sustainable management of Scotland's seas and one of its key aims is to streamline and simplify the licensing and consenting process for offshore renewable projects.

6.3.12 Projects have historically been required to seek licences and planning consent under several pieces of legislation before development can proceed. Prior to the introduction of the Act, developers would submit licence and planning consent applications to a number of authorities under various pieces of legislation. However, with the introduction of the Marine (Scotland) Act, co-ordinated applications for planning consent and associated licenses (under the Electricity Act, the Coastal Protection Act, and the Food and Environment Protection Act) can now be made via a single point of access, Marine Scotland's Licensing Operations Team (MS-LOT), as part of a unified licensing and consenting process.

The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2000

6.3.13 These Regulations implement the European EIA Directive 1985 (as amended, 2009), and outline the requirement for assessment of the effects of certain public and private projects on the environment. Such projects include the construction, extension and operation of a power station or overhead electricity lines under Sections 36 and 37 of the Electricity Act.

6.3.14 As the development is over 1MW and requires section 36 consent, it is considered to be a Schedule 2 development under The Electricity Works (EIA)(Scotland) Regulations 2000; defined as *"a generating station, the construction of which (or the operation of which) will require a section 36 consent but which is not Schedule 1 development".*

6.3.15 To ensure full compliance with the regulations, Lewis Wave Power will provide an Environmental Impact Assessment to accompany its Section 36 consent application.

6.3.16 Under Regulation 7, the developer (i.e. Lewis Wave Power) is entitled to ask the Scottish Ministers, before submitting an application for a Section 36 consent under the Act, to state in writing their opinion as to the information to be provided in the ES (i.e. to provide a 'Scoping Opinion').

6.3.17 In accordance with Regulation 7, Lewis Wave Power requested a formal scoping opinion in May 2011 (see *Chapter 2 Scoping and Assessment Methodology*) and this scoping report provided a summary of relevant information on the proposed development including:

- A plan which identifies the site which is the subject of the proposed development;
- A brief description of the nature and purpose of the proposed development and its possible effects on the environment; and
- An outline of further information that Lewis Wave Power intends to provide as part of the EIA process.

6.3.18 EIA regulations guidance states that the developer should also submit a draft outline of the Environmental Statement, giving an indication of what they consider to be the main issues.

6.3.19 Once they have all the information they require, the Scottish Ministers are required to consult and obtain the views of the Consultative Bodies defined in the Regulations (the Planning Authorities of the area in which the development is planned, Scottish Natural Heritage (SNH) and the Scottish Environment Protection Agency (SEPA), the developer and other organisations (as they see fit). When the Scottish Ministers issue a Scoping Opinion, they must state what information should be included in the Environmental Statement, giving their reasons why. Marine Scotland provided Lewis Wave Power with the Scoping Opinion in August 2011 (see *Chapter 2 Scoping and Assessment Methodology*).

Town and Country Planning (Scotland) Act 1997

6.3.20 The Town and Country Planning (Scotland) Act 1997 is the principal legislation governing the use and development of land within Scotland.

6.3.21 The Act is supported by various pieces of subordinate legislation, including the Town and Country Planning (Development Management Procedure) (Scotland) Regulations 2008, under which an application for outline planning permission would be considered.

6.3.22 The Town and Country Planning (Hierarchy of Developments) (Scotland) Regulations 2009 consider the scale of the Development, which would constitute a 'major development' under the regulations. This classification necessitates pre application consultation as set out in Part 2 of The Town and Country Planning (Development Management Procedure) (Scotland) Regulations 2008.

6.3.23 The Planning etc (Scotland) Act 2006 amends certain parts of the 1997 Act; including development plan preparation, development control (now known as development management) and enforcement. These changes amended but do not replace the 1997 Act, which remains the principal planning act in Scotland.

6.3.24 The EIA (Scotland) Regulations 2011 must also be considered and the relevant requirements must be satisfied in full, even if the application is for planning in principle.

Energy Act 2004

6.3.25 Sections 105 – 114 of the Energy Act 2004 introduce a decommissioning scheme for offshore wind and marine energy installations. Decommissioning responsibilities are not devolved to Scotland and licensing requirements lie with the Department of Energy and Climate Change (DECC). DECC will consult on a decommissioning plan, and MS-LOT will be involved at this stage. Under the terms of the Act, the Secretary of State may require a person who is responsible for one of these installations to submit (and ultimately carry out) a decommissioning programme for the installation. Lewis Wave Power will produce a decommissioning programme for the Lewis Wave Development to comply with DECC guidance.

Water Environment and Water Services Act (WEWS)

6.3.26 The WEWS Act sets out steps for the implementation of the river basin planning process in Scotland. Section 20 of this Act the sets out a requirement for control regimes to regulate all activities that pose a risk to the water environment. These arrangements were introduced in 2005 via The Water Environment (Controlled Activities) (Scotland) Regulations 2005 **(**CAR**).**

6.3.27 The CAR regulations provide ministers with powers to introduce regulatory controls over activities in order to protect the water environment (freshwater and marine). All point source discharges, abstractions, impoundments and some engineering work require an authorisation under these regulations. Low risk activities are likely to be subject to General Binding Rules (GBRs) and thus a licence is not required. Where activities are not covered by GBRs, the developer will need to apply to Scottish Environment Protection Agency (SEPA) for authorisation.

6.4 Consents and licensing

6.4.1 In order to permit the construction and operation of all components of the proposed wave array, the following consents and agreements will be required:

Offshore element of the project;

- Section 36 of the Electricity Act, 1989; and,
- Section 20 of the Marine (Scotland) Act Marine Licence (replacing Section 5 Part II of the Food and Environment Protection Act (FEPA), 1985 and Section 34 of Coast Protection Act, 1949[3]).

In addition the onshore elements of the project may require;

- Planning permission under the Town and Country Planning (Scotland) Act 1997; and
- Approval of a decommissioning programme under Energy Act 2004.

6.4.2 In addition to the above, further consents may also include:

- Harbour Works Licences from the relevant port or harbour authorities. This may be required for works within the statutory Harbour Authority limits, and where authority has Works Licensing Powers (ability to regulate right of navigation and fishing within area);
- Approvals from Scottish Environment Protection Agency (SEPA) under Section 20 of the Water Environment & Water Services (Scotland) Act 2003 and Water Environment (Controlled Activities) (Scotland) Regulations 2005 for activities liable to pollute or significantly affect the water environment
- Under The Conservation (Natural Habitats, & c.) Regulations 1994 a European Protected Species licence may also be required; and
- A licence may be required for disturbance to basking sharks;

6.4.3 Various guidance documents are being produced by the Scottish Government for marine renewable energy developers and are due for imminent release. At the time of writing Lewis Wave Power is aware of the following:

[3] From April 2011, a Single Marine Licence granted under the Marine (Scotland) Act 2010 and UK Marine and Coastal Access Act 2009 will replace the requirement for Coastal Protection Act consent and a FEPA licence.

- Marine Renewable Licensing Manual (final draft available for consultation[4]);
- Guidance on survey and monitoring for marine renewables deployments in Scotland (draft published on SNH website for review[5]); and
- A review of the potential impacts of wave and tidal renewable energy developments on Scotland's marine environment (awaiting draft).

Electricity Act 1989 ('S36 Consent')

6.4.4 Section 36 of the Electricity Act 1989 is the primary consent required from the Scottish Ministers (administered by Marine Scotland on their behalf) for the construction and operation of a power generating station situated within the territorial sea with a capacity of 1MW or more. Consent for the construction and operation of both phases of the development will therefore be sought under Section 36.

Marine Licence (Section 16)

6.4.5 From April 2011, under the Marine (Scotland) Act 2010 a single Marine Licence has replaced the previously separate FEPA and CPA licences required under the Food and Environment Protection Act 1985 (FEPA) the Coastal Protection Act 1949 (CPA).

6.4.6 A Marine Licence will be required for the Lewis Wave array due to the installation of the support structures, devices and associated cabling being considered as a deposit by construction activity both in the sea and or under the seabed as described within the legislation.

6.5 Conservation Regulations

Habitats Regulations Appraisal

6.5.1 Under the Conservation (Natural Habitats, etc & C.) Regulations 1994 (as amended in Scotland), where a development is proposed in or near to a Natura 2000 site, or in an area recognised as an important site for marine species which are a feature of a Natura 2000 site, the competent authority should determine, and inform the developer as early as possible, on the requirement to undertake an Appropriate Assessment (AA) prior to granting the relevant consents and licenses for development.

6.5.2 The AA tests whether a plan or a project is likely to have a significant effect on the integrity of a European and/or Ramsar site. The Habitats Regulations also require that, in determining whether a plan or project is likely to have a significant effect on a European site the plan or project should be considered both alone and in-combination with other plans or projects.

6.5.3 Consultation with Scottish Natural Heritage (SNH), the statutory advisor to Scottish Government on nature conservation matters has confirmed that the Lewis Wave Array is unlikely to be subject to HRA as the proposed development is sufficient distance from Natura 2000 sites to not to have an potential for significant impact upon those sites.

European protected species (EPS)

6.5.4 For any European Protected Species (EPS)[6]. Regulation 39 of the Conservation (Natural Habitats, & C.) Regulations 1994 makes it an offence to deliberately or recklessly capture, kill,

[4] http://www.scotland.gov.uk/Topics/marine/Licensing/marine/LicensingManual
[5] http://www.snh.gov.uk/docs/B925810.pdf

injure, harass or disturb any such animal. An EPS Licence is required for any activity that might result in disturbance to EPS. In the case of the Lewis Wave Array, SNH has advised that there will not be a requirement for an EPS licence for the current project as outlined in (*Chapter 5 Project description*). They have however advised that if the project were to move to within 50m of a water course or if otters were found during a pre construction survey of the site that an EPS licence would be required. In addition, a licence may be required to cause disturbance to basking sharks.

6.6 Development plans.

<u>Scotland (national) level plans</u>

6.6.1 There will be a single Scottish National Marine Plan, with a pre consultation draft produced for public review in 2011 a consultation draft anticipated in 2012. The plan will be prepared by Marine Scotland and will set national economic, social and marine ecosystem objectives alongside objectives relating to the mitigation of, and adaptation to, climate change. The plan may set out specific spatial requirements for particular types of activity or development where these are of national significance.

<u>Regional level plans</u>

6.6.2 These will be prepared for Scottish Marine Regions to take forward policies and priorities defined in the National Marine Plan. No time frame is currently available for this provision. Regions will be defined by Marine Scotland and managed by a Marine Planning Partnership which will comprise someone nominated by the Scottish Ministers as well as one or more public authorities and/or stakeholders. The Partnership's will prepare a regional plan for their area, which is likely to include a vision for the marine area covered by the plan, management policies for specific sectors, and a framework for decision making in relation to development consents. The regional plans could take around 2 years to produce after the finalisation of the National Marine Plan, so consultation on draft plans in 2014 / 2015 is anticipated.

<u>Terrestrial planning in Scotland</u>

6.6.3 Outline consent for the onshore project components associated with the Lewis Wave Array will be sought under The Town and Country Planning (Development Management Procedure) (Scotland) Regulations 2008.

<u>National planning</u>

6.6.4 Scottish Ministers are responsible for the National Planning Framework for Scotland (NPF) which sits at the top of the policy hierarchy and is the long term strategy for the development of Scotland.

6.6.5 The first NPF (NPF 1) was produced in 2004 and provides a non-statutory spatial planning framework for Scotland for the period to 2025. It identifies key drivers of change in the environment and economy of Scotland and defines strategic infrastructure requirements to provide a basis for future planning.

6.6.6 Several provisions of the NPF are of relevance to the current proposals: for example, the need for sustainable development, and the need to promote and deliver the Scottish

[6] EPS include all cetaceans and otters amongst other species

Government's renewable energy targets and aspirations. The framework also recognises the economic benefits that developing Scotland renewable energy potential could bring.

6.6.7 The second NPF (NPF 2) was published in 2009 and provides an important vehicle for the national debate about the future of Scotland. It will guide and provide a vision for Scotland's spatial development up to 2030, setting out strategic development priorities to support the Scottish Government's central purpose - promoting sustainable economic growth.

6.6.8 The introduction of NPF 2 is a big step towards securing the future of the renewable energy industry in Scotland; the Government clearly states its commitment to realising the power generating potential of all renewable sources of energy. NPF 2 recognises that longer term potential is likely to lie with new technologies such as wave and tidal power, biomass and offshore wind.

6.6.9 Scottish Planning Policy (SPP) is the statement of the Scottish Government's policy on nationally important land use planning matters. It was published in February 2010 as a result of the commitment to proportionate and practical planning policies. The SPP replaces a series of planning guidance documents, providing a shorter, clearer and more focused statement of national planning policy.

6.6.10 The SPP is a statement of Scottish Government policy on land use planning and contains the:

- Scottish Government's view of the purpose of planning;
- Core principles for the operation of the system and the objectives for key parts of the system;
- Statutory guidance on sustainable development and planning under Section 3E of the Planning etc. (Scotland) Act 2006;
- Concise subject planning policies, including the implications for development planning and development management; and
- Scottish Government's expectations of the intended outcomes of the planning system.

6.6.11 SPP contains 'subject policies', one of which relates to renewable energy. The following extracts are taken from this subject policy:

6.6.12 '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. Development plans should support all scales of development associated with the generation of energy and heat from renewable sources, ensuring that an area's renewable energy potential is realised and optimised in a way that takes account of relevant economic, social, environmental and transport issues and maximises benefits.'

6.6.13 'Off-shore renewable energy generation presents significant opportunities to contribute to the achievement of Government targets. Although the planning system does not regulate off-shore development, it is essential that development plans take into account the infrastructure and grid connection needs of the off-shore renewable energy generation industry. Development plans should identify appropriate locations for facilities linked to the manufacture, installation, operation and maintenance of off-shore wind farms and wave and tidal devices.'

Local planning

6.6.14 The Local Development Plan (LDP) for an area comprises both the approved structure and the adopted local plan. The Development Plan relevant to the Lewis Wave Development proposal consists of the:

- Western Isles Local Plan 2008; and
- Western Isles Structure Plan 2003.

6.6.15 The Comhairle nan Eliean Siar (Western Isles Council) has now reached the next stage in the LDP process with the publication of the Outer Hebrides Local Development Plan – Proposed Plan on 16 September 2011. The Proposed Plan sets out the Comhairle's settled view on planning policies and proposals for the Outer Hebrides over the next 5 year period and beyond. Table 6.2 below, identifies where relevant aspects of the LDP have been dealt with in this ES. The relevance of these policies is considered in each ES chapter.

Table 6.2 Adopted Development Plan Policies

ES chapter	Western Isles Local Plan 2008	Western Isles Structure Plan 2003
Chapter 7 Physical Environment and Coastal Processes		RM7 - Coastal Erosion
Chapter 8 Terrestrial Hydrology, Geology and Flood Risk	LP/DM4 - Flooding	DM8- Flooding
Chapter 9 Benthic Ecology	LP/ED4 - Aquaculture and Marine Planning Powers	RM11 - Habitats and Species
Chapter 10 Ornithology	LP/ED4 - Aquaculture and Marine Planning Powers	RM10 - Local Environmental Designations
Chapter 11 Marine Mammal and Basking Sharks	LP/ED4 - Aquaculture and Marine Planning Powers	RM11 - Habitats and Species
Chapter 12 Fish and Shellfish	LP/ED4 - Aquaculture and Marine Planning Powers	RM11 - Habitats and Species
Chapter 13 Terrestrial and Intertidal Ecology	LP/RM3 - Tree Protection and Management LP/ED4 - Aquaculture and Marine Planning Powers	RM3 - Safeguarding Locally Important Agricultural Land RM5 - Trees and Woodland Strategy RM10 Local Environmental Designations RM11 - Habitats and Species
Chapter 14 Seascape, Landscape and Visual Impact	LP/ED4 - Aquaculture and Marine Planning Powers	
Chapter 15 Shipping and Navigation	LP/ED4 - Aquaculture and Marine Planning Powers	
Chapter 16 Commercial Fisheries		
Chapter 17 Traffic and Transport	LP/ED4 - Aquaculture and Marine Planning Powers	
Chapter 18 Archaeology and Cultural Heritage	LP/RM1 - Built Heritage Conservation LP/RM2 - Archaeology and Archaeologically Sensitive Areas LP/STY8 - Setting of War Memorial LP/ED4 - Aquaculture and Marine Planning Powers	SC8 - Cultural Heritage RM8 - International Natural Heritage Designations RM9 - National Natural Heritage Designations RM12 - Conservation Areas RM13 - Listed Buildings RM14 - Historic Gardens and Designed Landscapes RM15 - Scheduled Ancient Monuments and other Archaeological Sites ED2 Development of Alternative and Renewable Energy Resources

Table 6.2 Adopted Development Plan Policies		
ES chapter	Western Isles Local Plan 2008	Western Isles Structure Plan 2003
Chapter 19 Onshore Noise[7]	LP/ED4 - Aquaculture and Marine Planning Powers	
Chapter 21 Socio-economics / Local Communities	LP/ED4 - Aquaculture and Marine Planning Powers	DM9 - Developer Consultation and Community Benefit ED2 Development of Alternative and Renewable Energy Resources
Chapter 22 Tourism and Recreation	LP/ED4 - Aquaculture and Marine Planning Powers	
Cumulative impacts are discussed within each relevant receptor chapter.	LP/ED4 - Aquaculture and Marine Planning Powers	

6.7 Summary

6.7.1 This chapter identifies relevant legislation and policies for the Lewis Wave Array, and shows that Lewis Wave Power is cognisant of them and their requirements.

[7] Note that issues relating to underwater noise are discussed within the relevant receptor chapters. For example, underwater noise impacts on marine mammals and on fish are discussed within those chapters respectively.

7. PHYSICAL ENVIRONMENT AND COASTAL PROCESSES

7.1 Introduction

7.1.1 This Chapter of the Environmental Statement (ES) describes the physical environment of the development area including surface and sub-surface geology, physical processes (wave and tidal regimes) and sedimentary processes (bathymetry, geomorphology and sediment transport).

7.1.2 This Chapter provides a baseline description of these parameters followed by an assessment of the magnitude of potential effects resulting from the construction, operation and decommissioning of the Lewis Wave Array, as well as those resulting from cumulative interactions with other existing or planned projects. Also included are the initial considerations with regard to potential mitigation measures and outline monitoring plans where deemed appropriate.

7.1.3 This section of the ES was written by Royal Haskoning, and incorporates technical input and review from Aquamarine Power (on behalf of Lewis Wave Power). Technical reports from Aspect Surveys for geophysical surveys and technical notes on metocean data are included as Appendices 7.1 and 7.2 respectively.

7.1.4 A further technical note Lewis Wave Array: Coastal Geomorphology and Physical Environment, produced for Marine Scotland in 2011 is also provided as Appendix 7.3.

7.2 Summary of assessment on physical environment and coastal processes

7.2.1 No habitats or species of conservation importance have been recorded within the development site (*Chapter 9: Benthic Ecology* and *Chapter 13: Terrestrial and Intertidal Ecology*).

7.2.2 No sensitive coastal receptors are present within the regional study area (Appendix 7.3).

7.2.3 The site is typically representative of the wider area off north-west Lewis. A Geological Conservation Review (GCR) site (north-west coast of Lewis) is located to the north of the study area, which is noted for its Quaternary stratigraphy (Gordon & Sutherland, 1993). Longshore sediment transport processes are characterised by a south to northerly regime which is interrupted by numerous outcropping rocky headlands which isolate pocket beaches. Each beach can be considered as an isolated sedimentary sub-cell of the coastal system and therefore the GCR will be unaffected by the development. Potential effects are temporally variable and spatially ranging, and are anticipated to be of negligible to moderate magnitude.

7.3 Potential effects

7.3.1 Wave and tidal characteristics (the hydrodynamic regime) can be changed or modified by the introduction of energy extraction devices within a water body, thereby altering the existing hydrodynamic regime. Such modifications may result in associated change(s) to sedimentary regimes and geomorphological expression of the seabed and coastline. Effects on the hydrodynamic and sedimentary regime may be localised (in the immediate vicinity of devices), at the near-field scale (in the vicinity of the entire development), or at the far-field scale (beyond the area of the development).

7.3.2 The development of any coastal or offshore infrastructure may alter hydrodynamic processes and coastal morphology. In this instance, the construction and operation of an offshore wave array, seabed pipework and coastal infrastructure at its landfall, has the potential to change the physical environment through alteration of existing hydrodynamic processes (i.e. waves, currents), sediment patterns (i.e. scour at devices, transport and deposition change through alteration of hydrodynamics) and coastal erosion (i.e. introduction of hard points on the coastline).

7.3.3 Although the motion of waves is most evident as a surface phenomenon, there are also movements below the water surface that decrease with depth, which could be influenced by the proposed array. In deep water, the water particles beneath a wave possess a circular orbital wave motion. This motion does not tend to reach the seabed until the wave reaches shallower water environments where the water particles have an elliptical orbit and wave motion is felt at the seabed, which contributes to stirring of sediments of the seabed.

7.4 Methodology

7.4.1 The assessment methodology adopted to understand potential for changes to the physical environment and coastal processes resulting from the development is different to those adopted in other sections of this ES. This is because the development will have effects on the hydrodynamic and sedimentary process regimes, but these effects are not considered to be impacts. Any potential effects will manifest upon other receptors such as marine ecology, fish and shellfish resources and sediment and water quality.

7.4.2 In terms of coastal geomorphology and physical processes (waves, tides and sediment transport patterns), sensitive receptors may be considered as, but not limited to:

1. Soft sedimentary coasts;
2. Ecologically sensitive areas of the coastline;
3. Designated habitats; and
4. Designated coastal sedimentary features (e.g. dunes).

7.4.3 Based on evidence gathered during a survey of the site and adjacent coast (see Appendix 7.3), and supported by conclusions drawn during intertidal survey at the site and adjacent coast (*Chapter 13: Terrestrial and Intertidal Ecology),* it can be concluded that there are no sensitive receptors within the development footprint and immediately adjacent coast.

7.4.4 Hence, the assessment in this chapter focuses on describing the changes/effects rather than defining the impact. Where an effect is identified upon a physical process (i.e. waves or tidal currents) the assessment assigns a magnitude to the degree of change. The resultant changes or effects are subsequently assessed for their potential to impact upon other environmental receptors, including assessment of their sensitivity, and discussed in the following Chapters:

- Chapter 9: Benthic ecology;
- Chapter 13: Terrestrial and intertidal ecology; and
- Chapter 20: Water quality.

7.4.5 There is no specific guidance available for the assessment of effects of wave arrays on benthic ecology. The equivalent guidance for offshore wind farm EIA by CEFAS (2004) has therefore been applied to this effect assessment.

7.4.6 The assessment of potential effects on the physical environment of construction, operation and decommissioning of the development is largely based on Expert Geomorphological Assessment (EGA) supplemented by conceptual understanding of hydrodynamic and sedimentary processes (see Appendix 7.3). EGA is a technique which involves interpreting a range of data and applying expert judgment to evaluate the functioning of hydrodynamic and sedimentary regimes and how any changes to these regimes may impact upon the environmental receptors, such as geomorphology and sediment distribution.

7.4.7 The physical environment is considered over two spatial scales:

- Near-field – the footprint of the development that resides in the marine, intertidal and terrestrial environment; and
- Far-field – the coastal area surrounding the development area over which remote effects may occur and interact with other activities.

Consultation

7.4.8 A Scoping Opinion was sought from both statutory and non-statutory consultees (Lewis Wave Power Limited, 2011) in May 2011. Further discussion has also been held with Marine Scotland Licensing Operating Team (MS-LOT) to determine approach to coastal processes (Marine Scotland letter 17th January 2012). All consultation and responses are detailed in Appendix 2.1, however, a short summary of the main points pertinent to the physical environment and coastal processes, along with an explanation of how they were addressed, are provided in Table 7.1, below.

Table 7.1 Consultation responses

Comments & Information	Response
Coastal erosion: A baseline should be made of the current state of coastal erosion adjacent to the proposed sites.	Consultation with MS-LOT in response to Royal Haskoning's Coastal Geomorphology Walkover Survey Report highlighted a further requirement for a Historical Trend Analysis (HTA) to provide information on the context of coastal erosion within the study area.
Changes in coastal processes and hydrodynamic conditions should be assessed within the ES.	Changes in coastal processes and hydrodynamic conditions are assessed via referencing to Aquamarine Power Wave Model and available site specific Metocean data.
Cumulative effects on coastal processes with respect to existing renewable and coastal developments should be assessed within the ES.	Cumulative effects on coastal processes with respect to existing renewable and coastal developments are assessed with respect to the Voith Hydro 4MW WavGen and Pelamis Wave Power Energy Projects.

Data collection

7.4.9 In order to inform the Environmental Impact Assessment (EIA) process geophysical, ecological and metocean data were collected for the development area. A summary of the data used to inform this Chapter is discussed in the following paragraphs and highlighted in Table 7.2

Metocean

7.4.10 The Hebridean Marine Energy Futures (HMEF), on behalf of Aquamarine Power and other partners, undertook a programme of oceanographic and meteorological measurements between October and December 2011. The results are reported in Hebridean Marine Energy Futures (2012). Three waverider buoys were deployed to measure a variety of parameters (i.e. wave height, wave period, wave orientation) Figure 7.1 presents the locations of the waverider buoy monitoring locations in relation to the study area.

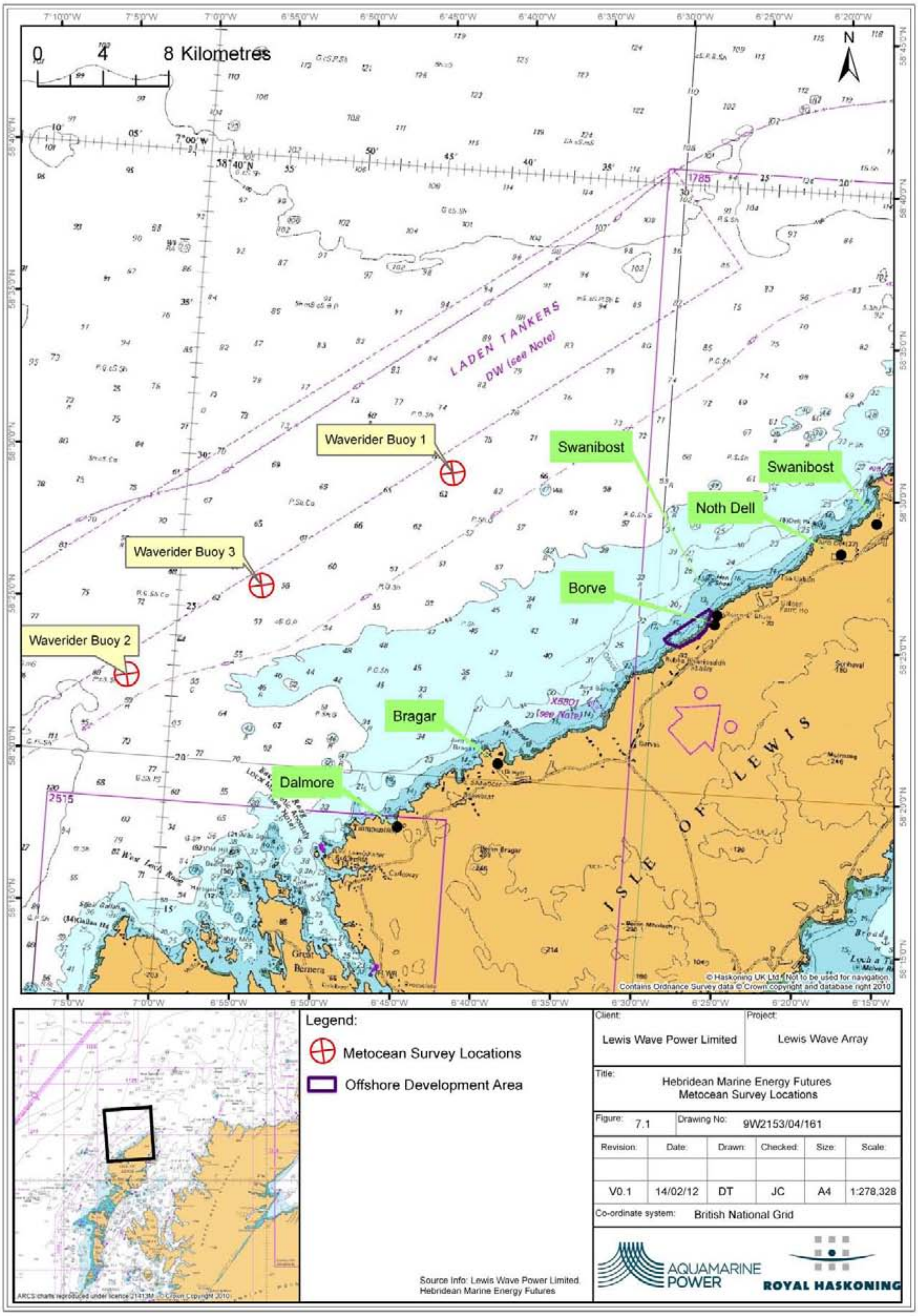


Figure 7.1 Hebridean Marine Energy Futures metocean survey locations

Geology and geomorphology

7.4.11 A geophysical survey including multibeam bathymetry and sub-bottom profiling was undertaken across the development area, between August and September 2010, by Aspect Surveys. The survey included:

- Full multi-beam bathymetry coverage of the development area;
- A classification of the seabed sediments;
- Information on the shallow geology of the study area;
- Variations in thickness and mobile sediment cover; and
- Information on areas of the survey site, where the seabed has steep sided features.

7.4.12 Maps and charts, including bathymetry and seabed features relative to Chart Datum (CD) were provided as deliverables. The survey results are reported in Aspect Surveys (2010). The full survey reports for the development are provided in Appendix 7.1. The extent of the geophysical surveys in relation to the development is presented in Figure 7.2.

7.4.13 A site-specific benthic survey was conducted by Envision (2011). Information acquired from this survey provided 'ground truthing' data which when used alongside the geophysical survey data supported the identification and distribution of substrate types.

7.4.14 Maps and charts, including bathymetry and seabed features relative to CD were provided as deliverables. The survey results are reported Technical Appendix 7.1. The extent of the benthic surveys in relation to the geophysical surveys and the development is presented in Figure 7.2.

7.4.15 The principal data sources relevant to the physical environment and coastal processes are shown below in Table 7.2.

Table 7.2 Existing data

Data source	Coverage	Author(s)	Year
The beaches of Lewis and Harris	Lewis and Harris	Ritchie & Mather	1970
Coasts and seas of the United Kingdom. Regions 15 & 16 North-west Scotland: The Western Isles and west Highland	Lewis	Barne et al	1997
Coastal cells in Scotland: Cells 8 & 9 – The Western Isles	Lewis	Ramsay & Brampton	2000
Waverider buoy report for three month period covering October-December 2011	Northwest Isle of Lewis	Hebridean Marine Energy Futures	Unpublished
Preliminary writings: Extreme waves, WECs and coastal erosion	Northwest Isle of Lewis	Vogel	Unpublished

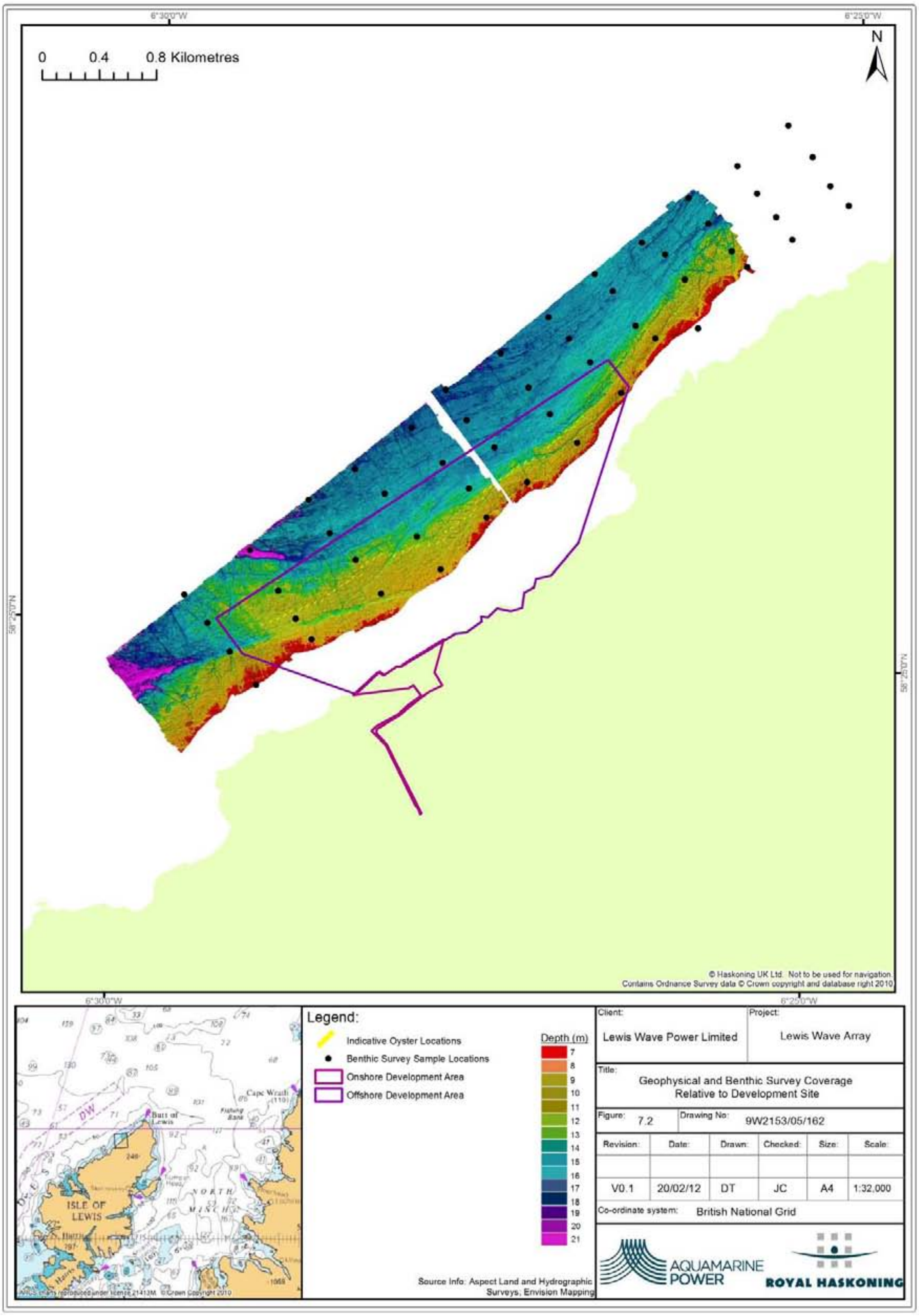


Figure 7.2 Geophysical and benthic survey coverage relative to study area and north-west Lewis

Assessment of significance

7.4.16 The magnitude of the potential for effects of the development is based on the intensity or degree of disturbance to baseline conditions and is categorised into four levels of magnitude, high, medium, low or negligible. The definitions of each of these are given in Table 7.3

Table 7.3: Criteria for assessing the magnitude of effects on the physical environment

Magnitude of effect	Definition
High	Fundamental, permanent / irreversible changes, over the whole feature / asset, and / or fundamental alteration to key characteristics or features of the particular environmental asset's character or distinctiveness. Effect certain or likely to occur.
Medium	Considerable, permanent / irreversible changes, over the majority of the feature / asset, and / or discernable alteration to key characteristics or features of the particular environmental aspect's character or distinctiveness. Effect certain or likely to occur.
Low	Discernable, temporary (throughout project duration) change, over a minority of the feature / asset, and / or limited but discernable alteration to key characteristics or features of the particular environmental aspect's character or distinctiveness. Effect will possibly occur.
Negligible	Discernable, temporary (for part of the project duration) change, or barely discernible change for any length of time, over a small area of the feature or asset, and/or slight alteration to key characteristics or features of the particular environmental aspect's character or distinctiveness. Effect unlikely or rarely to occur.

7.4.17 The sensitivity/value/importance of the receptor for each effect is normally characterised as one of four levels, high, medium, low or negligible. As outlined earlier in this section, there are no sensitive physical receptors present within the site or adjacent coastal areas (see 7.4.2). Sensitivity of physical features (seabed substrate and mobile bedforms) in the coastal area, to changes in coastal process, can therefore be considered to be negligible.

7.4.18 Table 7.4 combines the definitions of magnitude with the level of sensitivity/value/importance of receptor to provide a prediction of overall significance of the effect.

Table 7.4 Significance prediction matrix.

Magnitude of effect	Receptor sensitivity			
	Negligible	Low	Medium	High
High	Negligible	Moderate	Major	Major
Medium	Negligible	Minor	Moderate	Major
Low	Negligible	Negligible	Minor	Moderate
Negligible	Negligible	Negligible	Negligible	Minor

7.4.19 Based on the absence of sensitive physical receptors and the resulting negligible sensitivity, it can be seen that the significance of any effects on physical receptors will also be negligible.

7.4.20 As discussed earlier, the effect assessment undertaken later in this report will focus on magnitude (see 7.4.3), and magnitude assessments will then be cross referenced to assessments in relevant ES chapters.

7.5 Existing environment

Geology

7.5.1 The geological sequence along the coastal study area is relatively simple, comprising Pre-Cambrian Lewisian Gneiss mostly of the metamorphic type (see Figure 7.3). These high grade metamorphic rocks have undergone a complex deformation history and are of widely variable composition. Within the general uniformity of the geological conditions, however, a number of significant variations do occur, and frequently these variations are reflected in the resultant coastal landforms.

7.5.2 Some small igneous intrusions represent zones of weakness that are differentially eroded by marine or sub-aerial processes. However, the main lines of weakness, followed by many of the sea lochs and inlets, are structural lines of dislocation or crushing. On the smaller scale, factors such as variations in dip angles and the occurrence and density of joint planes exert important local influences on coastal evolution, especially on the cliff morphology. Headlands formed of Lewisian Gneiss display persistent jointing which acts as a major control mechanism for the formation of headlands.

7.5.3 Where the Lewisian Gneiss occurs within the inter- and subtidal, the exposed intertidal bedrock is typically a rugged, irregular rock platform with boulder spreads, reefs and small stack-like elevations (Ramsay & Brampton, 2000). This is supported by the benthic drop-down video survey which confirms that the substrate type consists mainly of rugged bedrock with numerous fault lines (Envision, 2011).

7.5.4 The bedrock geology is exposed in the form of sea cliffs and their fronting exposed intertidal rock platforms. These features have a significant influence on the development of the coastline by dissipating incident wave energy through bed friction and resulting wave breaking processes prior to waves interacting with the softer, more erodible Quaternary deposits.

7.5.5 There are no areas designated for their geological importance within the study area. One GCR site, noted for its Quaternary stratigraphy, is located to the north at the Butt of Lewis, approximately 20 kilometres (km) to the north of the development area.

Geomorphology

7.5.6 The terrestrial geomorphology of the study area is characterised as subdued topography typical of northern Lewis. The northern part of the island consists of a vast tabular plateau at an altitude of between 80 and 140 metres (m) above sea level. This plateau, broken in places by low residual hills which are tilted slightly towards the west, and almost always terminates sharply at the coast in cliffs, of variable height.

7.5.7 On the northern plateau, the mainland ice-sheet achieved little in the way of erosion other than limited scouring as it moved offshore towards the northwest (see Figure 7.1 for locations of places), though in its progression offshore deposited till of variable thicknesses. In some areas, such as around Swanibost, the till is thick and has been cut into sea cliffs. Elsewhere, the effect on the bedrock plateau has been much less, and in places pockets of weathered rock have been neither removed nor buried under till. In North Harris the most important glacial effects were wrought by local glaciers rather than the mainland ice-sheet per se. Glacial deposits typically consist largely of sand and gravel, which have been reworked by post-glacial sea-levels.

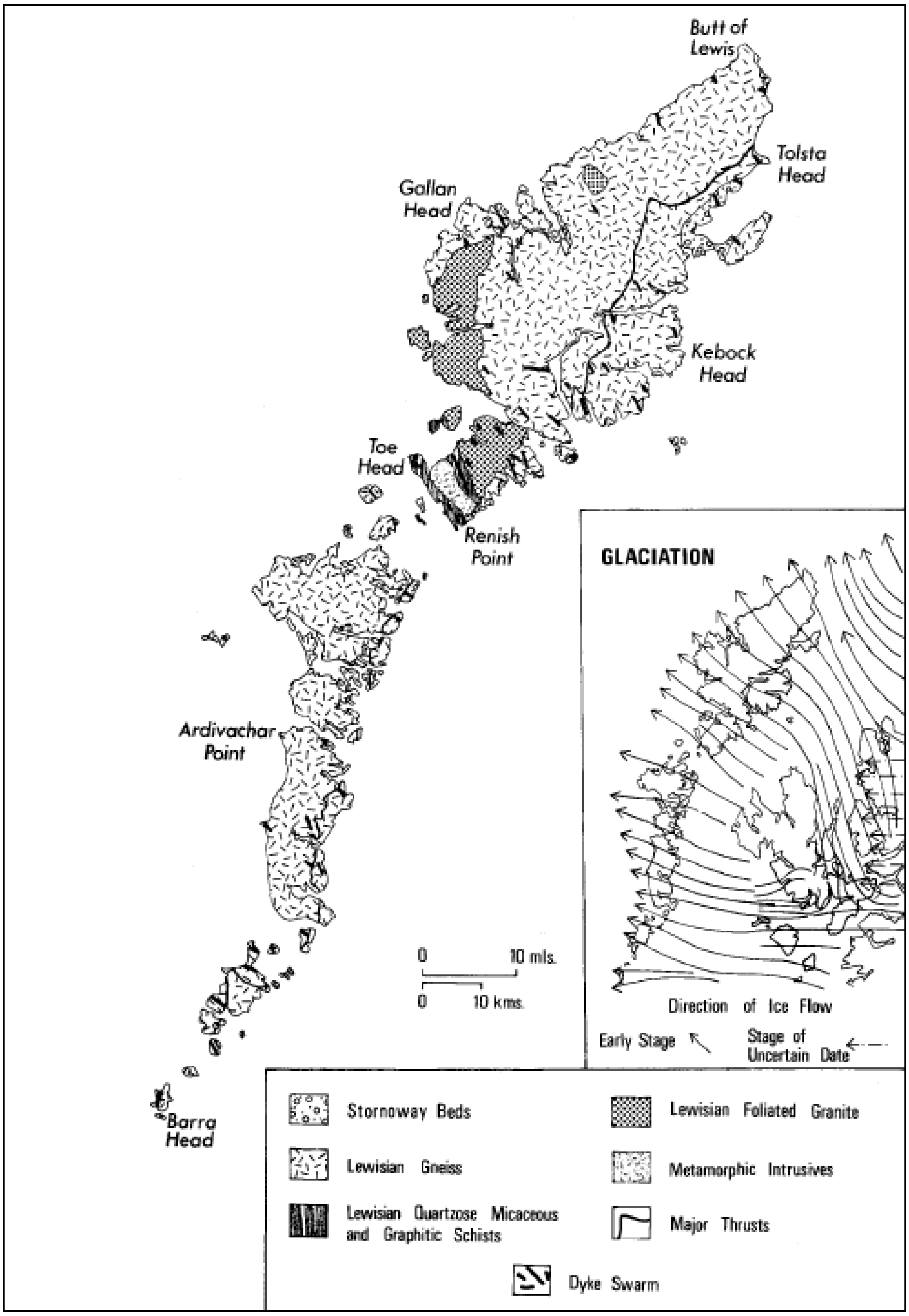


Figure 7.3 Geology and glacial ice flow directions (Source: Ritchie & Mather, 1970)

7.5.8 Since the Western Isles lay towards the margin of the Scottish ice-sheet, the weight and consequently the amount of depression of the land surface has been much smaller than that experienced on the mainland. Beaches formed in the late-glacial and post-glacial period are therefore expected to lie at heights not dissimilar to contemporary beaches (Ramsay & Brampton, 2000).

7.5.9 The coastal geomorphology of the study area is controlled by the incident, westerly dominated, wave regime, bedrock geology and overlying Quaternary sediments. The resulting west facing beaches are exposed to harsh hydrodynamic conditions and a high energy regime.

7.5.10 At Swanibost, to the north of the study area, wave erosion has resulted in the Quaternary deposits being actively cut into sea cliffs up to 20m in height. Erosion of these cliffs has exposed what is considered to be one of the best examples of a possible interglacial beach in Scotland (Ramsay & Brampton, 2000). However, within the study area Quaternary deposits are typically between 1-5m in height. Within the study area, between North Dell and Borve, the same beach has possibly been identified resting on a pre-Devensian shore platform and a variety of superficial deposits have been identified (Ramsay & Brampton, 2000).

7.5.11 Observations at Dalmore, to the south of the study area, by Vogler (Unpublished) indicate that beaches in the study area are heavily eroded in the winter months. This is preceded in the summer months by a period of sediment deposition when lower energy wave conditions transport sediments onshore (see Photo Plate 7.1). Such changes have resulted in the classification of the beaches as being in a state of dynamic equilibrium due to the balance of erosion and accretion between winter and summer respectively (Vogler et. al., 2011).

7.5.12 An increase in the frequency and severity of winter storms is expected as a result of global warming, though some uncertainty exists to the quantification of these changes. However, any change to the existing baseline regime will have potential implications for the existing equilibrium with the consequential permanent loss of sediment and associated effects upon the coastal geomorphology (Vogler, Unpublished).

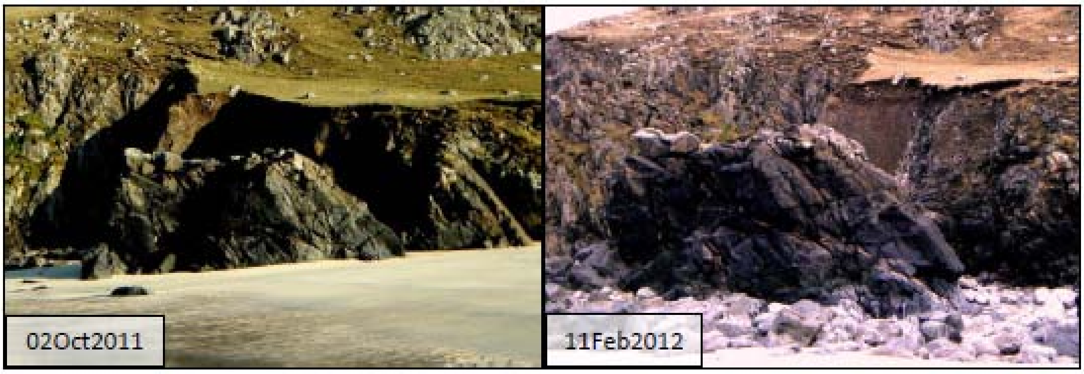


Plate 7.1 Observed beach changes at Dalmore Oct 2011 and Feb 2012

Seabed and bathymetry

7.5.13 Submarine contours exert a major control on the convergence and divergence of wave fronts, and in the movement of sediment landwards from the offshore. For the most part the submarine contours are parallel to the coastline, although the offshore gradient is spatially very variable. From the Mean Low Water Spring (MLWS) mark the seabed across much of the survey area slopes relatively steeply to the 10m depth contour, and then slopes more gradually down to 20m. Between 0.5km to 1.5km offshore, water depth varies between 13m and 15m.

7.5.14 As bathymetric contours are nearly parallel with the coastline, larger wave conditions will occur at a small angle of incidence to the shoreline due to refraction processes. Where deep water approaches close inshore cliffs are actively forming. The lack of sand beaches in south-east Lewis is partly explained by the gradient of the inshore zone and the high energy environment.

7.5.15 What little information is available from regional (far-field) bathymetric charts indicate that the seabed is comprised of predominantly rock; this is supported by the findings of the local site-specific (near-field) geophysical survey (see Aspect Surveys, 2010). The seabed and intertidal areas are typically rugged in nature and dominated by rocky outcrops of Lewisian gneiss bedrock. This rock is overlain within the intertidal zone in places by thin coverings of gravel and sand particularly in crevasses between shallower bare rock platforms. The rock surface is characterised by grooves and channels preferentially eroded along discontinuity planes.

7.5.16 Seabed surveys of a representative area of the coastline were carried out by Aspect Surveys in August 2010 and the results of this survey have informed this section. The survey encompassed the inshore waters from Bragar in the south to Mealabost Bhuirgh in the north.

Waves

7.5.17 The Western Isles are heavily exposed to a combination of long period ocean swell and waves driven by the local wind climate, hence exposure to a severe wind and wave climate characterises north-west Lewis. The nature of the Western Isles means that they are exposed to long fetches for wave generation in practically every direction, with the exception of eastern sector (offshore directed wind). The offshore wave climate is dominated by waves incident from 230o and 270o -N. Extreme offshore sea wave conditions have been predicted from the Met Office Wave Model and are presented in Table 7.5 (Ramsay & Brampton, 2000). Seabed bathymetry and tidal conditions then influence the propagation of waves from offshore, across the nearshore zone, to the shore.

Table 7.5: Met Office wave model data – offshore wave conditions

Return period	Total sea significant wave height (m)	Swell significant wave height (m)
1	12.80	5.67
10	15.14	6.90
100	17.32	8.06

7.5.18 The wave conditions on Lewis have been modelled by Lewis Wave Power using the MIKE21 Spectral Waves software. This has provided a 12 year hindcast record of wave conditions. This model has a low spatial resolution; however it provides a good indication of the average conditions on Lewis. The wave conditions have been assessed at a point on the most westerly region of the 10MW Agreement for Lease area at a distance approximately 600m from the shoreline.

7.5.19 Figure 7.4 displays the frequency of occurrence of conditions over the 12 year model run, with colours representing the significant wave height. Figure 7.4 highlights that the predominant wave direction is at approximately 290o, with only a very small proportion of waves approaching from the north easterly direction.

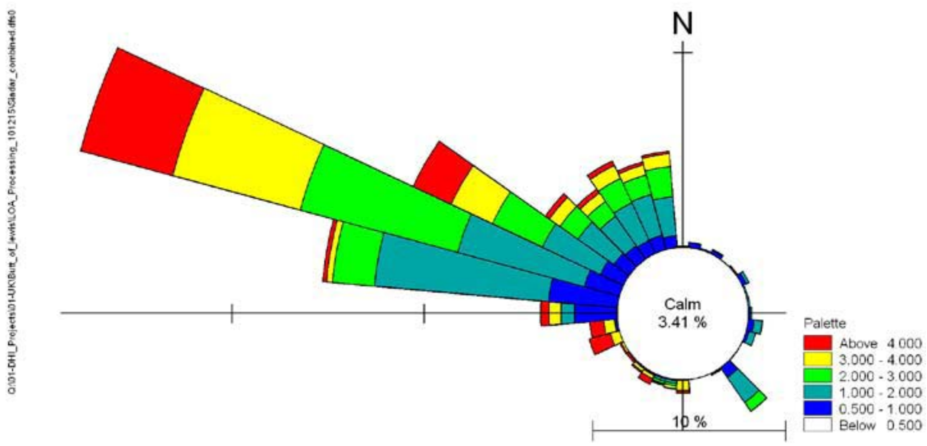


Figure 7.4 Significant wave height (m) conditions at lease area.

7.5.20 The wave model predicts that over a 12 year period the significant wave height is 7.7m, with a period 7.38 seconds. The predicted summer (March 21st to September 21st) significant wave height is 5.26m with a period of 6.68 seconds. The model also predicts that waves will on average most frequently occur from the west north-westerly direction (294° +95°/-42°) in winter and in the summer will be from more westerly direction (286°+101°/-34°)

7.5.21 Data collected by HMEF from Datawelll Waverider buoys deployed of Siadar (see Figure 7.1) are presented graphically for significant wave height (see Figure 7.5), maximum wave height and peak direction (see Figure 7.6) for the period October to December 2011. The wave data collected by HMEF (2011) support the findings of SNH (Ramsay & Brampton, 2000), in that incident winter waves most frequently occur from the north-westerly direction in winter (see correlation highlighted by red lines in Figure 7.6).

7.5.22 Six storm events (>10m) are captured over the deployment, occurring on the 18th October, 25th November, 8th, 9th, 25th and 28th December 2011, with a maximum wave height of ~21.0m recorded on the 13th December of 2011 (see Figure 7.6). As presented in Figure 7.6 the nearshore wave environment is dominated by waves incident from the northern sector, particularly the northwest between 240-300oN.

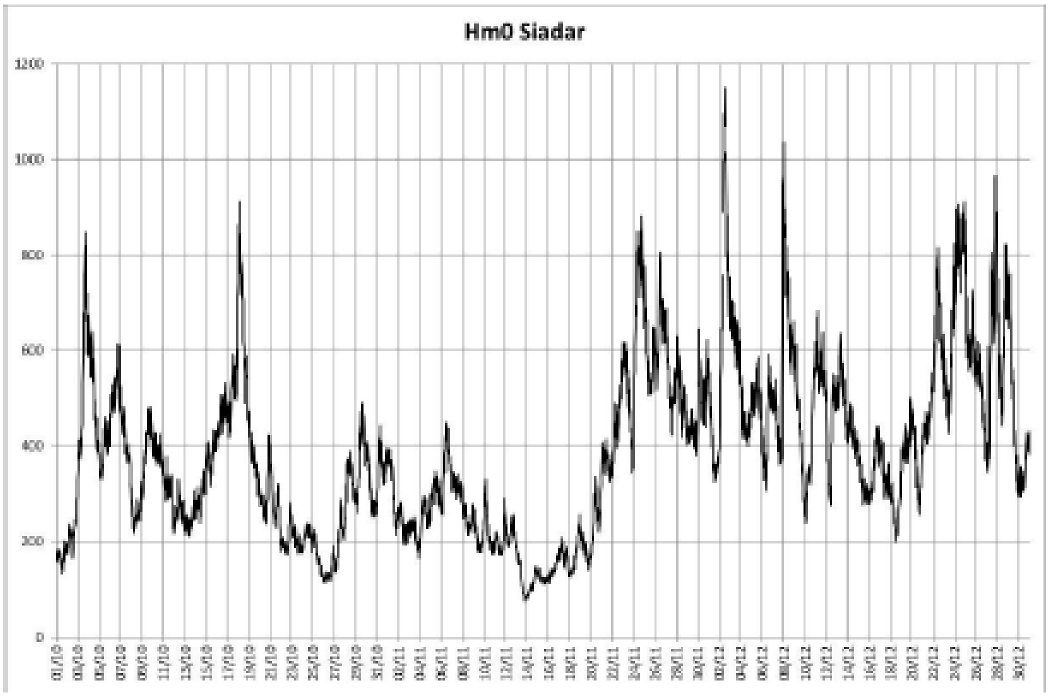


Figure 7.5 Significant nearshore wave height, Siadar, October to December 2011

Wave power

7.5.23 The Scottish Government (2010) has published a mean annual power value of 42.4Kw per metre wave crest for the Outer Hebrides. However, seasonal variability is high, with measurements taken from the Hebridean Marine Energy Futures Project wave buoy network, indicating a mean wave power of 190Kw/m in December 2011 (Vogler: Unpublished).

Tides and tidal currents

7.5.24 The tidal cycle along the study area is semi-diurnal and mesotidal in range, ranging from 3.26m during spring tides to 1.43m during neap tides. Modelling undertaken for the consented 4MW Voith Hydro WaveGen development at Siadar, and reported in the project ES, approximated the tidal range experienced at Siadar as 3.6m during spring tides and 1.6m during neap tides (Npower renewables & RWE group, 2007).

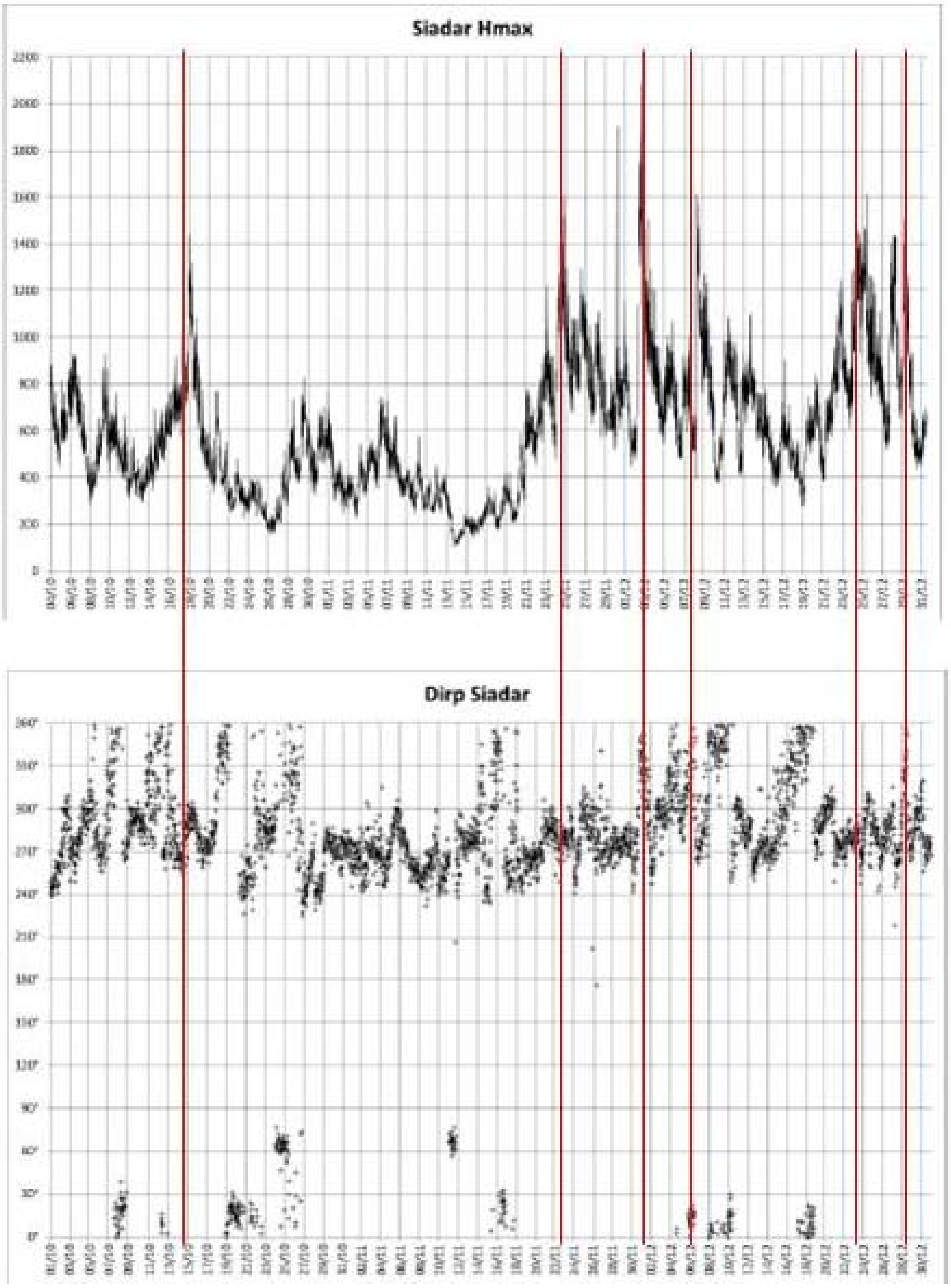


Figure 7.6 Maximum nearshore wave height, Siadar, October to December 2011

7.5.25 During seabed surveys a direct pressure recording tide gauge was deployed at Cárlabhaigh pier which lies 4.6 km (8.71 km by sea) south of the southern boundary of the area of search. Data were gathered over a period of 36 hours and compared to tidal data gathered on site during survey operations. The tidal range/ timings appear similar both at the proposed site and at Cárlabhaigh (Lewis Wave Power, 2011).

7.5.26 With the exception of the water surrounding the Butt of Lewis, the tidal currents are consistent and relatively low along the west coast. The flood tide runs in a southwest to northeast direction parallel to the coastline with the ebb tide flowing in the opposite direction. Tidal currents are consistent and of a relatively low magnitude along the west coast ranging from 0.13 m/s during neaps to 0.36 m/s during springs with little seasonal variability.

Littoral processes

7.5.27 The seabed sediments off the west coast of Lewis are thin and dominated by gravels which only become actively transported under storm wave conditions (Barne et al, 1997). In the offshore areas, net sediment transport is generally northwards as driven by residual currents, although numerous local eddies modify this broad pattern.

7.5.28 Littoral (shoreline) processes are dominated by wave and wind action with tidal currents exerting little influence along this headland-dominated coastline which contains numerous small coastal cells. Present day sediment input is limited. The major input arises from the erosion and reworking of Quaternary sediments (glacial deposits, wind blown sand and boulder clay) at the shoreline and is temporally limited to periods of high tides and severe wave conditions. This is a direct consequence of the degree of wave protection provided by intertidal outcropping bedrock which serves to disrupt the predominant wave regime and reduce energy within the nearshore area.

7.5.29 Previously, during periods of lower (than present) sea-levels, offshore deposits are likely to have been significant in terms of offshore to onshore sediment transport processes, providing materials for beach building. Present day fluvial sediment sources are also not significant (Ramsay & Brampton, 2000).

7.5.30 There is little sediment transport and exchange in and between the various headland dominated coastal cells and as such most of the beaches can be considered as independent sediment cells. According to information presented in the coastal cells for the Western Isles (Ramsay & Brampton, 2000), the dominant sediment loss mechanism within the study area is due to storm wave action resulting in offshore sediment transport. This material is likely to be transported offshore and become trapped on the rocky seabed and hence unlikely to be returned under normal wave conditions (Ramsay & Brampton, 2000).

7.5.31 Sandy material within the intertidal is likely to have originated from onshore glacial deposits. Off the west coast of Lewis, where the seabed is of rock, any glacial deposits which may have existed have already been swept clear by wave processes, so that the nourishment of the beaches is confined to the products of present minor marine erosion and limited fluvial supply.

7.5.32 Erosion of the gneiss bedrock is slow and provides little material for the beaches of this region. Most of what is provided to the beaches is derived from shell fragments moved onshore by waves. There is little longshore sediment transport within the study area with sediment movement generally confined to small coastal sub-cells, although there is expected to be some onshore transport of coarse sediments during high magnitude low frequency (HMLF) events such as storms.

7.5.33 The source of shingle and cobble within the intertidal zone, which comprise the main materials for beach building, is most likely derived from erosion of glacial till deposits located along the coastal frontage. According to Scottish Natural Heritage (SNH (2004)), waves are competent to mobilise rocks that are up to 0.5m in size, and are able to throw fist-sized rocks up to 100m inland from the summit of shingle ridges.

7.5.34 The coastline within the study area is characterised by a long term trend towards erosion, due to the severity of the wave climate and associated energy regime along the coastal frontage. Accretion does occur at discrete locations such as within the dune and machair systems to the north. The shingle and cobbles of the intertidal zone will provide a large degree of protection to the coastline under all but the most severe storm conditions. However, it is under these conditions that erosion of the beach will be most noticeable.

7.5.35 Benthic survey results indicate that there is an inshore to offshore pattern to substrate distribution (Envision, 2011). Sand, gravel and cobbles tend to occur in shallower areas closer to shore within bathymetric depressions. Offshore areas tend to be dominated by exposed bedrock.

7.5.36 The seabed within the development area is rugged and dominated by rocky outcrops of Lewisian gneiss. This rock is overlain in places by thin coverings of gravel and sand particularly in crevasses between shallower bare rock platforms. The rock surface is characterised by grooves and channels preferentially eroded along discontinuity planes.

Global warming and sea-level rise

7.5.37 Over relatively short temporal periods (e.g. months to a small number of years) the tidal signal can be regarded as varying relative to the datum of mean sea level (MSL). However, over longer temporal periods (e.g. beyond the duration of the 18.6 year lunar nodal cycle) MSL varies in response to sea-level rise. Hence the datum of MSL is non-stationary. Future sea-level rise results from the net effect of global change to sea-level and local changes to land levels due to post-glacial isostatic readjustment (rebound or subsidence).

7.5.38 Global warming is predicted to increase pressure on the coastline due to increased storminess and rising sea levels from thermal expansion of seawater and melting of far-field glaciers. The UK Climate Projections (UKCP) 09 has provided estimates for each decade of relative sea level changes with respect to 1990 levels. Central estimate values and 5th and 95th percentile limits of the range of uncertainty for three emissions scenarios (high, medium and low) are provided in Figure 7.7 for Edinburgh. Values for relative sea level rise indicate between 23.4cm (low) and 39.2cm (high) by the end of the 21st century.

7.5.39 The implications of sea-level rise over the coming century require consideration with regard to the proposed development, particularly with respect to ensuring that any nearshore development components are 'future-proofed'.

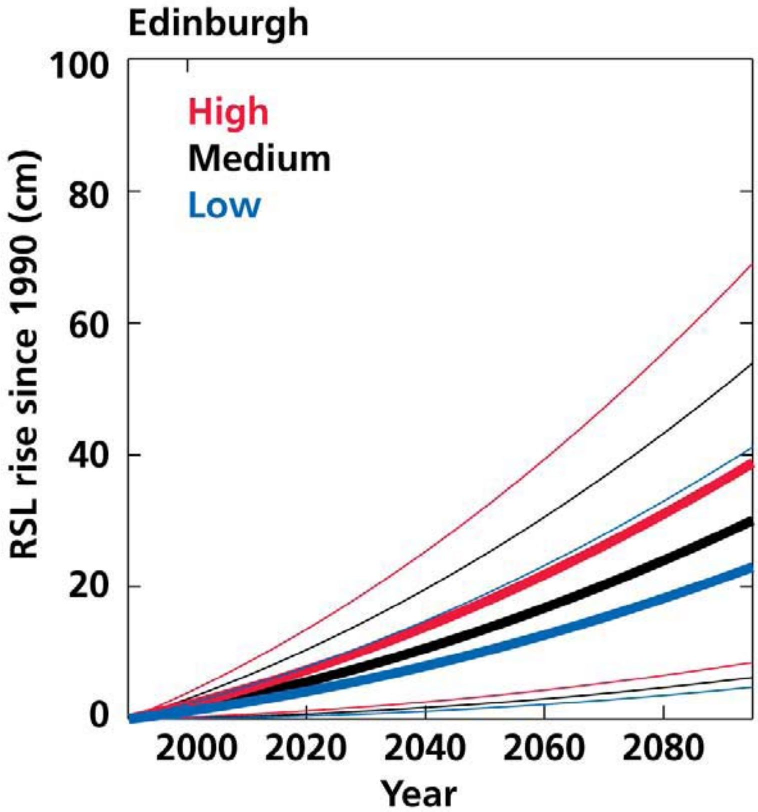


Figure 7.7 UKCIP09 sea-level rise for Edinburgh to 2095

(Source: http://ukclimateprojections.defra.gov.uk/images/stories/marine_pdfs/UKP09_Marine_report.pdf)

7.6 Impact assessment

Do nothing scenario

7.6.1 Under a do nothing scenario the coastline along the study area will continue to evolve in response to the external forcing parameters of wave and tidal processes.

7.6.2 It would be expected that the currently observed physical environment of the study area would remain largely unchanged, except for anticipated change to sea level. Although the frequency and severity of storm events is predicted to increase, there is some uncertainty over the quantification of these changes and their associated effects upon the coastline.

Potential impacts during construction

Impact 1: Effects on hydrodynamic regime

7.6.3 Effects may include localised changes to wave heights and periods, tidal current velocity and vectors from foundation installation, installation of pipes and associated infrastructure and working vessels.

7.6.4 The up to fifty 5m diameter monopile foundations will provide a secure and level base for the Oyster devices on the seabed at approximately 13m water depth below MSL. Monopiles will be drilled into the seabed and grouted in place from a jack-up barge supported by a single offshore tug (50 tonnes bollard pull or similar). Piling operations for the installation of monopiles are anticipated to last for approximately 4.6 days per monopile.

7.6.5 Final assembly of the Oyster Wave Energy Converter (WEC)s will be achieved using one offshore tug (50 tonnes bollard pull or similar) plus two further work boats (multicats or similar) and a dive support vessel. Four mooring anchors will be installed on each side of the Oyster WEC. Mooring anchors will be used to assist in securely lowering each Oyster WEC onto its foundation monopile. The installed Oyster flap width will be between 26 and 33m with a flap depth of 9 to11m.

7.6.6 Connecting hydraulic pipelines will each measure a maximum of 0.9m in diameter and run the length of the wave array. At up to eight separate locations the hydraulic pipelines (both high and low pressure) will be connected to “Shore Pipelines” which will transport the hydraulic fluid to the shore. For the purpose of the assessment presented here pipelines are assumed to be surface laid on the seabed and be stabilised using anchors as described in *Chapter 5 Project Description*.

7.6.7 To provide protection to offshore surface laid pipes, pipelines will be coated in concrete. Pipe preparation and installation is programmed to be complete in a six month period, with Oyster WEC installation occurring over a following six month period.

7.6.8 Given the limited period of time that the jack-up barges may be deployed at each Oyster location and the size of the jack-up legs compared to the wavelength of typical waves, the potential effects upon wave heights and periods are considered to be negligible, local, temporary and within the range of natural variability.

7.6.9 Potential changes to the tidal current regime during construction relate to the interruption of tidal flows as a result of the presence of jack-up barge legs during foundation installation. Currents would be modified in the immediate vicinity of the Oyster devices and support structures. In the immediate lee of each monopile there will be a flow separation zone and downstream turbulence. As with the potential changes to the wave climate, interruption to tidal current strength and orientation are considered to be localised, temporary in nature and within the range of natural variability.

7.6.10 The construction phase effects associated with monopile installation, attachment of Oyster devices, pipelines and the presence of construction plant upon the hydrodynamic regime is anticipated to be localised, temporary in nature and will not result in the permanent alteration of the existing hydrodynamic regime. Furthermore, the receptor is able to accommodate these potential changes to the hydrodynamic regime, given that they are within the bounds of natural variation, localised, temporary in nature, and reversible. Whilst the effects will occur, they will be of negligible magnitude within the development area, the immediate surrounds, or further afield.

7.6.11 As outlined earlier (see 7.4.20) the significance of any effect will be **negligible**

MITIGATION IN RELATION TO IMPACT 1
No mitigation is proposed. It is expected that the hydrodynamic regime will return to its pre-construction state upon the immediate cessation of construction activities.

Residual effect

7.6.12 The significance of any effect remains **negligible**.

Impact 2: Effects on sediments and sedimentary structures

7.6.13 Effects upon seabed sediment distribution patterns and to nearshore and longshore sediment transport processes

7.6.14 Potential changes to sediment distribution patterns and nearshore and longshore sediment transport processes are related to the direct disturbance of these features and secondarily via the creation, dispersion and subsequent settlement of sediment associated with the installation of monopiles, Oyster devices, subsea pipes and the presence of construction plant.

7.6.15 All construction plant will remain in the marine environment for a period of approximately 4.6 days for each monopile installation. The legs of the jack-up barges will be lowered and deployed once on site. All eight legs of the jack-up barge will need to be on the seabed for weight bearing before operations can commence. Once the barge is stable the drilling of the monopile socket will commence.

7.6.16 Monopile sockets will be drilled into the seabed from the jack up barge using a single drill bit. The drilling methods to be used will make use of sea water as the drilling fluid and all drill cuttings will be left offshore. The steel pile will be then be inserted into the socket and this will be grouted into place. The grout used for this purpose is cement based grout and will be dispensed using a grout line from the jack up barge. There is a potential loss of grout to the sea during routine grouting operations and flushing out of the grout hoses. However the amount of grout being pumped into the socket will be monitored from the surface and by divers and it is predicted that approximately 1m3 of grout may be lost from each operation equating to a total maximum loss of 50m3. The socket drilling and monopole installation will take up to 100hrs.

7.6.17 The volume of sediment released and its ultimate destination will depend on the installation method, the type of seabed substrate that is disturbed, and the direction, strength and persistence of tidal currents.

7.6.18 Four mooring anchors will be installed on each side of the Oyster device. Mooring anchors will be used to assist in securely lowering each Oyster onto its foundation monopile. The footprint of the jack up barge is likely to be approximately 20m2. Temporary grout bags will be positioned beneath one or more of the jack-up legs to ensure the barge is stable.

7.6.19 Installation of the WECs will be achieved using one offshore tug plus two further work boats (multicats or similar) and a dive support vessel. Four mooring anchors will be installed on each side of the WEC. Mooring anchors will be used to assist in securely lowering each Oyster WEC onto its foundation monopile. Monopile sockets will be drilled into the seabed from the jack up barge using a single drill bit. The drilling methods to be used will make use of sea water as the drilling fluid and all drill cuttings will be left offshore.

7.6.20 All pipelines to be installed in the offshore environment will be manufactured at an existing facility and will be towed to site in one length. Divers will remove kelp from the area up to 10m wide around where the surfaced laid pipelines will be installed. The kelp will be left offshore. Some seabed levelling works may also be required as well as insertion of grout bags into any gullies in the seabed over which the pipelines will be laid.

7.6.21 Prior to installation of the pipes at landing area the beach will be prepared to provide a level corridor on which to lay the pipes. The footprint for the construction corridor is 20m for each set of pipelines within the surf zone.

7.6.22 Due to the bedrock dominated nature of the seabed and the grain size of seabed sediments, typically gravel and coarser grained fractions, any sediment displaced as a result of the construction processes is likely to settle within metres of disturbance. Any material disturbed into the water column due to the construction activities will rapidly return to the seabed. Any sediment that is disturbed and enters into suspension could subsequently be transported and dispersed by the prevailing tidal currents, and will be deposited on the seabed.

7.6.23 It is worth noting that typically the volumes of sediment released as a result of the drilling process and other construction activities within a bedrock dominated environment are extremely small when compared to the same activities in soft sediment environments due to the consolidated nature of the deposits.

7.6.24 As stated previous, with the exception of the water surrounding the Butt of Lewis, the tidal currents are consistent and relatively low along the west coast. The flood tide runs in a southwest to northeast direction parallel to the coastline with the ebb tide flowing in the opposite direction. Tidal currents are consistent and of a relatively low magnitude along the west coast ranging from 0.13 m/s during neaps to 0.36 m/s during springs with little seasonal variability. Tidal currents will therefore not have the capacity to actively transport clasts greater in size than the sand sized fraction. Therefore, there is no active transport pathway for any generated sediments along the coastline.

7.6.25 The construction phase effects associated with monopile installation, attachment of Oyster devices, pipelines and the presence of construction plant upon sediment distribution patterns and nearshore and longshore sediment transport processes is anticipated to be localised, temporary in nature and will not result in the permanent alteration of these features or their defining characteristics. Furthermore, the sedimentary processes and receptors are able to accommodate these potential changes given that they are within the bounds of natural variation, localised, temporary in nature, and reversible. Whilst the effects will occur, they will of negligible magnitude within the proposed development area, its immediate surrounds, or further afield.

7.6.26 As outlined earlier (see 7.4.20) the significance of any impacts will be **negligible** for physical features.

MITIGATION IN RELATION TO IMPACT 2
No mitigation is proposed. It is expected that sediments and sedimentary structures will return to their pre-construction state within one month of the cessation of construction activities.

Residual effect

7.6.27 The significance of any effects remains **negligible**

Impact 3: Effects on geological and geomorphological formations

7.6.28 Effects to intertidal bedrock platform from pipe works and on coastal geomorphological formations from landfall.

7.6.29 A total of 40 to 50 Oyster WECs will be installed upon the seabed resulting in a direct loss of 981.75m2 of seabed (see Table 5.6: Section 5). Connecting pipelines will consist of two pipes (one high pressure and one low pressure) each 0.9m in diameter (1.8m). Each pipeline will run the length of the wave array, a maximum distance of 3.2km in length. Pipelines will result in a direct loss of 2,500m2 of seabed (see Table 5.6: Section 5). Common pipelines will result in a direct loss of 35,000m2 of seabed (see Table 5.6: Section 5), with pipelines being secured to the seabed using rock stabilisation anchors, resulting in the loss of 400m2 of seabed. The total area of seabed lost to the installation of pipelines equates to 38,881.75m2. Should the directionally drilled approach be adopted the area of seabed lost will be very substantially reduced.

7.6.30 Pipelines shall sit proud from the seabed and therefore form a barrier to longshore sediment transport. It is anticipated that due to the relatively small quantities of sediment transported within the nearshore zone that the potential effects of the construction phase shall not manifest until sometime after construction has completed. The potential effect is therefore assessed within the operational phase effects below.

7.6.31 The works at the landfall will include the creation of horizontal directional drill (HDD) ducts (as discussed in *Chapter 5: Project description*) and result in the excavation of 10,127m3 of materials. The advantage of this method is that burial can be achieved as the pipework is laid, thus minimising risk to the pipeline. Historically this installation method has provided minimal disturbance to the coastlines on which it has been employed and as such will not affect littoral processes (ABPmer and HR Wallingford, 2009). Given that the works will be restricted to the upper supra-tidal area (i.e. above Mean High Water Springs (MHWS)) there is no potential for effects on sediment transport.

7.6.32 The intertidal beach is characteristic of a highly dynamic environment which is anticipated to be relatively insensitive to localised, moderate duration (4 months) effects associated with the installation of HDD ducts. It is anticipated that upon cessation of the installation works that the beach would rapidly return to its pre-construction state.

7.6.33 Small-scale (metres) localised changes to sediment transport processes and the morphological expression of the intertidal beach are anticipated as a result of the construction phase of the development upon geomorphological formations associated with the landfall. It is expected that and potential changes to geomorphological formations shall be reinstated to their pre-construction state upon cessation of the works.

7.6.34 The potential effects upon the bedrock platform and coastal geomorphology from foundation installation, pipe laying and working vessels are within the bounds of natural variation, localised, temporary in nature, and reversible. It is anticipated that these changes will be of minor magnitude.

7.6.35 As outlined earlier (see 7.4.20) the significance of any effects will be **negligible**.

MITIGATION IN RELATION TO IMPACT 3
No mitigation is proposed.

Residual effect

7.6.36 The significance of any effect remains **negligible**.

Potential impact during operation (including maintenance)

Impact 4: Effects on hydrodynamic regime

7.6.37 Localised changes to wave heights and periods, tidal current velocity and vectors from foundation installation, pipe laying and working vessels.

7.6.38 The presence of static structures within the marine environment has the potential to affect the wave regime (height and period) due to the interaction of waves with these structures. Such interactions can have important implications upon the hydrodynamic regime and resultant sediment transport and seabed morphology by directly extracting energy from waves through the deployment of Oyster WECs. The development has the potential to affect the hydrodynamic regime by:

- Interaction with static structures, i.e. monopiles
- Energy extraction via WECs

7.6.39 Waves are disrupted by the presence of any static structure within the marine environment. Morrison's Equation states the relationship between wave disruption and the diameter of cylinders (monopiles) when the diameter (D) becomes large relative to the wavelength (L). A value of $D/L \geq 0.2$ is generally taken as the regime at which wave scattering become an important process. A wave is reflected when it interacts with a static structure which affects its incident path. On the sheltered side of the static structure a shadow zone is created where waves are bent (diffracted) around the static structure. The wave climate of the study area includes long period waves which are unlikely to be influenced by the monopile diameter proposed (~5m).

7.6.40 Incident waves may loose energy via direct energy extraction via the WEC array. The energy losses from waves as a direct result of WEC arrays have partially been explored by Vogler (2012, Unpublished). Analysis presented states that the available energy from a 1 metre (h) and 5 second (p) wave is 2.2Kw per metre wave length. This values increases almost nine times for a wave with twice the amplitude and period (h2m and p10s). For waves three times the height and period the power increases to 31.8 times that of a 1 metre, 5 second wave.

7.6.41 According to Vogler (Unpublished) individual wave heights in excess of 12m can be observed during autumn and winter storms of the north-west of Lewis. Such waves (h12m and p15s) have an associated power of 1,114Kw per metre (i.e. more than a MW per metre of each incident wave). Figures 7.5 and 7.6 indicates that maximum wave heights in excess of 20m were recorded during a storm on the 2nd and 3rd December 2011, with an associated wave power of 1,839Kw/m (Vogler, Unpublished).

7.6.42 Oyster WEC devices are rated in the range of 800KW to 1,000MW. Due to the confidential nature of the proposed technology, full technical specifications are currently not available to inform a detailed assessment of the energy extraction upon the local wave regime. Without full knowledge of all relevant parameters it is difficult to predict and disseminate the full impact of specific devices or arrays of devices, on the regional wave climate and associated coastal processes.

7.6.43 The final specifications of the Oyster devices deployed will be determined by experience gained from previous designs. Therefore, without full knowledge of all parameters it is difficult to accurately assess the potential energy losses associated with the proposed development during the operational phase.

7.6.44 The following assessment is adopted from Vogler (Unpublished) for a hypothetical device with a rated nominal wave power of 100kW/m. The figure of 100kW/m for the nominal power is taken arbitrarily and true values are likely to deviate considerably.

7.6.45 Wave power can be approximated by equation 1.

$$P \approx \rho g \frac{(H_m 0)^2}{16} C_g$$

7.6.46 Where: ρ is the density of seawater; g is gravitational acceleration, HmO is significant wave height and Cg is group velocity.

7.6.47 According to Vogler (Unpublished) for a wave of 5.5m height, 10.0s period in 60m water depth, an approximation of the wave power of 155kw is obtained and an wave energy extraction for the hypothetical WEC of 64.5%. However, a maximum wave of 11m and 10.5s, recorded of Siadar on the 2nd of December 2011, results in a peak power of 576kw/m, the power reduction of the hypothetical WEC is 17%.

7.6.48 The Oyster wave array shall result in wave energy extraction resulting in change to wave energy and resultant potential for a reduction in wave height in the lee of the WECs. The array shall consist of 40 to 50 WEC devices parallel to the coastline located between the 10 to 15m bathymetric contours. The array will be configured in a linear formation running roughly parallel to the coast, in an orientation designed to capture as much incident wave energy as possible, and will cover a distance of up to 3.2km from end to end (see Figure 5.2).

7.6.49 A minimum separation distance of 20m end to end between individual Oyster devices will be applied to final layout. As each WEC consists of a flap from 26 to 33m wide and 9 to11m deep, equating to a distance of 16.5m either side of the monopile, as a worse case scenario. This equates to structures within the upper 10m of the water column over greater than 50% of the development area.

7.6.50 Such reductions in wave energy shall result in shadow effects which can potentially give rise to changes in nearshore and shoreline processes. Such changes have been noted previously, particularly for devices situated in shallow water (<12m) (Amoudry, 2009). As the Oyster devices are fixed in orientation relative to the optimal wave direction, the power taken out of the waves at sub-optimal angles is reduced. For waves approaching between 0^o and 30^o (north-east and orientated with long axis of array and coastline) from the optimal direction, the hydrodynamic capture of the Oyster device is almost zero (Aquamarine Power, Ltd 2012.).

7.6.51 The distance offshore is a key determining factor in whether the waves have the ability to regroup within the lee of the array. Due to the Oysters being located within approximately 1km from the shore (measured shore normal south-east to north-west), it is not anticipated that reduction in wave height shall be recovered via wave regrouping within the lee of the structures. Wave extraction is therefore anticipated to result in minor to major magnitude changes to the incident wave energy regime dependant upon the nature of incident wave energy.

7.6.52 These changes are expected to be highly variable both spatially and temporally and vary in response to incident wave energy and wave height. Minor magnitude changes are to be expected during high magnitude low frequency (HMLF) storm events when the incident energy is an order of magnitude greater than for low magnitude high frequency (LMHF) fair-weather events when moderate effects are anticipated as a direct consequence of greater energy extraction in relation to wave energy availability. Reduction in wave energy will result in changes to the sediment transport regime within the lee of the devices (see Effect 5). As with hydrodynamics, these changes shall vary spatially and temporally in response to incident wave energy and wave height. Wave incidence from the north-west shall result in changes to the sediment transport processes to the south-east of the devices and along the coastline, with waves incident from the southwest resulting in changes to the north-east of the devices. As waves are highly variable in their incidence, these spatial and temporal changes shall not manifest continually over one area of the seabed. Therefore, changes to sediment distribution patterns are anticipated to be temporary in nature and reversible.

7.6.53 The confidence in the anticipated change to the hydrodynamic regime is moderate as the assessment presented herein is based on little site specific data, particularly the effects of diffraction and refraction in combination with wave energy extraction. As for the wave regime, the presence of static structures within the marine environment has the potential to affect the tidal regime due to the interaction of tidal flows with these structures. Such effects may manifest as changes to tidal current speed which manifest as flow separation and downstream (in the direction of tidal current flow) turbulence. Such changes are anticipated to be within the bounds of natural variation, localised, temporary in nature, and reversible and therefore of negligible magnitude.

7.6.54 As outlined earlier (see 7.4.20) the significance of any effects will be **negligible** for physical features.

MITIGATION IN RELATION TO IMPACT 4
No mitigation is proposed.

Residual effect

7.6.55 Although the significance of the effect remains **negligible**, a minor to major magnitude residual effect is anticipated as a result of the proposed development.

7.6.56 Visual, intertidal or bathymetric surveys will be undertaken at selected locations within the development site to assess the magnitude and extent of changes to sediment distribution patterns and coastal processes. The requirement for subsequent surveys will be planned depending on the results of initial monitoring. The requirement for visual, intertidal or bathymetric surveys will be discussed with MS-LOT and other key stakeholders.

Impact 5: Effects on sediments and sedimentary structures

7.6.57 Effects upon seabed sediment distribution patterns and on both nearshore and longshore sediment transport processes.

7.6.58 The development has the potential to affect sediments and sedimentary structures via:

- Scour development due to the interaction with static structures, i.e. monopiles; and
- Changes to sediment transport processes.

7.6.59 The process of scour while typically significant in areas of mobile substrates and unconsolidated sediments is deemed to be insubstantial due to the bedrock nature of the seabed. It is not anticipated that scour will develop in the immediate vicinity of the monopiles. However, the hydrodynamic process (flow separation and acceleration) leading to scour development shall still function potentially resulting in changes to the sediment distribution patterns within the near field area (~50m) of the monopiles (Amoudry et. al., 2009).

7.6.60 During the operational phase of the proposed development the key change relates to wave energy reduction in the lee of the Oyster WECs. Such changes may potentially disrupt near-field and longshore sediment transport processes. Given that longshore sediment transport along the coastline is acknowledged to be low, any potential effect upon the coastal system in terms of changes to the sedimentary regime may have important implications upon coastal development.

7.6.61 Reductions in wave energy in the lee of the WECs may result in localised changes to the nature of the seabed via the deposition of unconsolidated sediments. However, the dominant substrate types present in the survey areas are characteristic of a more exposed site, consisting predominantly of rugged bedrock. Boulder and cobble tend to occur in patches overlying bedrock or mixed with pebble and gravel in bathymetric depressions (gullies) and on other low-lying areas of rock (*Chapter 9: Benthic ecology*). Coarse sand tends to be restricted to the inshore areas and is apparently mobile, occurring as ripple features.

7.6.62 Where wave energy extraction is located within close proximity to soft-coastlines it is considered that the potential to alter the sediment dynamics is increased. However, due to the bedrock dominated nature of the coastline along the study area, the potential for any changes to coastal geomorphology are greatly reduced.

7.6.63 The sensitivity of the shoreline to incident wave energy has been demonstrated by Williams & Esteves (2005) based on simple continuity model driven by hindcast wave model data. Williams & Esteves (2005) demonstrated that changes to accretion and erosion patterns could be explained by changes to the incident wave energy and orientation. These changes in wave climate also have the potential to alter bedrock dominated coasts.

7.6.64 Pipelines laid on the seabed will act as a barrier to sediment drift within the nearshore zone and along the coastline from south to north. Such interruption to littoral processes will result in the accretion of sediment around the pipe and housing until such time as sediment accretion attains sufficient elevation to bypass the structure on the seabed.

7.6.65 The main effects of the operational phase on sediments and sedimentary structures relates to changes in littoral processes and the development of scour around the base of the foundations and ancillary infrastructure caused by local acceleration of tidal current flow around static structures. The depth of scour will depend on the local physical conditions, the thickness of the mobile layer, if present, and in the case of coastal sedimentary structures, the cohesiveness of the substrate.

7.6.66 As set out in Effect 4, a reduction in wave energy will result in changes to the sediment transport regime within the lee of the devices which shall contribute to potential changes to coastal processes. These changes shall vary spatially and temporally in response to incident wave energy and wave height. As waves are highly variable in their incidence, these spatial and temporal changes shall not manifest continually over one stretch of the coastline but vary in response to the incident wave direction.

7.6.67 The potential effects upon sediments and sedimentary structures resulting from the operational phase of the development foundation installation, pipe laying and working vessels are anticipated to be within the bounds of natural variation, localised, temporary in nature, and reversible, hence of minor magnitude.

7.6.68 Variations in layout can result in the reduction of effects upon the hydrodynamic regime with subsequent changes to the sediments and sedimentary structures. However, it is not anticipated that an alternative layout would result in a significant reduction of the anticipated effects upon sediments and sedimentary structures while maintaining economic viability.

7.6.69 As outlined earlier (see 7.4.20) the significance of any effects will be **negligible** for physical features.

MITIGATION IN RELATION TO IMPACT 5
No mitigation is proposed.

Residual effect

7.6.70 The potential effects shall result in spatially and temporally variations in sediments and seabed substrate distribution patterns. These changes are not anticipated to be permanent and shall continue to evolve in response to changes in the hydrodynamic environment.

7.6.71 Residual effects are anticipated to remain **negligible**.

Impact 6: Effects on geological and geomorphological formations

7.6.72 Effects to intertidal bedrock platform from pipe works and on coastal geomorphological formations from landfall

7.6.73 The main effects of the operational phase on geological and geomorphological formations relates to changes in littoral processes and subsequent effects upon exposed bedrock seabed and coastal geomorphology via the disruption or change to existing offshore to onshore processes resulting in coastal erosion (see Table 7.1).

7.6.74 The seabed is comprised predominantly of exposed Lewisian Gneiss overlain by patchy coarse grained sediments and boulders. Where pipelines are exposed and stand proud from the seabed, sediment shall accrete against the updrift side of the exposed infrastructure. Such changes in seabed substrate are not expected to be permanent and their spatial extent and duration of persistence shall vary in response to the natural variance of the hydrodynamic and sedimentary regime. It is anticipated that under storm conditions that any accreted material shall be dispersed into the nearshore sediment transport system. The magnitude of the potential effect upon the bedrock platform and landfall is considered to be low.

7.6.75 The existing coastal geomorphology along the Lewis coastline is a state of dynamic equilibrium with hydrodynamic and sedimentary processes and displays a marked seasonality in morphological variation in response to seasonal changes to the hydrodynamic regime (see Photo Plate 7.1). Changes in sediment accretion

7.6.76 The geological and coastal geomorphology of the study area is controlled by the geological structure of the Lewisian Gneiss. The operational changes to the wave climate are unlikely to affect this hard rock. Where the Lewisian Gneiss is overlain with Quaternary deposits there may be a reduction in the rate of coastal erosion as a direct consequence of reduced wave energy incident along the coast.

7.6.77 The potential effects upon geological and geomorphological formations resulting from the operational phase of the proposed development are anticipated to be within the bounds of natural variation, localised, temporary in nature, and reversible, hence of minor magnitude. The potential for this change to impact upon benthic ecology is assessed in Chapter 9: Benthic Ecology.

7.6.78 As outlined earlier (see 7.4.20) the significance of any effect will be **negligible**.

MITIGATION IN RELATION TO IMPACT 6
No mitigation is proposed.

Residual effect

7.6.79 The significance of any impact will remain **negligible**.

Potential impacts during decommissioning

7.6.80 At the current time, no specific proposals have been set out for the decommissioning of the wave array. It is assumed that permanently buried pipes would be left in place, and that devices and support structures would be entirely removed. Any exposed or potentially exposed pipe lengths would also need to be removed. Under this situation there would be no broad scale or long term effects on seabed or coastal processes. Effects would be similar to those identified during the construction phase, but with lower initial magnitude and would be informed via a detailed decommissioning plan which will be produced to outline how the approach to decommissioning will be undertaken.

Cumulative Effects

7.6.81 Current activities that may have an overlap with the Lewis Wave Array project are:

- 4MW Voith Hydro Wavegen Project – located at the mouth of the river Siadar; and
- Pelamis Wave Power – located in offshore waters west of Loch Roag.

7.6.82 However, it is unlikely that the construction phase of any of these projects will overlap with the construction phase of the Lewis wave array.

7.7 Conclusions

7.7.1 Anticipated effects within the north-western coast of the Isle of Lewis are expected to be relatively localised to the monopile foundations, Oyster devices and the seabed infrastructure that connects the Oyster devices together. It is considered that disturbance to the seabed will manifest over a spatially limited area, not be permanent and occur within a highly dynamic environment. In high energy environments, such as north-west Lewis, natural changes will occur frequently with any changes resultant from the presence of the wave array expected to be of low magnitude.

7.7.2 Wave energy extraction is anticipated to result in minor to major magnitude change to the incident wave energy regime dependant upon the incidence wave energy. Minor changes are to be expected during high magnitude low frequency (HMLF) storm events when the incident energy is an order of magnitude greater than for low magnitude high frequency (LMHF) fair-weather events when moderate effects are anticipated as a direct consequence of greater energy extraction in relation to energy availability.

7.7.3 The geological and coastal geomorphology of the study area is controlled by the geological structure of the Lewisian Gneiss. The operational changes to the hydrodynamic and sedimentary regimes are unlikely to affect this hard rock. Where the Lewisian Gneiss is overlain with Quaternary deposits there may be a reduction in the rate of coastal erosion as a direct consequence of reduced wave energy incident along the coast.

8. SOILS, HYDROLOGY AND HYDROGEOLOGY

8.1 Introduction

8.1.1 This chapter assesses the potential effects on soils, hydrology and hydrogeology as a result of construction, operation and decommissioning of the onshore aspects of the development.

8.1.2 This chapter outlines mitigation measures to control the predicted effects of the construction, operation and decommissioning. Following mitigation, an assessment of the significance of residual effects will be undertaken.

8.1.3 The onshore components (see *Chapter 5: Project Description*) comprise up to eight shore pipelines, which will connect to a common landing area or between two and eight separate landing areas depending on the final engineering requirements of the array. Pipelines will either be laid on the surface or in trenches, which will be 2 metres (m) wide by 2m deep. The shore pipelines may be installed using a horizontal direction drilling (HDD) method, and as such there is the potential that onshore drilling will be required. If pipelines are to be installed by HDD onshore then 32 boreholes from one or two separate locations within the onshore pipeline installation area will be required.

8.1.4 A number of structures and buildings will be constructed associated with the hydro electric power station within a compound of 10,000 m^2, comprising 2 main generating stations, tanks, diesel and fuel tanks, switch rooms, transformer rooms, diesel generator etc. Construction will take place in a phased approach. There will also be an area for temporary construction adjacent to the compound covering an area of 6,000 m^2. This area will be used to store vehicles and materials during construction.

8.1.5 A road will be built to connect the construction site to the A857. Part of an existing track will need to be upgraded and widened. A new access road will be built extending the existing track to the construction site. An additional track will be built to transport vehicles from the compound to either the point at which the pipelines make landfall at the shore, or up to two separate locations where HDD drilling rigs may be located.

8.1.6 Foundation type will depend on ground conditions. Where ground conditions are of poor quality for rock foundations for greater than 2m depth, it is likely that reinforced concrete raft foundation system will be used, however, where poor ground conditions are less than 2m deep, surface layers will be removed and reinforced concrete foundations will be direct into rock.

8.2 Summary of assessment on soils, hydrology and hydrogeology

8.2.1 This assessment has considered the potential impacts to the water and soil environment within 1kilometre (km) of the development site. A desk based assessment and a peat probe survey and water features survey have been undertaken to inform this impact assessment.

8.2.2 Potential impacts have been mitigated as far as reasonably practicable. All residual impacts are considered to be negligible with the exception of potential impacts associated with drainage and dewatering of peat during construction of the foundations of the hydro electric power station buildings, which is considered to be of minor adverse significance. Improvements to the current river crossing are considered to offer a positive benefit to the water environment.

8.3 Potential effects

8.3.1 The potential effects on the water and soil environment from the onshore elements of this development are considered to comprise:

- Changes to water runoff patterns;
- Changes suspended sediment levels and turbidity of watercourses;
- Pollution caused by accidental spills or leaks of potentially polluting substances;
- Drainage and dewatering of peatland;
- Peat slips;
- Carbon loss due to excavation of peat;
- Changes to the chemistry of the peatland;
- Pollution of watercourses as a result of drilling activities; and
- Flooding or surface ponding.

8.3.2 All of the potential impacts listed above have been addressed. Reference has also been made to Guidance produced to aid the consenting process for marine renewables in Scotland (EMEC and Xodus Group, in draft).

8.4 Methodology

8.4.1 The methodology is based on review of various data sources, including the following:

- Rainfall data obtained from Centre for Ecology and Hydrology Hydrometric Register;
- Topography taken from Ordnance Survey (OS) mapping at 1:25,000 scale;
- Geology data referenced from Geological Survey of Great Britain (Scotland), Lewis and Harris (North), 1:100,000 scale;
- Soil data referenced from Soil Survey of Scotland, Stornoway and North Lewis, Sheet 8, 1:50,000 scale; and
- Water resources (including abstractions and discharges) data obtained from Scottish Environment Protection Agency (SEPA).

<u>Legislation, Guidelines and Policy Framework</u>

8.4.2 The assessment has been undertaken with reference to statutory and general guidance and relevant legislation comprising:

- SEPA Pollution Prevention Guidance (PPG) Notes:
  - PPG 1 General Guide to prevention of water pollution;
  - PPG2 Above ground oil storage tanks;
  - PPG5 Works and maintenance in or near water;
  - PPG6 Working at construction and demolition sites;
  - PPG7 Safe Storage – The safe operation of refuelling facilities;
  - PPG 20 Dewatering underground ducts and chambers;
  - PPG21 Pollution incident response planning;
  - PPG 22 Incident response – dealing with spills

- Construction Industry Research and Information Association (CIRIA) publications:
  - C532 Control of water pollution from construction sites (2001);
  - C650 Environmental good practice on site (2006);
  - R168 Culvert Design Manual

- Legislative context:
    - The European Union (EU) Water Framework Directive 2000/60/EC;
    - Water Environment and Water Services (Scotland) Act 2003 (WEWS Act);
    - The Water Environment (Controlled Activities) (Scotland) Regulations 2011

- SEPA Position Statement to support the implementation of the Water Environment (Controlled Activities) (Scotland) Regulations 2005: Culverting of Watercourses

- Scottish Planning Policy (SPP), February 2010

- Good practice guidance including:
    - Good practice during wind farm construction, Joint publication by Scottish Renewables, Scottish Natural Heritage, Scottish Environment Protection Agency and Forestry Commission Scotland, Version 1, October 2010;
    - Floating roads on peat, Joint publication by Scottish Natural Heritage and Forestry Commission Scotland, August 2010;
    - Developments on peatland: Guidance on the assessment of peat volumes, reuse of excavated peat and minimisation of waste, Joint publication by Scottish Renewables, Scottish Environment Protection Agency, Version 1, January 2012;
    - Guidance: Developments on Peatland: Site Surveys, Joint publication by Scottish Natural Heritage, Scottish Environment Protection Agency, Scottish Government, The James Hutton Institute
    - Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments, Scottish Government, 2007;
    - Towards an assessment of the state of UK Peatlands, Joint Nature Conservation Committee, report number 445, April 2011;
    - Engineering in the Water Environment Good Practice Guide, Construction of River Crossings, Scottish Environment Protection Agency, First Edition, April 2008;
    - Guidelines for the risk management of peat slips on the construction of low volume / low cost roads over peat, Forestry Commission, Scotland, January 2006;
    - Construction tracks in the Scottish Uplands, Scottish Natural Heritage, 2005;
    - British Standards (BS) EN 13249 : 2001 'Geotextiles and geotextile-related products – Characteristics required for use in the construction of roads and other trafficked areas (excluding railways and asphalt inclusion)

Consultation

8.4.3 Discussions have been undertaken with SEPA prior to this assessment. A summary of the responses from SEPA with regards to the water environment are presented in Table 8.1.

Table 8.1 Key consultation responses

Comments & Information	Response
• SEPA confirmed on 15th December 2011 that it is unlikely there will be spawning fish in the burn at the road due to the distance of the culvert from the sea. • A Controlled Activities Regulations (CAR) notification would be required if the access track is a single track upgrade.	• The track is likely to be wider than 2 m. Further consultation with SEPA will be undertaken. The culvert (road crossing) will be designed with the capacity for a 1 in 200 year event.

Table 8.1 Key consultation responses	
Comments & Information	**Response**
• Further consultation will be required if the track is wider than 2 m or a double track. The culvert design should have the capacity for a 1 in 200 year storm event. • Flooding at the site is not a major concern for SEPA • Address standing water in the upgrade plan. • Follow good practice construction guidance to prevent pollution to water bodies.	• Flood risk assessment not undertaken as part of the EIA. • Standing water will be managed appropriately following best practice guidance during the construction phase of the work.
SEPA advised in the Scoping Opinion the following: • Utilise SEPAs PPG documents to design mitigation measures. • Identify location of and protective / mitigation measures in relation to all private water supplies within the catchment of the scheme. • Identify if the potential impacts of the proposal are likely to lead to deterioration of the water environment. • The application should meet the requirements of the Water Framework Directive (200/60/EC). • Consult Scottish Water to determine whether sewage discharges will be impacted by the development. • Where watercourse crossings are required, bridging solutions or bottomless or arched culverts which do not affect the bed or the banks of the watercourse should be used. • A flood risk assessment (FRA) should be submitted if the works are likely to exacerbate flood risk. • Watercourses should not be culverted as part of new development. Where culverts are unavoidable, they should be designed to maintain or improve existing flow conditions and aquatic life. A culvert may be acceptable as part of a scheme to manage flood risk or where it is used to carry a watercourse under a road or a railway. • A site survey of existing water features should be carried out. • A justification for each activity and how any adverse impact will be mitigated should be included. • A photograph of each affected water body should be included, along with dimensions.	• The ES will reference appropriate best guidance documents, which the construction and operational phase will adhere to. • Potential impacts and mitigation measures identified in ES. • A Water Framework Directive (WFD) assessment is included in this ES chapter. • Scottish Water will be consulted through the EIA process. This ES chapter has assessed the likely impact to the discharge consents. These are not considered to be significantly impacted during the construction or operation phases. • Watercourse crossing will be upgraded and designed to withstand a 1 in 200 year event. • An FRA is not required as part of this development. • A water features survey has been carried out and the results are reported in this ES chapter.
SEPA advised in the Scoping Opinion the following: • Demonstrate how layout and design avoid impact on peatland or mire systems. Where avoidance is impossible, provide details of how impact will be minimised and mitigation should be provided. Peat depth survey undertaken. • Minimise volume of excavated peat. An early discussion with SEPA with regards to peat waste is essential and minimisation of peatland disruption should be adopted.	• Peat survey has been undertaken and results are reported in this ES chapter. • Peat extraction will be minimised through construction design, including siting buildings on areas of thin (<1 m) peat and use of floating roads.

Table 8.1 Key consultation responses	
Comments & Information	**Response**
• The disposal of peat waste to borrow pits is not encouraged. • Peat buried at depth is likely to be subject to consent under SEPAs regulatory regimes. • It is essential that minimising the extraction of peat is explored and options identified to minimise risk in terms of carbon release, human health and environmental impact.	
SEPA advised in the Scoping Opinion the following: • A matter for planning and building standard authorities and civil engineers. • Guidance on preparing a peat stability report can be found on the Scottish Government website.	
SEPA advised in the Scoping Opinion the following: If groundwater dependent terrestrial ecosystems are found within 100 m from tracks, roads or trenches or 250 m from borrow pits and foundations, the likely impact of these will require further assessment. The results of the assessment and measures that will be taken to ensure the proposals do not have an unacceptable risk should be included in the ES.	No groundwater dependent terrestrial ecosystems are located at the site or within the surrounding area.
SEPA advised in the Scoping Opinion the following: List of groundwater abstractions within and outwith the site boundary should be provided.	There are no abstractions within the site boundary or surrounding area.
SEPA advised in the Scoping Opinion the following: Where a water abstraction is proposed, details are to be provided to SEPA.	
SEPA advised in the Scoping Opinion the following: • Identify aspects of work that might impact the environment, potential pollution prevention risks and mitigation measures. • Timing of works should be planned to take account of weather conditions, i.e. avoid potentially polluting activities in period of heavy rainfall. • Principles of a Construction Environmental Management Document (CEMD) should be used in the ES. • The CEMD should form the basis of a more detailed site specific Construction Environmental Management Plan (CEMP).	A CEMD and CEMP will be undertaken as part of the construction work, which will identify specific on site pollution control measures and timing of works to account for weather conditions.

Table 8.1 Key consultation responses	
Comments & Information	**Response**
• A CEMD should be submitted at least 2 months prior to the proposed development. This document should also include site specific CEMPs.	
SEPA advised in the Scoping Opinion The onshore components of the development should be assessed for flood risk from all sources.	SEPA advised, following clarification of the site location, that there is no requirement to undertake a flood risk assessment.
SEPA provided advice regarding groundwater dependant terrestrial ecosystems: • The access track should be a floating road over areas of deep peat, marshy grassland, or wet heath (as stated in the documentation) • The powerhouse, and any other construction should not be on areas of marshy grassland or wet heath (as recommended in the Phase 1 habitat report) • SEPA has advised any buried cableways should have mitigation to ensure they do not become preferential drainage conduits for areas of peat, marshy grassland, or wet heath. • If construction other than a floating road on peat is proposed on possible GWDTEs further investigation and mitigation would be required.	Final designs will be confirmed with SEPA prior to construction. Impacts to hydrology are discussed in Chapter 8: Soils, hydrology and hydrogeology

Data collection

8.4.4 The principal data sources relevant to water quality are shown below in Table 8.2.

Table 8.2 Table Existing data			
Data source	**Coverage**	**Author(s)**	**Year**
Geological Survey of Great Britain (Scotland), Lewis and Harris (North), 1:100,000 scale;	Lewis and Harris	Geological Survey of Great Britain	1981
Soil Survey of Scotland, Stornoway and North Lewis, Sheet 8, 1:50,000 scale;	Stornoway and North Lewis	The Macaulay Institute for Soil Research, Aberdeen	1985
Centre for Ecology and Hydrology Hydrometric Register (http://www.ceh.ac.uk/data/nrfa/)	UK	Centre for Ecology and Hydrology	1993 - 2010
SEPA RBMP interactive map	Lewis and Harris Coastal	SEPA	2008

Assessment of significance

8.4.5 This section outlines the methodology used to assess the significance of potential environmental impacts of the onshore elements of the development with respect to the water and soil environments. There are currently no published criteria for assessing or evaluating effects on soils, hydrology and hydrogeology. This assessment will be based on methodology derived from Institute of Environmental Management and Assessment (IEMA 2004)

8.4.6 Significance can be categorised into four levels of magnitude as described in Table 8.3.

Table 8.3 : Criteria for assessing the magnitude of potential effects on water and soil

Magnitude of effect	Definition
High	A fundamental change to the baseline condition, e.g. change to surface water flows, flood risk or erosion potential; change to WFD status of nearby water bodies; change in quality or quantity of abstraction; or loss of peatland habitat.
Medium	A detectible change in the baseline condition resulting in the non-fundamental temporary or permanent change to the condition of the water and soil environments.
Low	A minor change to the baseline condition of the water and soil environment (or a change that is temporary in nature).
Negligible	An imperceptible and/or no change to the baseline condition of the receptor.

8.4.7 The sensitivity of the receptor for each effect is characterised as one of three levels: high, medium or low or. The definition of each level is given in Table 8.4.

Table 8.4 Criteria for assessment of sensitivity of water and soil

Receptor sensitivity / value	Guideline criteria
High	• Site important on a European or global level, e.g. Ramsar sites • Public Water Supply Abstraction
Medium	• Site nationally important, e.g. Sites of Special Scientific Interest (SSSIs) • Local water supplies used for drinking water, including private water supply abstractions where no alternative supply exists • Groundwater or surface water abstractions used for non-drinking water purposes, such as agricultural supplies • Aquifer important for baseflow to rivers
Low	• Locally important sites • Unproductive aquifer, minor watercourse.

8.4.8 Table 8.5 presents the definition of significance based on the magnitude of potential effects and the sensitivity of receptors.

Table 8.5 Significance prediction matrix.

Magnitude of effect	Receptor sensitivity/value		
	Low	Medium	High
High	Moderate	Major	Major
Medium	Minor	Moderate	Major
Low	Negligible	Minor	Moderate
Negligible	Negligible	Negligible	Minor

8.5 Existing environment

8.5.1 This section describes the existing environment within the red line boundary and considers potential impacts to the water and soil environment within a radius of 1 km from the site boundary.

Topography, hydrology and climate

8.5.2 The site is adjacent to the coast, as shown on Figure 8.1. Where the proposed buildings and pipelines are located, the site slopes gently towards the coast from around 30m Above Ordnance Datum (AOD) to less than 10m AOD over a distance of approximately 250m. The proposed access track gently undulates from Siadar Iarach down to the Lambol Burn, from where the elevation increases again to a ridge at approximate NGR NB 390 555. The access track then slopes gently downwards to where it turns 90^{o} at NGR NB 389 555. The access track then remains at an approximate elevation of 30m AOD, until it meets the proposed buildings.

8.5.3 Figure 8.1 presents the topographic conditions at the site as well as the significant surface water features. The surface water features comprise the Allt Fisgro, Loch Bacabhat, the Lambol Burn and the Feadan Loch an Duin. The red line boundary is also presented on this figure.

8.5.4 With the exception of the southern extent of the access track, any rainfall falling on the site will drain in a north-westerly direction towards the coast. The southern extent of the access track (approximate NGR NB 394 948 to NB 390 555) lies within the surface water catchment of the Lambol Burn, which flows in a westerly direction. This burn is fed by the Loch Bacabhat, situated at approximately NGR NB 398 552. Loch Bacabhat is located approximately 425 m east of the access track.

8.5.5 The Feadan Loch an Duin is located approximately 30m west of the southern extent of the access track and flows in a north westerly direction to join the Lambol Burn approximately 30m downstream (west) of where the Lambol Burn is culverted beneath the existing access track.

8.5.6 The Allt Fisgro is situated outside the catchment of this site. It is located to the east of the site and flows in a north westerly direction to discharge into the sea.

8.5.7 A water features survey was undertaken by two Royal Haskoning Environmental Consultants on 8 and 9 February 2012. The survey comprised observations of water bodies within the site boundary or ones with the potential to be impacted. The Lambol Burn was identified as being potentially at risk from the development through works where the existing track crosses it and potential pollution events. This burn is currently culverted where the existing access track crosses it. Deep pooled water was observed at the upstream and downstream end of the culvert. The culvert entrance at the upstream end was observed to be around 1 m in diameter, whereas the downstream outlet was noted to be significantly smaller. Both the upstream and downstream ends of the culvert were noted to be significantly overgrown with grasses, potentially causing a partial blockage to flow. In general, the burn was estimated to be around 1m in width and the depth of water was estimated to be around 30 to 40 centimetres (cm) on the 8 February 2012. The photographs of the Lambol Burn taken during the site survey work are presented in Appendix 8.1.

8.5.8 The rainfall for the area is estimated to be in the order of 1500 millimetres (mm) based on the Standard period Average Annual Rainfall as measured by SEPA and reported by CEH for a monitoring station at Creed Bridge at NGR NB 403 325. The catchment area for this monitoring station is 43.4 km^2, described as gently-sloping peat covered catchment underlain by Lewisian Gneiss.

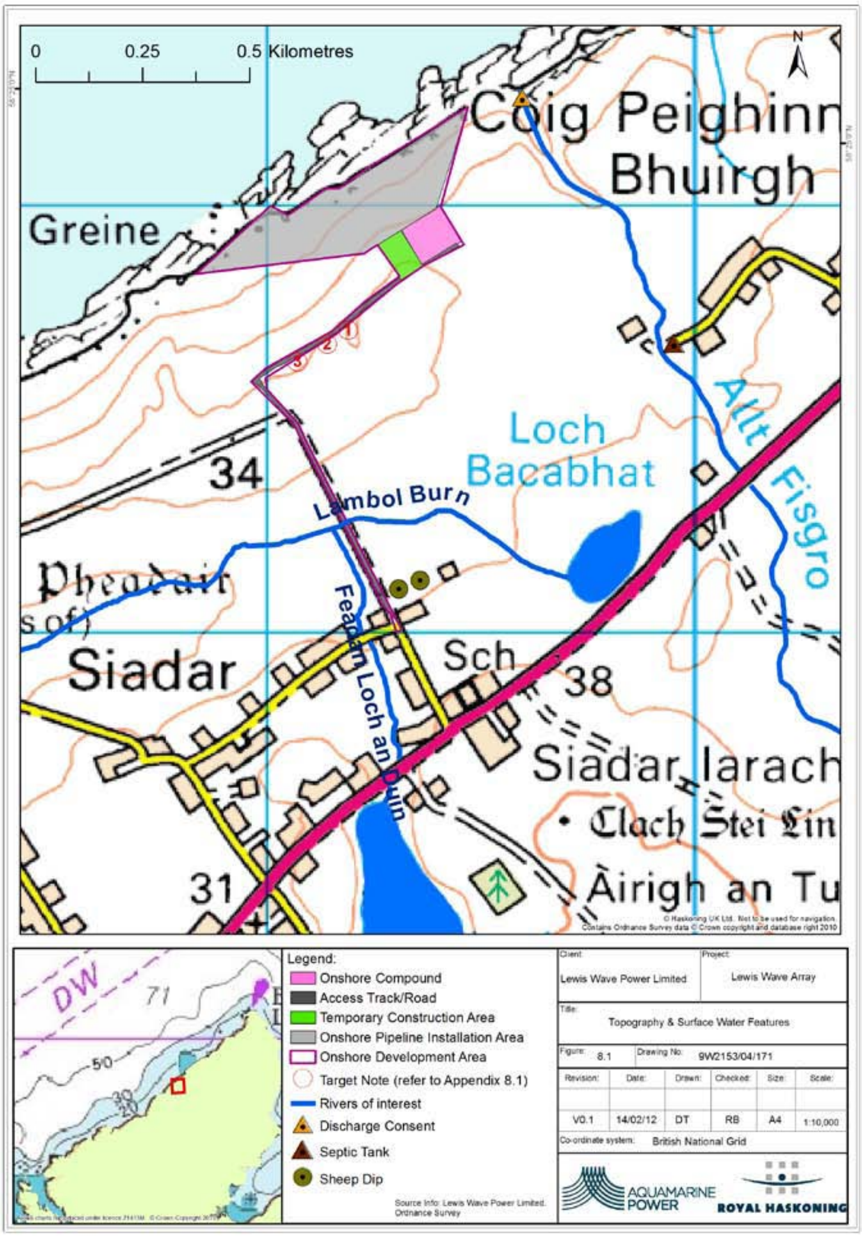


Figure 8.1 Topographic conditions and significant surface water features

Soils and geology

8.5.9 The Soil Survey of Scotland (Sheet 8 Stornoway and North Lewis) mapping indicates that the site is underlain by soil comprising peaty gleys, peat and some peaty podzols. The mapping states that the habitat type for this soil characteristic is bog and northern bog heather moor; northern Atlantic heather moor; and northern blanket and flying bent bog.

8.5.10 A peat depth survey was undertaken on 8 and 9 February 2012 by two Royal Haskoning Environmental Consultants (Appendix 8.1). The aim of which was to determine the presence of deep peat (defined as any soil with a peat layer greater than 1m deep (JNCC, April 2011)) within the footprint of the proposed development footprint boundary.

8.5.11 The scope of the survey, to meet requirements of the Scottish Government and (SEPA), comprised the following:

- An assessment of peat depth across the proposed scheme footprint using a 3m peat probe; and
- An assessment of peat type (i.e. degree of humification) where possible through excavation of top layers (coring of peat at depth was not within the scope of the survey).

8.5.12 A hand held Global Positioning System (GPS) was loaded with predetermined sample locations and used to navigate to target areas across the survey area The target areas included all access tracks; areas of proposed excavations; foundations; and construction areas. Where excavations for buildings/foundations are proposed, peat depth probing was undertaken at a greater intensity to gain a high density of data points for future interrogation within a Geographical Information Systems (GIS) terrain model to map the depths and extents of peat at the site.

8.5.13 Vegetation cover and type was noted for each sample point, as was the presence of dry or wet conditions. Photographs were also taken at each probe point. The results of the survey are presented in Appendix 8.1, along with a select number of photographs.

8.5.14 In summary, the results of the peat depth probe indicate that the soil depth near to the rocky foreshore is relatively shallow (<30 cm). There are pockets of standing water across the site. Sphagnum moss was observed in pockets across the site, which is typical of peat bog habitat. The slopes of the site are furrowed, due to historic peat cutting and the presence of lazy beds (originally excavated to lift up sods of peat).

8.5.15 Figure 8.2 presents the results of the peat depth survey. The deepest peat (>3 m) was observed in the area near to the Lambol Burn crossing. The majority of the site is underlain with peat deposits of depths less than 1 m. Peat at depths between 1 and 2 m was observed in the east of the site and in a discrete area immediately north of the proposed buildings.

8.5.16 The Geological Survey of Great Britain (Scotland) Lewis and Harris (North) mapping at 1:100,000 indicates that the site is underlain by Lewisian Gneiss. This is described as a medium to coarse-grained metamorphic rock.

Hydrogeology

8.5.17 Evidence of water logging and pooling on the surface indicates that the peat overlying the Lewisian Gneiss is saturated in places. The peatland at this site is partly or wholly rainwater fed as the Lewisian Gneiss underlying the peat is a hard impervious rock and would not provide sufficient groundwater flow to sustain the peat (i.e. the inflows minus evaporation must be greater than the outflows to sustain the peat habitat). As such, the peatland at this site is unlikely to comprise a groundwater dependent terrestrial ecosystem however this cannot be confirmed without further on-site investigation.

8.5.18 The underlying solid geology is not considered to be a productive aquifer in terms of water supply or base flow to rivers. Any groundwater flow through the Lewisian Gneiss would be through fractures, which, if present, are likely to be near the top of the Lewisian Gneiss.

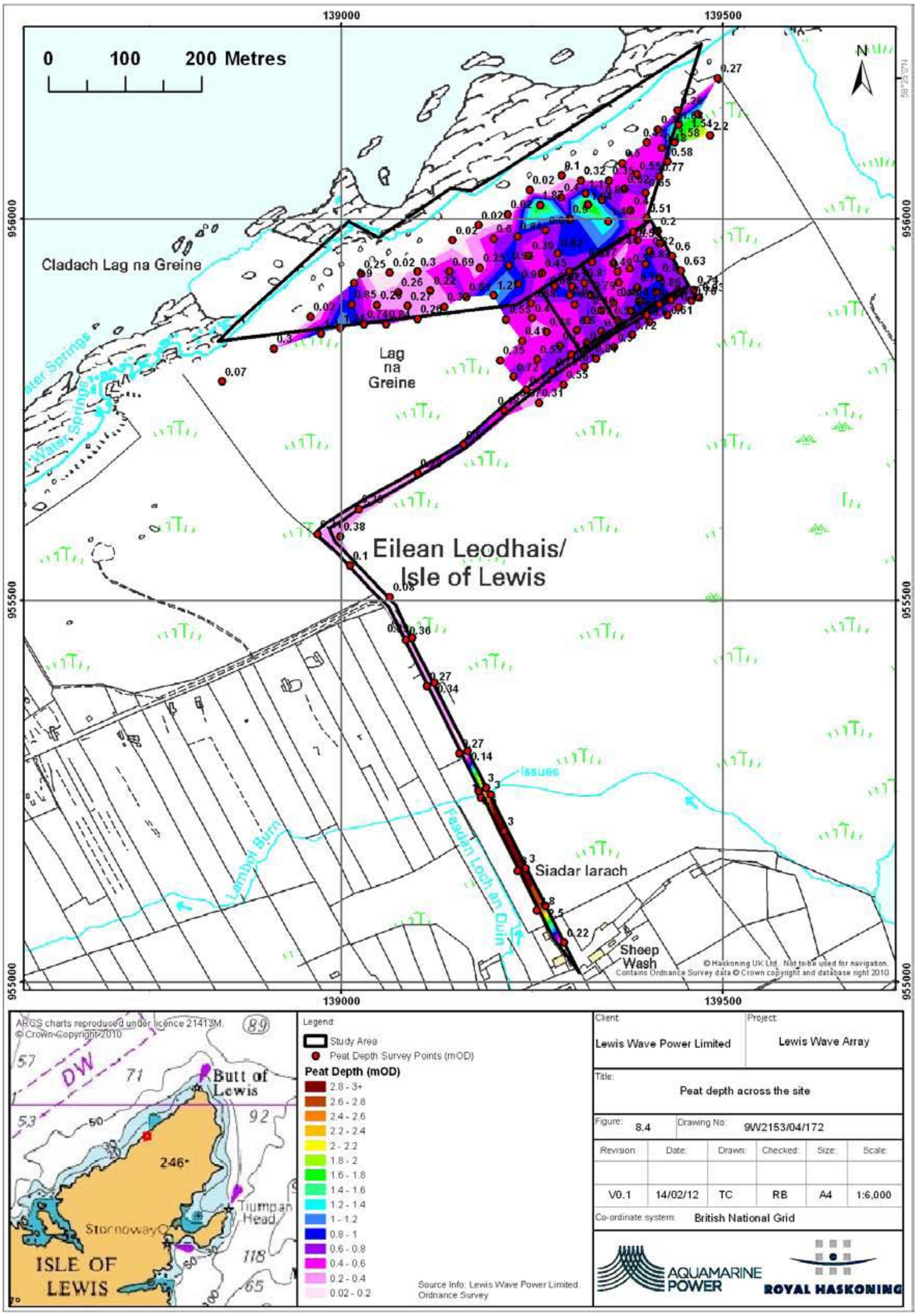


Figure 8.2 Results of the peat depth survey

Abstractions and discharge consents

8.5.19 There are no groundwater or surface water abstraction licenses or private water supply abstractions within 2 km of the site boundary.

8.5.20 There is one discharge consent within 2 km of the site boundary. It relates to a septic tank at NB 399 556, which discharges around NB 395 562. This is not considered to be of concern and is unlikely to be affected as a result of this development.

8.5.21 There are two locations near to the access track which are registered for the disposal of sheep dip (Figure 8.1).

Water quality

8.5.22 As part of their requirements under the Water Framework Directive (WFD), SEPA has assessed the status of all water bodies. Within the site and the surrounding area, only one watercourse has been assessed, namely the Abhainn Shiadair (identifier code 20803). This watercourse is downstream of the Lambol Burn and is therefore representative of the water quality at the site. Furthermore, as the Lambol Burn discharges into the Abhainn Shiadair, albeit at its downstream end prior to discharging into the sea, there is the potential that any activities during construction of operation could impact the status of it.

8.5.23 SEPA has reported the Abhainn Shiadair to be at an overall good status. This current status meets the requirements of the WFD, and as such there should be no deterioration in the status.

8.6 Impact assessment

Do nothing scenario

8.6.1 With regards to do nothing scenario, there is unlikely to be any significant change with respect to the current condition of the underlying soils, the drainage at the site and the hydrogeological conditions. It is likely, however, that if there is no intervention, the condition of the current river crossing will continue to deteriorate, potentially resulting in increased surface ponding adjacent to the river crossing and a negative impact to river fauna.

Potential impacts during construction

Impact 1: Change in surface water runoff patterns

8.6.2 23.4.3 The surface water runoff and drainage patterns are likely to be altered at the onshore site as a result of widening of the existing access track (New Road), construction of a new section of access track and excavation of foundations for the hydro electric power station and the onshore compound. This change in surface water runoff has the potential to result in increased flooding or surface ponding. The following measures will be put in place during construction to reduce any impacts: This is of particular risk during the construction of floating roads as a result of compression of peat causing loss of water and impeded surface runoff. The significance of this potential impact is considered to be **moderate adverse** on the basis that the sensitivity of the habitat is low (only locally important) and the magnitude of the effect is high.

MITIGATION IN RELATION TO IMPACT 1

- The construction contractor will develop and implement a construction method statement which adheres to the relevant best practise within Design Manual of Roads and Bridges (DMRB), Construction Industry Research and Information Association (CIRIA) ,SEPA guidance and in particular SNH and FCS guidance on Floating roads and construction on peat.
- Construction activities will be planned for drier periods were practicable. Meteorological Office forecasts will be consulted as well as flood warnings issued by Scottish Environment Protection Agency (SEPA) in order to determine where heavy rainfall may present a risk to the construction phase. Any construction work will stop when rain exceeds a certain threshold, to be determined as part of the Environmental Management Plan (EMP).
- Construction of the access track side verges will use where possible any excess peat from the excavation of foundations for buildings. Low verges will be constructed where possible to allow surface water to drain naturally and diffusely where it arises which will reduce the likelihood of surface water ponding to occur. This method of draining floating roads will preserve the local hydrology, which supports the ecology and habitat.
- Good practice guidance will be followed and in areas where the floating road (access track) is constructed parallel to the contours of the slope runoff will be intercepted and appropriately managed and discharged to the down slope area of the peat and allowed to follow natural drainage patterns.
- Use of low permeability backfill around trenches will reduce the likelihood of causing any change in surface water runoff patterns.
- Cut-off drains will be installed around buildings in order to intercept uncontaminated surface runoff and divert it to ensure natural drainage pattern.
- Care will be taken to avoid interference with the sheep dip disposal locations (Figure 8.1). If drainage patterns are unchanged there is no risk that potentially polluting substances contained in the sheep dip could result in pollution of the Lambol Burn.
- Cut-off drains will be installed around buildings in order to intercept any uncontaminated surface runoff and to divert it to ensure natural drainage pattern are preserved.
- Care will be taken to avoid interference with the sheep dip disposal locations. If drainage patterns are unchanged there is no risk that potentially polluting substances contained in the sheep dip could result in pollution of the Lambol Burn.

Residual effect

8.6.3 Implementation of the mitigation measures outlined above will reduce the significance of this potential impact to **negligible** on the basis that the magnitude of the effect will be reduced to low.

Impact 2: Generation of turbid runoff or runoff containing suspended sediments

8.6.4 During construction activities, including construction or widening of access tracks; construction of the river crossing; or excavation of foundations, turbid runoff could be generated, which could in turn impact nearby watercourses, specifically Lambol Burn and the adjacent coastal water body, namely Gallan Head to Butt of Lewis (refer to Chapter 20 Water Quality). The release in Dissolved Organic Carbon (DOC) from peatland at the site could result in water becoming brown. This potential impact is considered to be of **minor adverse** significance on the basis that the sensitivity of the habitat is low (only locally important) and the magnitude of the effect is medium.

MITIGATION IN RELATION TO IMPACT 2
• The construction contractor will develop and implement a construction method statement which adheres to the relevant best practise within Design Manual of Roads and Bridges (DMRB), Construction Industry Research and Information Association (CIRIA) ,SEPA guidance and in particular SNH and FCS guidance on Floating roads and construction on peat. • Construction activities will be planned for drier periods were practicable. Meteorological Office forecasts will be consulted as well as flood warnings issued by Scottish Environment Protection Agency (SEPA) in order to determine where heavy rainfall may present a risk to the construction phase. Any construction work will stop when rain exceeds a certain threshold, to be determined as part of the Environmental Management Plan (EMP). • Silt traps will be utilised to capture suspended solids, especially where construction is taking place on steeper land. Settlement ponds and attenuation areas will be employed where necessary. • Stockpiling of soils will be minimised. Any stockpiles will be located as far away from surface water features as possible.

Residual Impacts

8.6.5 Implementation of the mitigation measures outlined above will reduce the significance of this potential impact to **negligible** on the basis that the magnitude of the effect will be reduced to low.

Impact 3: Spills and leaks of oil, fuel and other potentially polluting substances

8.6.6 Spills and leaks of potentially polluting substances could occur during any construction activities, especially where vehicle movements are undertaken and in the temporary construction compound, where oil and fuel are likely to be stored. This could also occur during the laying of pipelines on the surface. Any spills and leaks could potentially impact the peatland habitat and nearby surface water receptors including the Lambol Burn and the downstream Abhainn Shiadair. Accidental spills and leaks could also potentially pollute the adjacent coastal water body namely Gallan Head to Butt of Lewis (refer to Chapter 20 Water Quality).

8.6.7 This potential impact is considered to be of **minor adverse** significance on the basis that the sensitivity of the habitat is low (only locally important) and the magnitude of the effect is medium due to the modest scale of the works.

MITIGATION IN RELATION TO IMPACT 3
• SEPA Guidance (PPG) will be followed to reduce the likelihood and magnitude of any spills and leaks. Specifically PPG) 1: General guide to the prevention of pollution, 2: Above ground oil storage, 5: Works and maintenance in or near water, 6: Working at construction and demolition sites, 7: Safe Storage – the safe operation of refuelling activities and 21: Pollution incidence response planning and Construction Industry Research and Information Association (CIRIA) C532 will be followed.   • Oil, fuel and any other potentially polluting substances will be stored in a designated storage area on site situated away from any sensitive receptors such as watercourses and will be stored within impervious bunds with 110% capacity to ensure complete spill / leak retention.   • Machinery and equipment will be routinely inspected to ensure they are in good working order and to detect any leakage at an early stage.   • Spill kits will be available on site at all times.   • Where appropriate wheel washing will be used to prevent excess soil being transferred to public roads.   • Any construction work will be undertaken in accordance with the EMP which will be developed in conjunction with the contractor and SEPA.

Residual effect

8.6.8 Implementation of the mitigation measures outlined above will reduce the significance of this potential impact to **negligible** on the basis that the magnitude of the effect will be reduced to low.

Impact 4: Drainage and dewatering of peat

8.6.9 Dewatering of peat may occur as a result of excavation of peat for the construction of foundations for the hydro electric power plant. This impact is considered to be short term and localised as the water table will return to equilibrium within a relatively short time. Installation of pipelines may lead to creation of a conduit for flow, which may in turn lead to a drying out of the surrounding peat. Furthermore, construction of the access track may alter drainage directions and lead to drying out of peat. Any alteration of flow patterns may lead to a diversion of drainage which could dry out peat.

8.6.10 Dewatering may also result from compression of the surface layers during construction, particularly during construction of temporary storage areas and the hydro electric power plant.

8.6.11 Dewatering may also result in peat being exposed to oxygen resulting in iron discolouration (caused by oxidation of ferrous iron to ferric iron, which results in the precipitation of ferric hydroxide). This ferric hydroxide precipitate can form a thick substance that could coat peat habitat or the bed of watercourses. This can lead to a detrimental impact on the flora and fauna of peat habitat.

8.6.12 Raft foundations may be utilised instead of concrete foundations, this would lead to a reduction in dewatering around the proposed hydro electric power building.

8.6.13 The significance of this potential impact is considered to be **moderate adverse** on the basis that the sensitivity of the habitat is low (only locally important) and the magnitude of the effect is high.

MITIGATION IN RELATION TO IMPACT 4

- Where required excavated peat will be kept wet to avoid oxidising conditions developing in the peat.
- If surplus peat is used in the construction of the floating road (access track) verges it will be laid in the same layer formation as excavated to reduce the likelihood of the peat drying out.
- Pre-construction geotechnical analysis will be undertaken to determine the likelihood of compression of peat and if required design adjustments will be made to ensure the peat habitat is protected, where practicable.
- Where any flows have been diverted from the peat during the construction of the floating road (access track) and created any water filled access track site depressions then appropriate mitigation, (for example plastic sheet piling dams) will be used.

Residual effect

8.6.14 Where raft foundations are used, the implementation of the above mitigation measures, the significance of the potential impact will be negligible on the basis that the magnitude of the effect will be reduced to low. However, where concrete foundations are used for the hydroelectric power plant buildings the significance of the potential impact will be **minor adverse** on the basis that the magnitude of the effect will be reduced to medium. It should be noted, however, that this impact is only considered to be of short term duration, until the water table within the peat reaches equilibrium.

Impact 5: Peat slips

8.6.15 Construction of access tracks, excavation of foundations and excavation of pipeline trenches may result in mass movement of peat. The Forestry Commission reports that there three mechanisms by which peat can fail during the construction process, comprising:

- failure of underlying peat along a slip surface;
- punching shear where the embankment settlement is accompanied by heave of adjacent peat; or
- during deposition of peat soil when porewater pressures are given insufficient time to dissipate (Forestry Commission, January 2006).

8.6.16 The peat depth survey has recorded peat across the study area, with deepest peat (in excess of 3m) around the crossing of the access track and Lambol Burn. Although the onshore works constitute a small development, the access track and onshore development site are on a slight slope and therefore there is the potential that a peat slip could occur at this site due to excavation of foundations adjacent to the slope. Final design of the access road and compound structure have not been completed, and during the design process further geotechnical investigations will be undertaken to address this risk. The resultant significance of this potential impact is predicted at this stage to be **moderate adverse** on the basis that the sensitivity of the habitat is low (only locally important) and the magnitude of the effect could be high.

MITIGATION IN RELATION TO IMPACT 5

- A pre-construction geotechnical investigation will be undertaken as part of wider survey of the site pre construction and this will allow informed assessment of the potential risk of peat slip.
- Relevant guidance will be adhered to including Guidelines for the risk management of peat slips on the construction of low volume / low cost roads over peat, Forestry Commission, Scotland, January 2006 and Construction tracks in the Scottish Uplands, Scottish Natural Heritage, 2005.
- During construction of the floating road (access track), peat will be loaded slowly to allow the underlying peat to respond to the increasing load and allow the peat time to consolidate and gain strength and not shear.
- The floating road (access track) will be subject to regular engineering control and monitoring to ensure construction and consolidation is proceeding as intended.
- The floating road will use a geogrid, which will comply with BS EN 13249: 2001. The benefits of this approach include:
  - reduction in the amount of fill to be won and transported on to site;
  - construction of a lighter road therefore settlement will be less;
  - reduction in settlement through spreading loads;
  - reduced impact on hydrology;
  - maintenance of surface layer of vegetation;
  - reduction in quantity of aggregate required, therefore, reduction in the traffic volumes;
  - less carbon released through reduced excavation of existing peatland.

Residual effect

8.6.17 Implementation of the mitigation measures outlined above are anticipated to reduce the significance of this potential impact to **negligible**, however as the geotechnical investigations have not yet been completed and therefore significance will be re-assessed once these investigations are complete.

Impact 6: Carbon loss

8.6.18 Peat is a natural sink for carbon dioxide. There is the potential that carbon could be lost as a result of excavation of peat for construction of foundations (hydroelectric power plant and temporary compounds). There is the potential that carbon loss could occur at this site due to excavation of foundations. The resultant significance of this potential impact is considered to be **minor adverse** on the basis that the sensitivity of the habitat is low (only locally important) and the magnitude of the effect is medium.

MITIGATION IN RELATION TO IMPACT 6

- Minimise the volume of peat to be excavated through use of floating roads and potential use of raft foundations for construction of buildings.
- Where possible re-use any surplus excavated peat in the verges adjacent to floating roads.
- Construct a floating road to reduce the impact on peat

MITIGATION IN RELATION TO IMPACT 6
• Building materials to be used on site will be locally won and alkaline stone such as limestone will not be used on site. To reduce an increase of pH in the acidic peat environment during construction.

Residual effect

8.6.19 Implementation of the mitigation measures outlined above will reduce the significance of this potential impact to **negligible** on the basis that the magnitude of the effect will be reduced to low.

Impact 7: Increase in pH of peatland

8.6.20 The pH of this peatland is likely to be highly acidic (pH<4). Materials, such as stone imported for use during the construction period may result in the pH of the peat environment increasing, affecting the flora and fauna of the peatland habitat and the quality of nearby watercourses. The resultant significance of this potential impact is considered to be **moderate adverse** on the basis that the sensitivity of the habitat is low (only locally important) and the magnitude of the effect is high.

MITIGATION IN RELATION TO IMPACT 7
• If possible, any building materials to be used on site will be locally won. • Alkaline stone, e.g. limestone will not be used on site.

Residual effect

8.6.21 Implementation of the mitigation measure outlined above will reduce the significance of this potential impact to **negligible** on the basis that the magnitude of the effect will be reduced to low.

Impact 8: Drilling fluids causing contamination of watercourses

8.6.22 Depending on the construction method selected, it may be necessary to drill up to 32 boreholes onshore in order to employ HDD methods to connect the pipelines to the offshore element of the development. The drilling activity will result in arising of drilling fluids or drilling cuttings, which may lead to contamination of nearby watercourses or the coastal water body. The resultant significance of this potential impact is considered to be **minor adverse** on the basis that the sensitivity of the habitat is low (only locally important) and the magnitude of the effect is medium.

MITIGATION IN RELATION TO IMPACT 8
• The drill fluid will comprise of water and non-oil based drilling fluid. Drilling fluids used will be non toxic and biodegradable. • A closed loop recycling system will separate drill cuttings from reusable drilling fluids limiting the quantity of seawater-based drill fluid and cuttings lost to the environment. Any drill cuttings excavated will be contained for appropriate disposal by licensed contractors.

Residual effect

8.6.23 Implementation of the mitigation measure outlined above will reduce the significance of this potential impact to **negligible** on the basis that the magnitude of the effect will be reduced to low.

Potential impacts during operation (including maintenance)

Impact 1: Flooding or surface ponding

8.6.24 During the operational phase there is the potential that flooding or surface ponding could occur around the river crossing. There is currently evidence of such surface ponding affecting both upstream and downstream of the culvert which currently passes under the access track at the site.

8.6.25 There is also the potential that pooling of water could occur adjacent to access tracks during the operational phase, resulting from pore water being squeezed out of compressed peat.

8.6.26 Pooling on the up gradient side of the access track could occur adjacent to the track which is constructed parallel to the contours.

8.6.27 This potential impact could result in vegetation changes or erosion of peat. The resultant significance of this potential impact is considered to be **minor adverse** on the basis that the sensitivity of the habitat is low (only locally important) and the magnitude of the effect is medium.

MITIGATION IN RELATION TO IMPACT 1

- The river crossing will be designed based on the identified catchment using a storm return period of 1 in 200 years to allow for climate change (Scottish Planning Policy, 2010). The crossing shall allow for additional capacity to allow for build up of deposits.
- The river crossing shall be carried out in accordance with the WFD 2007, CAR regulations (The Water Environment (Controlled Activities) (Scotland) Regulations 2005) and relevant authorisations will be obtained from SEPA. In accordance with SEPA guidance the following mitigation will be undertaken:
  - the natural flow depths will be maintained;
  - where possible, there will be natural substrate to the culvert base;
  - the culvert will be constructed to the same width as the natural active channel width;
  - the soffit of the culvert will be greater than the natural bank height;
  - the culvert alignment and slope will match that of the watercourse;
  - the culvert will be designed to prevent downstream and upstream bank and bed erosion; and
  - the culvert will not form a barrier to fauna.
- Routine maintenance will be undertaken to ensure that sediment and vegetation does not build up around the river crossing.
- Dams should be installed in the verges of tracks and backfilled with peat to prevent lateral flow of surface water.
- On going maintenance will be required to ensure that the dams installed in the track verges have been successful in reducing pooling of water.

MITIGATION IN RELATION TO IMPACT 1

- Appropriate drainage should be provided where the access track is located parallel to the contours, where the site slopes towards the sea. This may include appropriately spaced drainage pipes or culverts within the access track.

Residual effect

8.6.28 With adherence to the above mitigation, it is anticipated that there will be a **minor positive residual impact** on controlled water receptors. The upgrade of the existing access track will provide the opportunity to upgrade the current river crossing, where the Lambol Burn is culverted beneath the existing access track. This culvert is currently overgrown with grasses, limiting flow through the culvert. There is also currently ponding of water upstream and downstream of the culvert. Upgrading the river crossing to a higher standard will improve surface water flows in the area and provide a benefit to fauna.

Impact 2: Spills and leaks of oil, fuel and other potentially polluting substances

8.6.29 Spills and leaks of potentially polluting substances could occur during operation activities, especially where there are vehicle movements. There is also the likelihood that spills and leaks could occur during the operation of the hydroelectric power plant. Any spills and leaks could potentially impact the peatland habitat and nearby surface water receptors including the Lambol Burn and the downstream Abhainn Shiadair. Accidental spills and leaks could also potentially pollute the adjacent coastal water body namely Gallan Head to Butt of Lewis (refer to Chapter 20 Water Quality). This potential impact is considered to be of **minor adverse** significance on the basis that the sensitivity of the habitat is low (only locally important) and the magnitude of the effect is medium.

MITIGATION IN RELATION TO IMPACT 2

- SEPAs Pollution Prevention Guidance will be adhered to in order to reduce the likelihood and magnitude of spills and leaks. Specifically, adherence to:
    - PPG 1, 2, 5, 7 and 21
- Oil, fuel and other potentially polluting substances will be stored within a temporary storage site. Potentially polluting substances will be stored within impervious bunds with 110% capacity to ensure complete spill / leak retention.
- Spill kits will be available on site at all times.
- Equipment will be monitored on a regular basis to detect any leakage at an early stage.

Residual effect

8.6.30 With adherence to the above mitigation, it is anticipated that there will be a **negligible residual impact** on controlled water receptors.

Potential impacts during decommissioning

8.6.31 The potential effects during decommissioning of the onshore elements of the development are considered to be similar to those during the construction phase. As such, similar mitigation measures to those described for the construction phase are likely to be required to prevent impacts to the water and soil environment. Any updates to legislation of guidance will be adhered to and incorporated in mitigation design prior to decommissioning.

Cumulative effects

8.6.32 There is not considered to be any significant cumulative effects to the water and soil environment. There is a proposal to develop a wave energy project; the onshore elements of which are located approximately 1.5km south west of this site. Although the site is situated within the catchment of the Abhainn Shiadair, which the Lambol Burn flows into at its downstream end, there is unlikely to be any cumulative impacts assuming the mitigation outlined in this chapter is implemented.

8.7 Conclusions

8.7.1 The potential impacts on the water and soil environment within the development site boundary and within a radius of 1km of the site have been considered. Following implementation of mitigation measures the significance of the potential impacts are considered to be either of negligible impact or minor adverse impact. The minor impact is associated with dewatering or drainage of peat in the area of foundations of the hydro electric station. However, these potential impacts are considered to be short term impact until the water table in the peat reaches equilibrium. The improvement of the river crossing, where the access track crosses the Lambol Burn, is considered to comprise a positive impact.

9. BENTHIC ECOLOGY

9.1 Introduction

9.1.1 This chapter provides information on the presence, character and sensitivity of seabed communities within the vicinity of the Lewis Wave Array.

9.1.2 In addition it also reviews the potential impacts to marine benthic communities in relation to the development during construction, operation/maintenance and decommissioning. If required, potential mitigation measures to reduce these impacts are also discussed, along with any residual impact that remains after mitigation.

9.1.3 Potential impacts to the intertidal environment are considered in C*hapter 13 Terrestrial and Intertidal Ecology*.

9.2 Summary assessment of impacts on benthic ecology

9.2.1 No benthic habitats or species of conservation importance have been recorded within the development site (Envision, 2011 Appendix 9.1). Furthermore, the biotopes present at the development site are representative of the wider area off northwest Lewis (Moore and Roberts, 2011) and do not present any particular feature of conservation importance. All impacts are expected to be of low magnitude and, therefore, the significance of all potential impacts on benthic ecology is expected to be negligible.

9.3 Potential impacts

9.3.1 Some seabed preparation work will be required under the Oyster wave energy converter (WEC) footprint and some of the surrounding seabed area (See *Chapter 5 Project description* for more details). This is likely to take the form of kelp removal whereby divers will remove any seaweed in the areas under the surface laid pipelines, WEC's and any other associated seabed infrastructure. As the quantity of kelp to be removed would be comparatively small, the cut kelp will be discarded once cut.

9.3.2 The installation of piles, associated gap fillers, and structures linking the devices, represents a direct loss of seabed habitat within the installation footprint, although this loss is ultimately reversible. The area of natural seabed lost will be very small in relation to the overall area of similar habitats likely to exist within the study area. The maximum potential footprint of propose development offshore is predicted to be 25.97 hectares (ha) (see *Chapter 5 Project description* for details of infrastructures).

9.3.3 Changes to wave climate may alter the nature of the subtidal environment and result in changes in species composition. The devices and infrastructures including high and low pressure pipelines if pinned to seabed, are also likely to become colonised, forming an artificial reef structure. Given the specialist nature of species which live in wave exposed environments, it is expected that the species colonising the devices will be those which are already present in the area.

9.3.4 Increased suspended sediments during construction during drilling of monopile sockets will be rapidly dispersed in the high energy environment at the site and any potential to smother benthic organisms, particularly sessile filter feeders; will be extremely limited. In addition, sensitive features such as *Modioulus modioulus* beds were not recorded within the benthic habitat surveys (Section 9.5). Survey of the development site also shows limited sediment available for re-suspension during construction. There are no known sources of seabed contamination in the north-west of Lewis and so disturbance of contaminated sediments is not a concern for the proposed development.

9.3.5 As the Oyster WECs to be deployed in Lewis are largely constructed from fibre reinforced polymer (FRP) or composite materials (see *Chapter 5: Project Description* for device specifications) and no antifouling coatings will be used on these materials, no leaching of compounds is expected. However, possible leaching of compounds from the associated structures (for example, concrete, gap filling, pipelines or corrosion coatings on associated seabed structures) could have localised and limited impacts on some benthic species.

9.3.6 Renewable energy devices in the marine environment provide clean surfaces for settlement of native and non-native species and potentially could provide 'stepping-stones' for non-natives around the Scottish coastline. However, in the context of a site where the majority of the available habitat is hard rocky substrates the addition of new artificial hard substrate is very unlikely to have any effect.

9.3.7 The movement of vessels, barges, equipment, materials and components both around the UK coast and internationally, could potentially allow the accidental transfer of fouling organisms.

9.4 Methodology

Legislation, guidelines and policy framework

9.4.1 The Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora ('The Habitats Directive') aims to conserve biodiversity, providing a list of priority habitats (Annex I of the Directive) and species (Annex II of the Directive) to be protected by a Network of 'Natura 2000' areas including Special Areas of Conservation (SAC). The Conservation (Natural Habitats, & c.) Regulations, 1994 (as amended in Scotland) transpose the Habitats Directive into national law and outline the designation and protection required for 'European Sites' and European Protected Species' (EPS).

9.4.2 The Nature Conservation (Scotland) Act 2004 places duties on public bodies in relation to the conservation of biodiversity and outline the required protection for Sites of Special Scientific Interest (SSSI).

9.4.3 The 1992 Convention on Biological Diversity in Rio de Janeiro called for the creation and enforcement of national strategies and action plans to conserve, protect and enhance biological diversity. In 1994 the UK government outlined the UK Biodiversity Action Plan (UK BAP) in response to the Rio Convention.

9.4.4 The application for the offshore and intertidal elements of the development will be made under Section 36 of the Electricity Act 1989, currently managed by Marine Scotland Licencing Operating Teams (MS-LOT). A Marine Licence under the Marine (Scotland) Act, 2010, will also be required. Further details regarding the legislative context for this application are provided in *Chapter 6 Regulatory and Policy Context.*

9.4.5 The site specific benthic surveys conducted during baseline characterisation were informed by recent draft guidance on survey and monitoring for marine renewables developments in Scotland, commissioned by Scottish Natural Heritage (SNH) and MS-LOT (Saunders *et al.,* in press). Intertidal surveys were also completed and are discussed in Chapter 13 *Terrestrial and Intertidal Ecology*.

9.4.6 There is no specific guidance available for the assessment of impacts of wave arrays on benthic ecology. The equivalent guidance for offshore wind farm Environmental Impact Assessment (EIA) by CEFAS (2004) has therefore been applied to this impact assessment. These guidelines highlight the need for potential impacts to be identified prior to commencement of benthic survey in order to inform survey design. The guidance indicates that the main impacts to benthic ecology are likely to occur during the construction period of any development and may include physical disturbance of seabed substrata and alterations to the local habitat, as well as indirect effects arising from the re-distribution of sediment. The guidance also recommends assessment of the magnitude, and significance of change, to hydrodynamics at a site.

9.4.7 The European Marine Energy Centre (EMEC) has produced high level EIA Guidance for their wave and tidal test sites in Orkney which has been considered (EMEC, 2005) in this chapter. This guidance outlines legal and consenting requirements (EMEC EIA Guidance Section 1.2) and summarises survey and additional data requirements to inform the impact assessment.

9.4.8 SNH has recently been undertaking a review of marine habitats and species to identify those considered to be of greatest marine nature conservation importance in Scottish Territorial waters – referred to as 'Priority Marine Features'. This has resulted in the production of a draft list of Priority Marine Features (SNH, 2011). This list will be used to support the advice that SNH gives on marine biodiversity, playing a role in the delivery of new marine planning and licensing systems set out in the Marine (Scotland) Act (2010), and is a relevant document for assessing habitats and species of conservation importance within the study site.

9.4.9 Scottish Environment Protection Agency (SEPA) recommends that the applicant should consider the risks of non-native species in their EIA, including best-practice steps to which they can commit in order to manage these risks. Although guidance specific to the renewables industry is yet to be produced, guidance for other related industries will be useful in identifying ways to minimise risks. For example:

- The International Maritime Organisation (IMO) has produced guidelines which provide useful recommendations on general measures to minimise the risks associated with biofouling for all types of ships; and
- Guidance for the prevention and management of invasive species in the oil and gas industry has been produced www.ipieca.org/publication/alien-invasive-species-and-oil-and-gas-industry.

Consultation

9.4.10 Consultation with statutory bodies and key stakeholders was undertaken by Lewis Wave Power through the following scoping document: 'Environmental Scoping Report', Lewis Wave Power Ltd. (2011). The responses made by SNH are particularly relevant to this chapter. SNH provided statutory advice to MS-LOT on nature conservation, having a particular interest in species and habitats of local and national importance, and are outlined in Table 9.1, below.

Table 9.1 Issues raised by SNH and SEPA in the scoping opinion (Marine Scotland 2011)

Comments & Information	Response
Benthic ecology survey methodologies should be submitted to MS-LOT and SNH for comment, including the proposed development area with the zone of influence in order to make an accurate assessment of any potential impacts to benthic ecology.	Methodologies followed draft guidance (Saunders *et al*., in press) and were provided to MS-LOT and SNH for comment and standard methods of drop video survey were used to collect data.
Any rare and threatened habitats or habitats of conservation importance present, including Biodiversity Action Plan priority habitats, should be identified.	No such habitats were found in the development area or wider study area.

Table 9.1 Issues raised by SNH and SEPA in the scoping opinion (Marine Scotland 2011)	
Comments & Information	**Response**
Potential impacts due to suspended sediment and smothering were not scoped out at this stage as there may be protected habitats that are sensitive to this type of impact.	The installation method will use drilled rock sockets, and any sediment generated will be dispersed rapidly. No sensitive habitats have been identified.
The ES should quantify site preparation works and place it in context. Further information should be provided on the anti-foulants and hydraulic fluids to be used, together with an assessment of environmental risks and potential impacts.	Detail of the development and methods are provided in Chapter 5. No anti-foulant use is proposed and the hydraulic fluid consists of 95% water, with the remaining 5% benign additives to reduce foaming and increase lubrication (See Chapter 20: Water Quality).
The ES presents clear information on, and identification of, the main biotopes found on-site. The biotope/habitat map should be used by the applicant to inform their finalised array layout, taking account of likely impacts from pipelines on benthic ecology.	Survey data for the development area and wider study area is provided in Appendix 9.1.
SEPA encouraged the developer to draw up a protocol or method statement to remove the risk of introducing marine non-natives into this area either during the development of this project or during the construction, operational, maintenance or decommissioning phases of the project. Given that the accidental introduction of marine non-native has been highlighted as a risk for water body degradation SEPA recommend that controls should be included for marine non-native species in line with Water Framework and Marine Strategy Framework Directive objectives.	A method statement will be agreed with SEPA and SNH. The risk of introduction of non natives at the development site is likely to be low given the high energy conditions present and the specialist nature of species able to survive there. However, vessels using Loch Roag and other harbours for a period of time may pose a risk, depending upon their port of origin. A risk assessment approach is likely to be most appropriate, once details of vessels, ports or origins, potential species to be considered and time of operation are more developed.

Data collection

9.4.11 The presence, distribution and character of potential Annex I habitat and Annex II species (Habitats Directive EC/92/43/EEC) within the deployment site was characterised by a drop down video survey undertaken in 2011 by Envision Mapping Limited (Appendix 9.1).

9.4.12 The baseline conditions at the deployment site have also been determined from information derived from existing data sources and discrete surveys.

9.4.13 The principal data sources relevant to the benthic ecology are shown below in Table 9.1.

Table 9.1 Existing data			
Data source	**Coverage**	**Author(s)**	**Year**
Research cruises around Scotland	Scotland	Moore and Roberts	2011
Benthic survey report	Local study area	Envision	2011
Marine Scotland enabling action surveys	Scotland	Marine Scotland	2011
Regional local guidance	Scotland	Harrald	2010

Table 9.1 Existing data			
Data source	**Coverage**	**Author(s)**	**Year**
UK Priority Species and habitats	UK	JNCC	2010
UK BAP Priority Marine Species	UK	JNCC	2010
UK BAP Priority Marine Habitats	UK	JNCC	2010
Priority Marine Features	Scotland	Scottish Natural Heritage	2011

Assessment of significance

9.4.14 The significance of the effect imposed by the development is based on the intensity or degree of disturbance to baseline conditions and is categorised into four levels of magnitude, high, medium, low or negligible. The definitions of each of these are given in Table 9.2.

Table 9.2: Criteria for assessing the magnitude of effects on benthic ecology	
Magnitude of effect	**Definition**
High	Fundamental change to the baseline condition of the receptor, resulting in major alteration of the habitats, species or biodiversity.
Medium	Detectable change resulting in non-fundamental temporary or permanent consequential changes. Some deterioration observed in the quality of the most sensitive receptor leading to a partial alteration of habitats, species or biodiversity.
Low	Minor change with only slight detectable changes, which do not (or only temporarily) alter the baseline condition of the receptor.
Negligible	An imperceptible or no change to the baseline condition of the benthic community

9.4.15 The sensitivity/value/importance of the receptor for each effect is characterised as one of four levels, high, medium, low or negligible. The definition of each level is given below in Table 9.3.

Table 9.3: Sensitivity of benthic ecology		
Receptor sensitivity/ value	**Marine fauna and flora importance**	**Site designations**
High	International/ National	Sites or species that have been designated for their internationally or nationally important biodiversity or habitat (Special Area of Conservation (SACs), Special Protection Areas (SPAs), Ramsar, Sites of Special Scientific Interest (SSSIs), National Nature Reserves (NNR), UK Biodiversity Action Plan (BAP) Species or Habitats).
Medium	Regional	Sites or species that have been designated for their regionally important biodiversity or habitat (Local BAP species).
Low	Local	Sites or species that have been designated locally for their flora or fauna (Local Nature reserve - LNR) or undesignated sites of some locally important biodiversity or habitat.
Negligible		Other sites or species with little or no locally important biodiversity

9.4.16 Table 9.4 combines the definitions of magnitude with the level of sensitivity/value/importance of receptor to provide a prediction of overall significance of the effect. The boxes shaded red represent an effect which is likely to be considered significant within an EIA.

Table 9.4 Significance prediction matrix.

Magnitude of effect	Receptor sensitivity/value			
	Negligible	Low	Medium	High
High	Negligible	Moderate	Major	Major
Medium	Negligible	Minor	Moderate	Major
Low	Negligible	Negligible	Minor	Moderate
Negligible	Negligible	Negligible	Negligible	Minor

9.5 Existing environment

Regional

9.5.1 A regional survey was undertaken in 2009 to 2010 covering the area off north-west Lewis (Moore and Roberts, 2011). The surveyed covered an area from East Loch Roag to the Butt of Lewis at depths of 20 to 50m. The seabed was principally composed of uneven bedrock and patches of boulders and cobbles on medium-coarse sand. As presented in Figure 9.1, the substrate generally supported a low-diversity community, with crusts of coralline algae, *Parasmittina trispinosa* and *Spirobranchus* spp. coating the rock, which will be heavily grazed by the high numbers of *Echinus esculentus* (CR.MCR.EcCr.FaAlCr). At most sites the community was supplemented by abundant or superabundant brittlestars, with either *Ophiothrix fragilis* or *Ophiocomina nigra* dominating locally (CR.MCR.EcCr.FaAlCr.Bri). The area is more exposed than is typical for such crust biotopes and this was reflected in the presence of an, albeit sparse, sponge fauna at some sites, including massive forms, such as *Cliona celata* and *Pachymatisma johnstonia.*

9.5.2 None of the habitats recorded in this area are on the list of Priority Marine Features (PMFs) identified by SNH as part of their ongoing review of marine biodiversity in Scotland (*http://www.snh.gov.uk/protecting-scotlands-nature/safeguarding-biodiversity/priority-marine-features/priority-marine-features*). However, ling Molva molva, a mobile PMF species was occasionally observed amongst the rocks off the Butt of Lewis approximately 12km north of the proposed development.

Local

9.5.3 The local survey undertaken by Envision Mapping Limited covered the area off Siadar (Envision, 2011 Appendix 9.1) as presented in Figure 9.2. The maximum depth of the survey area is approximately 28m.

Substrate

9.5.4 The substrate types present in the Siadar benthic survey area (see Figure 9.2 and Appendix 9.1 for more details) are characteristic of a wave exposed site, consisting predominantly of rugged bedrock. Boulder and cobble tend to occur in patches overlying bedrock or mixed with pebble and gravel in gullies and on other low-lying areas of rock. Coarse sand tends to be restricted to the inshore areas and was apparently mobile, occurring in ripples and with no obvious fauna associated with it. No substrate finer than coarse sand was observed. These findings are in contradiction to the suggestion by Harrald *et. al*. (2010) that this whole 'Area of

Search' may be classed as the BAP Habitat (see JNCC, 2010c) 'Sublittoral sands and gravels'. However, the Envision observations do concur with those of Aspect (2010), and of Moore and Roberts (2011) and with towed video footage collected by Marine Scotland (2011) as reported by Lewis Wave Power Ltd. (2011).

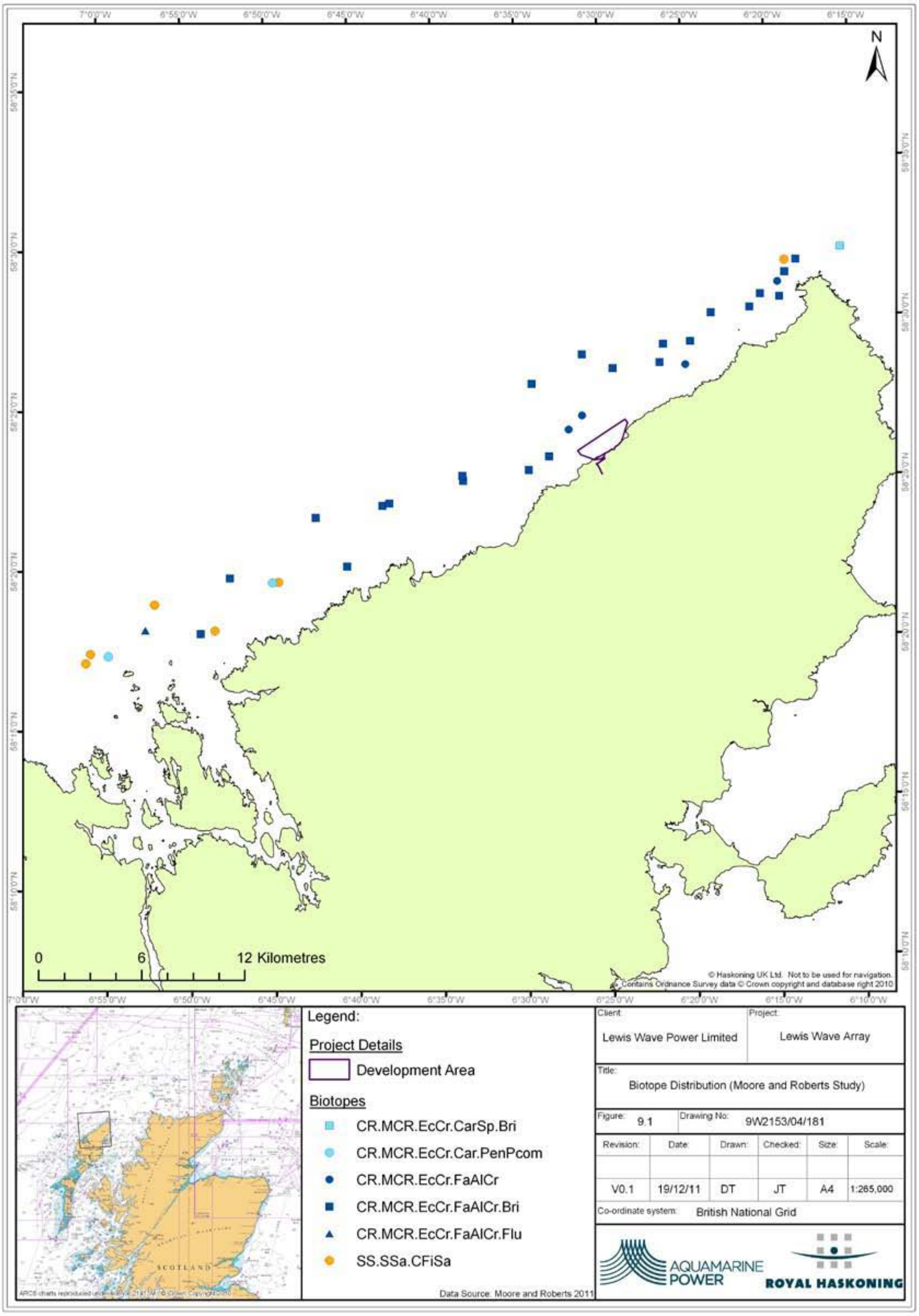


Figure 9.1 Distribution of biotopes off Lewis (Moore and Roberts, 2011)

Biota

9.5.5 Envision (2011), provides data on the distribution and abundance of the marine habitats present. There is good evidence that the dominant habitat consists of the kelp *Laminaria hyperborea.* This occurs either as 'forest' where the plants are tall and densely- growing, or as 'park' where the plants are much smaller and much less dense. The differences tend to be dependent on depth, with forest changing to park at roughly 18m depth as a result of declining light penetration. The kelp forest, in particular, supports diverse communities of red foliose algae and encrusting biota such as ascidians, bryozoans, sponges and coralline algae.

9.5.6 The biotopes tend to change with distance from shore (see Table 9.5 and Figure 9.2), with coarse sands and gravel occurring close inshore being replaced by kelp forest, then kelp park (both mainly on either bedrock or boulder/cobble).

Table 9.5: Biotopes within the study area

JNCC biotope code	Biotope definition
SS.SCS	Sublittoral coarse sediment (unstable cobbles and pebbles, gravels and coarse sands)
SS.SCS.ICS	Infralittoral coarse sediment
SS.SMp.KSwSS.LsacR.Sa	*Laminaria saccharina* and filamentous red algae on infralittoral sand
IR.HIR.KFaR.LhypR.Ft	*Laminaria hyperborea* forest with dense foliose red seaweeds on exposed, upper infralittoral rock
IR.HIR.KFaR.LhypR.Pk	*Laminaria hyperborea* park with dense foliose red seaweeds on exposed, lower infralittoral rock
IR.HIR.KFaR.FoR	Foliose red seaweeds on exposed, lower infralittoral rock
CR.MCR.EcCr.FaAlCr.Bri	Brittlestars on faunal and algal encrusted, exposed to moderately wave-exposed, circalittoral rock
CR.MCR.EcCr	Echinoderms and crustose communities

9.5.7 It is to be noted that this survey was carried out during the late summer, at a time when many of the fine red algae and encrusting species, such as ascidians and bryozoans are at their most abundant. Seasonal changes in some of the characteristic biota are to be expected.

Habitats and species of conservation importance

9.5.8 SNH has recently undertaken a review of marine habitats and species, to identify those considered to be of greatest marine nature conservation importance in Scottish Territorial waters – referred to as 'Priority Marine Features' (PMF). This has resulted in the production of a draft list of Priority Marine Features (SNH, 2011). Since this list will be used to support the advice that SNH gives on marine biodiversity, playing a role in the delivery of new marine planning and licensing systems set out in the Marine (Scotland) Act (2010), it is probably the most relevant document for assessing habitats and species of conservation importance within the study site.

9.5.9 None of the species recorded during the present survey is considered a PMF (see SNH, 2011). However, one of the biotopes identified as occurring within the study area is listed in the draft list of Priority Marine Features: 'Kelp and seaweed communities on sublittoral sediment' (SS.SMp.KSwSS). This was identified as *Saccharina latissima* (previously '*Laminaria saccharina*) and filamentous red algae on infralittoral sand' (SS.SMp.KSwSS.LsacR.Sa) and was present in the area, to the north of the Siadar survey area. This formed a small part of a 'mixed biotope' site together with '*Laminaria hyperborea* forest with dense foliose red seaweeds on exposed, upper infralittoral rock' (IR.HIR.KFaR.LhypR.Ft) and 'Infralittoral coarse sediment' (SS.SCS.ICS). This biotope is not specifically mentioned in the UK BAP Habitats list (JNCC, 2010c).

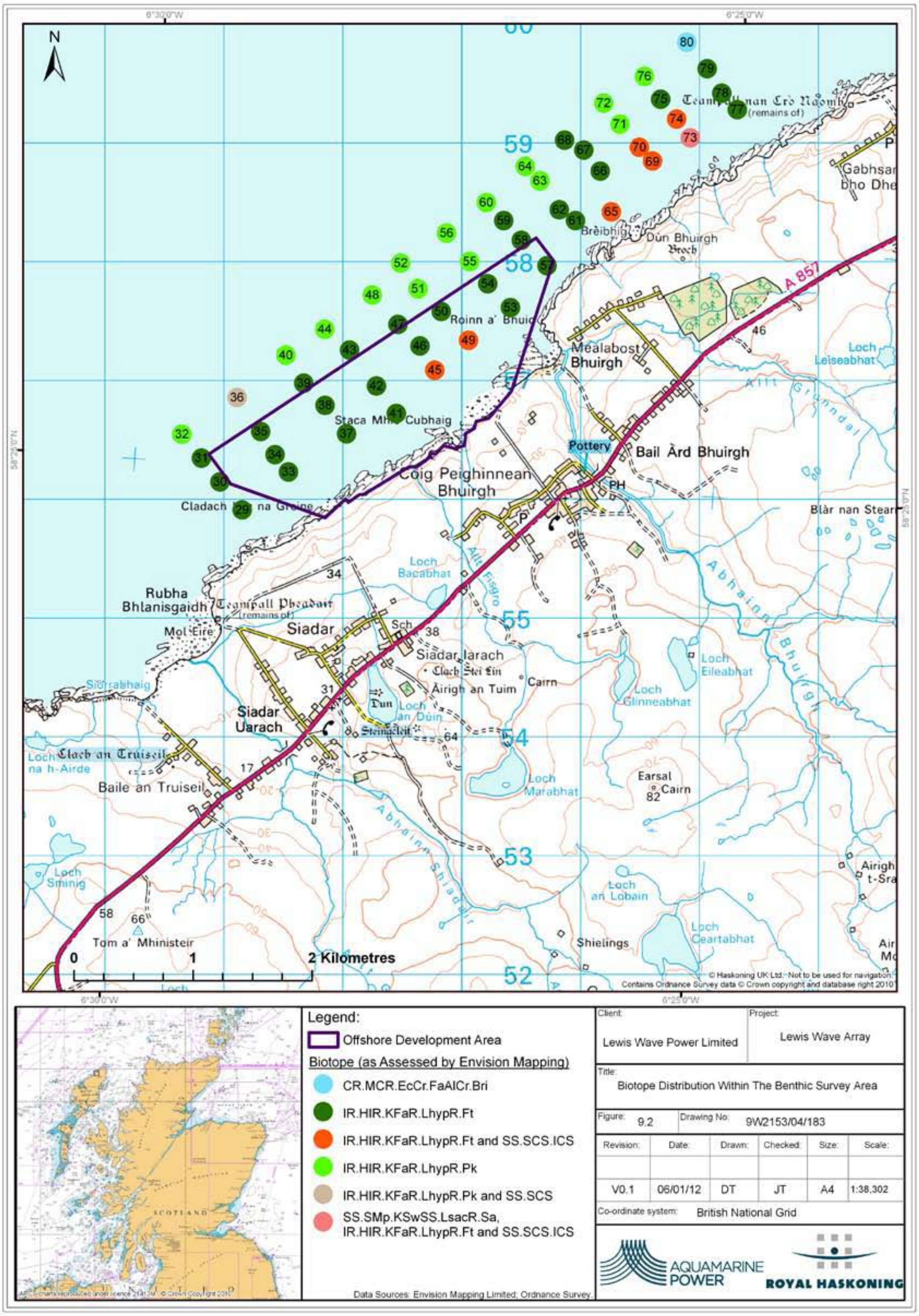


Figure 9.2 Distribution of biotopes recorded within the benthic survey area

9.5.10 UK BAP Species and Habitats lists have also been referred to as a benchmark to identify features of conservation importance. UK 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) (JNCC, 2010a).

9.5.11 None of the UK BAP Species (JNCC, 2010b) has been recorded within the benthic survey area. However, one of the habitats, 'Subtidal sands and gravels' (SS.SCS), was found to occur within the Siadar survey area on 8 occasions and is listed on the UK BAP Habitats list (see JNCC, 2010c).

9.5.12 Horse mussel (*Modiolus modiolus*) beds, which is included both in the SNH list of PMFs(SNH, 2011) and as a UK BAP Priority Habitat (JNCC, 2010c), has been reported to occur both within and near to the benthic survey areas (Harrald *et. al*., 2010). However, this species was not observed from the video footage obtained during the present survey. The horse mussel beds included in the BAP Habitat and PMF list occur in the circalittoral zone. Precise locations of the reported sightings are unclear but it would appear from the information given in Harrald *et. al*. (2010) that they are close inshore in the shallow sublittoral (infralittoral) zone.

9.6 Impact assessment

<u>Do nothing scenario</u>

9.6.1 Due to the lack of detailed historical datasets or ongoing monitoring in this area, it is not possible to understand how the benthic community has changed naturally over time. However, in high energy environments, such as the north-western coast of the Isle of Lewis, natural changes will occur frequently within benthic communities.

9.6.2 During a 'do nothing scenario' the benthic communities in the area are not be expected to show any detectable non natural change in the benthic environment. They would continue to be influenced and affected by existing human activities such as commercial fishing.

<u>Potential impacts during construction</u>

Impact 1: Habitat loss

9.6.3 The installation of piles, and structures linking the devices, represent a direct loss of seabed habitat within the installation footprint, although this loss is ultimately reversible. The area of natural seabed lost will be very small in relation to the overall area of similar habitats likely to exist within the study area.

9.6.4 Recent studies indicate that the environment off the north-west coast is fairly uniform, from Loch Roag in the south to the Butt of Lewis in the north (Moore and Roberts, 2011). The work, which covered an area of approximately 225km^2, found just two biotopes along the open coastline and the benthic survey conducted for this Environmental Statement (ES) found similar results to Moore and Roberts. We can therefore assume that the study area is generally representative of the wider region in terms of the substratum and associated fauna.

9.6.5 No benthic species or habitats of local, national or European importance were identified in the site or are expected to be impacted. Therefore, the sensitivity of the receptor is assessed as negligible.

9.6.6 The working footprint of the marine construction phase of the development has been calculated as between 46,520m^2 and 259,696m^2 (*Chapter 5 Project description*). The maximum possible footprint represents approximately 5.4% of the area that was surveyed during the benthic studies (Envision, 2011 Appendix 9.1) and less than 0.13% of the area surveyed by Moore and Roberts (2011). The footprint of habitat loss will be relatively small compared to the available resource of similar habitats in the development site and impacts will be temporary; the magnitude of benthic habitat loss is assessed as low

9.6.7 Based on negligible sensitivity of impacted habitats and low magnitude of effect the impacts of habitat loss are assessed as of **negligible** significance.

MITIGATION IN RELATION TO IMPACT 1
No mitigation is proposed

Residual impact

9.6.8 Impacts remain of **negligible** significance.

9.6.9 At present the magnitude of the impact is assessed using the greatest possible footprint of construction works to the benthic habitat. As the project develops and refines it may be possible to reduce the final seabed footprint from the worst case used in this assessment.

Impact 2: Increased suspended sediments / smothering

9.6.10 Smothering may occur within the immediate vicinity of works with sediments generated during drilling works carried in suspension and settle out in a layer thick enough to impair the feeding or survival of sessile filter feeding species.

9.6.11 In a high energy environment, such as north-west Lewis, very rapid dispersal of any disturbed or produced fine sediments means effects will be temporary and short term, indicating a low magnitude of impact. This combined with the negligible receptor sensitivity means that the impacts of increased suspended sediments are likely to be of negligible significance.

9.6.12 Increases in suspended sediment concentrations may also be caused by changes to sedimentation patterns as a result of localised changes to wave energy in the immediate vicinity of the array. However, the changes to wave characteristics will be extremely localised, and may not be detectable given the high energy within the wider resource of the north-west of Lewis and the small scale of the wave array. This is further discussed in *Chapter 7: Physical Environment and Coastal Processes*.

9.6.13 No species or habitat of conservation importance have been recorded during the recent studies (Moore and Roberts 2011, Envision 2011) and therefore the impact of increased suspended sediments and smothering will be of **negligible** significance.

MITIGATION IN RELATION TO IMPACT 2
No mitigation suggested

Residual impact

9.6.14 The impact of suspended sediments on the benthic ecology during construction will remain of **negligible** significance.

Impact 3: Risk of pollution incident during installation

9.6.15 The risk of spillage of contaminants from the devices and construction vessels during installation has been considered. Collision of vessels could result in spillages of contaminants, such as diesel.

9.6.16 The risk of pollution events will be minimised by following standard good practice, such as the Pollution Prevention Guidelines issued by SEPA (e.g. PPG 5: Works and maintenance in or near water).

9.6.17 All materials used during construction will require prior approval through the Marine Licensing process and any lubricants used will be low toxicity, will be biodegradable where possible, and will easily disperse in sea water.

9.6.18 Installation contractors will have in place appropriate Environmental Management Plans and Pollution Control and Spillage Response Plans prior to offshore construction activities commencing. These plans will act to reduce the potential for accidental pollution, manage the material allowed on site, and in the unlikely event of a pollution incident, they will ensure a rapid and appropriate response.

9.6.19 Given the management strategies and controls proposed it is expected that, should a spill occur, its scale and the nature of the contaminant will result only in a temporary and localised impact before dilution and dispersion, with effects therefore of low magnitude. Due to the dynamic and dispersive nature of the environment at the site, any material accidentally discharged would be rapidly dispersed and diluted, with the sensitivity of the receptor considered to be low. Therefore the overall effect of a pollution incident on the benthic ecology is likely to be of **negligible** significance.

MITIGATION IN RELATION TO IMPACT 3
No mitigation suggested

Residual impact

9.6.20 The impact of suspended sediments on the benthic ecology during construction will remain of **negligible** significance.

Potential impacts during operation (including maintenance)

Impact 1: Habitat alteration

9.6.21 Changes to wave climate and hydrodynamic regime could theoretically alter the nature of the subtidal environment and result in changes to the species composition of benthic communities (discussed below) as well as intertidal communities (*Chapter 13 Terrestrial and Intertidal Ecology)*.

9.6.22 An assessment has been made of potential changes to wave and tidal energy inshore of the development in *Chapter 7: Physical Environment and Coastal Processes*. The potential magnitude of change to hydrodynamic regime is considered to be of potentially major in terms of coastal processes, as a result of decreased energy inshore of the devices, but low to medium magnitude in terms of benthic ecology (see below).

9.6.23 A potential reduction in the wave energy of the magnitude identified in Chapter 7, may lead to significant changes in the shallow subtidal ecology. The ecology of the shallow subtidal is currently characteristic of wave exposed coastline, as would be expected. As detailed earlier in this chapter and in Appendix 9.1, the ecology of the development site is largely dominated by kelp park, giving way to kelp forest inshore, with associated foliose algae, coralline algae, sponges, bryozoans and ascidians. With an anticipated decrease in the magnitude of wave energy inshore of the wave devices, it is expected that the density of kelp in the inshore area may increase, as will the amount and species richness of the associated flora and fauna. Changes to epibiota (attached to the kelp) will be mirrored below the kelp with similarly increased density and species richness of biota on rock surfaces. Although the changes outlines above may be of considerable interest and significance biologically, the species and habitats involved are of negligible sensitivity (Table 9.3), as not containing species or habitats of conservation importance, regionally or locally (in the context of the north west coast of Lewis). It is likely that such changes will be well within natural levels of fluctuation and are likely to be indiscernible from adjacent areas.

9.6.24 The devices and infrastructure, including high and low pressure pipelines if surface laid on the seabed, are also likely to become colonised, as no antifouling coating will be used (see *Chapter 5 Project description*). The structures will therefore potentially act as an artificial reef. Given the specialist nature of species which live in extremely wave exposed environments, such as north west Lewis, it is expected that the species colonising the devices will be those already present in the area. However, as noted above, with decreasing wave energy, a greater density of kelp and associated biota may be anticipated.

9.6.25 There is ongoing work to design the gap filling structures that form part of the WEC footing assembly to also provide suitable habitat for juvenile lobster, crabs and other crustaceans.

9.6.26 No benthic species or habitats of local, regional, national or European importance are expected to be lost, or to change substantially. As a result the receptor sensitivity is assessed as negligible. However, the potential for changes in the wave energy present inshore of the devices may cause changes to ecology, and while the magnitude of these is unknown, is assessed as potentially being of between low and medium magnitude. Based upon negligible sensitivity and medium magnitude the significance of the impact is assessed as **negligible**.

MITIGATION IN RELATION TO IMPACT 1
No mitigation suggested

Residual impact

9.6.27 As no mitigation is suggested to reduce the impact of habitat alteration on the benthic ecology during operation/maintenance will it will remain of **negligible** significance.

9.6.28 The potential changes to hydrodynamics identified above are based upon current best knowledge. The consequential impact on benthic ecology are uncertain, given the absence of developments of similar scale or nature. It is proposed, therefore that monitoring of changes to ecology is included in post installation monitoring of the development, as part of MS-LOT's stated policy to "deploy and monitor". It is suggested monitoring of ecology at the site is initially intertidal (*Chapter 13: Terrestrial and intertidal ecology*) based on a similar assessment in that chapter. If a significant change in the intertidal is observed from the phases 1 and 2 of development (see *Chapter 5: Project Description*), it is suggested that it could then be assumed that changes of a similar nature may also be occurring subtidally. An appropriate subtidal monitoring plan could then be established to run during phases 3 and 4.

Impact 2: Impacts due to accidental pollution incident during operation

9.6.29 Given the lower levels of on-site activity, the risk of pollution caused by vessel collision during maintenance (e.g. spillage of vessel fuel) can be expected to be lower than during the construction phase.

9.6.30 Appropriate Environmental Management Plans and Pollution Control and Spillage Response Plans will be in place for operation. These plans will act to reduce the potential for accidental pollution, manage the materials allowed on site and in the unlikely event of a pollution incident, will ensure a rapid and appropriate response.

9.6.31 Maintenance operations are expected to provide less risk to accidental spillage than during construction; however, any use and discharge of chemicals during maintenance will be subject to controls as part of consent requirements.

9.6.32 Should a spill occur in a high energy marine environment, contaminants can be expected to rapidly disperse. The scale and the nature of the contaminant will result only in a temporary, localised and impact which will be of low magnitude. The benthic community is of low sensitivity and so the overall impact of pollution is likely to be of **negligible** significance.

MITIGATION IN RELATION TO IMPACT 2
No mitigation suggested

Residual impact

9.6.33 Following mitigation the impact of accidental spillages during operation/maintenance on the benthic ecology will remain of negligible significance.

<u>Potential impacts during decommissioning</u>

9.6.34 The potential impacts during decommissioning are expected to be of the same type and magnitude to those predicted during the construction phase. The loss of habitat during construction will transpose to a loss of artificial habitat during decommissioning and a return to the original situation (as described in the existing environment: section 9.5). Returning to the natural state has not been considered as an impact and due to the dynamic and changeable nature of a high energy environment, such as the western coast of the Isle of Lewis, it is expected that recoverability would be quick.

9.6.35 As discussed previously, IR.HIR.KFaR.LhypR.Ft (*Laminaria hyperborean* forest with dense foliose red seaweeds on exposed, upper infralittoral rock) is the dominant biotope throughout the development area and after decommissioning it is likely that much of the disturbed area would return to this biotope.

Cumulative impacts

9.6.36 Current activities that may have an overlap with the Lewis Wave Array project are:

- Voith Hydro WaveGen 4MW wave energy project – located at the mouth of the river Siadar
- Pelamis Wave Power – located in offshore waters west of Loch Roag

9.6.37 However, it is unlikely that the construction phase of any of these projects will overlap with the construction phase of the north-west Lewis wave array. Furthermore, potential cumulative impacts on the benthic ecology would only be in terms of additive impacts as neither the Voith Hydro WaveGen nor Pelamis Wave Power projects will be on the same sort of seabed type.

9.7 Conclusions

9.7.1 The dominant substrate within the survey areas is rugged bedrock, consistent with a high-energy marine environment. The dominant habitat consists of the kelp *Laminaria hyperborea* - as kelp forest. Kelp habitat commonly occurs on moderately to very exposed open coast around Scotland (MarLIN, 2007) and contains a diverse community of foliose red algae and encrusting biota.

9.7.2 None of the species observed from the video footage obtained is included on the SNH Priority Marine Features, or on the UK BAP species lists. One biotope, '*Laminaria saccharina* and filamentous red algae on infralittoral sand' (SS.SMp.KSwSS.LsacR.Sa), recorded at one video drop sample site, to the north of the Siadar area, is included on the SNH Priority Marine Features, and one habitat 'Sublittoral sands and gravels' which was found to occur within Siadar survey area, is included on the UK BAP habitat list.

9.7.3 Any impacts within the north-western coast of the Isle of Lewis are expected to be relatively localised to the piles of the devices and the infrastructure that links the devices. It is considered that disturbance to benthic ecology will be across a limited area, reversible and occur within an already dynamic and changing biological environment. In high energy environments, such as north-west Lewis, natural changes will occur frequently within benthic communities, with any changes as a result of the array of negligible significance.

10. ORNITHOLOGY

10.1 Introduction

10.1.1 This Chapter of the Environmental Statement (ES) evaluates the potential effects on birds of the Lewis Wave Array development. This Chapter compliments the separate evaluation of potential ecological effects in *Chapter 9: Benthic Ecology* and *Chapter 13: Terrestrial and Intertidal Ecology* and has been completed by Natural Research Projects Limited (NRP).

10.1.2 This Chapter is supported by Technical Appendix 10.1, Year 1 Bird Surveys Technical Report.

10.1.3 The Chapter describes bird interests within the offshore part of the development area, surrounding marine buffer area and the terrestrial area in the vicinity of the onshore site. The process used to determine the Nature Conservation Importance (NCI) of the bird species present is described and the ways in which birds might be affected by the construction, operation, decommissioning of the development are explained. The magnitude of potential impacts of the development and the significance of potential impacts are assessed.

10.2 Summary of assessment

10.2.1 A wide range of seabird species occur in the marine survey area for the Lewis Wave Array.

10.2.2 During the breeding season the numbers of individuals of each species that use the survey area for foraging are very small in the context of the size of their regional breeding populations. It is concluded that the survey area is of very low importance for foraging seabirds at this time of year.

10.2.3 Except for three species, the numbers of individuals of species that use the survey area for foraging in the non-breeding part of the year (e.g. winter) are also very small in the context of their regional population size. The numbers of red-throated diver, great northern diver and eider regularly foraging in the survey area during the non-breeding period approach or slightly exceed 1% of the regional (Western Isles) population size.

10.2.4 A high proportion of birds seen during survey work were simply flying through the marine survey area and not using it in any other way.

10.2.5 Several species of birds breed in the area surveyed in the vicinity of the onshore site. These include small numbers of dunlin, lapwing, curlew, and greylag goose. There is also a small mixed-species colony of breeding gulls.

10.2.6 Impacts during construction, operation and decommissioning are considered in relation to disturbance, collision risk, accidental release of contaminants, and changes to prey resource. Overall the impacts are considered to be of negligible magnitude to all species birds and are not judged to be significant.

10.3 Potential impacts

10.3.1 Ornithological interests have the potential to be affected by the following elements of the development:

- Construction activities;
- Operational activities, including Oyster wave energy converter (WEC) device function and maintenance works;
- Decommissioning;

- Cumulative effects of the development alongside other marine renewable power developments in the region whether operational or in application.

10.3.2 Potential effects of the development on birds include:

- Direct sea-bed habitat loss due to the placement of Oyster WECs;
- Indirect habitat loss due to the displacement of birds, in particular due to disturbance from vessels and operational Oyster WECs;
- Habitat modification due to the placement of Oyster WECs in the development site. The development site includes the offshore and onshore areas (*Chapter 5: Project Description*);
- Collision with, or entrapment by, Oyster WEC;
- Pollution and contamination, in particular from vessel discharges and accidental leakage of lubricants;
- Disturbance and habitat change on land, for birds in the vicinity of the onshore site;
- Uncertainties regarding climate change predictions mean that it is not possible at present to carry out a quantitative assessment of these effects on birds. However, climate change is widely perceived to be the single most important long term threat to the global environment, particularly to biodiversity and to birds. Thus, the continued rise in mean global temperatures is predicted to affect the size, distribution, survival and breeding productivity of many British bird species (Leech 2010).

10.3.3 The potential effects on birds from the development are likely to be:

- Displacement of birds as a result of construction and decommissioning disturbance activities;
- Displacement due to operational maintenance activities (especially from vessel movements and, perhaps, loud noise), and/or due to the presence of the operating Oyster WECs close to feeding sites;
- Pollutant contamination during operation; and
- Loss of sea-bed habitat due to Oyster device bases.

10.3.4 Potential for collision with Oyster WECs during operation is poorly understood as this technology has not yet been deployed in large scale field situations. Therefore potential effects are y be assessed qualitatively and by reference to other man-made structures for which there is experience on how birds respond.

10.3.5 It is apparent that not all of the potential effects are relevant to all types of bird potentially affected by the development. Notably, for terrestrial species the only potential impact will be increased land-based disturbance during construction and decommissioning, e.g. activities close to and on shore related to pier, construction compounds and the hydro electric power station. In addition, seabirds that restrict their activities to sea surface and air will not be at risk of collision and entrapment from submerged infrastructure.

10.3.6 A detailed project description, including the wave array layout and construction and operational procedures is presented in *Chapter 1: Introduction* and *Chapter 5: Project Description*.

10.4 Methodology

10.4.1 The following guidance and legislation was taken into account during this assessment:

Legislation

- Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2000
- Directive 2009/147/EC on the Conservation of Wild Birds (Birds Directive);
- Marine Works (Environmental Impact Assessment) Regulations 2007;
- Directive on Conservation of Natural Habitats and of Wild Flora and Fauna 92/43/EEC (Habitats Directive);
- The Wildlife and Countryside Act 1981 (as amended) (WCA);
- The Conservation (Natural Habitats &c.) Regulations 1994 (as amended); (The Habitats Regulations;
- The Nature Conservation (Scotland) Act 2004 (as amended) ;
- Marine Scotland Act 2010;
- Wildlife and Natural Environment (Scotland) Act 2011; and
- Development Sites and the Planning System and the Scottish Biodiversity Strategy and associated Implementation Plans.

Guidance

- Scottish Natural Heritage (SNH) 2006. Assessing significance of impacts from onshore wind farms on birds outwith designated areas.
- SNH 2009. Monitoring the impact of onshore wind farms on birds. SNH 2009. Gidance on methods for monitoring bird populations at onshore wind farms.
- SNH 2010. Survey methods for use in assessing the impacts of onshore wind farms on bird communities.
- Jackson and Whitfield (2011). Guidance on survey and monitoring in relation to marine renewables deployments in Scotland. Volume 4. Birds. Unpublished draft report to Scottish Natural Heritage and Marine Scotland.
- COWRIE (Camphuysen *et al* 2004). Towards standardised seabirds at sea census techniques in connection with environmental impact assessments for offshore wind farms in the U.K.
- COWRIE (Maclean *et al.* 2009) A review of assessment methodologies for offshore windfarms.

Conservation listings

- UK Biodiversity Action Plan (BAP);
- Birds of Conservation Concern (BoCC3) ‘Red List’ (Eaton *et al.* 2009); and
- IUCN threatened species list.

Designated sites

10.4.2 The development site is not statutorily designated at international or national level for ornithological interests.

10.4.3 The development could plausibly affect seabirds from international designated seabird breeding colonies (Special Protection Areas (SPAs) and Ramsar)) within the Western Isles and for some species further afield. In particular, Flannan Islands SPA, St Kilda SPA, North

Rona and Sula Sgeir SPA, Mingulay and Berneray SPA, and Shiant Isles SPA. These sites are also designated at national levels as SSSIs.

10.4.4 The development could plausibly affect birds from some inland international designated sites (SPAs and Ramsar) on Lewis. In particular, breeding red-throated diver, Arctic skua, dunlin and golden plover from Lewis Peatlands SPA and Ramsar site (sharing the same boundary) and corncrake from the Ness and Barvas SPA. These sites are also designated at national levels as Sites of Special Scientific Interest (SSSIs).

Consultation

10.4.5 A Scoping Opinion was sought from the Marine Scotland Licensing Operations Team (MS-LOT) (including statutory and non-statutory consultees) in May 2011. A short summary of the main points pertinent to birds raised by SNH and Royal Society of the Protection of Birds (RSPB) during this process, along with an explanation of how they were addressed, is provided in Table 10.1.

Table 10.1 Issues raised by SNH and RSPB in the Scoping Opinion (MS-LOT 2011)

Information and comment	Response
SNH highlighted on-going work to investigate the possibility of marine SPAs for inshore aggregations of non-breeding water birds and offshore aggregations of seabirds.	Noted. There is no further information on possible site proposed for north-west Lewis.
SNH highlighted the extensive foraging ranges of some seabirds and the resulting connectivity of often distant SPAs. Recommended using meta data on seabird foraging ranges, available from the Birdlife International database (http://seabird.wikispaces.com), to determine SPA qualifying species.	The foraging ranges of breeding seabirds are taken into consideration in the assessment using the most recent published evidence including the Birdlife database.
SNH approved of the use of the bird survey work from the Voith Hydro WaveGen 4MW Siadar Wave Energy Project Environmental Impact Assessment (EIA) for the Lewis Wave Array and stated that the information would provide a useful context to the on-going survey work.	The information gathered for the Voith Hydro WaveGen 4MW Siadar Wave Energy Project were not publicly available at the time of writing.
SNH recommended that 'habitat loss' be included to the list of key issues in Section 4.4.2 of the scoping document.	Both terrestrial and marine habitat loss is included in the assessment.
SNH highlighted the need to carefully assess, as part of the EIA, the level of potential disturbance during construction, operation and maintenance and decommissioning of the development.	Disturbance is assessed for all phases of the development.
SNH recommended that monitoring data gathered for the Oyster 1 and 2 testing at the European Marine Energy Centre (EMEC) should be used to inform the assessment of potential impacts for the Lewis Wave Array.	The monitoring data gathered from Oyster 1 was insufficient to inform this ES. The oyster 2 (i.e. Oyster 800) has not been commissioned at the time of this submission.

Table 10.1 Issues raised by SNH and RSPB in the Scoping Opinion (MS-LOT 2011)	
Information and comment	**Response**
SNH highlighted the need to consider the potential impacts of all elements of the onshore infrastructure on bird species, including species which are a qualifying interest of SPAs.	The assessment considers the possible effects of inshore infrastructure on moderate and high NCI species and whether any birds predicted to be affected are part of the qualifying interest of SPAs
SNH approved that the scoping document highlighted the need to carefully consider the potential effects of the development on birds of high conservation interest such as corncrake.	Corncrakes and other high NCI species were surveyed along the coastal strip adjacent to the development.
RSPB highlighted the need to thoroughly assess the potential impact on breeding red-throated divers using the sea in the vicinity of the development. Suggested that dedicated diver surveys in 2003 for the Lewis Wind Power proposal may be used as baseline data.	The value of the marine development area to feeding red-throated diver was quantified by the baseline surveys and the information gathered in 2003 by NRP examined. These studies show that the development area is of low importance for foraging red-throated divers in the breeding season.
RSPB highlighted the presence of breeding Arctic and occasionally little terns notably at Brue and Barvas, but also periodically at other coastal locations nearby. Recommended reviewing data on tern colonies, and offered to make these dataset available.	Baseline surveys were undertaken along the adjacent coast and found no breeding terns within 2kilometre (km) of the marine development area. The importance of the marine development area to foraging Arctic terns was measured and shown to be low.
RSPB highlighted the presence of high numbers of breeding black guillemots between Geodha Chaol to Geodha Ruadh in the vicinity of the development. Recommended reviewing relevant colony data for this species.	This comment has more relevance to the Labost survey area. Baseline breeding surveys were undertaken along the adjacent coast and found no breeding black guillemot within 2km of the Siadar/Mealabost marine development area. The importance of the marine development area to foraging black guillemot was measured and shown to be low.
RSPB recommended establishing a programme to monitor and measure changes in biodiversity that may occur as a result of the development.	The survey program (ongoing) establishes a baseline for long term monitoring of bird diversity and abundance. Proposed monitoring measures are described in Chapter 23, Summary of impacts, mitigation, good practice and monitoring
RSPB requested that they be consulted on any future applications.	Noted.

10.4.6 In December 2011, SNH was provided the results of the initial year of bird survey at the development, and asked to comment as to the potential requirement for Habitats Regulations Appraisal (HRA). SNH responded (letter of 23rd January), that was not likely to be a significant effect on qualifying features of the nearby Lewis Peatlands SPA. However, SNH will only make a full evaluation at the end of the second year of data collection.

Desk study

10.4.7 NRP identified the following key field survey requirements:

- Year-round vantage point (VP) surveys to assess the use of the sea and shorelines in the vicinity of the development by seabirds, waterfowl and waders;
- Walkover surveys of terrestrial habitats along the coastline within 1 km of the marine development area; and
- Breeding bird surveys in the vicinity of the onshore site.

10.4.8 The desk study identified that the site is not part of, or immediately adjacent to, any international or national designated site. However, because of the ranging behaviour of some bird species it is possible that there is connectivity between the development area and some designated sites in the region.

Field surveys

10.4.9 The field survey and data analysis methods and are fully described in Appendix 10.1: Year 1 Birds Technical Report and are summarised below.

10.4.10 Pilot work undertaken in September 2010 showed that shore-based survey methods were most appropriate to baseline characterisation surveys of the development area. Shore-based methods were chosen in preference to boat-based or aerial methods because, where practical, they have significant advantages in terms of the quality and quantity of data collected, organisational logistics and generally lower costs. The pilot work showed that from elevated vantage points (VPs) under reasonable conditions (sea state 4 or less) and, with the aid of a x25 spotting scope mounted on a tripod, it is practical to detect, identify and accurately map the location of birds seen up to at least 2 km from the coast. This distance comfortably allows the development to be included. Regular VP observations were made from September 2010 to September 2011.

10.4.11 VP survey work was conducted from two elevated VPs approximately 3km apart; one at Siadar and the other at Mealabost (Fig 2 in Appendix 10.1). Together, these two VPs gave total coverage of the development area and a buffer of at least 1km.

10.4.12 Approximately 12 hours of VP observations were conducted monthly from each VP typically consisting of four 3 hour sessions from each VP, each month. Survey work was conducted on 78 days during the year. As far as possible this was evenly spread between VPs, and across the day light hours and tidal conditions (Appendix 10.1).

10.4.13 The VP survey programme was designed to collect data on the distribution, abundance and behaviour of marine mammals as well as birds. Assessment of marine mammal results is covered in *Chapter 11 Marine mammals and basking shark*. VP surveys consisted of repeated alternating short bouts of three activities; snapshot scans (SSS) of birds and marine mammals (ca. 15 to20 minutes); timed marine mammal watches (MMW) (15 minutes); and timed flying bird watches (FBW) (5 minutes). Additional and similar survey work was undertaken at an alternative site at Labost. This survey work is not considered in the assessments but the results are reported in Appendix 10.1.

10.4.14 The SSS were designed to give instantaneous samples of the distribution, abundance and behaviour of all birds (and marine mammals) using the sea and coastlines within approximately 2km of a VP. The precise position of birds was recorded in terms of a compass bearing and angle of declination.

10.4.15 The timed 5 minute FBW were designed to systematically quantify the numbers of birds flying through the VP survey areas.

10.4.16 The shorelines adjacent to the marine survey area were surveyed for scarce breeding birds, non-breeding birds of conservation concern and waders by walkover surveys (see Figure 3 in Appendix 10.1). Walkover surveys were conducted on six occasions at approximately bi-monthly intervals through the year, with three visits made within the breeding season. All incidental records of scarce species seen at other times were also recorded.

10.4.17 Data on vessel activity were systematically collected during VP watches to provide information on baseline vessel disturbance levels as a source of reference for any subsequent monitoring.

10.4.18 The collection of baseline data is on-going and is planned to continue until two full years of data have been collected in September 2012.

Assessment of significance

10.4.19 The evaluation follows the process set out in the Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2000 ("the EIA Regulations") and guidance on the implementation of the Birds and Habitats Directives (SERAD 2000).

10.4.20 Judgement is made against the general expectation that the development would not have a significant adverse effect on the overall population, range or distribution; and that it would not interfere significantly with the flight paths of migratory birds. In assessing the effects, consideration is given to the relevant populations of the species. Trivial or inconsequential effects are excluded.

10.4.21 The assessment determines the potential effects of the development and the likelihood of their occurrence. In judging whether a potential effect is significant or not, two factors are taken into account:

- The magnitude of the likely effect; and
- The NCI of the species involved.

10.4.22 The significance of potential effects is determined by integrating the assessments of NCI, magnitude and vulnerability of effects in a reasoned way (IEEM, 2010). In judging significance, consideration is given to the population status and trend of the potentially affected species. If a potential effect is determined to be significant, measures to avoid, reduce or remedy the effect are suggested wherever possible.

Methods used to evaluate Nature Conservation Importance (NCI)

10.4.23 The NCI of the bird species potentially affected by the development is defined according to Table 10.2.

10.4.24 Species listed in Local Biodiversity Action Plans (LBAPs) would be considered moderately important only if the development supported at least 1% of the regional population.

Table 10.2: Determining factors for Nature Conservation Importance (NCI)

Importance	Definition
High NCI	Species listed in Annex 1 of the EU Birds Directive. Breeding species listed on Schedule 1 of the Wildlife and Countryside Act (WCA). • Species present (and in the case of seabird species making use of the area) in nationally important numbers (>1% national population).

Table 10.2: Determining factors for Nature Conservation Importance (NCI)	
Importance	**Definition**
Moderate NCI	• Other species listed in the UK Biodiversity Action Plan (BAP) • Other species listed on the Birds of Conservation Concern (BOCC) 'Red' list • Other species listed on the IUCN threatened list • Regularly occurring migratory species, which are either rare or vulnerable, or warrant special consideration on account of the proximity of migration routes, or breeding, moulting, wintering or staging areas in relation to the development. • Species present (and in the case of seabird species making use of the area) in regionally important numbers (>1% regional population).
Low NCI	All other species not covered above.

Methods used to evaluate the magnitude of effects

10.4.25 Effect is defined as a change in the assemblage of bird species present as a result of the development. Change can occur either during or beyond the life of the development. Where the response of a population has varying degrees of likelihood, the probability of these differing outcomes is considered. Note that effects can be adverse, neutral or favourable.

10.4.26 In determining the magnitude of effects, the sensitivity and ability to recover from temporary adverse conditions is considered in respect of each potentially affected population. Sensitivity is determined according to each species' ecological function and behaviour, using the broad criteria set out in Table 10.3. The judgment takes account of information available on the responses of birds to various stimuli (e.g. existing marine developments such as wind farms, noise and disturbance by humans). Note that behavioural sensitivity can differ even between similar species (Schueck *et al.,* 2001; Garthe and Hüppop, 2004) and that, within a particular species, some populations and individuals may be more sensitive than others, and sensitivity may change over time, for example due to habituation. Thus the behavioural responses of birds are likely to vary with both the nature and context of the stimulus, the experience and 'personality' of the bird.

10.4.27 Sensitivity also depends on the activity of the bird. For example, a species is likely to be less tolerant of disturbance whilst breeding than at other times; however tolerance is likely to increase as breeding progresses (Montgomerie & Weatherhead 1988). Seabirds at sea are likely to be more vulnerable to the effects of disturbance, displacement and barriers when they are subject to particular time and energy stress, e.g. when provisioning young and moulting. Some species, notably auks and duck species, are particularly vulnerable to disturbance during the period of annual wing moult because they are then temporarily flightless.

10.4.28 The sensitivity/value/importance of the receptor for each impact is characterised as one of four levels, high, medium, low or negligible. The definition of each level is given below in Table 10.3.

Table 10.3: Criteria for assessment of sensitivity of bird populations	
Receptor Sensitivity	**Definition**
High	No capacity to accommodate the proposed form of change.
Medium	Low capacity to accommodate the proposed form of change.
Low	Some capacity to accommodate the proposed form of change.
Negligible	Receptor is likely to have tolerance to accommodate the proposed change.

10.4.29 Effects are judged in terms of magnitude in space and time (Regini 2000). There are five levels of spatial effects and four levels of temporal effects as detailed in Tables 10.4 and 10.5, below.

Table 10.4: Criteria for assessing the magnitude of effects on bird populations	
Magnitude	**Definition**
Very High	Total/near total loss of a bird population or productivity, due to mortality or displacement or disturbance. Guide: >80% of population affected, >80% change in mortality or productivity rate.
High	Major reduction in the status or productivity of a bird population due to mortality or displacement or disturbance. Guide: 21-80% of population affected, 21-80% change in mortality or productivity rate.
Moderate	Partial reduction in the status or productivity of a bird population due to mortality or displacement or disturbance. Guide: 6-20% of population affected, 6-20% change in mortality or productivity rate.
Low	Small but discernible reduction in the status or productivity of a bird population due to mortality or displacement or disturbance. Guide: 1-5% of population affected, 1-5% change in mortality or productivity rate
Negligible	Very slight reduction in the status or productivity of a bird population due to mortality or displacement or disturbance. Reduction barely discernible, approximating to the “no change” situation. Guide: <1% population affected, <1% change in mortality or productivity rate.

Table 10.5: Scales of temporal magnitude	
Magnitude	**Definition**
Permanent	Effects continuing indefinitely beyond the span of one human generation (taken as approximately 25 years), except where there is likely to be substantial improvement after this period.
Long term	Approximately 15 - 25 years or longer (refer to above).
Medium term	Approximately 5 - 15 years.
Short term	Up to approximately 5 years.

10.4.30 Table 10.6 combines the definitions of magnitude with the level of sensitivity/value/importance of receptor to provide a prediction of overall significance of the impact.

Table 10.6: Significance prediction matrix.				
Magnitude of impact	**Receptor Sensitivity/Value**			
	Negligible	**Low**	**Medium**	**High**
Very High	Moderate	Major	Major	Major
High	Negligible	Moderate	Major	Major
Medium	Negligible	Minor	Moderate	Major
Low	Negligible	Negligible	Minor	Moderate
Negligible	Negligible	Negligible	Negligible	Minor

10.4.31 Magnitude of effect is assessed in respect of an appropriate ecological unit. In the present case for non-seabird species the appropriate regional unit is taken to be Natural Heritage Zone (NHZ) 3 'Coll, Tiree and the Western Isles'. For seabirds, the appropriate unit is considered to be 'Western Isles - Comhairle nan Eilean', which covers a similar area to NHZ 3, because this corresponds to one of the areas used to summarise data from national seabird censuses reported in 'Seabird Populations of Britain and Ireland' (Mitchell *et al.,* 2004).

10.4.32 Where the available data allows, the conservation status of each potentially affected bird species is evaluated within NHZ 3. For these purposes conservation status is taken to mean the sum of the influences acting on a population which may affect its long-term distribution and abundance. Where information on regional conservation status is unavailable, information on conservation status at a wider geographic scale is used, e.g., Forrester and Andrews et al 2007, Eaton *et al*. 2011.

10.4.33 Potential effects are evaluated in respect of all species of high or moderate NCI (see Table 10.6) that could be plausibly affected by the development.

10.4.34 In considering the NCI of potentially affected species, consideration has been given to the criteria in Table 10.2. As explained in the species accounts that follow, a number of high or moderate NCI species were screened out on the basis that they only overfly the site and therefore could not be plausible affected. These species were: whooper swan, barnacle goose, Greenland white-fronted goose, Manx shearwater, whimbrel, bar-tailed godwit, black-tailed godwit, common tern, peregrine and merlin. A few other high or moderate NCI species were screened out on the basis that numbers recorded were very small (<0.5%) in comparison to the regional population sizes and/or they were not regularly present, these included common scoter, black-throated diver, greenshank, starling, twite.

10.4.35 Common seabird species that do not merit a NCI categorisation of moderate or high on the basis of listing on Annex 1 of EU Birds Directive, Schedule 1 of WCA, BoCC Red List or UK BAP list, were not considered to merit moderate NCI unless more than 1% of the regional population regularly used the survey area in at least one season of the year. In deciding this, species that only exceeded the 1% threshold on account of birds flying through the site were not considered to qualify as moderate NCI as such transiting flying birds could not plausibly be adversely affected (i.e. they were categorised as low NCI). This meant that fulmar, gannet, kittiwake, razorbill, great-black-backed gull were all categorised as low NCI even though relatively large numbers overflew the survey area.

Potential impacts on SPA Interests

10.4.36 Based on data collected to date, the level of connectivity between birds using the survey area and SPA populations is considered to be either nonexistent or extremely low for all species that regularly use the site and could be plausibly affected by the development.

10.5 Existing environment

Physical environment

10.5.1 The north-west coast of Lewis has an open, exposed and relatively linear coastline comprising rocky foreshores, cobble beaches, areas of exposed bedrock small cliffs and pebble and sandy bays. The seabed typically slopes steeply from the Mean Low Water Spring mark to the 10m depth contour, and then more gradually to 20m at between 0.5 km to 1.5 km offshore. The depth range for the Oyster WECs at the development is 10 to 15m (See *Chapter 5 Project Description*. Land adjacent to the coast is a mix of gently sloping croft land on the coastal fringe, mostly with acid grassland pasture, and further inland gently undulating peat moorland. There are occasional steep-sided small rivers, streams and small lochs. A number of small crofting townships are also present along the coast comprising well scattered houses and other buildings. A detailed description of the marine and terrestrial habitats in the vicinity of the development area is provided in *Chapters 9: Benthic ecology* and *Chapter 13: Terrestrial and intertidal ecology*).

10.5.2 Shipping density in the coastal waters containing the development is very low with less than 20 ships per nautical mile per year Harald *et al.* 2010). A deep water shipping route runs parallel to and approximately 10km from the north-west Lewis coastline Fishing activity in the vicinity of the development is also low, mostly comprising small local potting vessels targeting crabs and lobster (Harald *et al.* 2010), see *Chapter 15: Shipping and navigation* and *Chapter 16: Commercial fisheries*.

Summary of ornithological interest

10.5.3 The following summary of the ornithological observations is based on the results of baseline studies at the development site and adjacent buffer areas made from September 2010 to September 2011. Details of spatial extent, timing and methods used in field surveys are given in Appendix 10.1.

10.5.4 The areas surveyed off the north-west Lewis coast covered a larger area than that of the development described in *Chapter 5 Project Description*. The location and coverage of the two VPs overlooking the development site, the coastal walkover survey routes and the areas searched for scarce birds are illustrated in Figure 3 in Appendix 10.1.

10.5.5 NCI is indicated for each recorded species, as outlined earlier (Section 10.4 Methods). While all bird species rely on terrestrial habitats in order to breed and to varying degrees at other stages of their life cycle, to ease interpretation, species have been placed into two categories depending on the extent and form of their exploitation of the marine environment to obtain food:

- Marine birds: seabirds which predominantly forage at sea, e.g., divers, auks, sea-ducks, shags/cormorants, gulls, terns gannet, skuas, shearwaters.
- Terrestrial birds: species which rely entirely, or predominantly, on terrestrial habitats e.g., raptors, swans, geese, waders, corncrake, passerines.

10.5.6 In summarising below the observations of species collected during baseline surveys (Appendix 10.1) the descriptions thoroughly consider the assemblage recorded. Consideration has also been given to the potential effects of the development (Section 10.2) when evaluating whether the species recorded may be potentially affected by the development (under basic criteria described by Section 10.3). If species are not thought to be plausibly affected under these criteria then this is noted; obviating any further consideration under the subsequent assessment process.

10.5.7 Thirty species of seabird were recorded using the Siadar/Mealabost survey area during the year. Summary accounts of all seabirds are given regardless of their NCI categorisation.

10.5.8 A range of non-seabird species also regularly use the Siadar/Mealabost survey area, summary accounts are given below for all high or moderate NCI species. These species include geese, swans, duck species other than seaduck, waders, raptors, corncrake and passerines. Gull species are included under marine birds above even though some gull species spend much of their time on terrestrial habitats. As with the marine species, the accounts that follow also screen out by reasoned argument those species for which regional populations could not plausibly be affected by the development and are therefore not considered further.

Red-throated diver

10.5.9 Red-throated diver (high NCI) was recorded on the sea in low numbers from July to March in the Siadar/Mealabost survey area; there were no records on the sea during April to June, the early part of the breeding season. In general birds on the sea were distributed in a band parallel to, and less than 1.3km from, the coast (Fig. 5 in Appendix 10.1) including the area for the Oyster WECs.

10.5.10 Red-throated diver is categorised as high NCI because it is listed on Annex 1 of the Birds Directive and on Schedule 1 of the Wildlife and Countryside Act.

10.5.11 The highest counts were during the winter (November to March), and during this period the maximum counts from Siadar was six birds and the maximum counts from Mealabost (on a different date) was seven birds. After correcting for distance-detection bias the estimated mean number present in the Siadar/Mealabost survey area was approximately four individuals in the early-winter period and approximately five individuals in the late summer period. The size of the regional wintering population is not known as a result of limitations in both survey coverage and in the methods used, when applied to this species. Aerial surveys along the west coast of Barra to Harris, O'Brien *et al*. (2008) gave an estimate of 55 birds, however, it is not clear how this figure is derived nor how the potential bias stemming from of low-level aircraft surveys was overcome. Incomplete surveys of Lewis (including the survey work undertaken for this development) and experience of local ornithologists indicate that the coasts around Lewis also hold moderate numbers of wintering red-throated divers, and that the O'Brien *et al.* estimate for Barra - Harris is likely to be an underestimate. Available evidence suggests that the regional (Western Isles) wintering population is likely to be at least 100 birds but is unlikely to be more than 300 birds. On this basis the numbers of red-throated divers present in winter in the Siadar/Mealabost survey area are likely to represent 2-4% of the regional wintering population. The Western Isles wintering population comprises <1% of the UK wintering population (17,000 birds, O'Brien *et al.* 2008).

10.5.12 No red-throated divers were recorded on the sea in the Siadar/Mealabost survey area between April and June (i.e. the spring passage period and early part of the breeding season). The numbers present from July to August (this corresponds to the chick provisioning period for local breeding birds) were very low with single birds being seen on just two occasions and no individuals seen on 94% of counts in these months (n=34 counts). The mean number present on the sea in the survey area in July and August, after correcting for distance-detection bias, was 0.4 individuals. It is also notable that no red-throated diver flights were seen directed to/from potential inland breeding sites and the survey area, nor were any flights involving an adult carrying prey. It is therefore concluded that the survey area is of very low importance for foraging red-throated divers during the breeding season. A previous study looking at the relative importance of different stretches of coast around the northern half of Lewis for red-throated divers during the breeding season showed that the Siadar/Mealabost stretch was of relatively low importance compared to many other stretches (Stirling & Hulka 2003).

10.5.13 It is likely that red-throated divers that forage in the survey area during the breeding season are from breeding lochans located 3 to6km from the development, within the Lewis Peatlands SPA (where this species is a qualifying feature). These lochans are at a distance within the typical foraging range of breeding adults. The estimated breeding population size for the Outer Hebrides is 317 pairs (Dillon *et al.* 2009), therefore the numbers typically using the development area is >1% of the regional breeding population.

Great northern diver

10.5.14 Great northern diver (high NCI) was recorded in the Siadar/Mealabost survey area in small numbers during the winter and spring periods and in very small numbers in the summer and autumn periods. This species does not breed in the UK and all birds present must be from breeding grounds in Iceland, Greenland or possibly Canada (Wernham *et al*. 2002). Immature birds often summer in Scotland and the birds present in the breeding season (i.e. summer) are assumed to be immature individuals, something that was often apparent from their plumage.

10.5.15 Great northern diver is categorised as high NCI because it is listed on Annex 1 of the Birds Directive and on Schedule 1 of the Wildlife and Countryside Act.

10.5.16 The maximum number seen from the Mealabost VP was nine birds in winter/spring and three birds in summer, and the maximum number seen from Siadar VP was 10 during the winter/spring period. The mean numbers present in the whole survey area (after correcting for distance-detection bias) was 8 to11 birds in the winter and spring periods and approximately 1 to2 birds in the summer and autumn periods.

10.5.17 Great northern divers on the sea in the Siadar/Mealabost survey area were most frequently recorded in a band parallel to, and less than 1km from the shoreline. This area coincides with the development site (Figure 7 in Appendix 10.1).

10.5.18 There is no estimate of the size of the regional great northern diver population. Aerial surveys based on sample transect 3.7km apart from the west coast of Barra to Harris have recorded 102, 128 and 188 birds respectively (Dean *et al.* 2004, Söhle *et al.* 2006, Lewis *et al.* 2008). The actual number present along this coast after correcting for sampling intensity (approx. 50%) and under-detection (likely to be at least 75%) is likely to be in the order of 5 to 10 times greater than the numbers recorded. The Lewis coast was not covered by these surveys but the species is known to be relatively common along the much of the west, north-west and east coast, though on average, densities are perhaps lower than along the area covered by aerial surveys further south. Given that the Lewis coastline is approximately the same length as the coastline covered by the aerial surveys, and that great northern diver also occurs along the east coast of Barra to Harris (albeit almost certainly at lower densities than along the west coast) it would be reasonable to estimate that the regional wintering population of great northern divers in the Western Isles is in the order of at least a 1000 birds. On this basis the Siadar/Mealabost survey area may contain on average about 1% of the regional population, i.e. the survey area would probably qualify as having regional importance for this species. This is not to suggest that the Siadar/Mealabost stretch of coast has particular importance for this species, rather, it is close to typical importance for the west coast of the Western Isles, with 7km of coast surveyed, around 1% of the Western Isles coastline.

10.5.19 Great northern diver is not a qualifying feature for any SPA in the region.

10.5.20 The over-wintering population of great northern diver in Scotland is estimated at approximately 2000-3000 birds (Forrester and Andrews 2007). However, this is almost certainly an underestimate as coverage has been incomplete and surveys from land are likely to under record the number of birds actually present.

Black-throated diver

10.5.21 A single black-throated diver (high NCI) was seen on the sea on a single occasion, it was off Mealabost in the autumn passage period. The survey area is clearly of very low importance to this species and for this reason the species is not considered further. Black-throated diver is categorised as high NCI because it is listed on Annex 1 of the Birds Directive and on Schedule 1 of the Wildlife and Countryside Act.

Fulmar

10.5.22 Small numbers of fulmar (low NCI) were recorded using the marine part of the Siadar/Mealabost survey area in the late winter (January-March) and very small numbers at other times of year. In the late winter period the maximum count of birds on the sea was 40 birds and the mean number (after correcting for distance –detection bias) was approximately three birds. At all other times of year the numbers using the site was far lower with <1 bird present on average. The Western Isles regional breeding population of fulmar is estimated at 118,073 pairs (Mitchell *et al.* 2004). Results from the European Seabirds at Sea database suggests that this species also occurs in waters around the Western Isles in very large numbers outside the breeding season (Pollock 2000). It is therefore concluded that the survey area is of trivial importance for foraging fulmars.

10.5.23 Small to moderate numbers of fulmar were recorded flying through the survey area (i.e. not using it) throughout the year except in September and October. Rates of passage varied between months from 11 and 44 birds per hour. Simple extrapolation of these rates indicates that relatively large numbers of individuals, potentially several thousand individuals, are likely to pass over the survey area in some seasons. It is concluded that the survey area lies below an important flight path for fulmars transiting parallel to the north-west coast of Lewis. It is clear from the base line surveys undertaken that this flight path is relatively wide, extending out from the coast westward to at least 5km, well beyond the development area.

10.5.24 The only fulmars breeding in the Siadar/Mealabost survey area were nine pairs on a low cliff located approximately 500m from the onshore site. These represent a negligible proportion of the regional breeding population. Breeding fulmars exhibit a very high tolerance of human activity close to their nest sites, e.g., they typically allowing people to approach to <10 m before flushing from their nests (D Jackson personal observation).

10.5.25 Given the very low importance of the survey area to foraging fulmars and this species' high tolerance of human activities it is not plausible that the development could adversely affect the regional population of fulmars. Therefore this species is not considered further in this chapter.

Manx shearwater

10.5.26 Manx shearwaters (low NCI) were recorded in small numbers between April and September. All but two birds (on the sea) were recorded flying through the survey area and none were seen actively foraging. Given the a regional population of approximately 66,0000 (including birds breeding on Rum) it is concluded that the survey area is of very low importance for foraging Manx shearwater. From June to September mean passage rates over the survey area were between 10-14 birds per hour. Simple extrapolation of these rates suggests that several thousands of individuals are likely to pass over the site each year. It is concluded that the survey area lies below an important flight path for Manx shearwater, however, it is also clear from the base line surveys undertaken that this flight path is relatively wide, extending out from the coast, westward to at least 5km, well beyond the development area.

10.5.27 Based on the mean maximum foraging distance of 196km (Birdlife International 2011), Manx shearwaters from two designated sites that have this species as a qualifying interest could theoretically be foraging in the survey area. These are St Kilda (5,000 pairs), and Rum (61,000 pairs) (JNCC 2011). The breeding population of Western Isles is a least 4800 pairs (Mitchell *et al*. 2004). The average numbers recorded in the Siadar/Mealabost survey area represent less than 1% of the regional breeding population and the survey area can be seen to be clearly of very low importance to this species and for this reason the species is not considered further.

Sooty shearwater

10.5.28 Sooty shearwaters (moderate NCI) were recorded in very small numbers flying passing through the survey area. In total, one bird was seen in July and four in August. Large (1000's) albeit poorly quantified numbers migrate through western Scotland in the late summer and autumn.

10.5.29 This species is rated as having moderate NCI because it is categorised as Near Threatened by IUCN. The survey area is clearly of low importance to this species, based on sightings, and for this reason it is not considered further.

Storm petrel

10.5.30 Storm petrel (high NCI) was recorded using the site in small numbers in July and August only. Most of the birds seen were clearly foraging and were not in transit. In this period the maximum number seen was seven individuals from the Mealabost VP and nine individuals from the Siadar VP. The mean number present in the whole survey area in this period was approximately two birds though this may be an underestimate as the distance-detection correction factors used for this species were perhaps too weak (there were too few records of this species to fully understand the strength of any distance bias in the data). Nevertheless, survey conditions in July and August (i.e. when this birds were present) were generally very good, so any underestimation is likely to be relatively small. The mean numbers of storm petrel present are well below the 1% of the regional breeding population which is estimated at 1833 pairs [note, the population size for this species is stated as 1833 'Apparently Occupied Sites', and some 'sites' potentially have more than one pair, (Mitchell *et al*. 2004)].

10.5.31 Storm petrel is categorised as high NCI because it is listed on Annex 1 of the Birds Directive.

10.5.32 The estimated mean maximum foraging distance for breeding storm petrels is 100km (Ratcliffe, Phillips & Gubbay 2000). There are several colonies within this distance of the survey area and which could therefore potentially be the breeding sites of the birds seen. It is also possible they were non-breeding birds. Two of the storm petrel colonies within 100km are SPAs where this species is a qualifying feature namely North Rona and Sula Sgeir (1000 pairs) and Priest Island (Summer Isles) (2,200 pairs) (JNCC 2011). However there are also several non-designated colonies within range such as Eilean Mor, Flannan Isles, 64km to the west of the survey area (7 apparently occupied sites) and Shillay 85km to the south-west of the survey area (328 apparently occupied sites) (JNCC 2004).

10.5.33 Apart from occasional short term temporary disturbance to a very few birds by vessels, this species is not likely to experience any adverse effects from the development. Given the scarcity of storm petrel in the survey area and the vastness of their potentially suitable foraging habitat around the Western isles, this species is not considered further.

Gannet

10.5.34 Gannet (low NCI) was recorded in the Siadar/Mealabost survey area in low to moderate numbers during the breeding season, moderate numbers during the autumn passage (October) and very low numbers during the winter. The vast majority of birds seen were not foraging but were flying over, i.e. they were in transit and making no use of the marine resources of the survey area. In the breeding season the maximum number of birds recorded using the area (i.e., foraging on sitting on the water) was seven individuals and the mean number using the area was <1 individual. At other times of year the maximum number recorded using the area was three individuals and the mean number was <1 individual. The Western Isles breeding population of gannet is estimated at 73,287 pairs (Mitchell *et al.* 2004), therefore is it concluded that the survey area is of negligible importance as a foraging site for gannets.

10.5.35 The numbers of gannets transiting over the survey area is large. In August and September mean passage rates (birds up to 2 km from the coast only) exceeded 100 birds per hour, and rates in April to July were in the range 24-71 birds per hour. Therefore, simple extrapolation suggests that potentially tens of thousands of individuals pass over the survey area each year as they transit along the north-west coast of Lewis, e.g., a rate of 100 birds per hour for 12 hours a day for 30 days would equate to 36000 individual birds (though it is not known if some individuals pass multiple times). The numbers of birds transiting over the site are well above 1% of the regional population. It is concluded that the survey area lies below an important flight path for gannets. It is clear from the base line surveys undertaken that this flight path is relatively wide extending out from the coast westwards to at least 5km, well beyond the development area.

10.5.36 It is likely that almost all gannets seen in the survey area are part of one of the several SPA populations in the region. On the basis of a mean maximum foraging distance for gannet of 309km (Birdlife International 2011) birds from North Rona and Sula Sgeir (10,400 pairs), St Kilda (50,050 pairs), Sule Skerry and Sule Stack (5900 pairs), and Fair Isle (1166 pairs) SPAs potentially forage or fly over the survey area during the breeding season.

10.5.37 It is not plausible that gannets transiting over the development area would be adversely affected by the development as there is no significant collision risk. Even if birds showed a displacement response this would only amount to a change in their flight route by a few hundred metres at most. It is clear that the survey area is of negligible importance for foraging gannets from any colony. For these reasons this species is not considered further.

Cormorant

10.5.38 Cormorant (low NCI) was recorded in very low numbers both on the sea and roosting on costal rocks adjacent to the development. The peak number recorded was 8 individuals but mean numbers present on the sea were much smaller, indeed no cormorants were present on most survey dates.

10.5.39 Even the peak numbers present are below 1% of the regional population and the distance to the closest designated site where this species is a qualifying feature is well above the mean maximum foraging distance (31.7km, Birdlife International 2011). For these reasons, coupled with the low NCI, this species is not considered further in this chapter.

Shag

10.5.40 Shag (low NCI) was recorded in small numbers on the sea and roosting on coastal rocks in the survey area throughout the year, but most commonly during the autumn and winter. The maximum count of shag was 10 individuals from Mealabost VP and 16 individuals from Siadar

VP (on a different date), both in the early winter period. The estimated mean number present in the whole survey area (corrected for distance-detection bias) was 8 to14 birds in the autumn and winter periods, 1 to 2 birds in the spring and summer periods (i.e. the breeding season). The Western Isles regional breeding population of shag is estimated at 2,661 pairs (Mitchell *et al* 2004). In western Scotland this species is largely sedentary though some individuals can disperse some distance from breeding sites (Wernham 2002). It is likely that the regional population in the autumn and winter is of a similar size to the breeding population, with the numbers present in the survey area at all times of year well below 1% of the regional population. It is concluded that the survey area is of very low importance to foraging and roosting shags.

10.5.41 Small numbers of shags were recorded flying over the survey area. However, there was no evidence of a net passage in any season (i.e. flights with an approximately north-east heading were similar to the number to flights with a south-west heading) and therefore the flights seem most likely represent local movements, for example between foraging areas and roost sites.

10.5.42 The distribution of shags on the sea in the survey area indicates that the majority of birds use the sea between the coastline and the Oyster WEC device boundary (Figure 15, Appendix 10.1).

10.5.43 Shags were not recorded breeding within the Siadar/Mealabost survey area. The distance from the survey area to the nearest designated site with shag as a qualifying interest is greater than the maximum foraging distance estimate for shag (20km, Birdlife International 2011). Therefore, it is very unlikely that the shags seen in the survey area are from designated sites with shag as a qualifying feature.

10.5.44 Given the very low importance of the survey area for shags, coupled with their low NCI, this species is not considered further in this chapter.

Eider

10.5.45 Eider (moderate NCI) was regularly present in the Siadar/Mealabost survey area in moderate numbers during the winter (November to March), but none were seen on the sea at other times of year. The maximum count of eider was 121 individuals from the Mealabost VP (in late January) and 73 individuals from the Siadar VP (in late December). The birds seen from the two VPs appeared to be largely the same individuals, with the eider flock(s) mainly in the Siadar area on some dates and mainly in the Mealabost area on others. The estimated mean number present in the whole survey area during the winter periods (corrected for distance-detection bias) was 40 individuals. The Western Isles wintering eider population has been estimated at approximately 6000 adults (Forrester and Andrews 2007). It is likely that the regional estimate is too low because many stretches of coast have not been surveyed, and surveys from the land are liable to overlook individuals at distance. Assuming the estimate in Forrester and Andrews is correct, the Siadar/Mealabost survey area holds on average 0.7%, and on occasions up to approximately 2% of the Western Isles wintering population. On this basis this stretch of coast qualifies as being of regional importance for this species.

10.5.46 Eider are categorised as moderate NCI because more than 1% of the regional wintering population regularly occurs in the survey area and because this species is on the Birds of Conservation Concern (BoCC) Red List.

10.5.47 Records of eider were not evenly distributed across the survey area: they showed a strong preference for the shallower areas closer to the shoreline and as result the majority of records were not within the Oyster WEC boundary (Figure 17 in Appendix 10.1). Eider feeds by diving to the seabed to catch mainly bivalve molluscs.

Other seaduck species

10.5.48 The Siadar/Mealabost survey area is of very low value to seaduck species other than eider, and for this reason no other species are considered in the assessment. The only other species seen on the sea were red-breasted merganser (low NCI) and common scoter (high

NCI). Red-breasted merganser was seen on the sea on only one occasion, of Siadar in April. Two common scoter were regularly seen from December 2010 to February 2012 off Siadar and were likely to be the same individuals, wintering in the area. Two individuals represent below 1% of the Western Isles wintering population of around 300 birds (concentrated in Sound of Taransay, Harris). Single or pairs of common scoter were recorded on the sea occasionally in spring and autumn also.

10.5.49 Small numbers of red-breasted merganser, scaup, common scoter and long-tailed duck were also recorded flying over the site, mainly in the autumn passage period.

Skuas

10.5.50 Arctic skua (moderate NCI) was not recorded in the survey area (either foraging or flying through) during the breeding season. It is concluded that the survey area is not an important area for foraging by breeding Arctic skuas from the regional population (156 pairs, Mitchell *et al*. 2004)). It is possible that breeding Arctic skuas do occasionally forage in the survey area but was not present on the survey dates but even if this was so it would not affect the conclusion that the area is of very low importance. The only record of Arctic skua in the survey area was a single bird seen passing south in October, the period of autumn passage. This was most likely a bird from Arctic breeding grounds.

10.5.51 Given the absence of Arctic skua in the breeding season and extreme scarcity at other times, this species is not considered further. Arctic skua is categorised as moderate NCI because it is on the BoCC Red List.

10.5.52 Great skua (low NCI) was recorded in very small numbers flying through the survey area in the spring and summer periods. The maximum count was three birds and the majority of records were of single birds. On four occasions single birds were seen on the sea suggesting that might have been feeding in the survey area. The only potential feeding behaviour witnessed was an individual harassing a flock of migrant geese and another individual harassing a guillemot.

10.5.53 The numbers seen represent well below 1% of the regional breeding population of 345 pairs (Mitchell *et al*. 2004). This species is not considered further.

Common gull

10.5.54 Common gull (moderate NCI) was recorded using the marine part of the Siadar/Mealabost survey area in small numbers in the breeding season and very small numbers at other times of year. They were predominantly seen either on the shore or on the sea close inshore. The maximum recorded in the breeding season was 40 birds and the mean (corrected for distance detection bias) was nine birds. In the autumn and winter periods the maximum recorded was 5 birds and the mean (corrected for distance detection bias) was <1 individual. In the context of the size of the regional breeding population (1707 pairs), it is concluded that the marine part of the survey area is of very low importance as a site for foraging common gulls. In addition, small numbers of common gull were seen flying through the survey area in all months of the year.

10.5.55 The common gulls present in the breeding season are likely to be from local non-designated breeding sites, in particular the small colony at Loch Bacabhat. It is not likely that birds were from designated sites because the nearest designated site that has common gull as a qualifying feature is beyond the maximum foraging distance for this species (50km, Thaxter *et al*. 2011

10.5.56 Approximately 50 pairs of common gulls bred at Loch Bacabhat, approximately 750 m away from the shoreline installation at Siadar. The Western Isles regional breeding population of common gull is estimated at 1,707 pairs (Mitchell *et al*. 2004). This estimate is almost certainly well below the actual breeding population because it excludes many small inland colonies (D Jackson personal observation).

10.5.57 The numbers breeding at Loch Bacabhat represents approximately 3% of the regional population estimate and for this reason the birds using the survey area are categorised as moderate NCI.

Lesser black-backed gull

10.5.58 Lesser black-backed gull (moderate NCI) was seen in the marine part of the survey area in small numbers during the breeding season. The maximum count was 10 birds but the average number recorded was <1. Additionally ten pairs of lesser black-backed gull bred at Loch Bacabhat, approximately 750 m away from the shoreline installation at Siadar. Lesser black-backed gull is a widespread breeding bird in Lewis with an estimated breeding population of 552 pairs (Mitchell *et al.* 2004). It is not a qualifying feature of any designated site in the region. The small breeding colony in the vicinity of the shore installation represents approximately 2% of the regional population, for this reason alone the birds using the survey area are categorised as moderate NCI.

Herring gull

10.5.59 Herring gull (moderate NCI) was recorded using the marine part of the survey area in small or very small numbers throughout the year. In the non-breeding parts of the year the maximum number recorded was 30 birds and the mean numbers present (corrected for distance-detection bias) were <1 to 6 birds depending on the season. During the breeding season (including August) the maximum number recorded was 24 birds and the mean (corrected for distance-detection bias) was approximately one bird. In the context of a regional breeding population of 2665 pairs (Mitchell *et al.* 2004) it is concluded that the survey area is of very low importance for foraging herring gulls.

10.5.60 Herring gull is on the BoCC Red List and for this reason is categorised as moderate NCI.

10.5.61 Small to moderate numbers of herring gulls were recorded flying through the survey area (i.e. not using it) especially during the winter months. From November to March mean passage rates were 15-31 birds per hour. Simple extrapolation suggests that the total numbers of individuals passing over the site is likely to be many hundreds or low thousands of individuals through the winter. It is concluded that the survey area lies below an important flight path for herring gull.

10.5.62 Thirty pairs of herring gull bred at Loch Bacabhat, approximately 750 m from the shoreline installation at Siadar. Herring gull is a widespread breeding bird along the coasts of Lewis. The Western Isles regional breeding population of herring gull is estimated at 2,665 pairs (Mitchell *et al.* 2004). The numbers recorded breeding in the vicinity of the shore installation represents approximately 1% of the regional population.

Great black-backed gull

10.5.63 Great black-backed gulls (low NCI) were recorded using the marine part of the survey area in small or very small numbers throughout the year. In the non-breeding parts of the year the maximum number recorded was 39 birds and the mean numbers present (corrected for distance-detection bias) were 1 to 5 birds depending on the season. During the breeding season (including August) the maximum number recorded was three birds and the mean (corrected for distance-detection bias) was approximately one bird. In the context of a regional breeding population of 2007 pairs (Mitchell *et al.* 2004) it is concluded that the survey area is of very low importance for foraging great black-backed gulls. No great black-backed gulls bred along the Siadar/Mealabost coast.

10.5.64 Moderate numbers of great black-backed gulls were recorded flying through the survey area (i.e. not using it) during the winter months, but at other times of year the numbers passing through the area were small or very small. From November to February mean passage rates were 19-55 birds per hour. The vast majority of these birds had a south-west heading. Simple extrapolation suggests that the total numbers of individuals passing over the site is likely to be many hundreds or low thousands of individuals through the winter. It is concluded that the survey area lies below an important winter flight path for great black-backed gulls. However, it is not plausible that great black-backed gull flying over the site would be adversely affected by the development. For this reason together with the low importance of the survey area for foraging this species is not considered further.

Kittiwake

10.5.65 Kittiwake (low NCI) was rarely recorded using the marine part of the survey area. No birds were seen on the sea or foraging in the Siadar/Mealabost survey area during the breeding season (April to July). During the rest of the year foraging birds were seen in the survey area on four occasions only, involving 27 individuals in total. In the context of a regional breeding population of 21,152 pairs (Mitchell *et al.* 2004) it is concluded that the survey area is of very low importance for foraging kittiwakes. Kittiwakes do not breed along the Siadar/Mealabost coast. The survey area is beyond the mean maximum foraging distance (66km, Birdlife International 2011) for any designated site that has breeding kittiwake as a qualifying feature.

10.5.66 Small numbers of kittiwakes were recorded flying through the survey area (i.e. not using it) from March to November, with average rates of passage in these months ranging from 1 to10 birds per hour. From December to February passage rates were much lower, with only four individuals seen in total. Considering the size of the regional population, the survey area is of relatively low importance as flight route for this species. It is not plausible that kittiwakes flying through the site would be adversely affected by the development and for this reason together with the low importance of the survey area for foraging, this species is not considered further.

Arctic tern

10.5.67 Arctic terns (high NCI) were recorded in small numbers feeding in the Siadar/Mealabost survey area between May and July, and these were likely to be locally breeding birds. Very small numbers were also recorded in August and September; these later birds were perhaps more likely to have been passage migrants from more northerly breeding grounds such as Iceland. The maximum recorded in the breeding season was 17 birds (in July), but the mean number (corrected for distance-detection bias) was <1 bird in May and June, rising to approximately seven birds in July and August. Arctic terns do not breed along the coast of the survey area but there are several small non-designated breeding colonies on the north-west coast of Lewis and these are likely to be the source of the birds seen in the survey area. The closest designated SPA which has breeding Arctic tern as a qualifying feature is well beyond the maximum foraging range (20.6km, Birdlife International 2011) and therefore it is very unlikely that the birds using the survey area are from SPA populations.

10.5.68 The Western Isles regional breeding population of Arctic tern is estimated at 4,146 pairs (Mitchell *et al.* 2004), thus the numbers using the survey area are well below 1% of the regional total. Nevertheless, as a species categorised as high NCI (because it is on Annex 1 of the Birds Directive) Arctic tern is considered in the assessment.

Other species of gulls and terns

10.5.69 Glaucous gull (3 birds), Iceland gull (4 records) and Bonaparte's gull (1 record) were recorded in the survey area containing the development, all except the Bonaparte's gull were flying through the site. Given their scarcity, and irregular presence, it is highly unlikely that any activities associated with the development will affect these species and as a result they are not considered further in this chapter

10.5.70 Flocks of black-headed gulls (low NCI) comprising 1-5 individuals were occasionally seen along the coast in the spring and summer. These represent well below 1% of the regional breeding population of 1112 pairs (Mitchell *et al.* 2004). This species is not considered further.

Common guillemot

10.5.71 Common guillemot (low NCI) was recorded in very low numbers on the sea during the summer and autumn only. Small numbers of guillemot were also occasionally seen flying over the survey area. In the seasons when present, the estimated average number of birds present on the sea in the survey area after taking into consideration distance-detection bias was just one individual and the maximum number was also just one bird. This represents a negligible proportion of the Western Isles breeding population (120,594 birds, Mitchell *et al*. 2004). It is concluded that the Siadar/Mealabost survey area is of very low importance as a foraging site for common guillemots.

10.5.72 Although it is possible that the common guillemot present in the breeding season are from a designated SPA population, this is unlikely because the distance to the closest SPA colony is 53km (the Flannan Isles SPA), a distance that is approaching the mean maximum foraging distance of this species (60km, Birdlife International 2011). More likely, the birds seen were from one of the nearer non-designated colonies or were non-breeding immature birds.

10.5.73 Given the scarcity of this species in the survey area and the abundance of this species elsewhere in the region, coupled with low NCI categorisation, it is not considered further in this chapter.

Razorbill

10.5.74 Razorbill (low NCI) was recorded using the survey area in small numbers in all months of the year except August, November and December. Small numbers of razorbill were also occasionally seen flying over the survey area. The maximum count of birds on the sea was 13 birds in the late winter period. After correcting for distance-detection bias, the mean number present in the survey area was 6 and 2 individuals in the autumn and late winter period respectively and <1 individual during the breeding season. These numbers represent a negligible proportion of the Western Isles regional breeding population (37,434 individuals, Mitchell *et al*. 2004). It is concluded that the Siadar/Mealabost survey area is of very low importance as a foraging site for razorbill.

10.5.75 The distance to the nearest SPA colony for razorbill (Flannan Isles, 53km away) is much greater than the mean maximum foraging distance (31km, Birdlife International 2011). Therefore, the birds using the area in the breeding season are most likely to be from closer non-designated breeding colonies or be non-breeding birds. Given the scarcity of this species in the survey area and the abundance of this species elsewhere in the region, coupled with low NCI categorisation, it is not considered further in this chapter.

Black guillemot

10.5.76 Black guillemots (low NCI) were recorded in small numbers on the sea, mainly in spring, summer and early winter. The maximum count was 11 birds, in the early winter period. After correcting for distance-detection bias, the mean number present in the survey area was <1 individual in the autumn and late winter periods, 14 birds in early winter period, and 7 and 4 individuals respectively during the spring and summer (breeding season). These numbers represent a negligible proportion of the Western Isles regional breeding population (4577 individuals, Mitchell *et al*. 2004). It is concluded that the Siadar/Mealabost survey area is of very low importance as a foraging site for black guillemot.

10.5.77 It is very unlikely that black guillemots present in the breeding season were from colonies designated as SPAs or SSSIs because the distance to the nearest designated site that has black guillemot as a qualifying feature (Monach Isles SPA) is greater than the maximum foraging distance of 55km (Birdlife International 2011). Although this species does not breed in the Siadar/Mealabost survey area, small numbers breed along the north-west coast of Lewis, and the birds present in the survey area are most likely to be from these local breeding sites. Given the scarcity of this species in the survey area and their abundance elsewhere in the region, coupled with low NCI categorisation, it is not considered further in this chapter.

Puffin

10.5.78 Puffin (low NCI) was recorded in very small numbers on the sea in the Siadar/Mealabost survey area during the late winter and spring periods only. The maximum count was just two individuals. The mean number present in these seasons (corrected for distance detection bias) was well below a single bird. Given the very large numbers of puffins breeding in the region (234,666 pairs, Mitchell *et al.* 2004), it is concluded that the survey area is of very low importance for foraging puffins.

10.5.79 Puffin was recorded flying through the survey area in small numbers during the summer months, particularly in July. It is possible that some of the puffins seen are from SPA colonies, in particular the Flannan Isles SPA which is 64km away, a distance that is only marginally beyond the mean maximum foraging distance estimate for puffin (62.2km, Birdlife International 2011), though it is also possible that these birds were from non-designated sites or were non-breeding birds. Given the scarcity of puffins in the survey area and the high abundance elsewhere in the region, coupled with low NCI categorisation, this species is not considered further in this chapter.

Swans and geese

10.5.80 Small numbers of whooper swan (high NCI), and moderate numbers of barnacle geese (high NCI), Greenland white-fronted geese (high NCI), pink-footed geese (low NCI) and greylag geese (migrants birds are low NCI) were recorded flying out at sea over the development area on various dates in spring and autumn. All these birds were apparently actively migrating birds either coming from or going to Iceland. Whooper swan barnacle geese and Greenland white - fronted geese are all categorised as high NCI because they are on Annex 1 of the Birds Directive.

10.5.81 The observations of migrating swans and geese confirm that the development area lies on an important migration pathway for these species linking Iceland and north-west Scotland. However, these birds typically fly well above sea level (>30m) and in any case the local geography does not in any way restrict opportunities for migrants to make minor adjustments to their route and thus avoid passing over the area should they choose. It is not plausible that the development will have an adverse impact on these species when migrating through nearby airspace. For this reason these geese and swan species are not considered further.

10.5.82 Greylag geese (high NCI) were commonly recorded (largest group was 129 birds) feeding on coastal pastures and wetlands adjacent to the Siadar/Mealabost survey area, especially during the winter months. Nine pairs of greylags with broods were recorded at Loch Bacabhat approximately 750m from the Siadar shore installation. Greylag geese breeding in the Outer Hebrides are listed on Schedule 1 of the Wildlife and Countryside Act 1981 and for this reason this species is categorised as high NCI and considered in the assessment.

Raptors

10.5.83 A single immature white-tailed eagle (high NCI) was seen flying over the coast in April. White tailed eagle is not known to breed or regularly hunt in the Siadar/Mealabost survey area, nor are the regular hunting ranges of any of the known Western Isles pairs expected to overlap this area as the breeding sites are too far away. It is highly unlikely that any part of the development process could potentially affect white-tailed eagles and therefore this species is not considered further. White-tailed eagle is categorised as high NCI because it is listed on Annex 1 of the Birds Directive and on Schedule 1 of the Wildlife and Countryside Act.

10.5.84 Merlin (high NCI) was seen on eight occasions (9 birds in total) with 3 in spring/summer and the remainder during autumn or winter. These records are likely to have comprised both birds from the local breeding population and Icelandic migrants. There is no evidence that merlin bred in the Siadar/Mealabost survey area (including in the vicinity of the pipeline route and onshore hydro electric power station), nor is the habitat suitable, but the coastal crofting strip in this area is likely to be within the peripheral hunting range of one of the breeding territories on the inland moors. Lewis holds nationally important populations of merlin. It is highly unlikely that any stage of the development could potentially adversely affect merlin and therefore this species is not considered further. Merlin is categorised as high NCI because it is listed on Annex 1 of the Birds Directive and on Schedule 1 of the Wildlife and Countryside Act.

10.5.85 Peregrine (high NCI) was seen on five occasions along the survey area coast, though only one of these records was in the breeding season. Peregrines do not breed within the Siadar/Mealabost survey area nor is there any suitable nesting habitat, but they do breed in small numbers elsewhere on Lewis. It is highly unlikely that any stage of the development could potentially affect peregrine and therefore this species is not considered further. Peregrine is categorised as high NCI because it is listed on Annex 1 of the Birds Directive and on Schedule 1 of the Wildlife and Countryside Act.

Waders

10.5.86 Golden plover (high NCI) was recorded in small numbers during the autumn, winter and spring flying through survey area and on coastal land adjacent to the development. Most birds seen at these times are likely to be from the Icelandic breeding population. Golden plover is categorised as high NCI because it is listed on Annex 1 of the Birds Directive.

10.5.87 Golden plover does not breed within the Siadar/Mealabost survey area nor is there any suitable nesting habitat, but they do breed in moderate numbers elsewhere on Lewis including the Lewis Peatlands SPA, where this species is a qualifying interest. Furthermore, there was no evidence that golden plover breeding at the Lewis Peatlands SPA used pastures in the Siadar/Mealabost survey area for feeding. It is therefore unlikely that any component of the development could have an effect on breeding golden plover in the area, including those from the the qualifying population in the Lewis Peatlands SPA, and therefore this species is not considered further.

10.5.88 Lapwing (moderate NCI) was recorded occasionally during walkover surveys. Five pairs of lapwing bred in the area surveyed in the vicinity of the onshore hydro electric power station at Siadar. These represent well below 1% of the regional breeding population of at least 4337 pairs (Jackson *et al*. 2004) The only record outside the breeding season was 20 birds seen feeding in pasture along the coast in December approximately 2km south-west of the onshore hydro electric power station. Lapwing is categorised as moderate NCI because it is on the BoCC Red List and it is a UK BAP species.

10.5.89 Non-breeding dunlin was recorded in very low numbers at certain places along the coast, especially in the autumn passage period, when most birds are likely to be from the Icelandic breeding population (*Schinzii* race). However, they were not recorded in Coastal Section 9 (Siadar), the only stretch that would be directly affected by the development. Therefore, non-breeding dunlin are not included in the assessment.

10.5.90 Three pairs of dunlin of the *Schinzii* race (high NCI) were recorded breeding in the vicinity the shore installation at Siadar. This number of breeding pairs is well below 1% of the breeding regional population size of 4790 pairs (Forrester and Andrews 2007) and therefore the development area is not regionally important for this species. Dunlin of the (*Schinzii* race) is categorised as high NCI because it is listed on Annex 1 of the Birds Directive.

10.5.91 A few small flocks whimbrel (high NCI) totalling 36 birds were recorded, all flying over during the spring passage period. All birds were likely to be migrants from the Icelandic breeding population. No whimbrel was recorded resting or feeding on coastal habitats and it is therefore it is not plausible that the development could affect this species and therefore this species is not considered further. Whimbrel is categorised as high NCI when breeding because it is listed on Schedule 1 of the Wildlife and Countryside Act, it is also on the BoCC Red List.

10.5.92 Small groups of curlew (moderate NCI) were recorded flying along the coast mainly during the winter. Two breeding pairs were recorded, one near loch Bacabat, approximately 600m from the shore installation at Siadar, and the other in approximately 2 km further to the SW . This is less than 1% of the regional breeding population of approximately 300 pairs ((Forrester and Andrews 2007). Curlew is categorised as moderate NCI because it is a UK BAP species.

10.5.93 One non-breeding greenshank (high NC, WCA Schedule 1), two bar-tailed godwit (high NCI, Birds Directive Annex 1) and one black-tailed godwit (high NCI, WCA Schedule 1) were recorded during survey work during spring or autumn migration period, either flying through or feeding at a loch margin. Given the very low numbers of these species recorded it is highly unlikely that any form of the development process could potentially affect the populations of these species and therefore this species is not considered further.

Corncrake

10.5.94 Two calling male corncrake (high NCI) were recorded in Siadar/Mealabost coastal strip covered by walkover breeding season surveys. Both these birds were approximately 1.5 km from the area of the shore development at Siadar and therefore could not be plausibly be affected by the development. For this reason this species is not considered further in the assessment part of the chapter. Corncrake is high NCI because it is on Annex 1 of the Birds Directive and Schedule 1 of the Wildlife and Countryside Act. Corncrake is also on the BoCC Red List and is a UK BAP species.

10.5.95 The strip of croftland along the north-west coast of Lewis, including the area adjacent to the development, is of regional importance for this nationally rare species. Indeed, parts of this area form the Ness and Barvas SPA where breeding corncrake is the qualifying feature. Appropriate management of the relatively small areas of grassland around the onshore hydro electric power station at Siadar could create new suitable breeding habitat and thereby potentially benefit this species. Suitable management methods are described in the Local and national biodiversity action plans for this species (JNCC. 2010, SNH and Comhairle nan Eilean Siar 2005) and have been widely used elsewhere in the region to good effect.

Other terrestrial birds

10.5.96 Starling (moderate NCI) was commonly recorded during surveys of the coastal areas adjacent to the development. Starling is moderate NCI because it is on the BoCC Red List and is a UK BAP species. However, it is a very common species on crofting land throughout the Western Isle and this species is extremely tolerant of human disturbance, as a result it is not considered further.

10.5.97 A single flock of non-breeding twite (moderate NCI) was recorded on coastal land adjacent to the development: there was no evidence of breeding. Twite is moderate NCI because it is on the BoCC Red List and is a UK BAP species. This species is a common species on coastal croftland throughout the Western Isles. This species is tolerant of human disturbance and is therefore not considered further.

10.5.98 A wide variety of other bird species, all categorised as low NCI, were recorded in small numbers during the surveys. In all cases these species are not considered further because at worst the development could lead to negligible effects on a small number of individuals such as occasional short-term temporary disturbance. These species include sparrowhawk, kestrel, buzzard, mallard, teal, wigeon, pintail, gadwall, shelduck, pochard, tufted duck, redshank, turnstone, ringed plover, knot, sanderling, common sandpiper, oystercatcher and snipe. Full details of the records and locations for these species are given in Appendix 10.1.

10.5.99 The NCI and wider conservation importance of the species recorded during surveys, and discussed above, is summarised in Tables 10.7 and 10.8 respectively.

Table 10.7: NCI of potentially affected species

NCI category	Species
High	Red-throated diver, great northern diver, Arctic tern, dunlin, greylag goose (breeding only), corncrake

Table 10.7: NCI of potentially affected species	
NCI category	**Species**
Moderate	Eider, sooty shearwater, Arctic skua, herring gull, common gull, lesser black-backed gull, lapwing, curlew
Low	All other species (including fulmar, Manx shearwater, shag, gannet, razorbill, common guillemot, black guillemot and kittiwake)

Table 10.8: Summary of status of bird species recorded in baseline surveys

Species	NCI category	Importance to foraging for breeding birds	Importance to foraging non-breeding birds	Important flight path	No. breeding within 1km of shore station (% of regional total)
Marine species					
Red-throated diver	High (A1)	Very low	Moderate (winter) (ca. 2-4% of reg. pop)	no	none
Great northern diver	High (A1)	None	Moderate (all year) (ca. 1% of reg. pop)	no	none
Fulmar	Low	Very low	Very low	yes	9 pairs, (<1% of reg. pop)
Manx shearwater	Low	Very low	Very low	yes	none
Storm petrel	High (A1)	Very low	Very low	no	none
Gannet	Low	Very low	Very low	yes	none
Cormorant	Low	Very low	Very low	no	none
Shag	Low	Very low	Very low	no	none
Eider	Moderate (RL)	none	Moderate (winter) (ca. 1-2% of reg. pop)	no	none
Common scoter	High (A1)	none	Very low	no	none
Herring gull	Moderate (RL, Reg Brd)	Very low	Very low	yes	30 pairs, (c. 1% of reg. pop)
Lesser black-backed gull	Moderate (Reg Brd)	Very low	Very low	no	10 pairs, (c. 2% of reg. pop)
Great black-backed gull	Low	Very low	Very low	yes	none
Common gull	Moderate (Reg Brd)	Very low	Very low	no	50 pairs, (c. 3% of reg. pop)
Kittiwake	Low	Very low	Very low	no	none
Arctic skua	Moderate (RL)	none	none	no	none
Arctic tern	High (A1)	low	none	no	none
Common tern	High (A1)	Very low	none	no	none

Table 10.8: Summary of status of bird species recorded in baseline surveys

Species	NCI category	Importance to foraging for breeding birds	Importance to foraging non-breeding birds	Important flight path	No. breeding within 1km of shore station (% of regional total)
Common guillemot	Low	Very low	Very low	no	none
Razorbill	Low	Very low	Very low	yes	none
Black guillemot	Low	Very low	Very low	no	none
Puffin	Low	Very low	Very low	no	none
Terrestrial species					
Barnacle goose	High (A1)	none	none	yes	none
Greylag goose	High (S1)	low	low	yes	9 pairs (<1% of reg. pop)
Greenland white-fronted goose	High (A1)	none	none	yes	none
Golden plover	High (A1)	none	Very low	no	none
Dunlin	High (A1)	Very low	none	no	3 pairs (<1% of reg. pop)
Corncrake	High (S1, A1, RL, UK BAP)	none	none	no	0 pairs, but potentially suitable habitat
Marine species					
Red-throated diver	High (A1)	Very low	Moderate (winter) (ca. 2-4% of reg. pop)	no	none
Great northern diver	High (A1)	None	Moderate (all year) (ca. 1% of reg. pop)	no	none
Fulmar	Low	Very low	Very low	yes	9 pairs, (<1% of reg. pop)
Manx shearwater	Low	Very low	Very low	yes	none
Storm petrel	High (A1)	Very low	Very low	no	none
Gannet	Low	Very low	Very low	yes	none
Cormorant	Low	Very low	Very low	no	none

Table 10.8: Summary of status of bird species recorded in baseline surveys

Species	NCI category	Importance to foraging for breeding birds	Importance to foraging non-breeding birds	Important flight path	No. breeding within 1km of shore station (% of regional total)
Shag	Low	Very low	Very low	no	none
Eider	Moderate (RL)	none	Moderate (winter) (ca. 1-2% of reg. pop)	no	none
Common scoter	High (A1)	none	Very low	no	none
Herring gull	Moderate (RL, Reg Brd)	Very low	Very low	yes	30 pairs, (c. 1% of reg. pop)
Lesser black-backed gull	Moderate (Reg Brd)	Very low	Very low	no	10 pairs, (c. 2% of reg. pop)
Great black-backed gull	Low	Very low	Very low	yes	none
Common gull	Moderate (Reg Brd)	Very low	Very low	no	50 pairs, (c. 3% of reg. pop)
Kittiwake	Low	Very low	Very low	no	none
Arctic skua	Moderate (RL)	none	none	no	none
Arctic tern	High (A1)	low	none	no	none
Common tern	High (A1)	Very low	none	no	none
Common guillemot	Low	Very low	Very low	no	none
Razorbill	Low	Very low	Very low	yes	none
Black guillemot	Low	Very low	Very low	no	none
Puffin	Low	Very low	Very low	no	none
Terrestrial species					
Barnacle goose	High (A1)	none	none	yes	none
Greylag goose	High (S1)	low	low	yes	9 pairs (<1% of reg. pop)
Greenland white-fronted goose	High (A1)	none	none	yes	none
Golden plover	High (A1)	none	Very low	no	none

Table 10.8: Summary of status of bird species recorded in baseline surveys

Species	NCI category	Importance to foraging for breeding birds	Importance to foraging non-breeding birds	Important flight path	No. breeding within 1km of shore station (% of regional total)
Dunlin	High (A1)	Very low	none	no	3 pairs (<1% of reg. pop)
Corncrake	High (S1, A1, RL, UK BAP)	none	none	no	0 pairs, but potentially suitable habitat

10.6 Impact assessment

Do nothing scenario

10.6.1 In a 'do nothing' scenario the range of bird species and their abundance occurring in the areas potentially affected by the development would not be expected to remain constant over the next 20 years, although the range of bird species and their abundance are expected to remain broadly similar to that recorded in the baseline surveys. There is a wealth of long term monitoring data on bird populations in the UK and these show populations can fluctuate markedly and ranges change in their extent. For example, the JNCC program of monitoring breeding seabird colonies (Mitchell *et al.* 2004). Where seabirds choose to feed is also influenced by prey availability, and this will vary, on occasions markedly so, from year-to-year and from season-to-season in response to natural changes in the marine environment such as sea temperature, currents, and plankton density. Similarly, on land, the areas chosen by birds such as waders and corncrake for breeding and feeding will vary from year to year and season to season in response to vegetation structure and invertebrate abundance (amongst other factors), which in turn reflect natural and man induced changes to the environment.

<u>Potential impacts during construction</u>

Impact 1: disturbance of terrestrial birds

10.6.2 Surveys to locate the nests of birds listed in Schedule 1 of the WCA will be undertaken prior to construction (and prior to decommissioning) works, during the period March-August, in the areas affected by shore works and buffered to 500m. In the event that an active nest of a Schedule 1 species is discovered within distances (of construction activities) given in Whitfield *et al.* 2008 (or within a 500m radius of the nest for species not listed by Whitfield *et al*., 2008) then shore activities within the specified distance, would be halted immediately. A disturbance risk assessment prepared under a Breeding Bird Protection Plan (BBPP) for the site, would detail measures considered necessary to safeguard the breeding attempt (e.g. exclusion zones or restrictions on timing of works) would be submitted to SNH for agreement before recommencing work.

10.6.3 Construction activities close to the active nest sites of specially protected species (i.e. species listed on Schedule 1 of the Wildlife and Countryside Act 1981) would be avoided through the proposed BBPP (see above) and therefore disruption of active breeding attempts is highly unlikely. On the basis of the 2011 breeding bird survey results, no species listed on Schedule 1 of WCA is expected to nest within 500m of the development during construction, though it is possible that greylag goose and corncrake could do so in the future.

10.6.4 Birds that are disturbed at breeding sites are vulnerable to a variety of potential effects that may lead to a reduction in the productivity and survival rates of bird populations, including:

- the chilling or predation of exposed eggs / chicks;
- damage or loss of eggs / chicks caused by panicked adults;
- the premature fledging of young; and
- reduced feeding efficiency.

10.6.5 No nest sites of terrestrial species categorised as high or moderate NCI were recorded at distances from the shore development site at which disturbance of breeding birds should occur (Whitfield *et al.,* 2008). Therefore, it is unlikely that there will be any direct effects on breeding terrestrial birds during construction. In 2011, two pairs of dunlin and one pair of lapwing bred approximately 350 m from the shore development site, and one pair of curlew approximately 600 m away (none of these species are on Schedule 1 of WCA). These species are known to have low sensitivity to human disturbance, for example they are known to readily tolerate pedestrians and operating agricultural machinery at distances of down to at least 200m from nest sites (approximately 300m for curlew). Therefore, the birds on these territories are unlikely to be adversely affected by construction disturbance.

10.6.6 The small mixed-species colony of gulls and breeding greylag geese at Loch Bacabhat are located approximately 750m from the shore development site and are therefore well beyond the distance at which any disturbance is plausible. It is concluded that any disturbance during construction period will be short term temporally and negligible spatially. Therefore, the impact of disturbance to these species of terrestrial birds is judged to be of **negligible** significance.

10.6.7 Construction disturbance may also potentially have an adverse effect through displacement of foraging birds, at any time of year. For species which forage in terrestrial habitats the terrestrial area which will be affected during construction is small relative to foraging ranges of the species concerned. Moreover, the baseline survey results suggested that no 'terrestrial' species made frequent use of the areas liable to be affected during construction. In addition, since construction will be short-term it is unlikely that there will be any measurable effect on populations of terrestrial species (i.e. dunlin, lapwing, greylag goose). It is concluded that the impact of disturbance and so disturbance effects during construction will be of **negligible** significance

MITIGATION IN RELATION TO IMPACT 1
No mitigation is required for any species.

Residual impact

10.6.8 The initial and residual impact remains **negligible**, however, the following legislative requirements will be adhered to.

10.6.9 The proposed BBPP for the site will protect against the possibility of construction activities causing disturbance to high NCI species. In particular, it will prevent the disturbance of breeding birds listed on Schedule 1 of the Wildlife and Countryside Act; disturbance of these species at their nests or when they have dependent young is illegal.

10.6.10 Surveys to locate the nests of birds listed in Schedule 1 of the WCA will be undertaken onshore prior to construction (and decommissioning) works during the period March to August. These surveys will be undertaken to inform measures to safeguard any breeding attempts from disturbance.

Impact 2: disturbance of seabirds

10.6.11 It is likely that noise and disturbance from vessels associated with construction activities would temporarily displace some foraging or resting seabirds from marine habitats. Potential adverse effects are likely to be greatest but not restricted to, the period when birds breed.

10.6.12 Disturbance effects on seabirds during construction would be confined to routes travelled by construction and survey vessels, and the vicinity of Oyster WECs. Construction is anticipated to 4 years and up to 4 breeding seasons as described in *Chapter 5: Project Description*.

10.6.13 None of the seabird species of high or moderate NCI breed in or close to the areas that will be potentially affected by construction disturbance. Therefore the sensitivity of seabird breeding sites to vessels movements during the construction period is assessed as negligible.

10.6.14 Any construction disturbance of seabirds would be temporary and of short term and of negligible magnitude. The sensitivity to disturbance of the populations of all seabird species that forage in the development area is considered to be negligible or low (depending on species). Based on observations of the response of seabirds disturbed by vessels during baseline survey work, and similar observations at other marine site in western Scotland the most likely effect of any additional disturbance from construction vessels would be for birds to be temporarily inconvenienced as they relocate to a nearby location, typically no more than a few hundred metres away.

10.6.15 In all cases the numbers of individuals of each seabird species using the Siadar/Mealabost survey area represent at most a small proportion of the regional populations. For two species only (red-throated diver and eider) do the numbers present regularly exceed 1% of the assumed regional population, and even then only by a relatively small margin and only during the non-breeding part of the year (winter). These factors indicate a low to negligible magnitude of effect on bird populations. Furthermore, construction work would be phased over approximately 4 years, and the area potentially affected by disturbance at any one time will be only a small part of the overall development area.

10.6.16 Although construction disturbance (including noise) could potentially affect almost all seabird species using the marine development area, it is predicted that the effects of any disturbance will be will be short term temporally and of negligible spatial magnitude. It is therefore unlikely that the effects would have a measurable effect on abundance, survival or productivity at the regional scale. Therefore, the predicted impacts are assessed as **negligible**.

MITIGATION IN RELATION TO IMPACT 2
No mitigation is required for any species, but best practice is recommended (see Section 10.6.17 to 10.6.20).

Residual impact

10.6.17 The impact remains **negligible**.

10.6.18 Good practice would aim to minimise vessel disturbance to seabirds using the coastal waters north-west of Lewis by avoiding where possible preferred feeding and resting areas and adopting voluntary speed restrictions. Studies elsewhere indicate the severity of disturbance by boats is related to speed (Ronconi and Cassady St. Clair, 2002). Vessel speed limits are commonly used to limit disturbance to seabirds in the vicinity of colonies and feeding sites; however there is no accepted maximum permissible speed. A maximum vessel speed of 15km/hr (approximately 8 knots) is likely to give most seabird species time to move away from an approaching vessel without resorting to flight.

10.6.19 Construction and survey vessels will follow defined routes as far as possible, between ports and the development sites as a means of reducing disturbance of seabirds. Studies have shown that disturbance is reduced if birds can predict where the disturbance will occur (Schwemmer *et al.* 2010).

Impact 3: habitat loss

10.6.20 The land taken by the development during construction will result in loss of terrestrial habitat, mainly restricted to an area of acid grassland, which coincides with the footprint of the onshore hydro electric power station, as well as a temporary construction area, and an onshore pipeline / trenching area (*Chapter 5: Project Description)*.

10.6.21 There will be some long term loss from construction of the hydro electric power station and a series of shore access tracks (also on acid grassland) and some habitat loss for the footprint of pipelines if they are to be surface laid (see *Chapter 5: Project description* and *Chapter 13: Terrestrial and intertidal ecology*). If directional drilling is used, there will need to be up to two 30m^2 areas for locating drilling rigs. This will result in some short term habitat loss while habitat recovers from pipe laying or directional drilling works.

10.6.22 Other terrestrial habitats impacted are at the margins of the existing track, which will be widened and upgraded as part of the development, with some long term loss. All impacts on terrestrial habitats are considered further in *Chapter 13: Terrestrial and intertidal ecology*.

10.6.23 The area of acid grassland and other habitat lost is of low value to bird species present and is not part of the breeding territories of any species categorised as either moderate or high NCI.

10.6.24 The loss of sea-bed habitat caused by the deployment of Oyster monopiles and seabed infrastructure is discussed in more detail in I, where the magnitude of effect from habitat loss during construction is assessed as low and the associated impacts assessed as of negligible significance.

10.6.25 Elements of habitat loss in both terrestrial and marine seabed, will be long term (Table 10.5), although of negligible magnitude (Table 10.4). Therefore the impacts of direct habitat loss due to sea-bed take and land take are deemed **negligible** for all species under the terms of the EIA Regulations.

MITIGATION IN RELATION TO IMPACT 3
No mitigation is required for any species.

Residual impact

10.6.26 Effects of habitat loss will remain negligible.

10.6.27 There are likely to be modest opportunities to manage the grassland in the immediate vicinity of the onshore hydro electric power station to benefit breeding corncrake (high NCI) using simple methods that have been successfully deployed elsewhere in the Western Isles.

Potential impacts during operation (including maintenance)

10.6.28 For all terrestrial species of high or moderate nature conservation importance, magnitude of effects of the development will be low or negligible and the significance of impacts is assessed as **negligible**.

Impact 4: disturbance of seabirds

10.6.29 For all seabird species a potential effect during the operational phase of the development is disturbance from foraging areas, principally by maintenance and survey vessels. Although essentially similar in nature to vessel disturbance caused during the construction phase, the frequency and duration of any disturbance caused during the operational phase is likely to be much less. Therefore, following the additional reasoning outlined for Impact 2 (Vessel disturbance in the construction phase), it is predicted that the likely effects of vessel disturbance on seabird species during the operational phase will be negligible.

10.6.30 The presence of operational Oyster WECscould cause displacement of seabirds from their immediate vicinity. There are currently no arrays of Oyster WECs in operation and therefore no information on how seabirds respond to them. However, there is a considerable body of experience as to how seabirds respond to other manmade objects in the marine environment. To seabirds on the sea surface or in flight, Oyster WECs will appear as slow moving but fixed objects of approximately 30 m length, 3.5 m width, protruding above the sea surface by approximately 1 to 5m depending on tide state. Therefore, from a seabirds' perspective, their overall appearance will be quite similar to a moderate-sized vessel (such as a fishing trawler albeit with reduced superstructure) at its mooring but without any on board human activity. It is likely that seabirds will exhibit a broadly similar response to Oyster WECs as they do to moored vessels of a similar size. Furthermore, as the WECs are permanently present, birds are likely to habituate to their presence over time, unlike moored vessels that tend only to have a temporary presence.

10.6.31 For all the seabirds regularly occurring on the site the expected response to Oyster WECs is likely to be similar to their response to large vessels; varying from slight attraction through neutral to mild avoidance. Gulls and tern species (together with shag and fulmar) are all likely to show either no discernible response or be mildly attracted, depending on whether or not they can perch on emerged parts of the superstructure. For these species any impacts are likely to be either neutral or beneficial. Diver species and eider (together with auks, gannet, shearwater and petrels) are likely to show either no discernible response or mild avoidance at a scale of a few hundred metres at most. Evidence of such tolerance can be seen by the frequent use made by divers and eider of many of Scotland's harbours and shipping lanes (e.g. Firth of Forth, Sound of Islay, Montrose harbour channel and Stornoway harbour).

10.6.32 For the purposes of assessment a hypothetical worst-case scenario is assumed in which all foraging seabirds would be displaced from the whole Oyster WEC boundary area, plus a 250m buffer. This would effectively equate to the loss of 2.4 km^2 of sea area, and amount to the loss of approximately one quarter of the marine habitat in the Siadar/Mealabost survey area (i.e., 2.4 km^2 /11 km^2). Therefore, at worst the effect of displacement would be to reduce numbers of foraging birds in the survey area by one quarter. On average, at the season of greatest abundance, this worse-case scenario would mean the loss of feeding resource for approximately one individual wintering red-throated diver, 2 - 3 wintering great northern divers and approximately 10 wintering eider duck. In all cases these numbers are below 1% of the assumed regional population. Only for red-throated diver is this loss possibly approaching around 1%, but for the reasons stated earlier (see Section 10.5 Red throated diver) the published regional wintering population estimate for this species, upon which the percentage is based, is too low. The proportions of the regional populations of all other seabird species that would be potentially displaced under this hypothetical worse-case scenario are in all case well below 1% of the regional populations. Therefore, it is predicted that the likely effects of displacement from operational Oyster WECs on seabird species during the operational phase will be of negligible magnitude, although long term. It is assessed concluded that the predicted impacts of displacement in the operational phase are of **negligible** significance.

MITIGATION IN RELATION TO IMPACT 4
No mitigation is required for any species.

Residual impact

10.6.33 The residual impact will remain negligible for all species.

10.6.34 The good practice mitigation methods for Impact 2 (vessel disturbance in the construction phase) will also be followed in the operational phase and this will reduce disturbance by vessels.

Impact 5: Attraction of seabirds

10.6.35 Where operational Oyster WECs attract seabird species then this could be potentially benefit populations, either through providing temporary (wave condition dependant) safe roost sites or enhanced feeding conditions. Such effects would amount to habitat modification. When the emergent part of the WEC superstructure is not moving too rapidly then gulls and tern species and shag, and possibly black guillemot also, are likely to perch there. The surfaces of the WECs and support structures (see *Chapter 5: Project Description*) are likely to be colonised by marine weed and benthic animals, to some extent also potentially providing artificial reef habitat and fish aggregation which could in turn provide enhanced feeding for birds. Eider in particular could benefit from enhanced feeding if some structures are colonised by mussels. Although these possible benefits to birds are necessarily speculative given the lack of operational experience, they are reasonable and are likely to occur to some extent.

10.6.36 Any beneficial effect on regional bird populations is likely to be of **negligible** significance.

MITIGATION IN RELATION TO IMPACT 5
No mitigation is required for any species.

Residual impact

10.6.37 Effects of attraction will remain negligible for all species, however, although it may be mildly beneficial for some seabird species, the residual impact remains of negligible significance.

Impact 6: collision and entrapment of diving seabirds

10.6.38 The Oyster WEC could theoretically pose a collision or entrapment risk to diving seabirds leading to death or injury, though in practice it is not clear how this could happen with the design of device proposed. Due to the novel nature of the technology and the lack of studies on similar devices there is no information on how diving birds are actually affected by operational WECs. This information gap requires investigation (Shields, 2009).

10.6.39 Until they are deployed the impact of the WECs on bird behaviour cannot be assessed quantitatively nor fully discounted. However, the response of seabirds to other large passively moving structures in the marine environment, for example large navigation buoys and large mooring systems suggests that any risks are likely to be extremely low.

10.6.40 Death and injury to diving birds caused by underwater collision with solid man-made structures (excluding nets) appears to be a non-issue to date; a literature search on this topic providing no examples. The design of Oyster WECs is such that it should not be possible for a diving bird somehow to become trapped below water and drown.

10.6.41 Whilst recognising that there remains uncertainty over quantifying collision and entrapment risks it is judged on the basis of birds' responses to other structures and the design of the proposed devices that the risks are very small and that even were there to be an occasional fatality this is very unlikely to have a discernible effect on the regional population of any species. Therefore, it is predicted that the likely effects of underwater collision or entrapment on diving seabird species caused by operational WECs will be negligible magnitude, although temporally long term. It is judged this effect is of **negligible** significance.

MITIGATION IN RELATION TO IMPACT 6
No mitigation is required for any species as effect is not significant.

Residual impact

10.6.42 Impacts of collision and entrapment will remain negligible for all species.

10.6.43 Results of research and monitoring on this subject is being undertaken by Marine Scotland. The results will be followed and should there be evidence of potential mortality risks, then measures will be considered that aim to prevent it occurring. Aquamarine will share any relevant data it may collect on this subject with the regulator in the spirit of promoting as wide an understanding as possible of risks of collision and entrapment.

Impact 7: marine pollution and contamination

10.6.44 The release of fuels, fluids and other marine pollutants and the toxic effects of anti-fouling chemicals could have lethal and sub-lethal effects on seabirds and their prey. As the various regulations and codes of practice covering the safe use of oil, lubricants, chemicals and antifouling paints in the marine environment will be fully complied with, the risks of such contamination occurring would be limited to accidental release (see *Chapter 20: Water quality*). The development will adopt an explicit policy to deal rapidly and effectively with any accidental release of pollutants.

10.6.45 Given such a contingency policy, and given that: a) that the potential quantities of any oil or chemicals accidentally released would be at most small; b) that wave action would quickly disperse and dilute any contaminants and, c) that the numbers of all seabird species using the Siadar/Mealabost survey area are small in a regional context, then the impact of the likely effects on regional seabird populations is assessed as negligible magnitude, and short term temporally. It is judged that the significance of this impact is **negligible**.

MITIGATION IN RELATION TO IMPACT 7
No mitigation is required.

Residual impact

10.6.46 Provided good practice guidelines are adhered the impacts of pollution and contamination on marine birds populations will remain not significant for all species

10.6.47 Good practice methodology will be adhered to regarding pollution and contamination control (see *Chapter 20: Water Quality*).

Potential impacts during decommissioning

Impact 8: Vessel disturbance

10.6.48 Disturbance effects due to decommissioning are anticipated to and be of lower intensity than during construction, and so effects would be similar in nature but of lower magnitude than during installation.

10.6.49 It is predicted that the effects of disturbance will be will be medium term temporally and of negligible magnitude. It is therefore unlikely that the effects would have a measurable effect on abundance, survival or productivity of species at the regional scale. Therefore, the significance of predicted effects is assessed as **negligible**.

MITIGATION IN RELATION TO IMPACT 8
No mitigation is required for any species.

Residual impact

10.6.50 The residual impact will remain negligible for all species.

10.6.51 The good practice mitigation methods for Impact 2 (vessel disturbance in the construction phase) will also be followed in the operational phase and this will reduce disturbance by vessels.

Impact 9: Habitat reinstatement

10.6.52 Habitat (marine and terrestrial) reinstatement requirements would be set out in consultation with the statutory authorities at the time of decommissioning. It is anticipated that Oyster devices would be removed at the end of the operational phase. The reinstatement of habitats during decommissioning is considered likely to be of negligible magnitude and medium term for all species. Any impacts judged are assessed as having **negligible** significance..

MITIGATION IN RELATION TO IMPACT 9
No mitigation is required for any species.

Residual impact

10.6.53 The significance of impact remains negligible.

10.6.54 The good practice measures will make it more likely that habitat reinstatement measures provide benefits for high NCI bird species. Nevertheless given the small size of the areas that would require reinstatement, the residual impact are likely to remain negligible for all species.

10.6.55 Good practice guidance on habitat reinstatement prevailing at the time of decommissioning will be followed. Where it is practical, and with statutory approval, habitat reinstatement will to aim to directly benefit bird species of high NCI. For example, on terrestrial areas measures might be aim to benefit species such as breeding corncrake and dunlin.

Cumulative effects

10.6.56 The EIA Regulations require that the development be assessed cumulatively along with other projects or plans. In doing so, guidance on assessing cumulative effects (King *et al.* 2009) has been followed. In considering cumulative effects it is necessary to identify any effects that are minor in isolation but which may be major additively.

10.6.57 'Target' species were taken to be those species of high and moderate NCI (Table 10.2) and for which there was some indication of a potential impact as a result of the development which may be exacerbated cumulatively. In assessing cumulative impacts of development projects only wave power developments were considered; whilst terrestrial species may be affected by other forms of development (e.g. onshore wind energy schemes) the predicted impacts of the development described herein on these species were so small that they could not conceivably contribute measurably to any cumulative regional effects.

10.6.58 Current activities that may contribute to cumulative impacts with the development are:

- Voith Hydro WaveGen 4MW Wave Energy Project – located at the mouth of the river Siadar; and
- Pelamis Wave Power – located in offshore waters west of Loch Roag.

10.6.59 The construction and operation of two additional wave projects in this area has the potential to increase vessel activity in the area and therefore disturbance of seabirds. In the absence of environmental information for the Pelamis Wave Power project near Loch Roag, it is assumed that these projects will require similar levels of vessel activity to the Lewis Wave Array and that the operators would follow similar mitigation measures to reduce vessel disturbance (see Impact 2). On this basis, it is very unlikely that the cumulative disturbance by vessels from these projects would have a significant adverse effect on the regional population any seabird species.

10.6.60 The operation of arrays of wave energy devices at the two additional wave project areas has the potential to increase displacement of seabirds from foraging areas. In the absence of environmental information for the Pelamis Wave Power project near Loch Roag, it is assumed that size of the areas from which displacement might occur due to these additional projects are no larger than for the Lewis Wave Array. On this basis, the total area potentially affected by displacement from the vicinity of devices will be very small in the context of the area of coastal marine waters in the region (Western Isles). Therefore it is unlikely that the cumulative amount of displacement of seabirds from foraging areas in the region would have a significant adverse effect on the regional population any seabird species. The regional wintering red-throated diver population is likely to be the most sensitive receptor bird population to the effects of displacement. The available information suggests that the cumulative effects of the three proposed wave energy projects on this population are likely to be **negligible**.

10.6.61 In conclusion, the cumulative combined effects of the development and other projects are likely to be negligible in magnitude although long term. Any associated impacts are assessed as of **negligible** significance.

10.7 Conclusions

10.7.1 It is concluded that the likely impacts of the development on regional populations of all bird species are **negligible** under the terms of the EIA Regulations.

10.7.2 It is also concluded that the likely cumulative effects of the development together with the two other proposed wave energy developments in the Western Isles on regional populations of all bird species are **negligible.**

10.7.3 Available information indicates, beyond reasonable scientific doubt, that the development will not, either alone or in combination, have a significant effect on any classified or proposed SPAs.

11. MARINE MAMMALS AND BASKING SHARKS

11.1 Introduction

11.1.1 This chapter of the Environmental Statement (ES) describes the existing environment within the proposed Lewis Wave Array and in the wider Western Isles region, and assesses the potential interactions between the development and marine mammals, which include pinnipeds (seals) and cetaceans (whales, dolphins and porpoises), as well as basking sharks.

11.1.2 This chapter characterises the distribution and abundance of marine mammal species which have been recorded within the study area and wider region through site specific or regional surveys (see Figure 11.1). Subsequently, it presents the findings of an assessment of potential impacts arising from the construction, operation and decommissioning phases of the proposed development on marine mammal and basking sharks and provides detail on potential mitigation and monitoring measures for those potential impacts that have been considered to be significant.

11.1.3 This chapter should be read in conjunction with *Chapter 12: Fish and Shellfish*, *Chapter 15: Shipping and Navigation*, and *Chapter 20: Water Quality*.

11.2 Summary of assessment on marine mammals

11.2.1 The study area for marine mammal and basking shark receptors considers the wide range of relevant species. The regional study area of the Western Isles is considered to provide context to the immediate study area (Figure 11.1). The immediate study area was observed from the northern vantage points of the shore based survey (see Figure 11.2).

11.2.2 A number of marine mammal species are found in the regional study area for the Lewis Wave Array, including grey seal, harbour seal, common dolphin, harbour porpoise, Risso's dolphin and minke whale. Basking shark is also considered in this assessment. The year 1 shore based survey data indicates that the Siadar area is not of particular importance to marine mammals or basking sharks (Appendix 11.1).

11.2.3 Impacts during construction, operation and decommissioning are considered in relation to noise, collision risk, accidental release of contaminants, and changes to prey resource. Overall the impacts are considered to be of minor significance to marine mammals and basking sharks based on their ability to avoid the relatively small development area.

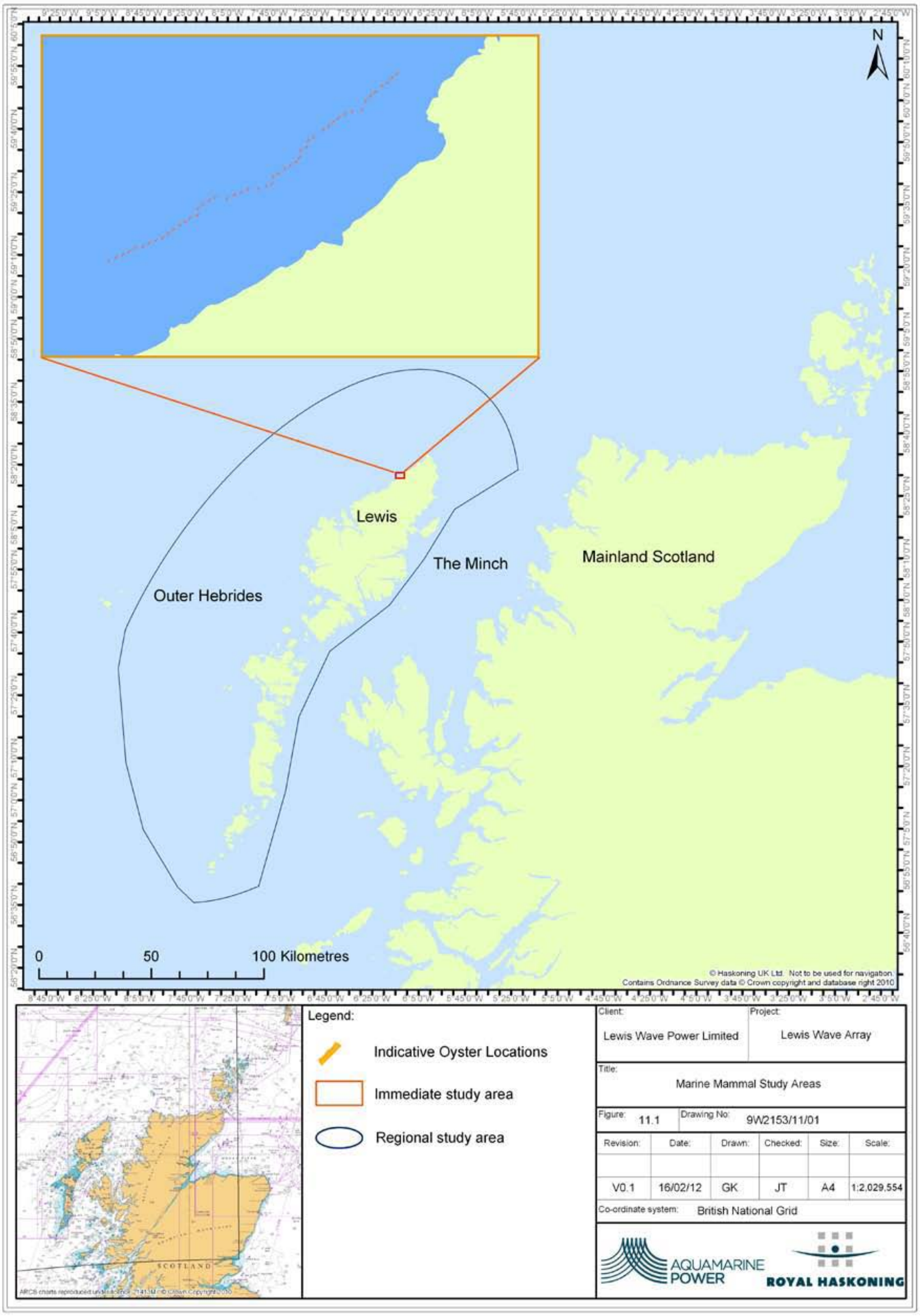


Figure 11.1: Marine mammal study area

11.3 Potential impacts

11.3.1 **Underwater noise** associated with installation, operation, maintenance and decommissioning of the wave array could influence the normal activities of marine mammals. Many species of marine mammal use sound for detection of prey, communication and navigation. An increase in noise levels can mask biological acoustic cues used for hunting and social activity. Installation will involve drilling one monopile socket per Oyster device and may include horizontal directional drilling of the pipelines. It is important to note that the design of the project has developed to avoid the need for noisy percussive piling technology.

11.3.2 During the operational phase, underwater noise and vibrations may result from the movement of the Oyster flaps and the periodic increase in vessel activity during maintenance. The impact of underwater noise from the project on marine mammals around Lewis will depend on the levels of existing ambient noise in the study area.

11.3.3 The impact of underwater noise on marine mammals during construction and operation is considered further in Section 11.6.

11.3.4 **Collision** with vessels associated with installation and maintenance of the wave array could cause physical harm and possible fatality to marine mammals. Collision with Oyster devices is unlikely due to the static nature of the installation and the slow speed of the moving flaps. However this is considered further, along with risk of collision with vessels, in Section 11.6.

11.3.5 **Accidental release of contaminants** such as fuel, from vessels associated with the development and additives to the predominantly fresh water hydraulic fluid. Lewis Wave Power is committed to using environmentally friendly substances. The potential impact from contaminants is discussed further in Section 11.6.

11.3.6 **Indirect impacts from changes to prey resource** are considered in Section 11.6, cross referencing the impacts on fish and shellfish (discussed in *Chapter 12 Fish and Shellfish*).

11.3.7 **Barrier effects** were 'scoped out' as a result of the open nature of the waters around the north coast of Lewis and the expectation that marine mammals will be able to pass around the wave array.

11.3.8 **Electromagnetic fields** are not applicable to the Lewis Wave Array as electricity generation takes place on shore.

11.4 Methodology

11.4.1 This assessment follows the latest, appropriate, guidance on Environmental Impact Assessment (EIA) (EMEC and Xodus group in press; Cefas, 2004 and IEMA 2006) and draws experience from recent examples of similar renewable energy projects in the UK and Europe. The existing environment outlined in Section 11.5 provides the baseline for impact assessment.

11.4.2 The impact assessment uses a "Rochdale Envelope approach" to project description (see *Chapter 2 Scoping and Assessment Methodology*) and in line with best practice the realistic worst case scenario (WCS) is considered for each potential impact on marine mammals and basking shark.

Legislation, Guidelines and Policy Framework

11.4.3 All cetaceans are European Protected Species (EPS) under Annex IV of the Habitats Directive (European Union (EU) Directive 92/43/EEC) because they are classified as being endangered, vulnerable or rare. Harbour porpoise *Phocoena phocoena* is also listed under

Annex II, while grey seal *Halichoerus grypus* and harbour seal *Phoca vitulina* are also protected under Annex II.

11.4.4 All small cetaceans are protected by the international Agreement on Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS).

11.4.5 Grey seal and harbour seal are also listed on Annex V of the Habitats Directive, which requires their exploitation or removal from the wild to be subject to management measures.

11.4.6 The Habitats Regulations 1994 (as amended in Scotland in 2004, 2007, 2008(a) and 2008(b)) implement the species protection requirements of the Habitats Directive in Scotland on land and inshore waters (0-12 nautical miles). Part II of the Habitats Regulations outlines protection for Special Areas of Conservation, designated for habitats listed under Annex I of the Habitats Directive or species listed under Annex II of the Habitats Directive. Part II of the Habitats Regulations details the protection given to EPS.

11.4.7 A license is required if the risk of injury or disturbance to EPS is assessed as likely under regulations 41(1)(a) and (b) in The Conservation of Habitats and Species Regulations and 39(1)(a) and (b) in The Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007 (amended in 2009 and 2010). It is expected that an EPS license is not likely to be required for the development.

11.4.8 Under the Marine (Scotland) Act 2010 it is an offence to kill, injure or take a seal at any time of year except to alleviate suffering or where a licence has been issued to do so by the Scottish Government. It is an offence to harass seals at haulout sites which have been identified for protection under Section 117 of the Marine (Scotland) Act 2010.

11.4.9 The Convention on the Conservation of Migratory Species (The Bonn Convention) aims to conserve migratory species and their habitats. The common dolphin is afforded strict protection as an endangered migratory species, listed under Appendix 1 of the Convention. This has been ratified in the UK by the Wildlife and Countryside Act (1981)

11.4.10 The Wildlife and Countryside Act 1981 (as amended) ratifies the Bonn Convention and provides for the protection of all cetaceans found within UK territorial waters. Under Section 9 of the Act, it is an offence to intentionally kill, injure or take cetaceans; and to cause damage or destruction to certain areas used by cetaceans for shelter and protection, or to intentionally disturb animals occupying such areas.

11.4.11 The Nature Conservation (Scotland) Act 2004 amends and improves the species protection provided by the Wildlife and Countryside Act 1981 to provide extension to existing protections for cetaceans from intentional disturbance to encompass protection from reckless disturbance as an offence. Basking sharks have full protection from intentional or reckless disturbance in Scottish waters (up to 12 miles offshore) under Section 6.

11.4.12 Short-beaked common dolphin *Delphinus delphis*, bottlenose dolphin *Tursiops truncatus* and harbour porpoise are awarded strict protection under Appendix II of the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention). All remaining cetaceans not listed in Appendix II are listed in Appendix III of the Bern Convention providing these species with more limited protection. The Bern Convention was ratified by the Habitats Directive (92/43/EEC).

11.4.13 The OSPAR Convention outlines species and habitats which require further protection. Of the species expected within the Lewis study area, the harbour porpoise and basking shark are listed as threatened and declining (Annex IV).

11.4.14 Lewis Wave Power is also aware of the following non statutory measures:

- The UK Biodiversity Action Plan (BAP),
- The List of Priority Marine Features (PMFs)
- Comhairle nan Eilean Siar (Western Isles) Biodiversity Action Plans (BAP).

11.4.15 The UK BAP lists grouped plans for baleens whales, small dolphins, and toothed whales as well as plans for each individual species. Six species of baleen whale are listed; blue whale *Balaenoptera musculus*, fin whale *Balaenoptera physalus*, sei whale *Balaenoptera borealis*, minke whale *Balaenoptera acutorostrata*, humpback whale *Megaptera novaeangliae*, and northern right whale *Eubalaena glacialis*. Six small dolphin species are listed; bottlenose dolphin, Risso's dolphin *Grampus griseus*, white-beaked dolphin *Lagenorhynchus albirostris*, Atlantic white-sided dolphin *Lagenorhynchus acutus*, Short-beaked common dolphin, and striped dolphin *Stenella coeruleoalba*. The toothed whale species included are northern bottlenose *Hyperoodon ampullatus*, Cuvier's *Ziphius cavirostris*, Sowerby's *Mesoplodon bidens*, True's beaked whale *Mesoplodon mirus*, killer whale *Orcinus orca*, long-finned pilot whale *Globicephala melas*, and sperm whale *Physeter microcephalus*. The basking shark *Cetorhinus maximus* is also listed under the UK BAP.[1]

11.4.16 Relevant species listed as PMFs include bottlenose dolphin, harbour porpoise, killer whale, minke whale, Risso's dolphin, common dolphin, white-beaked dolphin, harbour seal, grey seal, and basking shark.[2]

11.4.17 There are currently no marine mammal species or basking shark listed in the Comhairle nan Eilean Siar (Western Isles) BAP.

Consultation

11.4.18 A Scoping Opinion was sought in May 2011 from both statutory and non-statutory consultees, including the Whale and Dolphin Conservation Society (WDCS). A short summary of the main points pertinent to marine mammals raised during this process, along with an explanation of how they were addressed, is provided in Table 11.1.

Table 11.1 Issues raised in the scoping opinion (Marine Scotland 2011)

Comments & Information	Response
Scottish Natural Heritage (SNH) highlighted the decline in harbour seals and the need for this to be included in the EIA. The Potential Biological Removal (PBR) for harbour seals in the Outer Hebrides management area is 54 for all activities in the area.	The status of all relevant marine mammal species is outlined in section 11.5 'Existing Environment'. The impact assessment does not predict fatalities to marine mammals due to the negligible magnitude of all impacts. In addition the Year 1 vantage point survey indicated minimal use of the immediate study area by harbour seals, with no sightings recorded.
The ES should provide information on the acoustic properties of any 'significant	Underwater noise characteristics are outlined in detail in Appendix 11.2

[1] http://webarchive.nationalarchives.gov.uk/20110303145213/http://ukbap.org.uk/species.aspx

[2] http://www.snh.gov.uk/docs/B874876.pdf

Table 11.1 Issues raised in the scoping opinion (Marine Scotland 2011)	
Comments & Information	**Response**
underwater noise' generating activities (e.g. drilling, device operation). The ES should identify appropriate mitigation measures.	Construction noise is identified in paragraphs 11.6.3 and 11.6.4 The approach used to estimate operational noise in the absence of data is outlined in paragraph 11.6.40 Given very low levels of noise generated during drilling and operation, no mitigation is suggested for the associated impacts. The greatest noise levels will be caused by vessel noise. Mitigation measures are suggested in relation to maintaining steady speeds and gradual acceleration / deceleration.
Impacts of noise including behavioural effects should be considered in detail. Noise monitoring from Oyster 2 at the European Marine Energy Centre should be compared with modelled noise analysis.	Detailed noise information is provided in Appendix 11.2. Modelling indicates that only behavioural effects are likely to be caused by the development, i.e. no physical effects on marine mammals. These behavioural effects are discussed in section 11.6 'Impact Assessment'
SNH highlighted that certain haulout sites have been identified for protection under Section 117 of the Marine (Scotland) Act 2010 as detailed in the Scottish Government consultation	These are outlined in Figure 11.2. Given the low levels of magnitude of the potential impacts on marine mammals and the distance of the haul out from the development it is expected that there will be no significant impact on the haul out sites listed.
The recent identification of the seal corkscrew death phenomenon should be considered for any vessels with ducted propellers used during installation and maintenance	No vessels with ducted propellers are to be used in the proposed development.
Basking sharks are likely to use the area for passage and/or feeding. The risks of disturbance are similar to those of marine mammals. Establishing the distribution and usage by basking sharks will be critical in determining the likelihood and significance of the array leading to any substantial loss of foraging habitat (potentially due to noise).	Basking sharks were recorded during the vantage point surveys and their distribution and site usage is outlined in the Section 11.4 Existing Environment, paragraphs 11.5.38 to 11.5.41
WDCS outlined the importance of adequately considering cumulative and in-combination impacts.	This is considered in the Impact Assessment, paragraphs 11.6.65 to 11.6.69.

11.4.19 Consultation was undertaken with SNH and MS-LOT on the results of the first year's vantage point survey for marine mammals and basking shark (Appendix 3.1). SNH confirmed the frequency of seal, cetacean and basking shark records is relatively low, and that at this interim stage, these data suggest no likely significant effect on breeding grey seals, qualifying features of North Rona and Monach Isles SACs. SNH have confirmed they will make full evaluation and advice regarding grey seals on submission of the report at the end of the second year of Vantage Point data collection. SNH recommend that continuation of survey work until September 2012 to capture two years of baseline data, as taking into consideration the above observations, further data collection would be advantageous to provide a better baseline for post-construction monitoring and a more robust and informed decision making process. The second year of baseline monitoring is currently underway.

Data collection

11.4.20 Information has been collected through a desk-based literature review and from shore based vantage point surveys conducted by Natural Research Projects on behalf of Lewis Wave Power.

11.4.21 Vantage point survey data collected between September 2010 and September 2011 is used in the impact assessment. The methodology was agreed with SNH and largely follows the SNH draft guidance on survey and monitoring in relation to marine renewables deployment in Scotland (Jackson & Whitfield, 2011; MacLeod *et al.*, 2011; Sparling *et al.,* 2011). 188 hours of survey were undertaken at the Siadar (95 hours) and Mealabost (93 hours) vantage points. In addition a further 91 hours of data were collected at the Labost vantage point. The Labost area to the south is no longer being considered for development but this work can provide information about the wider region.

11.4.22 The principal data sources relevant to the marine mammals are shown below in Table 11.2.

Table 11.2 Existing data

Data source	Coverage	Author(s)	Year
APPENDIX 11.1: Year 1 Marine Mammal Data	North west coast of Lewis	Royal Haskoning	2011
APPENDIX 11.2: Underwater noise impact study in support of the Oyster Wave Energy Project	North west coast of Lewis	Kongsberg	2012
Scottish Marine Renewables Strategic Environmental Assessment (SEA).	Scotland wide	Faber Maunsell	2007
Scientific Advice on Matters Related to the Management of Seal Populations	UK	SCOS	2010
Small cetaceans in the European Atlantic and North Sea	UK	SCANS II	2006
Coasts & Seas of the United Kingdom, Region 15 & 16 North-west Scotland: The Western Isles and west Highland	NW Scotland	JNCC	1997
JNCC Cetacean Atlas	UK	Reid *et al*	2003
NBN Gateway maps	UK	National Biodiversity Network	2012
Scotland's Marine Atlas	Scotland	The Scottish Government	2011

Assessment of significance

11.4.23 The significance of the impact from the development is based on the intensity or degree of disturbance to baseline conditions and is categorised into four levels of magnitude, high, medium, low or negligible. The definitions of each of these are given in Table 11.3 (based on Faber Maunsell, 2007).

Table 11.3: Criteria for assessing the magnitude of impacts on marine mammals and basking shark

Magnitude of impact	Definition
High	Affect an entire population / habitat causing a decline in abundance and / or change in distribution beyond which natural recruitment would not return that population / habitat, or any population / habitat dependent upon it, to its former level within several generations of the species being affected.
Medium	Damage or disturbance to habitats or populations above those experienced under natural conditions, over one or more generation, but which does not threaten the integrity of that population or any population dependent on it.
Low	Small-scale or short-term disturbance to habitats or species, with rapid recovery rates, and no long-term noticeable effects above the levels of natural variation experienced in the area. The impacts are not sufficient to be observed at the population level.
Negligible	An imperceptible and/or no change to the baseline condition of the receptor.

11.4.24 The sensitivity/value/importance of the receptor for each impact is characterised as one of four levels, high, medium, low or negligible. The definition of each level is given below in Table 11.4. By using a conservation value approach to define the sensitivity there can be no marine mammals or basking sharks below a medium sensitivity (national conservation status).

Table 11.4: Criteria for assessment of sensitivity of marine mammals and basking shark

Receptor sensitivity	Definition
High	International conservation status (e.g. Habitats Directive Annex II species, European Protected Species).
Medium	National conservation status (e.g. UK Biodiversity Action Plan).
Low	Receptor of regional importance. All marine mammals and basking sharks have importance beyond a regional scale.
Negligible	Receptor of low importance, at a local scale. All marine mammals and basking sharks have importance beyond a local scale.

11.4.25 Table 11.5 combines the definitions of magnitude with the level of sensitivity/value/importance of receptor to provide a prediction of overall significance of the impact. Red cells indicate impacts which may be considered to be significant within an EIA

Table 11.5: Significance prediction matrix.

Magnitude of impact	Receptor sensitivity/value			
	Negligible	Low	Medium	High
High	Negligible	Moderate	Major	Major
Medium	Negligible	Minor	Moderate	Major
Low	Negligible	Negligible	Minor	Moderate
Negligible	Negligible	Negligible	Negligible	Minor

11.5 Existing environment

11.5.1 In line with consenting, EIA and Habitats Regulations Appraisal (HRA) Guidance (EMEC & Exodus Group, 2010) this section aims to characterise the existing marine mammal baseline, providing the following information where possible:

- Species in the area, particularly protected sites and species;
- Number, distribution and location of sightings;
- Known routes (including migratory routes) and movements in and around the development site;
- Importance of the site to each species identified, i.e., key breeding or feeding ground;
- Specific use of the site and the temporal and spatial use, for example, known seal haul out sites, known feeding or breeding grounds and the extent of these, migration routes and what times of the year; and
- Group makeup (proportion of young and adults).

Pinnipeds

11.5.2 During the site specific vantage point surveys only the only seal species recorded was grey seal *Halichoerus grypus*. Unidentified seal species were also recorded and while it is possible that these could be harbour seals it is most likely that they were grey seals (Appendix 11.1). Seals are known to travel substantial distances while foraging for food and utilise the whole water column. It is therefore probable that both seal species commonly found in the Outer Hebrides may be found within or in close proximity to the proposed development.

11.5.3 Figure 11.2 shows haul out sites considered as potential sites to be designated to protect seals from harassment under the Marine (Scotland) Act 2010. There are no potential haul out sites for designation on the north-west coast of Lewis although a number of haul out sites are within the foraging range of grey and harbour seals. No haul out sites were recorded within the visible areas of the 2 vantage point surveys within the development site at Mealabost, and Siadar (Appendix 11.1).

11.5.4 The exposed nature of the coast means it is not favoured by harbour seals which prefer sheltered bays and inlets or intertidal sandbanks (Duck, 2010). Grey seals will haul out on more exposed sites, but the closest regularly used breeding site is Gasker (Gaisgier) 60km to the SW (site no. 124 shown in Figure 11.2)

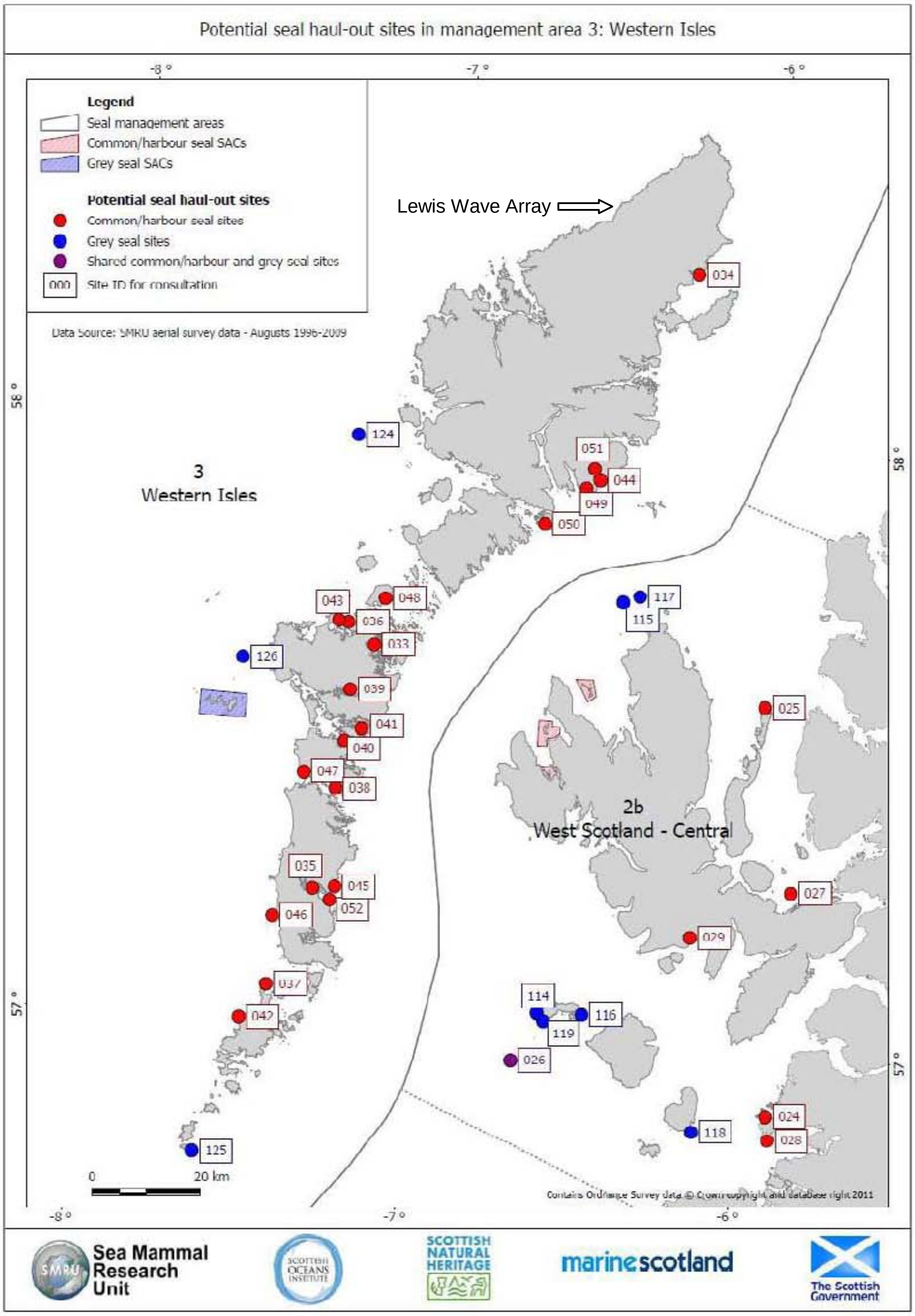


Figure 11.2. Potential haul out sites for designation (Source: The Scottish Government, 2011b)

11.5.5 Figure 11.3 shows the distribution of sightings recorded in proximity to the Siadar site during the Year 1 vantage point survey.

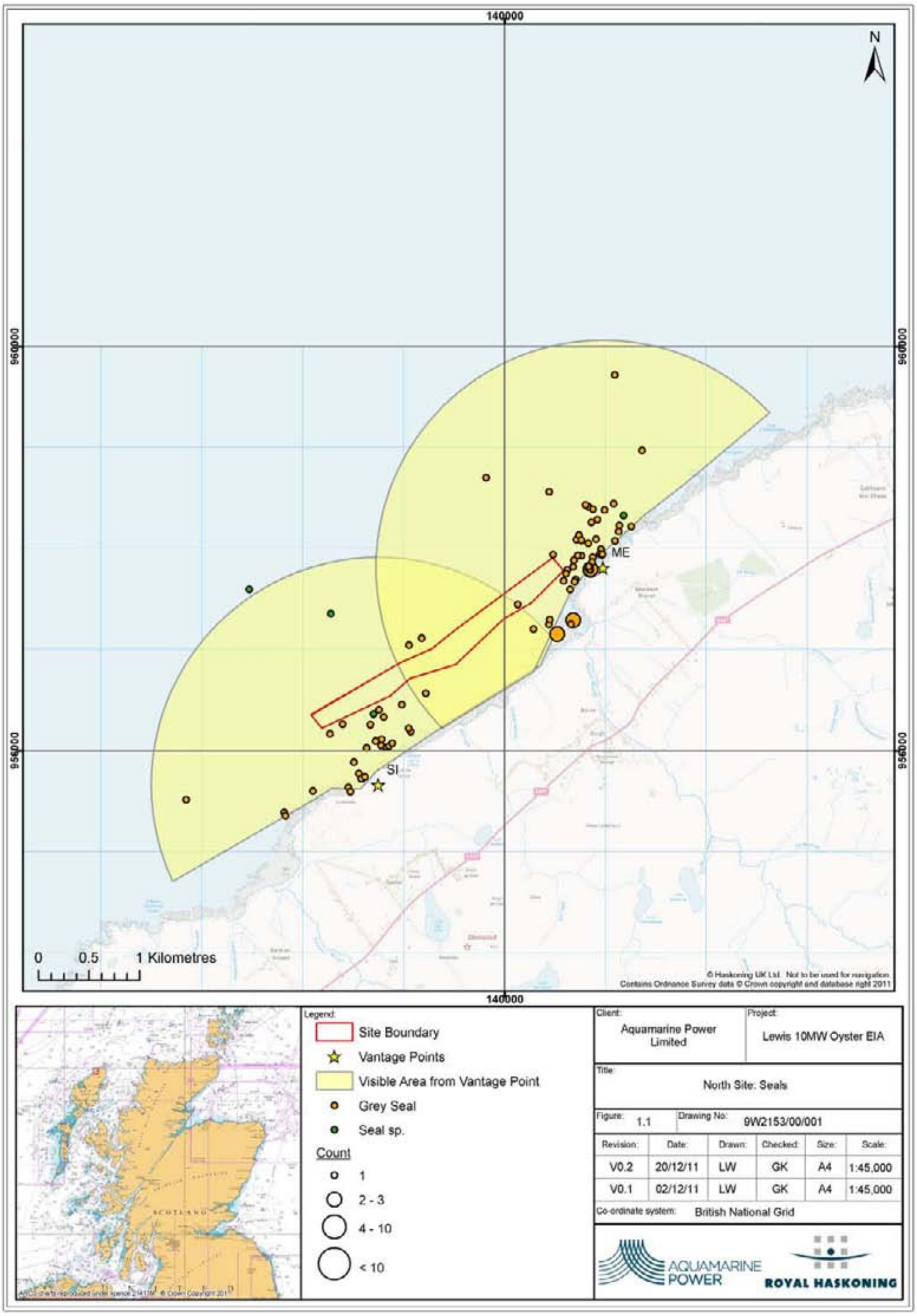


Figure 11.3: Distribution of seal sightings at the development site from the Siadar (SI) and Mealabost (ME) vantage points (source: vantage point survey, see Appendix 11.1)

11.5.6 Latest available data from 2009 estimated UK grey seal pup production at 42,296, with 12,113 pups born in the Outer Hebrides (based on SMRU aerial survey data). In the Inner and Outer Hebrides grey seal pup production has been relatively constant since the mid-1990s. The number of pups born increased more rapidly pre-1990s (since the 1960s when records began). The best estimate of grey seal population size for the UK is 119,400 (95% CI 181,400

– 243,000). This estimate is based on modelled population parameters based on 2009 estimates of pup production. (SCOS, 2010)

11.5.7 The most recent count of harbour seal in the Western Isles (from latest data in 2008) was 1,804. This count provides a minimum estimate of population size which is 35% lower than the peak counts in 1996. SCOS (2010) estimated a gradual decline of around 3% per annum between 1996 and 2008. The most recent estimate of minimum population size for the UK and Ireland is 28,557 (based on data collected between 2007 and 2009; SCOS 2010)

11.5.8 During the Year 1 vantage point survey grey seals were recorded relatively consistently throughout the year with dips in the numbers recorded during May and June (Appendix 11.1). Figure 11.3 shows most sightings (0.4 individuals per hour of effort) were recorded close to the Mealabost vantage point at the northern extent of the development site. 0.2 animals per hour were recorded from the Siadar vantage point.

11.5.9 During the vantage point surveys grey seals were generally recorded resting. With few feeding records the survey area is not likely to be an important feeding ground (Appendix 11.1).

11.5.10 In the UK, principle prey items are of grey seal include sandeel, whitefish (cod *Gadus morhua*, haddock *Melanogrammus aeglefinus*, whiting *Merlangius merlangus* and ling *Molva molva*), and flatfish (plaice *Pleuronectes platessa*, sole *Solea solea*, flounder *Platichthys flesus*, dab *Limanda limanda*) (SCOS, 2009).

<u>Cetaceans</u>

11.5.11 During the site specific vantage point surveys common dolphin *Delphinus delphis*, harbour porpoise *Phocoena phocoena*, Risso's dolphin *Grampus griseus* and minke whale *Balaenoptera acutorostrata* were recorded as well as unidentified dolphin.

11.5.12 Figure 11.4 shows the distribution of cetacean sightings recorded in proximity to the Siadar site during the Year 1 vantage point survey.

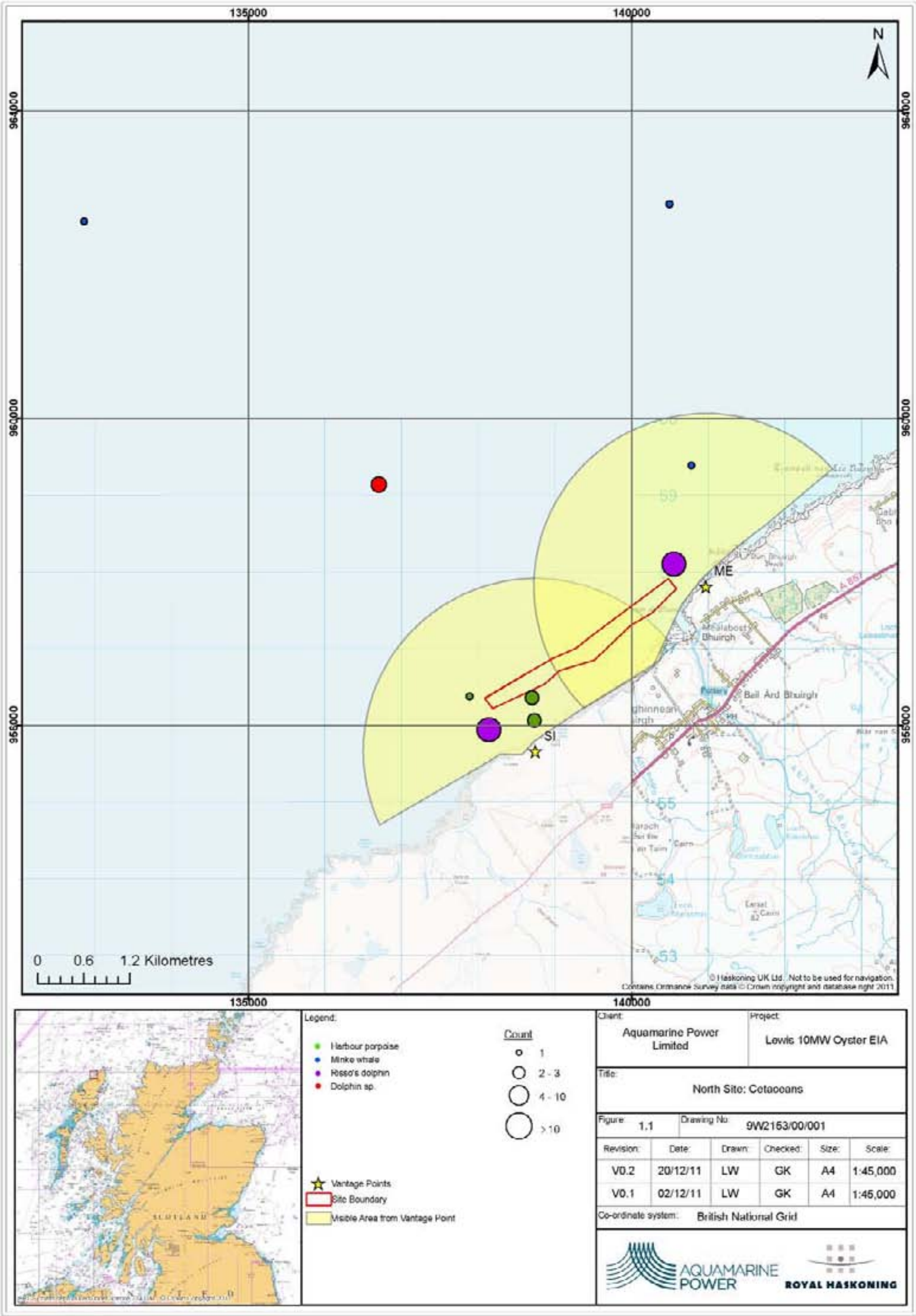
11.5.13 During the Year 1 vantage point survey Risso's dolphins and Minke whales were recorded relatively consistently from both of the vantage points at the development site. Harbour porpoise were only recorded at one vantage point (Siadar, at the south of the development area). (see Appendix 11.1)

Minke whale

11.5.14 Reid *et al.* (2003) shows a high number of sightings off the west coast of Scotland, including around Lewis. During the vantage point surveys minke whales were recorded on two occasions, however sightings were at around 1.5 to 5km from the vantage point (Figure 11.4) and therefore further offshore than the proposed development (Appendix 11.1). In addition an unconfirmed sighting of a possible minke whale was recorded approximately 9km from the vantage point.

11.5.15 SCANS II (2006) provides an abundance estimate of 18,614 (95% CI=10,445-33,171) for the SCANS II survey area based on 2005 aerial and boat based surveys. Density mapping in SCANS II (2006) shows relatively low densities around Lewis.

11.5.16 Evans *et al*. (2003) reports that sighting rates of minke whales increased in west, north and east Scotland since the early 1990s until 2002 (the latest available data at the time of reporting).



Source Info: NRP Year 1 data

Figure 11.4. D istribution o f c etacean sightings at t he development site from t he S iadar (SI) and Mealabost (ME) vantage points (source: vantage point survey, see Appendix 11.1

11.5.17 Minke whale occurs throughout the year on the north-west European continental shelf, however most sightings off Scotland occur between May and September (Faber Maunsell, 2007). During the vantage point surveys minke whales were recorded in April, June and October (Appendix 11.1).

11.5.18 Minke whale feed on schooling prey, typically fish or crustaceans (Faber Maunsell, 2007). The two confirmed sightings during the vantage point survey showed no evidence of feeding as far as could be ascertained from the vantage point; the whales appeared to be transiting through the site.

Risso's dolphin

11.5.19 Risso's dolphin is distributed across north-east European waters. However the shelf waters off north-west Scotland, and particularly around the Inner and Outer Hebrides, have the greatest density of sightings (Faber Maunsell, 2007). Two pods of five and six Risso's dolphins were recorded close to the Siadar site during the vantage point surveys (Figure 11.4).

11.5.20 No population assessment exists for Risso's dolphins in north-east Atlantic waters. The SCANS II survey found no Risso's dolphins (SCANS II, 2006). This means that the present status of Risso's dolphins occurring in UK waters is not known sufficiently to estimate population and trends (WDCS, undated).

11.5.21 The ecology of Risso's dolphin is not well known. In the UK, Risso's dolphin seems to be equally common throughout the year in some areas, and show no evidence of seasonal migration (Evans *et al.,* 2003). During the Year 1 vantage point surveys Risso's dolphin was recorded from March to August (Appendix 11.1).

11.5.22 During the vantage point surveys feeding activity was suspected (but could not be confirmed) to the south of the development area but there was no evidence of feeding at the development site. The key prey species of Risso's is squid and occasionally small fish (Seawatch Foundation, undated a).

Common dolphin

11.5.23 Common dolphin is abundant in the offshore waters of the Scottish west coast. Pods of ten to twenty animals were recorded south of the proposed development area (Appendix 11.1). There were no sightings of common dolphin made from the vantage points at the proposed development however, there were unidentified dolphin recorded from the Siadar vantage point.

11.5.24 SCANS II (2006) provides an abundance estimate of 63,366 (95% CI=26,973-148,865) for the SCANS survey area based on 2005 aerial and boat based surveys. Density maps provided in SCANS II (2006) show an area of high density to the south of the Western Isles and low density to the north, close to the proposed development.

11.5.25 Evans *et al*. (2003) reports that sighting rates of harbour porpoise increased in west Scotland during 1994 to 2002 (the latest available data at the time of reporting).

11.5.26 Common dolphin migrates northwards in summer and is frequently seen in the Sea of the Hebrides (to the south of the proposed development) in the warmer months (Faber Maunsell, 2007). Sightings during the vantage point surveys were only recorded at the Labost vantage point, south of the development, during July and October (Appendix 11.1).

11.5.27 During the vantage point surveys common dolphin were recorded feeding south of the development area but as previously discussed they were not recorded at the development area itself. Common dolphin prey is generally small schooling fish (Faber Maunsel, 2007).

Harbour porpoise

11.5.28 Harbour porpoise is widely spread across European continental shelf waters. Porpoise sightings during the year 1 vantage point surveys were relatively evenly spread between the north (SI and ME vantage points) and the south sites (LA vantage point).

11.5.29 SCANS II (2006) provides an abundance estimate of 385,617 (95% CI=261,266-569,153) based on 2005 aerial and boat based surveys. Evans *et al.* (2003) shows increasing sightings across the UK from 1989 to 2002 (the latest available data at the time of reporting).

11.5.30 Density maps provided in SCANS II (2006) show areas of high density (around 0.6 porpoise per km^2) in the Sea of Hebrides and around the north coast of the Scottish mainland. Along the north-west coast of Lewis, close to the development area the density estimate is relatively low at around 0.2 porpoise per km^2.

11.5.31 During the vantage point surveys harbour porpoise was recorded in groups of one to three. There was one sighting per month in September, November, March and August. In December two sightings were recorded, one at Labost (south of the development area) and one at Siadar.

11.5.32 Harbour porpoise was recorded swimming at slow, normal, and fast speed during the vantage point survey. Slow travel may indicate feeding activity, however there is no evidence that the study area provides a unique or important feeding site.

White beaked dolphin

11.5.33 White beaked dolphin appear to have Scottish coastal waters as their centre of distribution in the North East Atlantic and are predicted to be the second most abundant cetacean below harbour porpoise (Northridge *et al*. 1995 cited in Faber Maunsell, 2007). However no white-beaked dolphin were recorded during the vantage point surveys.

11.5.34 SCANS II (2006) provides an abundance estimate of 22,664 (95% CI=10,341-49,670) based on 2005 aerial and boat based surveys.

11.5.35 White-beaked dolphins eat a variety of prey, such as cod, whiting, hake, haddock, mackerel, and herring, various species of sandeels, gobies, flatfishes, and scaldfishes (Seawatch Foundation, undated b).

Atlantic white sided

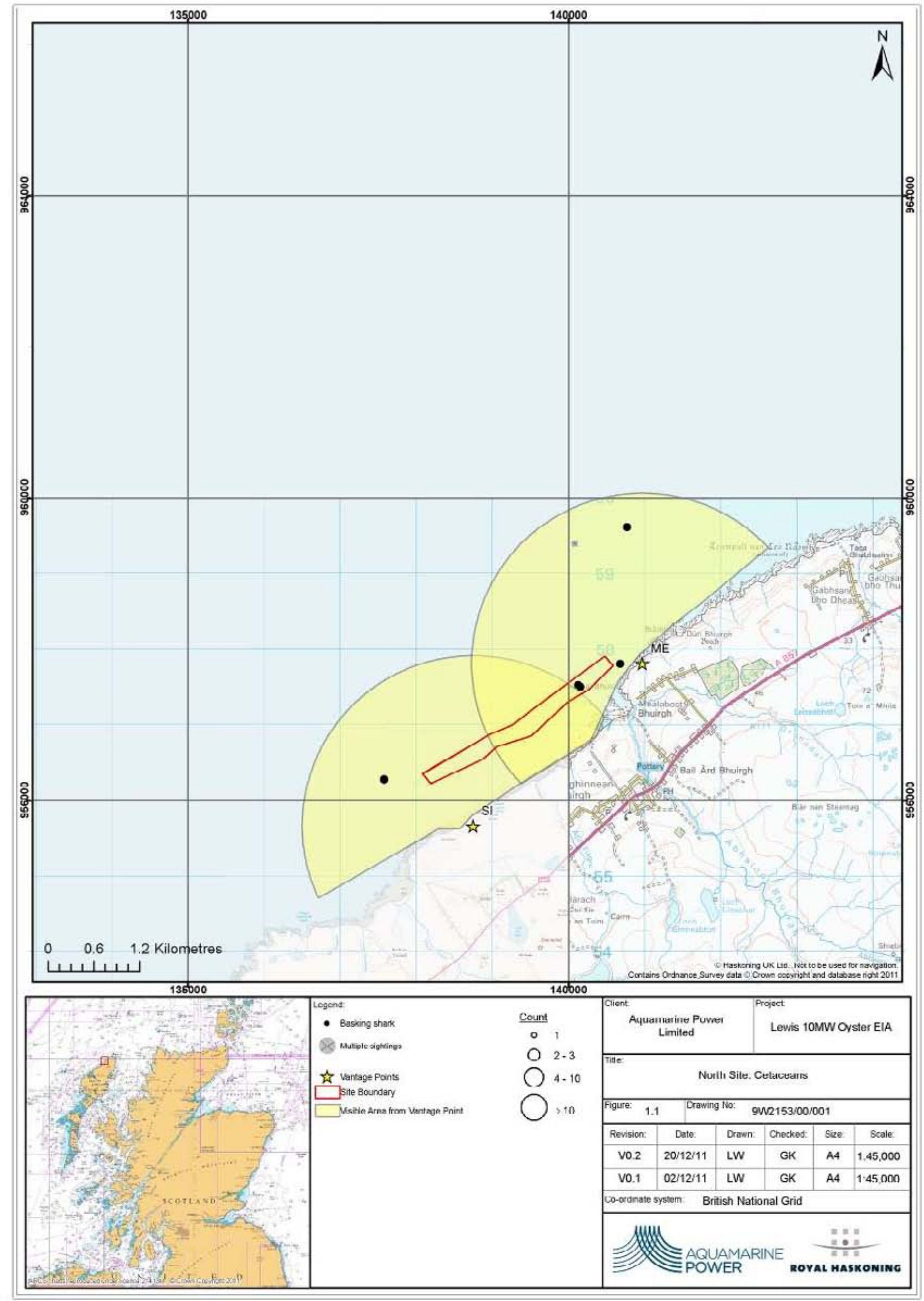
11.5.36 White-beaked and white-sided dolphin are often seen together and therefore have similar distributions, but it can be difficult to distinguish the species. SCANS II (2006) provides an abundance estimate for white beaked and/or white sided dolphin of 37,981 (95% CI=19,169-75,255) based on 2005 aerial and boat based surveys. No white-beaked dolphin was recorded during the vantage point surveys.

11.5.37 As with white beaked dolphin, white sided dolphin prey on a wide variety of schooling fish.

Basking shark

11.5.38 Basking shark *Cetorhinus maximus* was sighted from each of the vantage points during the Year 1 survey. Sightings have been recorded around the whole Scottish coast, with sightings peaking in the summer months especially at a number of hot spots on the west coast (The Scottish Government (2011). Basking shark was sighted from May to August during the vantage point surveys.

11.5.39 Figure 11.5 shows the distribution of basking shark sightings recorded in proximity to the development site during the Year 1 vantage point survey.



Source Info: NRP Year 1 data

Figure 11.5. Distribution of basking shark sightings at the development site from the Siadar (SI) and Mealabost (ME) vantage points (source: vantage point survey, see Appendix 11.1)

11.5.40 They are known to migrate over large distances in both offshore and coastal waters at depths from the surface to over 750m. They are particularly associated with tidal fronts on the continental shelf and shelf edge where they feed on plankton (Scottish Government, 2011). The surveys undertaken by Natural Research Projects recorded basking sharks displaying feeding behavior on four occasions out of a total of eight sightings. (Appendix 11.1).

11.5.41 OSPAR (2009) report 50-90% population wide declines in recent years although there are limited data to validate these trends. As a result of declining numbers recorded the basking shark is listed as threatened and/or declining under the OSPAR convention (OSPAR, 2009).

Underwater noise

11.5.42 Underwater background noise levels within the development area were recorded during August 2011 (Kongsberg 2011b). The background noise level at the Siadar site was 119 ± 6 dB re 1 Pa. Such levels are consistent with measurements made in shallow coastal waters around the UK (Nedwell *et al.* 2003). (Appendix 11.2)

11.6 Impact assessment

Do nothing scenario

11.6.1 In a 'do nothing' scenario the marine mammal status would be expected to follow consistent trends as identified in Section 11.5 'Existing Environment'. Harbour seal and basking shark numbers appear to be decreasing. This is predicted to continue until the population reaches sustainable numbers and levels off, or until sufficient understanding of the cause of declines can be gained, appropriate management strategies followed. Other marine mammal species in the area are believed to be increasing or stable. It is reasonable to expect that species with increasing numbers will reach a level at which this will naturally level off.

Potential impacts during construction

Impact 1: Potential injury and disturbance caused by noise

11.6.2 The absence of any pile driving during construction reduces the potential noise impact for the installation of the development in comparison to many other marine developments, in particular offshore wind farms. The noise caused by drilling the sockets for the monopiles and the associated increased vessel activity is considered in this impact assessment.

11.6.3 Drilling noise levels were measured for the Oyster 800 Array project at the European Marine Energy Centre (EMEC) Wave test site, Billia Croo, Orkney during summer 2011. Measurements recorded during the drilling of the socket for Oyster 801 indicated that the total underwater noise levels (defined as the sum of background noise and drilling noise) were 153.8±12.1 dB re 1 Pa at 1m (Kongsberg 2011a). This method will be used at Lewis.

11.6.4 Shipping noise was estimated based on available data and literature. There are currently no specific details available for noise levels of the types of vessels that are expected to be used on the development. Available information for an equivalent tug type vessel is used to provide the parameters that characterise vessel noise for the Lewis Wave Array, giving a broadband source level of 172 dB re 1 μPa at 1m (Appendix 11.2).

11.6.5 Table 11.6 shows the predicted ranges at which strong and mild avoidance behaviour can be expected for pinnipeds (seals), odontocetes (toothed whales) and mysticetes (baleen whales) for a single drilling event with associated construction vessels.

Table 11.6: Avoidance behavioural ranges during construction				
	Strong avoidance (90dBht)		Mild avoidance (75dBht)	
	Vessels	Drilling	Vessels	Drilling
Pinnipeds	9 m	3 m	58 m	21 m
Odontocetes	47 m	18 m	300 m	115 m
Mysticetes	208 m	17 m	1700 m	112 m

11.6.6 To take into account the phased approach to construction and installation of the development Table 11.7 shows the predicted ranges at which mild avoidance behaviour can be expected for odontocetes and mysticetes for installation of a single Oyster device in combination with operation of devices installed during an earlier phase. The criterion denoting the onset of strong avoidance when exposed to installation noise in the development is met at distances less than the Oyster spacing for all target species. Hence strong avoidance from cumulative impacts in relation to operation of an earlier phase during the construction of later phases should not arise.

Table 11.7: Avoidance behavioural ranges during construction and operation scenarios		
	Odontocetes	Mysticetes
3 operational WECs + 1 installation	150 m	120 m
10 operational WECs + 1 installation	250 m	140 m
25 operational WECs + 1 installation	280 m	170 m

11.6.7 Given the open nature of the development site, displacement of odontocetes and mysticetes from areas of up to 280m and 170m, respectively is not predicted to cause any barrier effect. As the development site is not known to provide an important feeding or breeding ground to marine mammals this level of displacement is expected to cause an impact of negligible magnitude.

11.6.8 Appendix 11.2 shows that hearing damage (Permanent Threshold Shift (PTS)) or Temporary Threshold Shift (TTS) is not likely to occur for any marine mammal species.

11.6.9 Marine mammals are of high sensitivity due to their international conservation status and basking sharks are of medium sensitivity due to their national conservation status (see Section 11.4). As a result the significance is predicted to be **minor adverse.**

MITIGATION IN RELATION TO IMPACT 1
No mitigation is proposed, but best practice is recommended (see 11.6.12).

Residual impact

11.6.10 Residual impact remains of **minor** significance.

11.6.11 A protocol will be established to ensure the vessels involved in installation will move at a steady speed and in a predictable and planned course throughout their operation in line with the Code of Conduct outlined by DSP (2009). This will allow marine mammals sufficient time to move away from vessels.

Impact 2: Collision risk with construction vessels

11.6.12 Research has shown that although a rare occurrence in UK waters, collisions do occur between marine mammals and vessels operating at speed, which may result in fatal injuries or wounding[3].

11.6.13 Ship strikes are known to cause mortality to marine mammals. However it is not possible to fully quantify strike rates as it is believed that a number go unnoticed.

11.6.14 Injuries tend to fall into two categories:

- Lacerations from propellers; and
- Blunt traumas from impact with the hull.

11.6.15 Injuries can be fatal and non-fatal, but it is possible that those which do not cause immediate death could potentially leave the animal vulnerable to secondary infection, other complications or predation (Wilson *et al.,* 2007).

11.6.16 The main drivers that are thought to influence the number and severity of ship strikes are reviewed in Wilson *et al*., (2007) as:

- Vessel type and navigation speed.
  - Serious injury rarely occurs if animals are struck by vessels travelling at speeds below 10 knots (Laist *et al*., 2001);
  - Laist *et al*., (2001) concluded that vessels over 80m in length cause the most severe or lethal injuries.
- Underwater noise – high levels of ambient noise can result in difficulty in detection of approaching vessels;
- Weather conditions and time of navigation – this can both affect the ability of crew to locate whales and add to ambient noise; and
- Whale behaviour which is species specific; juvenile and sick individuals appear to be more vulnerable.

11.6.17 As outlined in *Chapter 15 Shipping and Navigation,* large vessels (those monitored by the Automatic Identification System (AIS)) tend to use a deep water route approximately 10 nautical miles (nm) off the north-west coast of Lewis. These were recorded at an average of just under two vessels per day. Track density around the proposed development is low at 0 to 3 over 56 days of survey. In addition there are a number of smaller fishing vessels operating in the area and a recreational cruising route in light use.

11.6.18 *Chapter 5 Project Description* outlines the low number of vessels required during installation. Vessel types include a jack up barge, tug boat, two multicat boats and a dive boat. Dynamic positioning vessels are not required.

[3] http://www.ukmarinesac.org.uk/activities/ports/ph3_2_2.htm

11.6.19 A jack up barge will be used for drilling activities and will move back to shore to resupply after 2 to 6 monopiles have been completed (see *Chapter 5 Project Description*). The jack up barge will travel at slow speeds of around 10 knots or less, and only small workboats and crew transfer vessels (<25 m) may operate at speeds of 20 to 30 knots.

11.6.20 Construction and installation of Phases 2 to 4 of the Lewis Wave Array are estimated to each have similar requirements to Phase 1.

11.6.21 There is no evidence suggesting any collisions with marine mammals during construction (or subsequently) for SeaGen in Strangford Lough, Northern Ireland. SeaGen was installed using a crane barge, a barge and supporting vessels e.g. dive boats.[4] A number of marine mammal monitoring measures were used in Strangford Lough (Royal Haskoning, 2010).

11.6.22 It is unlikely that fatal collisions will occur but in this unlikely event species currently experiencing decline i.e. basking shark and harbour seals will be the most susceptible. The Potential Biological Removal (PBR) for basking sharks is unknown but given the low level or collision risk and the low number of basking shark (four recorded between May and August only), the likelihood of a fatal collision is very low. The calculated PBR for harbour seals in the Western Isles for all anthropogenic activities is 54 (Scottish Government, 2012). Given the low numbers of harbour seals around the proposed development (none were recorded during the vantage point surveys) it is unlikely that vessel collisions in relation to the proposed development will contribute to the PBR. Grey seals are the most abundant marine mammal in the area. The calculated PBR for grey seals in the Western Isles for all anthropogenic activities is 408 (Scottish Government, 2012) and therefore the population has a high capacity to tolerate slightly increased collision risk. Given the low numbers of vessels the likelihood of fatal collisions is low.

11.6.23 The magnitude of potential collision impacts is predicted to be negligible due to being unlikely to occur and any risk being temporary during the construction phase.

11.6.24 Marine mammals are of high sensitivity due to their international conservation status and basking sharks are of medium sensitivity due to their national conservation status (see Section 11.4).

11.6.25 The significance of collision risk on marine mammals is therefore predicted to be **minor**.

MITIGATION IN RELATION TO IMPACT 2
No mitigation is proposed, but best practice is recommended (see 11.6.28).

Residual impact and best practice

11.6.26 Residual impact remains of **minor** significance.

11.6.27 A protocol will be established to ensure the vessels involved in installation will move at a steady speed and in a predictable and planned course throughout their operation in line with the Code of Conduct outlined by DSP (2009). This will allow marine mammals sufficient time to move away from vessels.

[4] http://www.seageneration.co.uk/seagen-installation.asp

Impact 3: Accidental release of contaminants

11.6.28 The risk of spillage of contaminants and the impact on water quality during the construction phase has been considered within *Chapter 20 Water Quality.*

11.6.29 *Chapter 5 Project Description* outlines the commitment to use the most environmentally friendly hydraulic fluid in the Oyster devices as possible. The fluid will be predominantly (94.9%) fresh water with 5% additive (Eco Stack Magic) to improve lubricity and 0.1% defoaming agent (Agent 70). A non-oil based drilling fluid will be used during installation drilling activities.

11.6.30 Spillage of vessel fuel in the event of an accident could also present a potential contaminant, however given the low number of vessels and the small size of construction vessels the volume of fuel with potential to be spilt is low. In a high energy marine environment such as the north-east coast of Lewis, contaminants can be expected to rapidly disperse and it is expected that should a spill occur, its scale and the nature of the contaminant will be limited.

11.6.31 Seals and cetaceans generally have the capacity to cope with small levels of contamination becoming more sensitive during breeding (Scottish Executive, 2007) however, as stated in Section 11.5: Existing Environment section the site is not an important breeding ground.

11.6.32 *Chapter 20 Water Quality* states that the residual impact on marine water quality is negligible and, as a result the magnitude of the impact on marine mammals is predicted to be negligible.

11.6.33 Marine mammals are of high sensitivity due to their international conservation status and basking sharks are of medium sensitivity due to their national conservation status (see Section 11.4). As a result, the potential impact from accidental release of contaminants is **minor.**

MITIGATION IN RELATION TO IMPACT 3
No mitigation is proposed, but best practice is recommended (see 11.6.36 and 11.6.37).

Residual impact and best practice

11.6.34 Residual impact remains of **minor** significance.

11.6.35 Construction vessels will work under safe operating procedures developed by Aquamarine to minimise the risk of spills.

11.6.36 Any chemicals used during construction will require prior approval through the licensing process and any lubricants will be non toxic, biodegradable and capable of dispersal in seawater.

Impact 4: Indirect impacts of changes to prey resource

11.6.37 The grey seal is an opportunistic predator of fish and invertebrates. Development specific land based observation data collected between September 2010 and September 2011 shows that the majority of grey seals were exhibiting a ‘bottling’ or ‘bobbing’ (resting) behaviour, indicating that these areas are not likely to be important feeding grounds.

11.6.38 The low numbers of other marine mammal species recorded during year one of shore based survey suggests that the site is not an important feeding ground for any marine mammals.

11.6.39 Basking sharks were observed feeding within and close to the proposed development site during the vantage point surveys. It is anticipated that any change to coastal processes is unlikely to have a significant effect on the plankton resource as it will be on a relatively small spatial scale relative to the Western Isles region used by basking sharks and therefore the magnitude for basking sharks will negligible. Basking sharks are of medium sensitivity due to their national conservation status (see Section 11.4) and therefore the significance for basking sharks will be **negligible**.

11.6.40 As discussed in *Chapter 12, Fish and Shellfish* the construction process has the potential to impact on certain fish species, however, the residual significance of these impacts is predicted to be minor to negligible. Given these low levels of predicted changes to prey resource and the evidence from the Year 1 shore based data which indicates the site is unlikely to be an important feeding ground, the magnitude is predicted to be negligible. Marine mammals are of high sensitivity due to their international conservation status (see Section 11.4). As a result the impact on marine mammals is predicted to be of **minor** significance.

MITIGATION IN RELATION TO IMPACT 4
No mitigation suggested but best practice is recommended (see 11.6.43 and 11.6.44).

Residual impact and best practice

11.6.41 Residual impact remains of **minor** significance.

11.6.42 Any relevant mitigation measures in relation to the indirect effects of changes to prey resource will be focused on the prey species directly and are therefore covered in *Chapter 12 Fish and Shellfish.*

11.6.43 The residual impact assessed in *Chapter 12 Fish and Shellfish* is used in assessing the changes to marine mammal prey resource. Therefore it is incorporated in the level of magnitude for the impact on marine mammals. As such no further mitigation is recommended here and so there is no change to the residual impact, giving a **minor** residual significance.

Potential Impacts during operation (including maintenance)

Impact 1: Potential disturbance caused by operational noise

11.6.44 The onshore location of all electro-mechanical power generation equipment reduces the requirement for vessels for maintenance and repair activities. *Chapter 5 Project Description* outlines the low number of vessels required during operation and maintenance including a multicat every five years (for 20 days) and a dive boat every 6 months (for 10 days). This level of vessel movements is predicted to cause no significant noise impact.

11.6.45 Operational noise is based on synthetic data. It is speculated that the Oyster device is likely to have low operation noise levels. Anecdotal evidence from divers working on the Oyster 800 Array at EMEC suggests that the highest levels of noise arising may be attributed to the noise of the hydraulic fluid running through the pipelines. In order to complete the acoustic assessment, the noise level was estimated using a synthetic spectrum based loosely on drilling noise with its overall noise level reduced by an arbitrary 3 dB.

11.6.46 Table 11.8 shows the predicted ranges at which strong and mild avoidance behaviour can be expected for pinnipeds, odontocetes and mysticetes during operation of a single Oyster device. These are slightly lower than the construction drilling noise and significantly lower than the construction vessel noise outlined in Table 11.6, as could be expected.

Table 11.1: Avoidance behavioural ranges during operation		
	Strong avoidance (90dBht)	**Mild avoidance (75dBht)**
Pinnipeds	2 m	12 m
Odontocetes	16 m	101 m
Mysticetes	9 m	59 m

11.6.47 To take into account operation of a number of Oyster devices and the phased approach to commissioning, Table 11.9 shows the predicted ranges at which mild avoidance behaviour can be expected for odontocetes and mysticetes. The criterion denoting the onset of strong avoidance when exposed to operational noise in the proposed development is met at distances less than the Oyster spacing for all target species. Hence strong avoidance from cumulative impacts in relation to operation of all Oyster devices per phase will not arise.

Table 11.2: Avoidance behavioural ranges during construction and operation scenarios		
	Odontocetes	**Mysticetes**
3 operational WECs	110 m	60 m
10 operational WECs	170 m	75 m
25 operational WECs	260 m	80 m
40 operational WECs	300 m	100 m

11.6.48 As discussed for the construction phase, the open nature of the development site allows marine mammals to move around any noise displacement zones with no barrier effect and because the development site is not known to provide an important feeding or breeding ground to marine mammals displacement of up to 300m and 100m (for odontocetes and mysticetes, respectively) is expected to cause an impact of negligible magnitude.

11.6.49 Marine mammals are of high sensitivity due to their international conservation status and basking sharks are of medium sensitivity due to their national conservation status (see Section 11.4). As a result the significance is predicted to be **minor.**

MITIGATION IN RELATION TO IMPACT 1
No mitigation suggested.

Residual impact and best practice

11.6.50 It is not expected that it would be necessary to mitigate operational noise given the very low levels described in paragraphs 11.6.39 to 11.6.44 and in further detail in Appendix 11.2. As a result the residual impact remains of **minor** significance.

Impact 2: Collision risk with maintenance vessels and WECs

11.6.51 As discussed in Operational Impact 1 the levels of maintenance vessels predicted are very low due to the presence of the power generation equipment onshore. As a result the magnitude of marine mammals and basking sharks colliding with operation and maintenance vessels is predicted to be negligible

11.6.52 Due to the flaps of the Oyster device moving slowly in time with the waves it is deemed unlikely that a marine mammal or basking shark would encounter a moving part without being able to move away.

11.6.53 There is potential that marine mammals may be attracted to the Oyster devices through curiosity or aggregation of prey species. Wilson (2007) reports that seals may try to haul-out on wave devices (of a buoy design) and cetaceans could collide with devices by swimming into them. Collision is dependant on how aware marine mammals are of the presence of the Oyster devices. Table 11.8 shows the ranges at which marine mammals are predicted to exhibit avoidance responses to the WEC during operation. Mild avoidance is predicted at distances of 12m for pinnipeds, 101m for odontocetes, and 59m for mysticetes it is expected that the likelihood of collisions would be very low. The magnitude of operational collision risk is therefore predicted to be negligible.

11.6.54 Basking sharks are present in the area in low numbers during the summer when they therefore have potential to collide with the Oyster devices. There is no evidence of basking sharks swimming into a tethered structure and because basking sharks generally cruise a slow speeds (0.85m/s to 1.08m/s (Sims, 199)) it is deemed very unlikely that they would encounter an Oyster device without being able to manoeuvre around it. As a result the magnitude of collision risk is predicted to be negligible.

11.6.55 Marine mammals are of high sensitivity due to their international conservation status and basking sharks are of medium sensitivity due to their national conservation status (see Section 11.4). Therefore this impact is predicted to be, at worst, of **minor** significance.

MITIGATION IN RELATION TO IMPACT 2
No mitigation suggested, but best practice is recommended (see 11.6.58).

Residual impact and best practice

11.6.56 It is not expected that it would be necessary to mitigate collision risk during operation given the very low likelihood of collisions occurring. As a result the residual impact remains of **minor** significance.

11.6.57 A protocol will be established to ensure the vessels involved in operation move at a steady speed and in a predictable and planned course throughout their operation in line with the Code of Conduct outlined by DSP (2009). This will allow marine mammals sufficient time to move away from vessels.

Impact 3: Accidental release of contaminants

11.6.58 As with the construction phase the substances proposed for the development will be as environmentally friendly as possible. Given the low number of vessels associated with operation the risk of accidental fuel spillage is minimal. In a high energy marine environment, contaminants can be expected to rapidly disperse.

11.6.59 As discussed in the construction impact assessment seals and cetaceans generally have capacity to cope with some water contamination (Scottish Executive, 2007).

11.6.60 *Chapter 20 Water Quality* states that the residual impacts on water quality are of negligible significance and, as a result the magnitude of the impact on marine mammals is predicted to be negligible.

11.6.61 Marine mammals are of high sensitivity due to their international conservation status and basking sharks are of medium sensitivity due to their national conservation status (see Section 11.4). As a result the significance of contaminants is predicted to be **minor**.

MITIGATION IN RELATION TO IMPACT 3
No mitigation suggested, but best practice is recommended (see 11.6.64 and 11.6.65).

Residual impact and best practice

11.6.62 Residual impact remains of **minor** significance.

11.6.63 Maintenance vessels will work under safe operating procedures developed by Aquamarine to minimise the risk of spills.

11.6.64 Chemicals used will require prior approval through the licensing process and any lubricants will be non toxic, biodegradable and capable of dispersal in seawater.

Impact 4: Indirect impacts of changes to prey resource

11.6.65 As discussed in the construction impact assessment sections the shore based marine mammal data collected between September 2010 and September 2011 suggests that the site is not an important feeding ground for any marine mammals.

11.6.66 Basking sharks were observed feeding within and close to the proposed development site during the vantage point surveys. It is anticipated that any change to coastal processes is unlikely to have a significant effect on the plankton resource as it will be on a relatively small spatial scale relative to the Outer Hebrides region used by basking sharks and therefore the magnitude for basking sharks will negligible. Basking sharks are of medium sensitivity due to their national conservation status (see Section 11.4) and therefore the significance for basking sharks will be **negligible**.

11.6.67 As discussed in *Chapter 12 Fish and Shellfish* the operational phase of the proposed development is predicted to cause minor residual impact on fish and shellfish, the key prey resource for marine mammals. This is likely to cause an impact of negligible magnitude to marine mammals. As with the construction phase, marine mammals are predicted to have high sensitivity due to their international conservation status and therefore the significance of changes to prey resource during operation is predicted to be **minor**.

MITIGATION IN RELATION TO IMPACT 4
No mitigation suggested

Residual impact and best practice

11.6.68 Any relevant mitigation measures in relation to the indirect effects of changes to prey resource will be focused on the prey species directly and are therefore covered in *Chapter 12 Fish and Shellfish.*

11.6.69 The residual impact assessed in *Chapter 12 Fish and Shellfish* is used in assessing the changes to marine mammal prey resource. Therefore it is incorporated in the level of magnitude for the impact on marine mammals. As such no further mitigation is recommended here and so there is no change to the residual impact, giving a **minor** residual significance.

Potential impacts during decommissioning

11.6.70 The following impacts caused by the decommissioning phase of the proposed development are predicted to be of the same nature and magnitude as those discussed for the construction phase:

- Noise associated with cutting to remove devices and decommissioning vessels;
- Collision risk with decommissioning vessels;
- Accidental release of contaminants; and
- Indirect changes to prey resource.

11.6.71 Drilling will not occur during decommissioning and instead cutting activities are likely to provide a source of noise. However there is currently no data available on cutting noise from the large scale tools likely to be used for this operation. In the absence of any suitable data, it is proposed that drilling noise will be a suitable proxy for cutting noise and therefore the spatial extent of cutting noise is likely to be the same as for construction drilling noise.

11.6.72 Therefore the impacts to marine mammals are likely to be of the **minor** significance, in line with those assessed during construction however the baseline environment at the time of decommissioning can not be predicted at this stage.

Cumulative effects

11.6.73 The principal offshore activities which could result in in-combination impacts with the development are commercial fisheries and other marine traffic. These contribute to noise disturbance and potential collision risk for marine mammals.

11.6.74 Current activities that may contribute to cumulative impacts with the proposed development are:

- Voith Hydro WaveGen (4MW) – located at the mouth of the river Siadar; and
- Pelamis wave – located in offshore waters west of Loch Roag.

11.6.75 The Environmental Statement for the Voith Hydro WaveGen Project (Npower Renewables, 2007) discusses moderate significance in relation to noise impacts on marine mammals. The timescale for construction of the SWEP is unknown and therefore the worst case scenario would be that there could be an overlap in construction period.

11.6.76 In the absence of environmental information for the Pelamis project near Loch Roag it is assumed that the distances to which potential disturbance of marine mammals during construction may occur are of a similar scale to the Lewis Wave Array. As such there is not predicted to be an overlap in noise footprint, resulting in no cumulative noise impact.

11.6.77 The construction and operation of two additional wave projects in this area has the potential to increase shipping activity in the area and therefore collision risk. It is assumed that these projects will require similar levels of shipping to the Lewis Wave Array.

11.7 Conclusions

11.7.1 A number of marine mammal species are found in the study area for the Lewis Wave Array, including grey seal, harbour seal, common dolphin, harbour porpoise, Risso's dolphin and minke whale. Basking shark is also considered in this assessment. Studies of the existing environment indicate that the Siadar site does not provide an important haul out site for seals and there is no evidence that the site is an important breeding or feeding ground for marine mammals or basking shark although there were some records of grey seals and basking shark feeding at the site. Despite the low use of the Siadar site by marine mammals and basking shark, the wider area around the Outer Hebrides continues to be important for marine mammals and basking shark.

11.7.2 The levels of noise predicted during construction, operation and decommissioning have potential to cause small displacement areas which are unlikely to have a detrimental impact on marine mammals and basking sharks given the wide area of alternative habitat in the Outer Hebrides. Collision risk with construction vessels and the Oyster devices is deemed unlikely, as is any significant impact in relation to potential contamination and changes to prey resource.

11.7.3 Overall the impacts are considered to be of **minor adverse** significance to marine mammals. Mitigation strategies are suggested where appropriate in line with Lewis Wave Power's commitment to best practice.

12. FISH AND SHELLFISH

12.1 Introduction

12.1.2 This Chapter describes the existing environment with regard to the fish and shellfish resource within the vicinity of the Lewis wave array development area, as well as the wider region which includes the seas around north Lewis.

12.1.3 This Chapter serves to provide a description of the distribution and seasonal abundance of fish and shellfish species which have been recorded within both the study area and across the wider region. This description draws upon data collected through site specific and / or regional surveys, in the published and grey literature, as well as original data collection. Subsequent to this, the assessment of potential impacts of the construction, operation and decommissioning phases of the development on the existing environment are presented and detail on the proposed mitigation.

12.1.4 This Chapter should be read in conjunction with *Chapter 9 Benthic Ecology*, *Chapter 10 Ornithology*, and *Chapter 16 Commercial Fisheries* in order to gain a full overview of baseline conditions and potential impacts.

12.2 Summary of impacts assessment on fish and shellfish

12.2.2 Studies of the existing environment indicate that a large variety of fish and shellfish species may be present within the development site, however due to the high energy environment and lack of suitable habitat it is unlikely that the area is used extensively for spawning and nursery grounds. The greatest impacts are likely to occur during the construction phase and will be mainly associated with disturbance of habitat with particular significance for less mobile species such as crustaceans. However all impacts were considered to be of negligible significance and with suggested mitigation may have beneficial effects.

12.3 Potential effects

12.3.2 Guidance produced to aid the consenting process for marine renewables in Scotland (EMEC and Xodus Group, in draft) lists the potential impacts that wave and tidal energy developments may have on fish and shellfish as:

- Collision risk;
- Barrier to movement / interruption of known migratory routes;
- Substratum loss, in particular in relation to benthic spawning fish and shellfish, loss of nursery grounds and the potential loss of or damage to habitat supporting food supply and providing shelter;
- Disturbance/injury as a result of noise, vibration etc.
- Pollution from routine and accidental discharges;
- Changes in suspended sediment levels and turbidity;
- Electric and magnetic field effects;
- Disruption of feeding and spawning; and
- Displacement from spawning and feeding areas.

12.3.3 The guidance also highlights that any negative impacts on fish and shellfish species may have a negative impact to commercial fisheries with potential knock on effects to the local economy.

12.3.4 All of the potential impacts listed above are included within the impact assessment (Section 12.6 Impact Assessment), apart from electric and magnetic field effects which have not been considered in this assessment because these will not be emitted in the marine environment by the Oyster wave array (*Chapter 5: Project Description*).

12.4 Methodology

12.4.2 This assessment follows the latest, appropriate, guidance on Environmental Impact Assessment (EIA) (EMEC and Xodus Group in press; Cefas, 2004 and IEMA 2006) and draws on experience from recent examples of similar renewable energy projects in the UK and Europe. A baseline for fish and shellfish within the study area (as defined below) was established through a desk based review and an impact assessment was then conducted to predict the potential significance of the impacts of the development upon that baseline.

12.4.3 The impact assessments use a Rochdale Envelope approach (See *Chapter 2: Scoping and assessment methodology*), where any uncertainty regarding aspects of the project description leads to the use of a realistic worst case scenario for each of the receptors assessed.

Defining the Study Areas

12.4.4 Two scales of study area have been identified, within which potential impacts on fish and shellfish will be considered. These are displayed in Figure 12.1 and are:

- The **Local Study Area** (LSA) which contains the offshore development area and is largely dictated by the benthic survey area (See *Chapter 9: Benthic Ecology*); and
- The **Regional Study Area** (RSA) which is defined by International Council for Exploration of the Sea (ICES) rectangle 45E3 (see Figure 12.1 below).

Data collection

12.4.5 The principal data sources relevant to fish and shellfish are shown below in Table 12.1

Table 12.1 Existing data

Data source	Coverage	Author(s)	Year
Spawning and Nursery Grounds	UK	Cefas (Ellis *et. al*. 2011)	2010
Spawning and Nursery Grounds	UK	Cefas (Coull et. al.)	1998
Landings data	ICES Rectangles 45E3, 45E4, 46E3 and 46E4	Marine Scotland Science	2006-2010
Benthic Survey Report	Local Study Area	Envision	2011
National Biodiversity Network (NBN) Gateway	UK	NBN	1990-present
Scottish marine renewables strategic environmental assessment (SEA)	Scottish waters	Faber Maunsell and Metoc plc	Produced in 2007 and compiles a series of relevant data sources
Western Isles District Salmon Fisheries Board (WIDSFB)	North-west Coast of Lewis	WIDSFB	2012

12.4.6 The above data were interrogated as part of a desk study to compile a list of all species that may be present within the study areas.

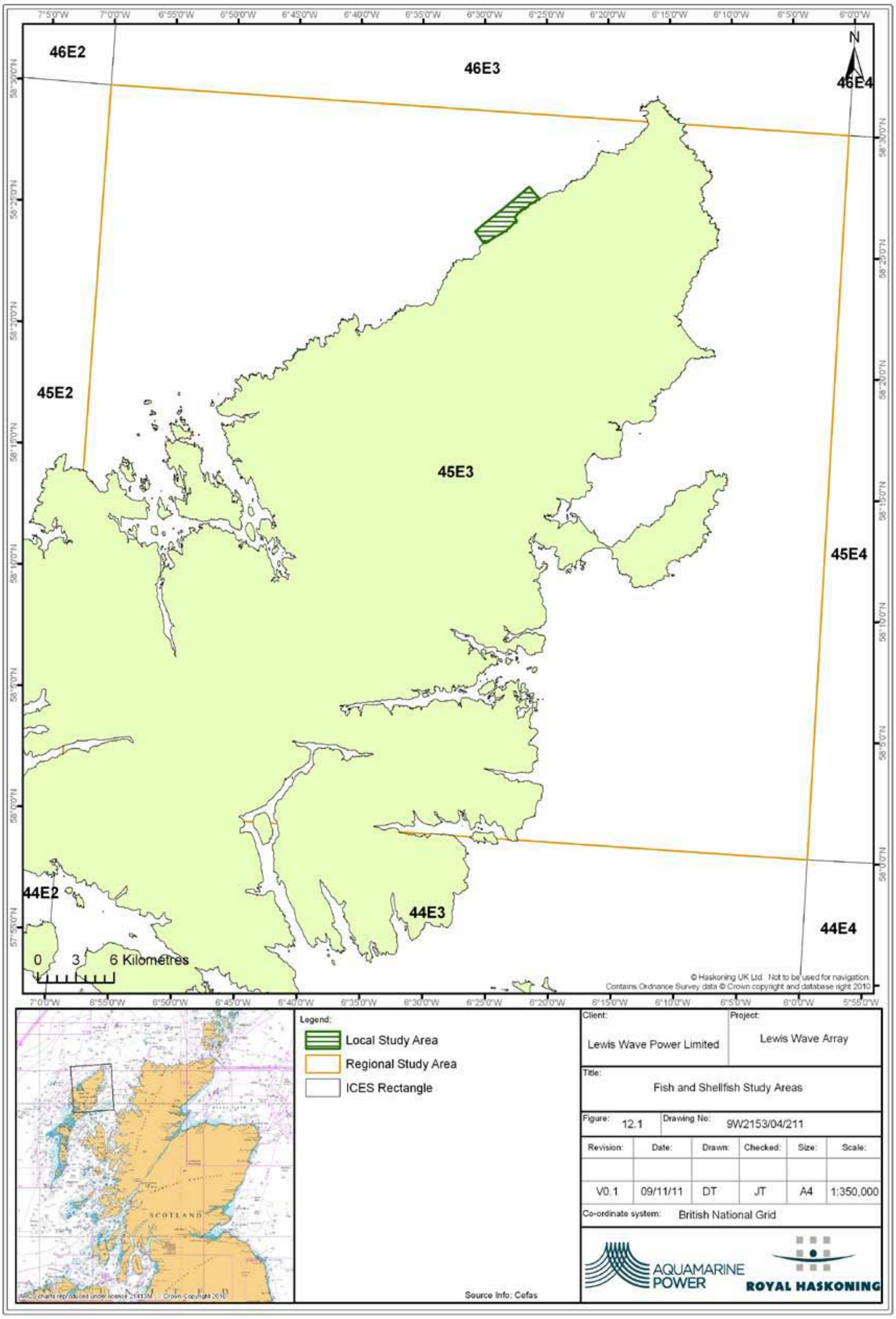


Figure 12.1 Fish and shellfish and commercial fisheries study areas

Legislation, Guidelines and Policy Framework

Legislation

12.4.7 There are a number of regulatory frameworks which will be taken into account when assessing the impacts of the development on fish and shellfish. These include:

- EC Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Flora and Fauna (the Habitats Directive).
- Marine Scotland Act 2010.
- Conservation (Natural Habitats &c) Regulations 1994 (the Habitats Regulations), as amended in Scotland.
- Wildlife and Countryside Act 1981.
- Water Environment (Controlled Activities) (Scotland) Regulations 2011 (CAR).
- OSPAR Convention. The Convention for the Protection of the Marine Environment of the North-East Atlantic.
- Nature Conservation (Scotland) Act 2004

Non-statutory measures are outlined in the following:

- The UK Biodiversity Action Plan,
- The List of Priority Marine Features (PMFs)
- Western Isles Biodiversity Action Plans.

EIA Guidance

12.4.8 The European Marine Energy Centre (EMEC) and Xodus Group environmental consultants (in draft) were commissioned by Marine Scotland to produce a guidance document to help developers with consenting, Environmental Impact Assessment (EIA) and Habitats Regulations Appraisal (HRA) for marine renewable energy developments in Scotland. The draft version of this document highlights the following guidance with regards to fish and shellfish.

12.4.9 The baseline assessment should identify the presence, distribution, seasonality and abundance of fish and shellfish both at the site and in the surrounding area and indicate the relative importance of these species. The baseline assessment should include consideration of the following:

- The nearest protected habitats;
- Species of fish/shellfish, that are of conservation importance;
- Species of fish/shellfish in the area that are of most importance to recreational and commercial fisheries;
- Species that have restricted geographical distribution and are locally abundant;
- Species of elasmobranch fish (as these considered sensitive to marine developments); and
- Identification of migratory and spawning fish that may be affected by the development.

12.4.10 In identifying the above species, the baseline assessment should include the following aspects for each:

- Spawning areas and seasons;
- Nursery grounds;
- Feeding grounds;
- Over-wintering areas for crustaceans such as lobster/crab; and
- Migration routes.

12.4.11 EMEC has also developed EIA guidance for wave and tidal energy developers seeking consent within the EMEC test site on Orkney. These guidelines give an overview of the potential impacts of marine energy development on fish and shellfish resources, but do not discuss detailed EIA reporting requirements. The guidance suggests that the following potential effects on fish resources, which may also be relevant in other locations, such as Lewis:

- Behavioural changes and altered well-being associated with noise, light and other disturbances;
- Changes in fish health resulting from release of contaminants; and
- Entrapment / collision with underwater devices.

Consultation

12.4.12 A Scoping Opinion was sought from both statutory and non-statutory consultees (Lewis Wave Power Limited, 2011) in May 2011. Responses are detailed in Appendix 2.1, and a short summary of the main points pertinent to fish and shellfish raised during this process, along with an explanation of how they were addressed, is provided below inTable 12.2.

Table 12.2 Comments/ I nformation r aised i n th e s coping o pinion (Marine S cotland 2011)

Comments/ Information	Response
Marine Scotland Licensing Operations Team (MS-LOT) expressed a need to consult with Salmon Fisheries Boards and Fisheries Trusts.	Lewis Wave Power sent a copy of the scoping report to the Association of Salmon Fisheries Boards (ASFB) and to the Western Isles District Salmon Fisheries Board (WIDSFB) (which is run in Association with the Outer Hebrides Fisheries Trust). In addition to this further written correspondence with ASFB and WIDSFB was conducted.
It was recommended that the Environmental Statement identify a monitoring scheme which would identify any changes to the local populations pre, during and post construction.	As no impacts are predicted to be of greater than minor adverse significance no monitoring is suggested for fish or shellfish species. A full environmental monitoring programme will be developed post consent, however natural fish is not anticipated as part of it.
The Scoping Opinion suggested that a HRA may need to be undertaken which would consider the impacts of the development on Atlantic salmon populations from the Langavat Special Area of Conservation (SAC).	The scoping opinion was formulated prior to the offshore development area being refined to its current location (Figure 12.1) and size. At the time of issue of the scoping opinion the “Area of Search” was approximately 21kilometres (km) from the Langavat SAC and covered an area of 55km^2 (Lewis Wave Power Limited, 2011). The refined total working footprint of the project is now over 40km from the Langavat SAC, has an area less than 2km^2 in the marine environment and is therefore unlikely affect salmon populations from that SAC. In further consultation correspondence SNH (Appendix 3.1) advised that an HRA would not be required (MS LOT were party to this correspondence).

12.4.13 Consultation was also conducted with the local marine fishing industry, through a questionnaire and face to face meetings (see *Chapter 15: Commercial Fisheries* for more details), the results of which have informed the characterisation of the baseline in section 12.5 Existing Environment.

Assessment of significance

12.4.14 The significance of effects of the development is based on the intensity or degree of disturbance to baseline conditions (as outlined in section 12.5 Existing environment) caused by the project. This can be categorised into four levels of magnitude: high, medium, low or negligible. The definitions of each of these are given in Table 12.3.

Table 12.3 Criteria for assessing the magnitude of potential effects on fish and shellfish

Magnitude of effect	Definition
High	A fundamental change to the baseline condition of the marine fish or shell fish.
Medium	A detectible change in the baseline condition resulting in the non-fundamental temporary or permanent change to the condition of marine fish and shellfish.
Low	A minor change to the baseline condition of marine fish and shellfish resources (or a change that is temporary in nature).
Negligible	An imperceptible and/or no change to the baseline condition of the receptor.

12.4.15 The sensitivity of the receptor for each effect is characterised as one of four levels, high, medium, low or negligible. The definition of each level is given below in Table 12.4.

Table 12.4 Criteria for assessment of sensitivity of fish and shell fish

Receptor sensitivity/ value	Guideline criteria
High	The fish and shellfish baseline environment is subject to major change(s) due to impact. Or The local study area contains species of international or national conservation importance/ value that will be permanently significantly altered by the development.
Medium	The fish and shellfish baseline environment clearly responds to effect(s) in quantifiable and/or qualifiable manner. Or The local study area contains species of national or regional conservation importance/value which will be permanent significantly altered by the development.
Low	The fish and shellfish baseline environment responds in minimal way to effects such that only minor change(s) are detectable. Or The local study area may contain species of local conservation importance/ value which will be permanently significantly altered.
Negligible	The fish and shellfish baseline environment responds in minimal way to effect such that only minor change(s) are detectable. Or Sites contain no features of local conservation importance/ value.

12.4.16 Table 12.5 combines the definitions of magnitude with the level of sensitivity/value/importance of receptor to provide a prediction of overall significance of the effect. The categories highlighted in red are considered to be significant in the context of the EIA.

Table 12.5 Significance prediction matrix.

Magnitude of effect	Receptor sensitivity/value			
	Negligible	Low	Medium	High
High	Negligible	Moderate	Major	Major
Medium	Negligible	Minor	Moderate	Major
Low	Negligible	Negligible	Minor	Moderate
Negligible	Negligible	Negligible	Negligible	Minor

Limitations and uncertainties

12.4.17 The impact assessment considers a baseline established through a desk based study and uses a Rochdale Envelope approach to project description. This method results in the assessment of a worst case and therefore is at risk of over stating the potential significance of some impacts from the development.

12.4.18 The desk based review indicates the presence (or absence) of fish species within the study areas and whether spawning and nursery behaviour occurs there. Some assumptions have been made in order to carry out the impact assessment. These include:

- As spawning and nursery ground data (which varies in seasonality and location over time (Ellis *et.al*., 2010)) is only available at a very coarse level, it has been assumed that, if the study areas overlap with spawning or nursery grounds then fish are using the study areas for those purposes unless there is strong evidence to the contrary.
- As landings data are only available at a resolution of an ICES rectangle, (a rectangle is '30 min latitude and 1° longitude in size (see Figure 12.1) it is not possible to ascertain which of those landings were from the LSA. Therefore it has been necessary to take all the landings data from the RSA area and assume that any of these species may be present within the LSA unless there is evidence to the contrary.
- Migratory patterns of fish and shellfish species are not clearly defined in available literature; therefore if there is evidence to suggest that a species may transit the study area, it has been assumed that some individuals of that species are present.

12.5 Existing environment

12.5.2 This section describes the existing environment within the LSA in which the development will be located and considers the RSA as illustrated in Figure 12.1 and explained in Section 12.4 Methodology.

12.5.3 Distribution patterns of fish and shellfish are determined by a number of factors. Over broad spatial areas, the main abiotic factors that affect the distribution of fishes and fish communities are water temperature, salinity, depth, local scale habitat features and substrate type. Biotic factors include predator-prey interactions, competition and anthropogenic factors. For example, the presence of artificial structures in the marine environment and practice of fisheries activities are important factors at various temporal and spatial scales.

Species present

12.5.4 In order to compile a list of fish and shellfish species potentially present within the study areas it is necessary to interrogate a number of resources including: landings data covering the RSA (provided by Marine Scotland Science); the Scottish Renewable Energy Strategic Environmental Assessment (SEA) (Faber Maunsell, 2007); knowledge acquired through consultation with local fishermen; and data recorded as part of the Benthic Survey (See *Chapter 9: Benthic Ecology* for details).

Local study area

12.5.5 The LSA is characterised by water depths ranging from 10to 20metres (m) and the dominant substrate type recorded across the area is rugged bedrock (Envision, 2011). Areas of boulder, cobble and gravel occur in patches across the site. The gravel patches probably occurring where they have gathered as a result of wave action, such as in gullies and along the fault lines identified by Aspect Land and Hydrographic Surveyors during their survey work (see Appendix 7.1). Coarse sand was the finest sediment observed and this was found relatively close inshore off Sgeir lasgan and Torsuigabac. Fine sand and mud are not a feature of the study area.

12.5.6 No site specific dedicated fish surveys were undertaken for this project; however a benthic survey was completed primarily to inform *Chapter 9: Benthic Ecology*. The survey consisted of 52 dropdown video samples taken across 13 transects within the LSA.

12.5.7 During the benthic survey the brown crab *Cancer pagurus* and fish of the genus *Pollachius* (which includes pollock and saithe) were identified. Brown crab were recorded at inshore stations 29 and 45 (See Figure 9.2 in *Chapter 9: Benthic Ecology*) in the southern and mid-section of the LSA and the fish species was recorded at the offshore station 31, north of the LSA.

12.5.8 Consultation with the local fishing industry indicated that the common lobster *Homarus gammarus*, the European spiny lobster *Palinurus elephas*, brown crab *Cancer pagurus*, velvet swimming crab *Necora puber*, monkfish *Lophiidae* spp., common skate *Dipturus batis* and mackerel *Scomber scombrus* have been recorded, caught or observed within the LSA.

Regional study area

12.5.9 In order to identify the main species potentially present within the LSA, landings data from ICES rectangle 45E3 has been interrogated. A summary of the species for which more than 20 tonnes were landed (which is also the top ten most landed species) is provided in Table 12.6. A complete list of all species landed within that area by year (including 2005) is also displayed in Appendix 12.1.

It is recognised that fishing methods and species targeted are largely market driven and landings may not be completely representative of all species within the area. In addition to landings data, other sources of information have been used to determine the presence of fish and shellfish species and to assess their relative importance. A secondary reference point has been provided by the list of finfish and shellfish species presented in the Scottish Marine Renewables SEA (Faber Maunsell, 2007), which draws together several sources and considers much of the west coast of Scotland, including the study areas.

Table 12.6 Species landings data (tonnes) for the top 10 species landed 2006 – 2010 from ICES rectangles 45E3

Species	Scientific Name	Quantity (tonnes)
Mackerel	*Scomber scombrus*	5734.55
Nephrops (Norway lobster)	*Nephrops norvegicus*	3497.61
Brown crab	*Cancer pagurus*	2991.49
Velvet swimming crab	*Necora puber*	308.78
Scallops	*Pecten Maximus*	297.19
Herring	*Clupea harengus*	154.43
Lobsters	*Homarus gammarus*	109.76
Spurdog	*Squalus acanthias*	40.05

Table 12.6 Species landings data (tonnes) for the top 10 species landed 2006 – 2010 from ICES rectangles 45E3		
Species	**Scientific Name**	**Quantity (tonnes)**
Other or mixed demersal	*Osteichthyes*	39.18
Green crab	*Carcinus maenas*	20.65

Data Source: Marine Scotland website: Fishing effort and quantity and value web page

12.5.10 Mackerel were the most landed species from the RSA between 2006 and 2010, comprising 43% of the landings. Shellfish species which include Nephrops, brown crab, velvet swimming crab and scallops also comprise a significant amount of the landings and these species together with mackerel make up the vast majority (97%) of the total landings (Table 12.6).

12.5.11 A number of the entries in the landings data displayed in such as those in Appendix 12.1 are generic groups such as 'monks and anglers', and 'skates and rays'. The Marine Renewables SEA (Faber Maunsell, 2007) has been used to identify what species within these groups are most likely to occur within the RSA and it was concluded that the category monks and anglers is likely to refer to the most commonly caught monk or angler fish *Lophius piscatorius*, while skates and rays is likely to refer to the most commonly caught species, spotted ray *Raja montagui* along with the thornback *Raja clavata*. These species have been included in the baseline.

Spawning and nursery grounds

12.5.12 The LSA and RSA are within spawning and nursery grounds of a number of species. These are summarised in Table 12.7 and are displayed in Figures 12.2-12.7. These data represent the best available information but provide a rather course and broad-scale overview of spawning and nursery areas without identifying areas of particular importance.

Table 12.7 Species with spawning and/or nursery grounds within the RSA			
Common name	**Scientific Name**	**Spawning ground distance from LSA (km)**	**Nursery ground distance from LSA (km)**
Blue whiting	*Micromesistius poutassou*	NA	0***
Cod	*Gadus morhua*	NA	0*
Common skate	*Dipturus batis*	NA	0*
European hake	*Merluccius merluccius*	NA	0*
Haddock	*Melanogrammus aeglefinus*	21.7**	0**
Herring	*Clupea harengus*	0**	0***
Lemon sole	*Microstomus kitt*	0**	0**
Ling	*Molva molva*	NA	0*
Mackerel	*Scomber scombrus*	6.5*	0*
Norway pout	*Trisopterus esmarkii*	0**	0**
Saithe	*Pollachius virens*	12.1**	NA
Sandeel	*Ammodytes spp*	0*	0*
Sprat	*Sprattus sprattus*	0**	23.8**
Tope	*Galeorhinus galeus*	NA	0*
Whiting	*Merlangius merlangus*	NA	0***

* indicates low intensity ** indicates undetermined intensity and ***indicates high intensity. LSA refers to Local Study Area. Source Information: Cefas (Coull *et.al.* 1998; Ellis *et. al*., 2010).

12.5.13 Analysis of all of the data sources, as detailed earlier, allows compilation of a list of species that may be present within the study areas. The list is displayed in Appendix 12.3 and includes important species, in terms of:

- Commercial value;
- Sensitivity (those that have nursery and/ or spawning grounds in the vicinity of the development); and
- Local importance (Species that have been identified as locally important by the local fishing industry).

12.5.14 The list also includes anadromous[1] species that have been identified as present through the consultation process (both through the Scoping Opinion and further consultation with the Western Isles District Salmon Fisheries Board (WIDSFB)), including Atlantic salmon *Salmo salar*, European eel *Anguilla anguilla,* sea trout *Salmo trutta*, river lamprey *Lampetra fluviatilis* and sea lamprey *Petromyzon marinus*, as well as other species of high conservation concern such as the thornback ray *Raja clavata,* the spotted ray *Raja montagui* and the basking shark *Cetorhinus maximus*.

Protected species

12.5.15 Many of the fish and shellfish identified in the species list (Appendix 12.3) are protected by international or national legislation, or through voluntary agreement such as:

- The EU Habitats Directive 92/43/EEC (as amended);
- The Oslo and Paris Conventions for the protection of the marine environment of the North-East Atlantic (OSPAR) List of Threatened and/or Declining Species and Habitats;
- The International Union for Conservation of Nature (IUCN) has compiled a list of species that are endangered;
- The CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora);
- The Western Isles Biodiversity Action Plan which a contribution to the wider UK Biodiversity Action Plan;
- The draft Priority Marine Features (PMF) list which contains habitats and species which the Scottish Government believes to be of greatest conservation importance in Scottish territorial waters; and
- The Wildlife and Country side act provides the cornerstone to nature conservation in the UK. Section 9 of the act allows for the protection of specifically listed wild animals, including marine species (listed in Schedule 5 of the Act). Schedules 5, 8 and 9 are reviewed every five years and revised. The next scheduled review is 2013.

[1] fish species that spend part of their life at sea, but migrate up rivers in order to breed.

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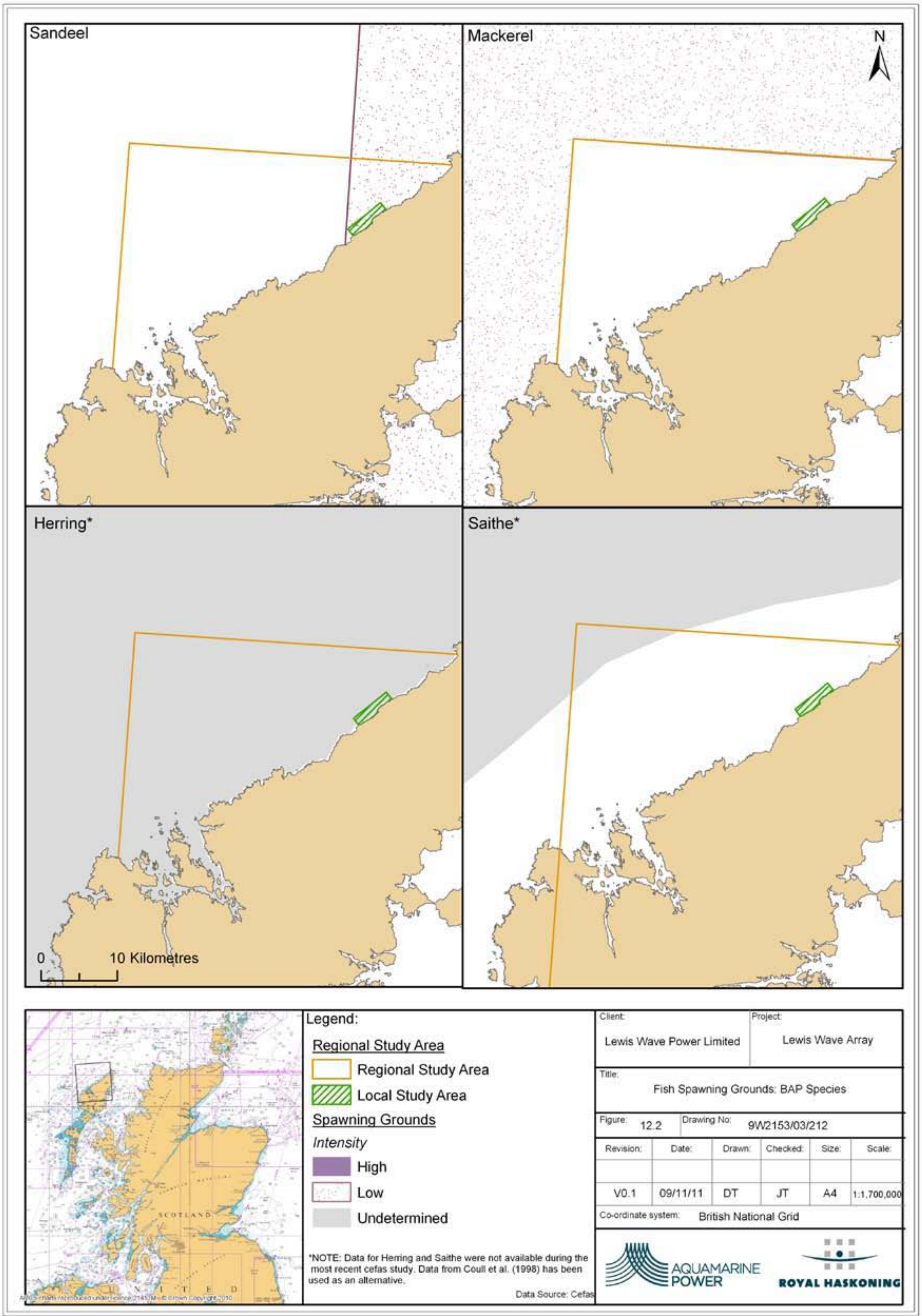

Figure 12.2 Fish spawning grounds in the vicinity of the study areas

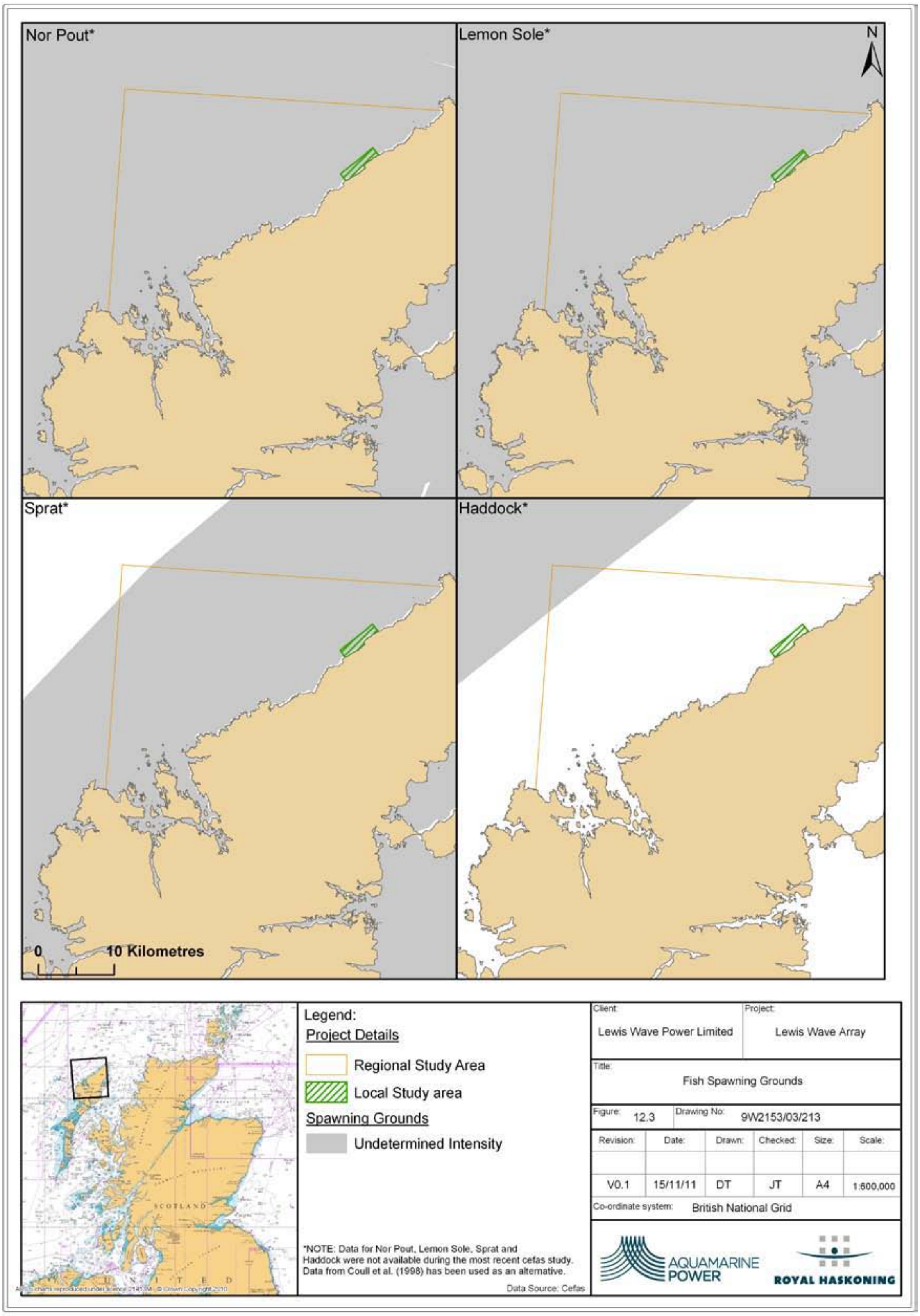

Figure 12.3 Fish spawning grounds in the vicinity of the study areas

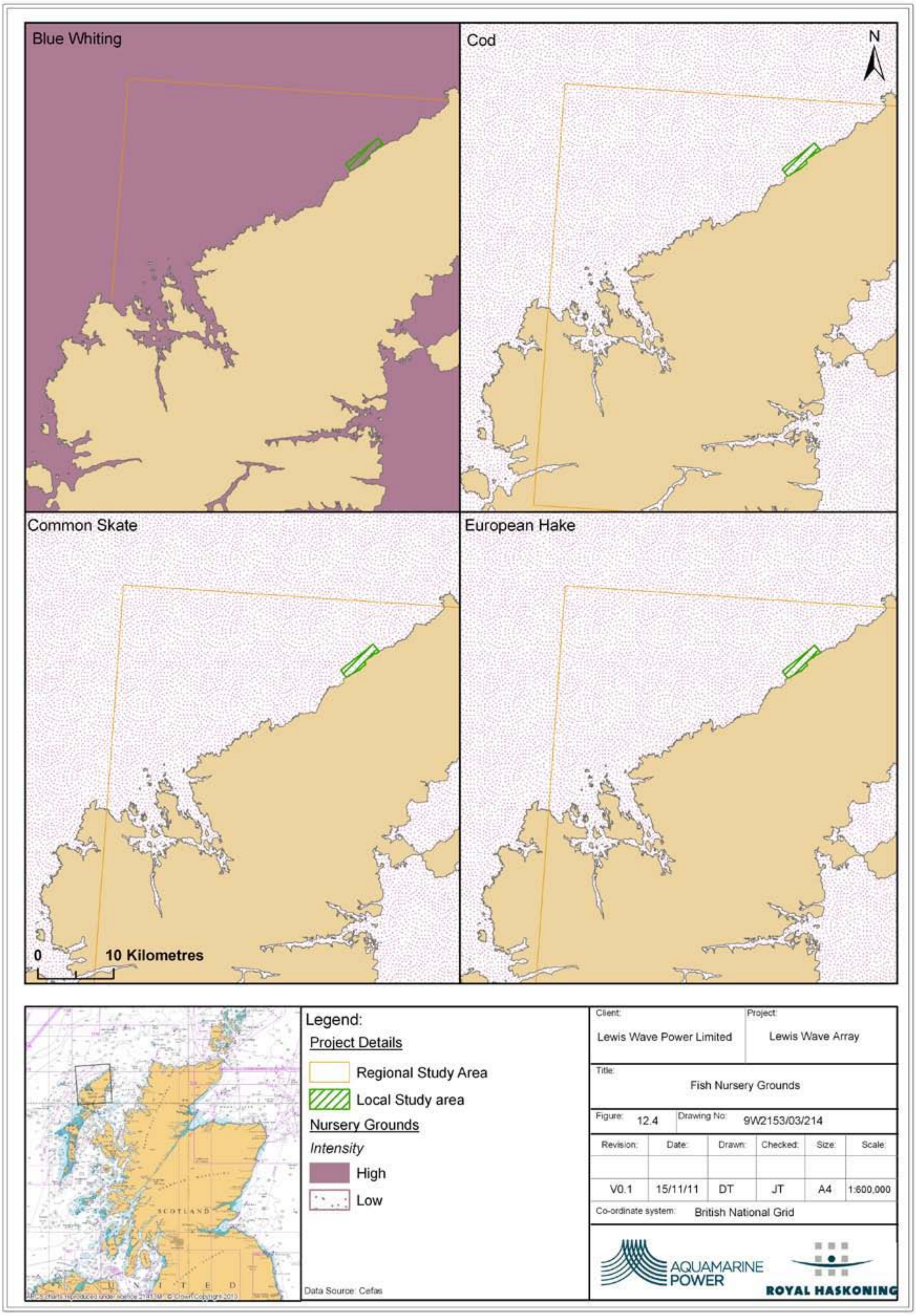

Figure 12.4 Fish nursery grounds in the vicinity of the study areas

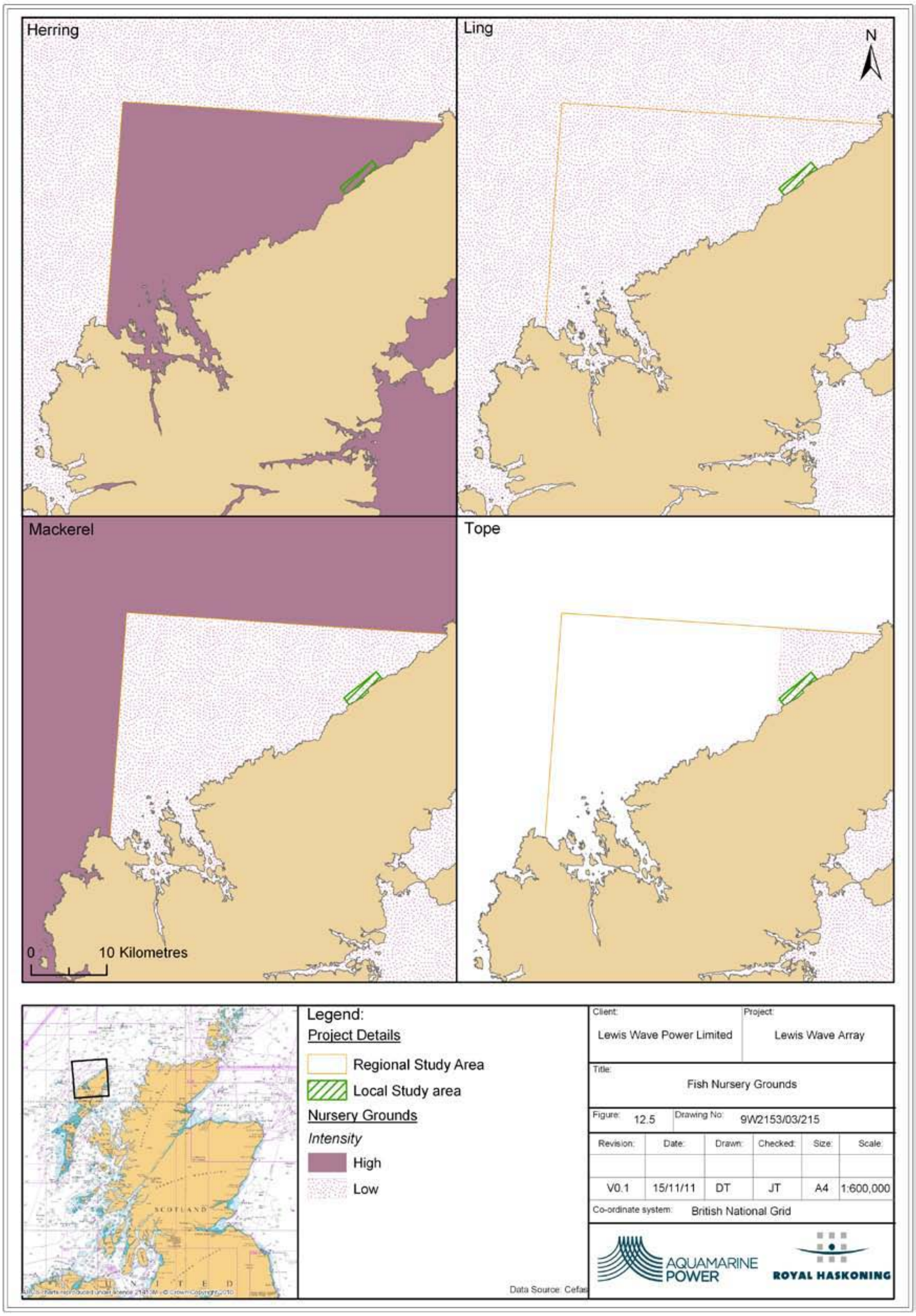

Figure 12.5 Fish nursery grounds in the vicinity of the study areas

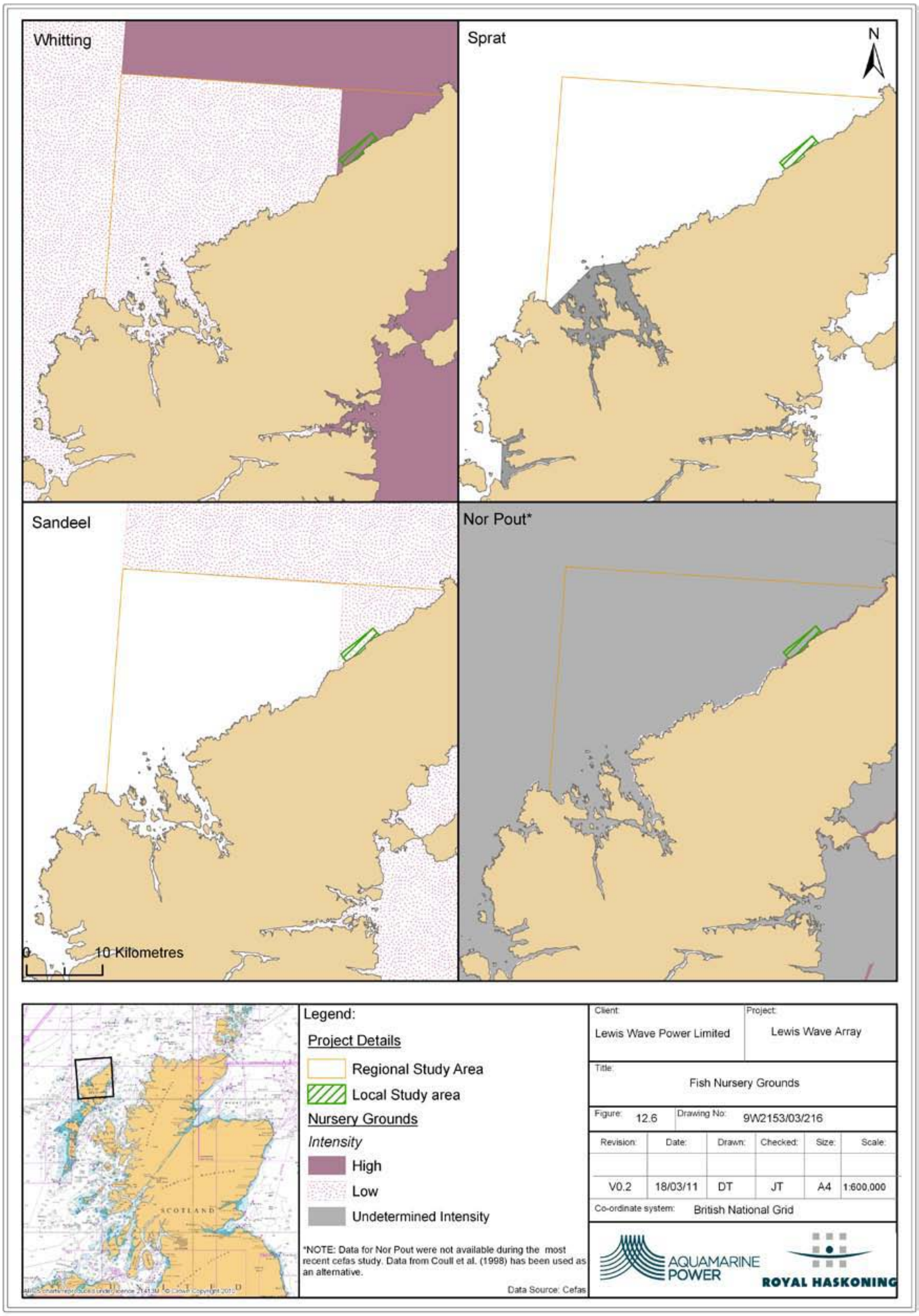

Figure 12.6 Fish nursery grounds in the vicinity of the study areas

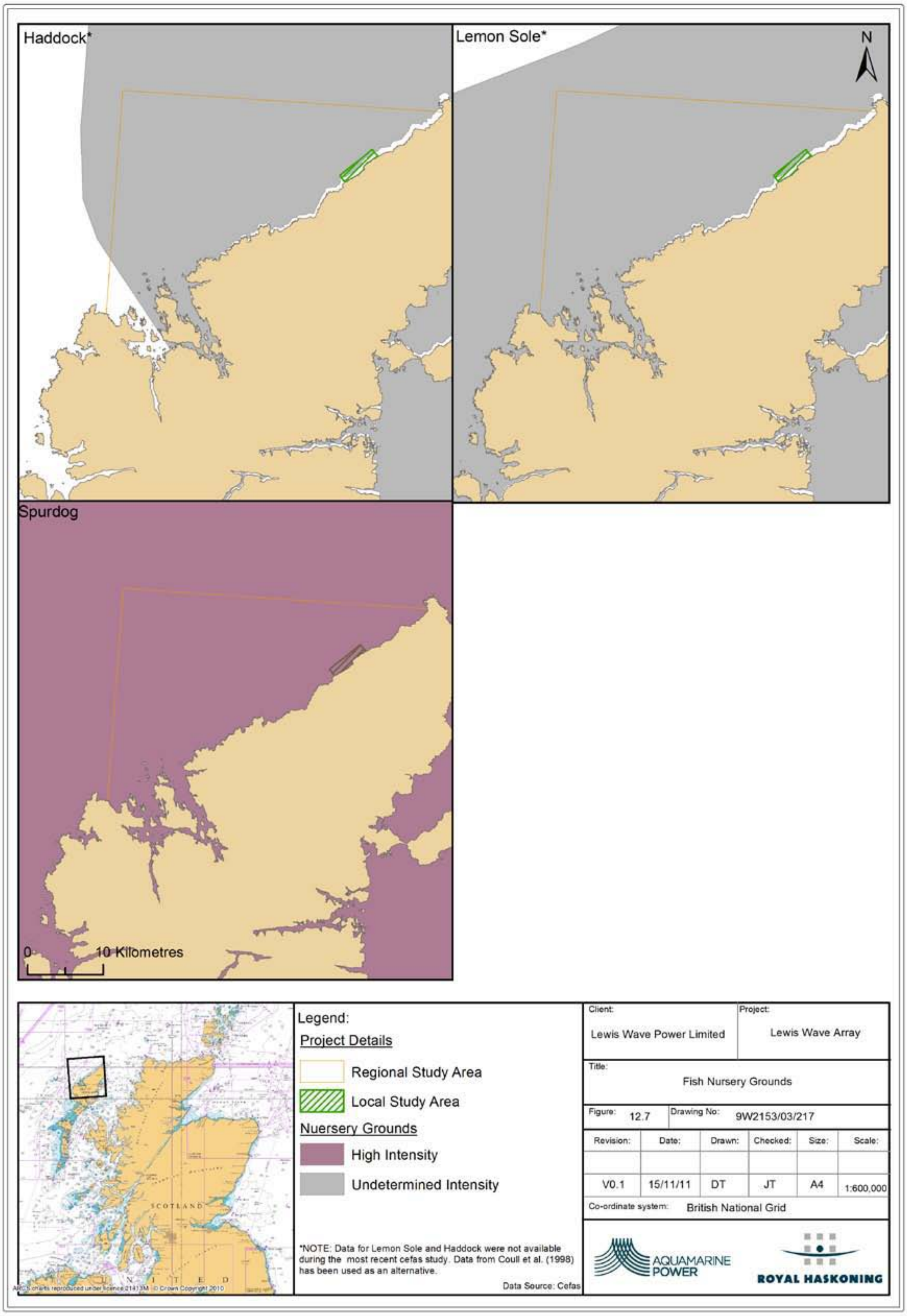

Figure 12.7 Fish nursery grounds in the vicinity of the study areas

Trends in abundance

12.5.16 Interrogation of the landings data reveals that the amount of fish taken from the RSA has steadily declined during the period 2006-2010. This could potentially mean one of two things; either that there has been a decrease in fishing effort within the region (See *Chapter 16: Commercial Fisheries* for more details on fishing effort in the RSA) or that there is less biomass of commercial species present. In order to ascertain which of these scenarios more is likely the landings quantities (tonnes) for each year was standardised using effort data (Marine Scotland Fishing Effort and Quantity and Value web page). Figure 12.8 below show total landings from within the RSA per day of fishing effort.

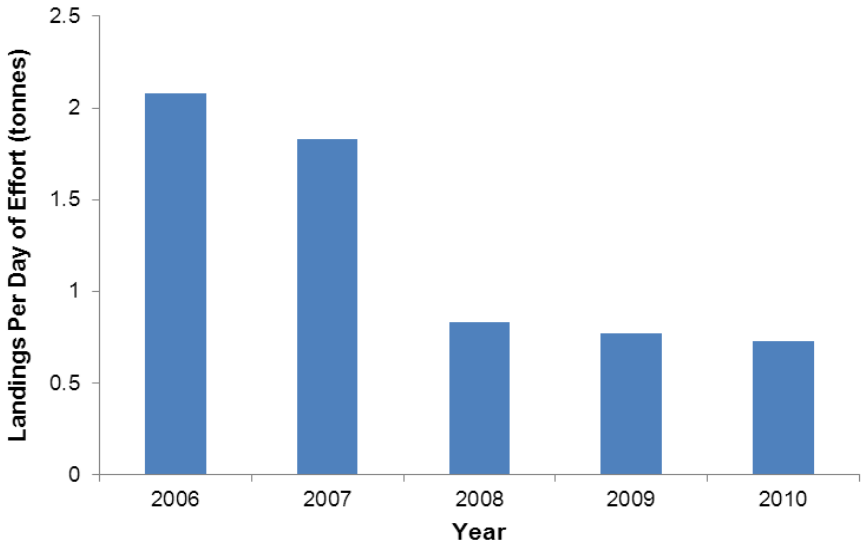

Figure 12.8 Total landings from the RSA (ICES rectangle 45E3) by year per day of effort.

12.5.17 The declining trend observed in Figure 12.8 indicates that the second scenario discussed above is likely to be true and the amount of commercially exploited fish within the RSA has decreased year by year since 2006. The trend does however, appear to be plateauing.

Individual species accounts

12.5.18 This section uses the list in Appendix 12.3 (species of importance that may be present within the LSA) as a starting point and then through a high level assessment process eliminates species that are unlikely to be present in significant numbers due to reasons such as habitat preference and behaviour. Table 12.8 summarises the justification as to why species are included or excluded from further investigation.

Table 12.8 Species likely to be present in within the LSA

Species	Likely to be present in the LSA	Justification
Lobster	Yes	Landed from the site by local fishermen and the has a habitat preference of rock reef which are present within the LSA
Brown Crab	Yes	Landed from the site by local fishermen and the has a habitat preference of rock reef which are present within the LSA
Velvet swimming crab	Yes	Landed from the site by local fishermen and the has a habitat preferences of rock reef which are present within the LSA
European spiny lobster	Yes	Landed from the site by local fishermen and the has a habitat preferences of rock reef which are present within the LSA
Nephrops (Norway lobster)	No	Suitable habitat is not present within the LSA

Table 12.8 Species likely to be present in within the LSA		
Species	**Likely to be present in the LSA**	**Justification**
Green crab	Yes	Suitable habitat is available within the LSA
Scallops (King and Queen)	No	Not observed during the benthic survey and suitable habitat is not present at the LSA.
Mackerel	No	Landings from the RSA are very sporadic and were 0 in 2010 (Appendix 12.1); Cefas data indicates that the RSA is part of a mackerel nursery ground (Figure 12.2) however juveniles of this species are not likely to use the inshore waters of the LSA due to the high energy environment and proximity to the shore.
Herring	No	Landings from the RSA are very sporadic only occurring in significant quantity in 2007 and although the RSA and LSA are within herring spawning grounds (Figure 12.2) herring deposit their eggs on stable coarse sand and gravel; this habitat is not in abundance across the development site.
Blue whiting	No	This species is usually found in water depths far greater than those present within the LSA (Barnes *et. al.,* 2008a ; DECC 2008)
Monkfish	No	Although identified as potentially present within the LSA by local fishermen due to the shallow exposed high energy nature of the developmentsite it is unlikely to be present in any great numbers.
Haddock	No	Adults occur at depths of 40 to 300m over sand and gravel; The LSA does not contain these conditions. Although part of the RSA is within a haddock spawning ground (Figure 12.3) and the RSA and LSA are within a haddock nursery grounds (Figure 12.4) this species spawn during late winter and early spring (Table 12.9) when construction activities are unlikely to take place and it is also recognised that haddock nursery grounds are usually located offshore (Faber Maunsell 2007).
Cod	Yes	The LSA is within a low intensity nursery ground. Juvenile cod have a preference for rocky shores such as those that exist within the LSA; however the very strong wave action within the site may act as a deterrent to young cod.
European hake	No	Adults are found in water depths between 75 and 350m (Barnes, 2008c) and although the LSA is within hake nursery grounds of low intensity (Figure 12.4) juveniles of this species show a preference for muddy sediment, where they feed on crustaceans; As the LSA does not support these habitats hake are unlikely to be present within the LSA.
Lemon sole	No	This species was landed in very low quantities from the RSA (appendix 12.1). The LSA is within lemon sole spawning and nursery grounds (Figure 12.3 and 12.7) however this species spawn in deep water and the pelagic eggs and larvae occupy progressively deeper water as they develop (Faber Maunsell, 2007) and therefore are unlikely to be present within the LSA.
Ling	Yes	The LSA is within a low intensity nursery ground for this species (Figure 12.5) which has a preference for rock habitat in water depths as shallow as 10m such as is found within the LSA. Spawning

Table 12.8 Species likely to be present in within the LSA		
Species	**Likely to be present in the LSA**	**Justification**
		however will not occur within the LSA as water depths of 100-300m are required (Rowley, 2008) and adults will not be present as they prefer deeper water.
Norway pout	Yes	The LSA is within spawning and nursery grounds for this species (Figure 12.4 and 12.6 respectively). Although the high energy environment within the LSA may deter this species their presence within the area cannot be ruled out.
Saithe	No	Adults inhabit water depths of between 100 and 200m. There are no spawning and nursery grounds within the LSA although spawning does occur offshore within the RSA (Figure 12.2).
Sandeel	No	Although the north-eastern corner of the RSA and the entire LSA are within spawning and nursery grounds of low intensity (Figures 12.2 and 12.6 respectively) sand eels have a habitat preference for stable sand or gravel which is not in abundance within the LSA.
Sprat	Yes	They occur from the surface to about 100m depth but are generally found in shallower waters and therefore may occur across the LSA. The majority of the RSA and the entire LSA are within a sprat spawning ground (Figure 12.3).
Whiting	Yes	The LSA is located at the southern edge of the high intensity nursery ground (Figure 12.6).
Common skate	No	Although this species was identified as possibly being present within the LSA through consultation with local fishermen (See *Local study area* 12.5.5) it has a preference for finer sediment substrates which are not present within the LSA
Thornback ray	Yes	This species can be found on patches of sediment among rocky outcrops and boulders and as this habitat occurs within the LSA thornback ray may be present.
Spotted ray,	No	This species is found from shallow waters with the majority of the population found from 100-500m. It lives on soft substrates, preferring sand (Ellis *et. al*., 2007) and therefore is unlikely to be regularly present within the LSA.
Spurdog	Yes	This species was identified as potentially being present within the LSA through consultation with the local fishing industry (Appendix 16.4). The RSA and LSA form part of a large, high intensity, nursery ground for this species (Figure 12.7).
Basking shark		See *Chapter 11 Marine Mammals and Basking sharks*
Tope	Yes	The north-eastern corner of the RSA and the entirety of the LSA are within a nursery ground of low intensity (Figure 12.6) for this species.
Salmon	Yes	Identified as present through consultation with WIDSFB
Sea trout	Yes	Identified as present through consultation with WIDSFB
European eel	Yes	Identified as present through consultation with WIDSFB

Table 12.8 Species likely to be present in within the LSA		
Species	**Likely to be present in the LSA**	**Justification**
Lamprey	Yes	Very little is known about the migratory patterns of Lampreys in the marine environment and therefore they cannot be discounted.

12.5.19 It is assumed that all species identified as likely to be present within the LSA have the potential to be effected by the development. Further information regarding the ecology of these species is provided below and is used to determine the sensitivity of the species in the impact assessment.

Shellfish

12.5.20 Shellfish are very important to the RSA area and make up 54% of the live weight of species landed from the ICES rectangle. Consultation with local fishermen has also revealed that shellfish are the main target of fisheries operating within the LSA.

Lobster

Consultation with the local fishing industry revealed that lobsters *Homarus gammarus* are the primary focus of fishing within the area. These species have a preference for rocky reef habitats of mid to high energy environments (Galparsoro *et al.,* 2009) such as those that occur within the LSA (*Chapter 9: Benthic Ecology*). Within the wider RSA lobster was the seventh most landed species (Table 12.6).

Spawning occurs in late summer or autumn after which lobster eggs are carried by the female under the abdomen until they are ready to hatch usually in early summer. They are rarely thought to undertake any significant migrations (Fisheries Research Services, 2004).

Brown crab

12.5.21 Brown crab *Cancer pagurus* (also called the edible crab) is one of the three main shellfish species targeted by fishermen in the LSA (*Chapter 16: Commercial Fisheries*) and were the third most landed species from within the RSA between 2006 and 2010 (Table 12.6).

12.5.22 Brown crab are mostly found in rocky areas such as those that characterise the LSA (*Chapter 9 Benthic Ecology*), but may also be found on sand, gravel and mud from the intertidal to 100m depth (Niel and Wilson, 2008). During benthic surveys (Envision, 2011) individuals of this species were identified at two locations (see *Local study area* above). Mating occurs in spring and summer. Females are 'berried' (carrying eggs under the abdomen) for 6-9 months after copulation and release the larvae in late spring/early summer (Thompson *et al.,* 1995). Tagging studies show that edible crabs may move a few kilometres a day, and hundreds of kilometres in the long term (The Scottish Government, 2011).

Velvet swimming crab

12.5.23 The velvet swimming crab *Necora puber* (also known as the devil crab), is, the third of the three main species targeted by fishermen in the LSA. Velvet swimming crab is mostly found in rocky areas with reefs, boulders and large stones. After spawning (in late summer or autumn), eggs are carried by the female under the abdomen until they are ready to hatch. Hatching normally takes place in early summer, and the larvae are distributed by water movements before settling to the seabed as miniature adults. Velvet crabs are rarely thought to undertake any significant migrations (Fisheries Research Services, 2004) and this species was not identified during the benthic survey (Envision, 2011).

European spiny lobster

12.5.24 The crawfish or European spiny lobster *Palinurus elephas* was identified as potentially present within the LSA during consultation with the local fishing industry. This is to be expected as their preferred habitat is rocky, exposed coasts (Jackson *et.al*., 2009). This species is a UK BAP species and has also been identified as a PMF by SNH. The main UK populations of this species are confined to the west coast of Scotland with a small population occurring in Cornish waters.

Green crab

12.5.25 The green crab or common shore crab *Carcinus maenas* is a feature of the landings form the RSA and was the 10th most landed species (Table 12.6). This species is common in the intertidal and subtidal around much of the UK and can be found in a variety of different habitats. Spawning in Scotland occurs during the spring and females are then berried for up to 4 months, depending on temperature, before the eggs hatch.

Fish

Cod

12.5.26 Cod *Gadus morhua* is landed from within the RSA in small numbers, typically representing less than one tonne in live weight. Landings of this species have rapidly declined since 2007 (Appendix 12.1), this may be an indication of declining populations, as the west coast stock has been defined as collapsed, or it may be as a function of reductions in TACs for this species over the same time period.

12.5.27 Juveniles cod are demersal, with nursery areas located in coastal waters from the Clyde northwards and they exhibit a preference for rocky shores. The LSA however is not likely to be favoured by the juvenile cod due to its very strong wave action. Cod is listed as vulnerable in the IUCN Redlist.

Ling

12.5.28 Ling *Molva molva* landings regularly comprise approximately half a tonne a year from the RSA (Appendix 12.1) between 2006 and 2010, with landings appearing relatively stable. Ling is the largest species of the cod (gadoid) family and is widely recorded around the British Isles. It is a deep water species found at depths of up to 600m but juveniles and occasionally adults are found as shallow as 10m. This species is primarily solitary and benthic in habit, found amongst rocks, crevices and wrecks in deep water. Spawning occurs offshore between March and August (Rowley, 2008) at a depth of 100-300m and therefore will not occur within the LSA. The LSA is within a nursery ground for ling that has been identified as being of low intensity (Figure 12.5).

Norway pout

12.5.29 Norway pout *Trisopterus esmarkii* does not feature in the landings from the RSA (Table Appendix 12.1). However they are identified in the renewable energy SEA (Faber Mansuell, 2007) as being present within the SEA area (Appendix 12.2).

12.5.30 The Norway pout is a small fish from the cod family that can grow up to about 20cm in length and lives for about three years. Spawning occurs from January to April and the RSA is within a spawning ground of low intensity (Figure 12.4). The eggs and larvae are pelagic and the RSA and LSA are within a nursery ground of undetermined intensity (Figure 12.6).

Sprat

12.5.31 Sprat *Sprattus sprattus* were landed from the RSA only in 2005 and in 2007, all other years between 2005 and 2010 showed no landings (Appendix 12.1). This indicates that this species presence within the study area is occasional as there is currently no TAC for this species (www.ices.dk). Sprat is a short-lived pelagic species that is widely distributed off western Scotland. They occur from the surface to about 100m depth but are generally found in shallower waters and therefore may occur across the LSA.

12.5.32 Sprat is a batch spawner that spawns throughout the summer producing pelagic eggs. The majority of the RSA and the entire LSA are within a sprat spawning ground (Figure 12.3). Nursery areas for this species are located in inshore waters along the west coast of Scotland the nearest of which is located approximately 20km to the south of the LSA in Loch Róg

(Roag) (Figure 12.6). Mature fish often migrate inshore during the winter (September to March).

Whiting

12.5.33 Whiting *Merlangius merlangus* was landed from the RSA during each year between 2006 and 2009 but not in 2010. Landings peaked in 2008 and declined in 2009 (Appendix 12.1). This indicates that the abundance of this species within the region decreased in 2009 and 2010. ICES concluded that stocks in west of Scotland are at a historical low despite decreases in fishing mortality since 2010 (ICES, 2011).

12.5.34 Whiting occurs throughout the northeast Atlantic from shallow inshore waters down to 200m (ICES, 2011) near mud and gravel bottoms, but also above sand and rock (Barnes, 2008e). Whiting has a prolonged spawning period from February to June however the RSA is not within an area known for whiting spawning (Ellis *et.al*., 2010). The eggs and larvae are pelagic and on the west of Scotland the young, often 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 the sea lochs) and result from an active migration. Whiting remain in these areas for one or two years (Faber Mansell, 2007). The RSA is within areas of both high and low intensity nursery grounds, while the LSA is located at the southern edge of the high intensity nursery ground (Figure 12.6).

Thornback ray

12.5.35 The thornback ray *Raja clavata* was identified in the Scottish Marine Renewables SEA as potentially being present within RSA (Faber Mansell, 2007) and if landed would have been recorded within the “skates and rays” category along with common skate described above and the spotted ray described below. Skate and rays ranked 13th in the landings data (Table Appendix 12.1). Thornback rays are found in a wide range of habitats from mud, sand, shingle and gravel. They are also found on patches of sediment among rocky outcrops and boulders such as is present within the LSA (*Chapter 9 Benthic Ecology*). They are most commonly found between 10to 60m. Although mainly a non-migratory species, the fish often moves close inshore during the spring (Wilding & Snowden, 2008).

12.5.36 Spawning occurs in inshore waters between February and September, with a peak in May and June and a theoretical maximum of 140 to160 eggs being laid a year (Shark Trust, 2009a). Information regarding the nature of the substrate on which this species lays its eggs is not freely available and therefore it must be assumed that this species could potentially lay its eggs in the LSA. Tagging studies indicate that juveniles are non-migratory and remain on inshore nursery grounds, with adults undertaking seasonal migrations, moving into shallower water during summer, and offshore in the. Feeding migrations may also occur (ICES Fishmap undated).

Spurdog

12.5.37 The spurdog or spiny dogfish *Squalus acanthias* was eighth most landed species from within the RSA between 2006 and 2010 (Table 12.6). Landings of this species have markedly decreased over this period (Appendix 12.1), which may indicate a declining trend in the abundance of this species over this time period. The species is protected under a number of pieces of legislation and international agreements and the RSA and LSA form part of a large, high intensity, nursery ground for this species (Figure 12.7).

Basking shark

12.5.38 For information regarding basking sharks, please see *Chapter 11: Marine mammals and Basking sharks*.

Tope

12.5.39 Tope *Galeorhinus galeus* were identified in the Scottish Marine Renewables SEA as potentially being present within RSA (Faber Mansell, 2007). This species is a benthopelagic and demersal species inhabiting the upper continental shelf down to a depth of 550m

(Barnes, 2008f). The northeastern corner of the RSA and the entirety of the LSA are within a nursery ground of low intensity (Figure 12.6) for this species. Tope is an ovoviviparous species, meaning it gives birth to live young, gestation period is approximately 12 months, after which females move into shallow areas and bays to give birth to litters of 6–52 pups, depending on the size of the mother. These pups measure from 30–35cm in length and remain in the nursing areas for their first year or two. In Scottish waters, the tope is highly migratory, moving north in summer and south in winter (Shark Trust, 2009c).

Anadromous fish

12.5.40 Due to their ecology anadromous fish are particularly vulnerable to anthropogenic impacts along migratory routes. Any degradation of their natal rivers[2] or of the marine environment can have a negative effect on the population size. Declines in populations of Atlantic salmon (The Atlantic Salmon Trust, 2011), sea trout (MacKenzie *et.al*., 1998) and European eels (www.iucnredlist.org) have all been widely reported across Europe and in Scotland. These species are of particular concern due to their high economic and/or conservation value, broad geographic distribution and their extensive marine migration through Scottish coastal waters (Malcolm *et.al.,* 2010). Furthermore our understanding of the migratory patterns of these species at sea is poor.

12.5.41 For the reasons stated above, a much wider RSA (than that used for other fish and shellfish seen in Figure 12.1) has been adopted for anadromous fish species. The anadromous fish RSA includes the entire northwest coast of Scotland (Figure 12.9).

Salmon

12.5.42 Atlantic salmon *Salmo salar* is widely distributed in Scottish waters, with populations widely recognised as being of national and international importance, both in terms of a commercial resource and nature conservation.

12.5.43 Salmon is a protected species and is one of eight fish species listed in Annex II of the EU Habitats Directive 92/43/EEC (as amended). SACs have been designated in Scottish waters to contribute to the European network of important high-quality conservation sites for salmon, the closest of which to the LSA is the Langavat SAC, approximately 40km south of the LSA (Figure 12.9 and Table 12.9). Little Gruinard River, River Narver, River Thurso and Berriedale and Langwell Waters are also designated for the protection of salmon and details of their relevance to the LSA are provided in Table 12.9. Two other SACs within the RSA include salmon as “a qualifying feature, but not a primary reason for site selection”, these are also detailed in Table 12.10 below.

12.5.44 The Langavat SAC conservation objectives for Atlantic salmon are:

(i) To avoid deterioration of the habitats of the qualifying species or

(ii) Significant disturbance to them, thus ensuring that the integrity of the SAC is maintained and that they make an appropriate contribution to achieving favourable conservation status for the qualifying species. And to ensure for the qualifying species that the following are maintained in the long term:

And to ensure that the following are maintained in the long term:

(iii) Population of the species, including range of genetic types for salmon, as a viable component of the SACs.

(iv) Distribution of the species within sites.

(v) Distribution and extent of habitats supporting each species.

(vi) Structure, function and supporting processes of habitats supporting each species.

[2] The river that they originate from and for many species the river which they will return to in order to breed

Table 12.9 SACs in the north west of Scotland that have been designated with Salmon as a primary feature or as a qualifying feature.

SAC	Priority	Distance by Sea (km) from LSA
Langavat	Primary	40
North Harris	Qualifying	65
Little Gruinard River	Primary	105
River Borgie	Qualifying	137
River Naver	Primary	138
River Thurso	Primary	181
Berriedale and Langwell Waters SAC	Primary	275

12.5.45 The condition of the Langavat SAC is currently said to be “Unfavourable, but “Recovering” (http://gateway.snh.gov.uk/sitelink). Consultation with SNH indicated that they consider that there will be no significant impacts on the Langavat SAC caused by the development and therefore an HRA is not required.

12.5.46 Data sourced from the NBN gateway (NBN, 2011) which provides records from the Biological Records Centre database indicates that salmon are, or have historically been, present within three rivers on the north-west coast of Lewis (Figure 12.10). These are all located to the south of the LSA and are the River Barvas which is 6.7km distant, the River Arnol which is 10.4km and the River Shawbost, 15.4km from the LSA. In addition to these three rivers it has been confirmed through consultation with the WIDSFB that salmon have been positively identified during recent surveys within the river Siadar located 1.1km to the south of the LSA and 1.6km south of the nearest potential siting of an Oyster wave energy convertor (WEC).

12.5.47 Adult salmon 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 (September – November). After spawning in October to December the adult fish return seawards over a period of up to several months.

12.5.48 The juvenile life stage of salmon takes place in fresh water and typically lasts for between 1 and 4 years before migration down river to the sea as smolts. Atlantic salmon grow rapidly by feeding in the ocean but return to their native rivers to spawn. There are distinct components to the homeward migration. The first phase occurs in the sea and is rapid and highly directed, probably involving navigation or orientation using position of sun and reference to the Earth’s magnetic field (Hansen & Quinn, 1998). The second phase is the upstream migration. Very little is understood of the phase of migration between location by salmon of the home land-mass and identification of the home river (Malcolm *et. al*., 2010).

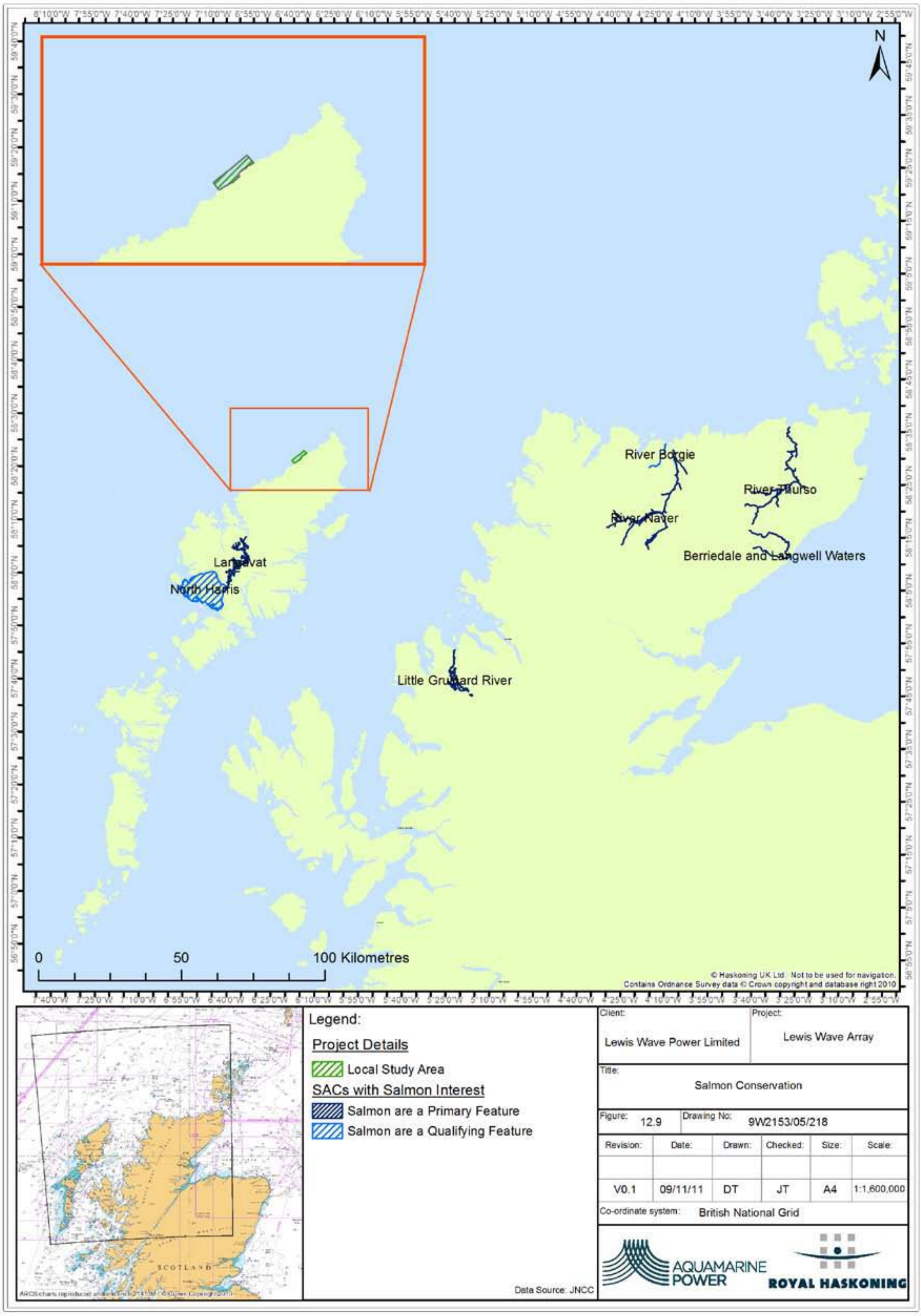

Figure 12.9 Special Areas of Conservation designated for salmon or with salmon as a qualifying species.

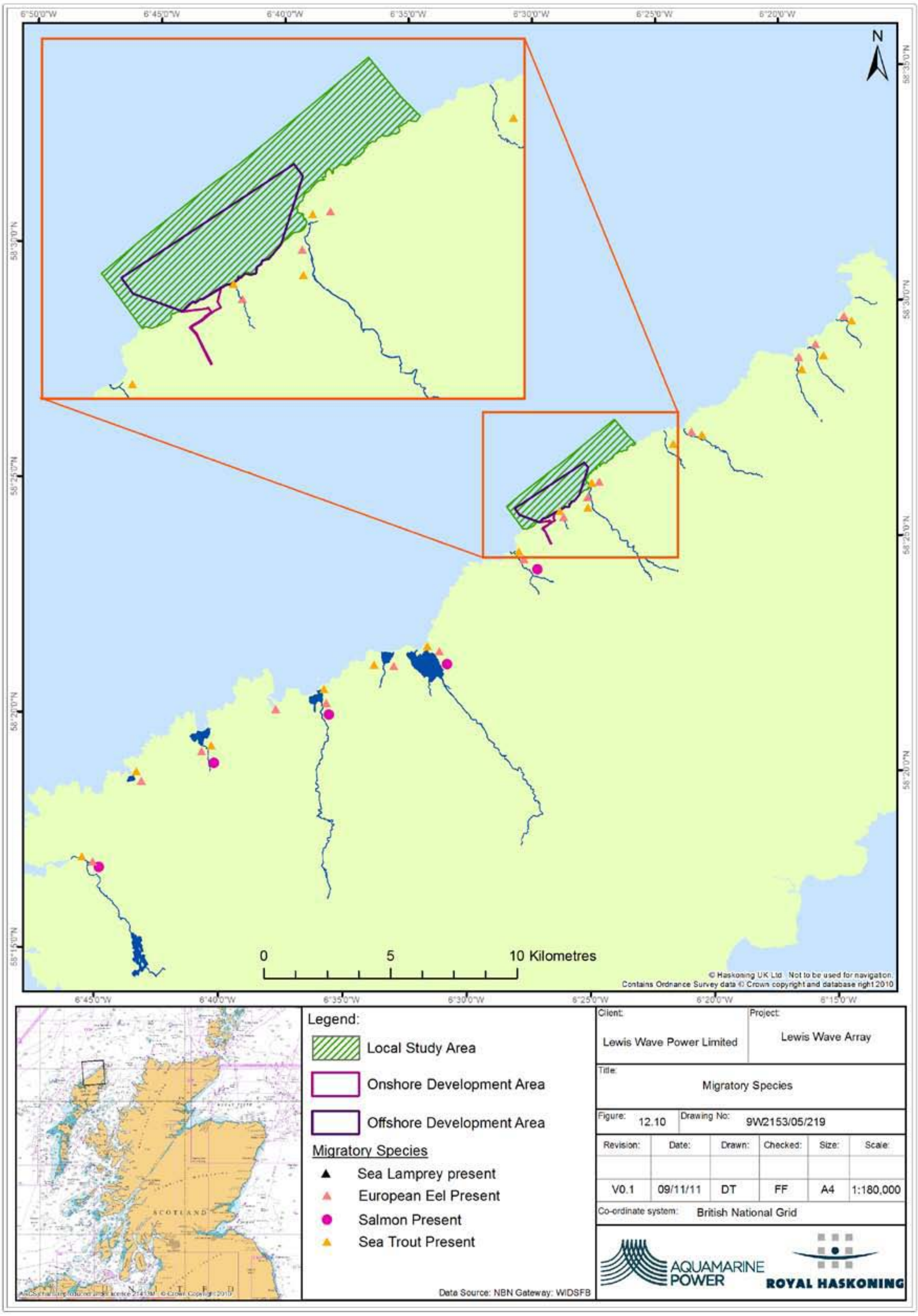

Figure 12.10 Migratory species present in rivers in the vicinity of the Local Study Area

12.5.49 There is little systematic information on the routes used by Atlantic salmon to migrate from Scotland to their distant ocean feeding grounds. Based on currently available 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 off-shore areas (Malcolm *et al*, 2010). Information presented in Malcolm *et.al*., (2010) indicates that salmon migrating from rivers on the west coast of Lewis may travel north toward the Norwegian Sea and are therefore likely to pass the LSA. However studies of post smolt[3] salmon in Norway and Canada (Lacroix *et al.,* 2005 and Thorstad *et.al.,* 2004) have suggested that salmon do not use the near shore environment on their migrations, with fish tending to travel adjacent to the shore at a distance of between 2.5 and 5km in the former study and at a mean distance of 370m in the later study. Other studies also provide evidence for this behaviour (Malcolm *et. al*., 2010) indicating that any salmon migrating past the study area from more southern rivers are likely to be further offshore than the development area.

12.5.50 Rod catch data provided by Marine Scotland indicates that salmon abundance in Loch Roag has steadily fallen since a peak in 1967 of 3423 fish to below 30 adult fish caught per year between 1999 and 2004 (Figure 12.11). There has however been an increase in the number of grilse[4] in this data set which supports the theory that salmon populations are maturing earlier and returning to natal rivers to spawn at a younger age (Malcolm *et.al*., 2010)

12.5.51 Atlantic salmon is a host species for freshwater pearl mussels *Margaritifera margaritifera,* one of the most critically endangered molluscs in the world. Around 6% of the world's remaining functional population of freshwater pearl mussel is found in Lewis and Harris.

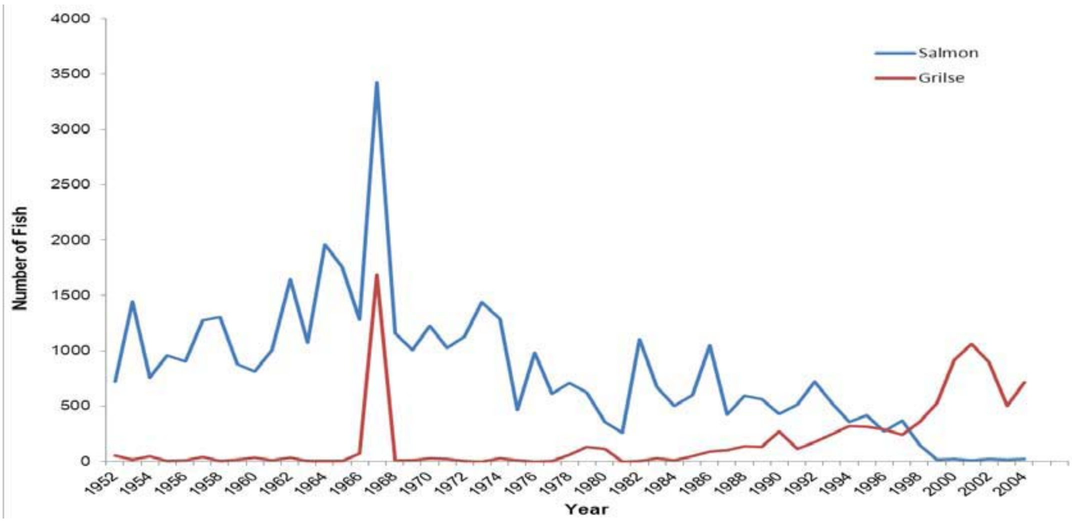

Figure 12.11 Salmon rod catch data from loch Roag from 1952 to 2004. Data source: Marine Scotland

Sea trout

12.5.52 Data sourced from the NBN gateway show that sea trout *Salmo trutta* has been recorded in most of the main rivers on the northwest coast of Lewis (Figure 12.10). Trout spawn in winter from October to January. The eggs are shed in small depressions known as redds which are cut by the female in the river gravel, usually in upstream reaches.

[3] Term used to describe salmon that are entering the sea from their natal river for the first time

[4] Young salmon that returns to fresh water after one winter in the sea

12.5.53 Sea trout may spend a variable number of years in fresh water before migrating to sea, where they may spend variable periods of time before reaching maturity. In contrast to salmon, immature sea trout often return to fresh water to over-winter. Once sea trout reach the sea they appear to remain within nearshore waters rather than undergoing extensive migrations offshore (DECC, 2009). Malcolm *et.al.* (2010) concluded that no reliable inferences can be drawn as to the marine distribution of adult sea trout.

12.5.54 As with salmon, sea trout are also a host species for the freshwater pearl mussel and therefore decline in populations of this fish species is likely to have a negative impact upon the population of pearl mussels.

European eel

12.5.55 The European eel *Anguilla anguilla* has been recorded in many rivers on the north west coast of Lewis (Figure 12.10) and may therefore migrate through the LSA. The life-cycle of the European eel is partially understood; with spawning thought to occur in the vicinity of the Sargasso Sea after which larval eels cross the Atlantic Ocean. By the time they reach the continental shelf of Europe the larvae metamorphose into un-pigmented "glass" eels, at around 5cm in length. Some of these glass eels remain in the sea, some ascend the rivers of Europe, and others may move back and forth between marine, estuarine and freshwater environments.

12.5.56 After a growth stage, which can last from 3 to 60 years depending on environmental conditions, the eels metamorphose into "silver" eels and begin the return migration to the spawning grounds. It is possible that a significant proportion of the total European population may pass through the seas around Scotland.

12.5.57 Recruitment of juvenile eels to the European stock is presently at about 5% of levels that in the 1970s (ICES, 2009). This collapse threatens aquatic biodiversity and the socio-economic value of eel fisheries throughout its range. The problem is internationally recognized as a conservation priority: the IUCN assessed the European eel as 'critically endangered'.

Lamprey

12.5.58 The sea lamprey *Petromyzon marinus* has been recorded in the black water river located in loch Roag approximately 40km south of the LSA. Both the sea lamprey and the river lamprey (*Lampetra fluviatilis*) migrate up rivers to spawn and spend the larval stage buried in muddy substrates in freshwater. Both species need clean gravel for spawning, and silt or sand for the burrowing juveniles. Once metamorphosis takes place, the adults migrate to the sea where they live as a parasite on various species of fish (DECC, 2009).

12.5.59 Both species of lamprey are highly protected and are listed in Annex II of the EU Habitats Directive 92/43/EEC (as amended). In order to meet the requirements outlined in Article 3 of the Habitats Directive, SACs have been designated in Scotland the closest of which are River Spey (for Sea Lamprey) over 320km by water to the east of the LSA and Endrick water (for river Lamprey) over 500km to the south of the LSA.

Sensitivities to wave array development

12.5.60 Work completed for the Saltire leasing round (Harald *et. al*., 2010) indicates that January to April and August through to September are the most sensitive time periods for fish and shellfish species that exist off the north-west coast of Lewis.

12.5.61 The Scottish Marine Renewables SEA (Faber Maunsell, 2007) identifies the sensitivity of fish and shellfish species to impacts associated with wave and tidal developments. Table 12.10 has been adapted from the information contained in the SEA and lists those fish and shell fish species that are assumed to be present within the study areas.

Table 12.10 Sensitivity of fish and shellfish assumed to be present within the study area to possible impacts from wave arrays (adapted from Faber Maunsell, 2007)

Species	Smothering	Change in suspended sediment	Increased turbidity	Substratum loss	Decrease in wave exposure	Contamination	Underwater noise
Blue whiting	Not assessed in the SEA						
Brown crab	Low	Not sensitive	Not sensitive	Unknown	Low	Unknown	Unknown
Cod	Not sensitive	Not sensitive	Unknown	Not relevant			High
European eel	Not assessed in the SEA						
European spiny lobster	Not sensitive	Not sensitive	Not sensitive	Not relevant	Not sensitive	Unknown	Not sensitive
Green crab	Not sensitive	Not sensitive	Not relevant	Low	Low	Low/Very low	Not sensitive
Lemon sole	Low	Low	Unknown	Not relevant	Not relevant		Low
Ling					Not relevant		
lobster	Low	Not sensitive	Unknown	Medium	Low	Unknown	Unknown
Norway pout	Not sensitive	Not sensitive	Unknown	Not relevant	Not relevant		Unknown
River Lamprey	No information						
Salmon	Not sensitive	Not sensitive	Unknown	Not relevant	Not relevant		Low
Sea Lamprey	Not assessed in the SEA						
Sea trout	Not sensitive	Not sensitive	Unknown	Not relevant	Not relevant		Unknown
Spurdog	Not sensitive	Not sensitive	Unknown	Unknown	Not relevant	Unknown	Unknown
Thornback ray	Low	Not sensitive	Unknown	Not relevant	Not relevant	Unknown	Low
Tope	Not sensitive	Not sensitive	Unknown	Not relevant	Not relevant	Unknown	Unknown
Velvet swimming crab	Low	Not sensitive	Unknown	Unknown	Low	Unknown	Unknown
Whiting	Not sensitive	Not relevant	Unknown	Not relevant	Not relevant	Unknown	Unknown

12.6 Impact assessment

Do nothing scenario

12.6.2 If the development does not proceed it is expected that trends in the baseline will continue on their current path.

Potential impacts during construction

Impact 1: Physical barrier to movement / interruption of known migratory routes.

12.6.3 The installation of the Oyster wave array will be phased over a period of four to six years (*Chapter 5 Project description*). Due a number of limiting factors, including vessel availability, weather conditions and supply chain logistics, construction will only occur over a small area of the total development site at any one time. As a result, the barrier to fish or shellfish passing through the site during the construction phase will be both small, relative to the available sea area, and temporary. As construction nears completion and more of the WECs and infrastructure have been installed, any barrier effects will gradually increase until they reach the levels which are predicted for the operation period (refer to Impact number 1 in Section: Potential effects during operation).

12.6.4 The main species likely to migrate through the development site are salmon and sea trout on their migration from rivers south of the development (including the Siadar river located 1.6km south) site north to their feeding grounds in the Norwegian Sea or when returning to breed. Salmon and sea trout are strong swimming, streamline fish, easily capable navigation around any physical barrier that the installed infrastructure may present.

12.6.5 The main way in which the process for which construction of the development would create a barrier to salmon and sea trout would be through underwater noise emissions. A study into the potential impacts of underwater noise produced by construction of the Oyster wave array development on Atlantic salmon and sea trout was conducted by Kongsberg Maritime Ltd (Appendix 11.2). The study concluded that no behavioural reactions are likely to be seen in Atlantic salmon or sea trout when they are exposed to drilling noise and that only mild behavioural impacts out to a maximum distance of 2m may be seen when they are exposed to vessel noise.

12.6.6 Studies indicate that migrating salmon travel in parallel to the coastline, from close to shore, to distances that can be several kilometres from the shore (Malcolm *et. al*., 2010 and further information in Section 12.4 salmon). As a result of this distribution and the limited period over which construction will occur, only a small subset of the relevant populations of migrating fish, notably the Siadar river population, will encounter a potential barrier(s). Therefore the magnitude of any barrier effects of the construction of the development causing a barrier to migration of fish and shellfish will negligible.

12.6.7 The sensitivity of salmon in respect to this impact can be considered to be low as despite their international importance (see paragraph 12.4.85) they are not likely to show any avoidance behaviour to construction activities (Appendix 11.2). Therefore the significance of the impact of physical barriers to fish and shellfish species is likely to be of **negligible** significance.

MITIGATION IN RELATION TO IMPACT 1
No mitigation suggested

Residual effect

12.6.8 As no mitigation is suggested the residual impact will of **negligible** significance.

Impact 2: Substratum/benthic habitat loss

12.6.9 The development will cause substratum loss throughout the construction period both through direct placement of objects on the seabed and through preparation work prior to installation (See *Chapter 5 Project description* for details). Substratum loss will only directly affect species using the seabed, including all shellfish and demersal species listed in Table 12. 8.

12.6.10 Recent studies indicate that the environment off the northwest coast is fairly uniform, from Loch Róg (Roag) in the south to the Butt of Lewis in the north (*Chapter 9 Benthic Ecology*). It has been described as principally composed of uneven bedrock and patches of boulders and cobbles on medium-coarse sand, with the substrata generally supporting a low-diversity community (Moore and Roberts, 2011). The survey work, which covered an area of approximately 225km^2, found just two biotopes along the open coastline and the benthic survey conducted for this ES found similar results to Moore and Roberts over an area of 4.8km^2. It can therefore be assumed that the LSA is generally representative of the wider region in terms of the substratum and associated fauna. In addition no sensitive benthic habitats were identified in either of the above studies (*Chapter 9 Benthic ecology*).

12.6.11 The working footprint of the marine construction phase of the development has been calculated as between 4.65 Hectares (ha) and 25.97ha (*Chapter 5 Project description*). The maximum possible footprint thus is approximately 5.4% of the area that was surveyed during the benthic studies (*Chapter 9 Benthic ecology* and Envision, 2011) and less than 0.13% of the area surveyed by Moore and Roberts (2011). Therefore the magnitude of benthic habitat loss will be negligible.

12.6.12 Many of the species that make use of the benthic habitats such as cod, common skate, thornback ray, spurdog and European spiny lobster have some status under a number of different pieces of legislation and agreements therefore the sensitivity of the receptor to loss of substratum must be considered to be intrinsically high. However the scale of the habitat loss compared to the overall local habitat resource is of negligible magnitude. The sensitivity of the receptor to the loss of rocky habitat as a result of the development within the local area is considered to be negligible. In accordance with Table 12.5 the impact of loss of substratum/ benthic habitat will be of **negligible** significance.

MITIGATION IN RELATION TO IMPACT 2
No mitigation suggested

Residual effect and best practice

12.6.13 As no mitigation is suggested the residual impact will of **negligible** significance.

12.6.14 At present the magnitude of the impact is assessed using the greatest possible footprint of construction works to the benthic habitat. As the project develops the size of the footprint will be reduced.

Impact 3: Disturbance/injury as a result of noise, vibration.

12.6.15 Underwater noise can have direct impacts upon marine species through physical damage or can have indirect impacts through avoidance behaviour. Numerous studies have investigated the sensitivity of marine species to underwater noise and Table 12.10, which has been adapted from work completed for the marine renewables SEA (Faber Maunsell, 2007), summarises the noise sensitivity of the species which may be present within the LSA in the right hand column. Although for many species the sensitivity to underwater noise is unknown for herring, sprat and cod sensitivity to underwater noise is known to be high. As outlined in Section 12.5 Existing environment (Table 12.8) sprat and cod may be present within the LSA.

12.6.16 Kongsberg Maritime Ltd was commissioned to carry out a study into the likely impacts of noise created by the development on Atlantic salmon, sea trout, hearing specialists and hearing generalists. The report concluded that "*no behavioural reactions are likely to be seen in Atlantic salmon, European eel, sea trout and hearing generalist fish respectively when they are exposed to drilling or operational noise while mild behavioural reactions out to a maximum* *distance of 5m may be seen when they are exposed to vessel noise*". For hearing specialist fish, only vessel noise was predicted to be sufficiently loud to elicit a strong behavioural reaction and then only out to a distance of 8m. Mild behavioural reactions were predicted out to a maximum distance of around 73m, 4m and 1m when exposed to vessel, drilling and operational noise respectively.

12.6.17 As only hearing specialists will be affected by construction activities and then only at a maximum distance on 73m the magnitude of the impact is considered to be within the low category (See Table 12.3). Hearing specialists such as sprat (which are predicted to be present (Table 12.8)) are strong swimming fish and will easily be able to avoid the development site meaning that the sensitivity of fish and shellfish to underwater noise has been categorised as low. Therefore in accordance with Table 12.5 the overall impact of Disturbance/injury as a result of noise and vibration is predicted to be of **negligible** significance.

MITIGATION IN RELATION TO IMPACT 3
No mitigation suggested

Residual effect

12.6.18 As no mitigation is suggested for this impact the residual impact will of **negligible** significance.

Impact 4: Pollution from routine and accidental discharges.

12.6.19 Lewis Wave Power Limited is committed to using the most environmentally friendly materials within the Lewis development wherever practicable. An inventory of the fluids to be used during the in the development is provided within *Chapter 5 Project description* (Table 5.5). Table 5.5 also includes the risk of leak or discharge to the marine environment. No fluids that may/will be lost to the offshore environment are toxic and the majority of materials that will enter the marine environment during construction (mainly grout) are designed to cure rapidly and therefore will not disperse into the water column.

12.6.20 The drilling fluids likely to be similar to bentonite will be lost to the marine environment if the HDD drilling option is required (see *Chapter 5 Project Description* for more details). Bentonite is non-toxic and disperses rapidly into water and therefore will have little effect on marine organisms. The LSA is characterised by an extremely high energy environment in which any pollution (routine or accidental) discharge will be dispersed very rapidly. Furthermore the LSA is not geographically enclosed in any way and therefore any discharges will be dispersed over a very wide area and will not accumulate locally.

12.6.21 An assessment of the impacts of "Marine pollution from construction to water quality" has been made in *Chapter 20 Water quality* which predicted a minor adverse impact reducing to negligible with appropriate migration. Therefore the magnitude of this impact on marine species is considered to be negligible.

12.6.22 The species that will be most affected by pollution and accidental discharges are the less mobile species that are unable to avoid any pollution or discharge source. These include the crustaceans of which limited information on their sensitivity is available. Table 12.11 provides a summary of the sensitivities to pollution as compiled by the Marine Life Information Network (MarLIN).

Table 12.11 Sensitivities of relevant species to potential pollution. Source: MarLIN		
Species	**Sensitivity**	
	Heavy metal contamination	**Synthetic compound contamination**
Brown Crab	Low	Moderate
Common Lobster	Unknown	Unknown
European spiny lobster	Unknown	Unknown
Common shore crab	Very low	Low
Velvet swimming crab	Unknown	Unknown

12.6.23 Although data is not available for lobster or velvet swimming crab, the assumption has been made that these species have similar sensitivities to brown crab and common shore crab and therefore the maximum sensitivity of any fish or shellfish species to pollution during construction is likely to be within the medium category (as brown crab is given a sensitivity of moderate for synthetic compound contamination).

12.6.24 Pollution events experienced during construction will be localised and are likely to result in very small quantities of material being lost to the marine environment and therefore a very limited number of individuals would have the potential to be affected. In accordance with Table 12.5 the impact of pollution from routine and accidental discharges is assessed as being of **negligible** significance.

MITIGATION IN RELATION TO IMPACT 4
No mitigation suggested

Residual effect

12.6.25 As no mitigation has been suggested the residual impact will remain at **negligible** significance.

Impact 5: Changes in suspended sediment levels and turbidity.

12.6.26 The substrate across the study area has been described as being dominated by rugged bedrock with only small areas of boulder, cobble and gravel occurring in patches (*Chapter 9 Benthic Ecolog*y). Therefore most of the construction activities will not disturb sediment as there is very little present throughout the site. The main activities that will contribute to increases in suspended sediment will be the drilling of the pile sockets, anchors and the bore holes if the HDD option is used for pipeline installation (See *Chapter 5 Project description* for details). In the case of the HDD option a closed loop system will be used to minimise the loss of drill cuttings and drilling fluids to the environment.

12.6.27 Drilling activities will occur intermittently over a five year period and will be temporal in nature only occurring during favourable weather conditions and for short periods of time (*Chapter 5 Project description*). The near shore environment off the west coast of Lewis is extremely high energy and experiences large waves with wave action of prolonged duration, which will disperse and dilute any suspended sediment very rapidly.

12.6.28 The species within present within the RSA (See Appendix that are considered to be most sensitive to increases in suspended sediment are herring, scallops and nephrops (Faber Mansuell, 2007). As discussed in the individual species accounts, it is unlikely that herring, nephrops and scallops are present within the LSA (Table 12.8) and therefore increases in suspended sediment are not likely to impact upon these species; therefore the magnitude of the effect is likely to be at worst negligible. Lemon sole is reported as having low sensitivity to changes in suspended sediment (Table 12.10) and all other species are not sensitive to this impact and therefore a sensitivity of rating of low is assumed. In accordance with Table 12.5 the likely significance of changes in suspended sediment levels to fish and shellfish will be of **negligible** significance.

MITIGATION IN RELATION TO IMPACT 5
No mitigation suggested

Residual effect

12.6.29 As no mitigation has been suggested the residual impact will remain at **negligible** significance.

Impact 6: Displacement of or loss of spawning grounds.

12.6.30 The LSA has been identified (using Coull *et., al* 1998 and Ellis *et. al.,* 2010 data provided by Cefas) as being within spawning grounds for herring, lemon sole, Norway pout, sandeel and sprat (Table 12.6), as well as in the vicinity of spawning grounds for haddock and saithe. The development has the potential to result in a temporary disturbance and loss of spawning grounds during construction as well as the permanent direct loss of parts of the spawning grounds during operation (considered below in Impact 6 Operational Impacts) for these species. This will occur through a number of activities including the placement of the devices, pipelines and other associated infrastructure on the seabed (see *Chapter 5 Project Description* for more details).

12.6.31 Herring and sandeel require stable coarse grained sediment on which to lay their eggs. These environments do not occur within the project development area and therefore it is considered that these species will not spawn within the LSA (As outlined in section 12.4). The development will therefore have no effect on the spawning of herring and sandeels.

12.6.32 Lemon sole uses deep water locations to spawn. As the LSA is between 10 and 15m deep (CD) this species will not use the area for spawning and with therefore not be impacted by the development.

12.6.33 Norway pout and sprat are both pelagic spawners, releasing sperm and eggs into the water column. There is potential for these two species to use the LSA (Table 12.8) for spawning. The wider spawning ground for Norway pout includes much of the waters that surround the UK and the spawning grounds for Norway pout extend round the entire north coast of Scotland and into the northern north sea and into the Norwegian sea (Coull *et. al.* 1998).

12.6.34 The working construction footprint of the marine phase of the development has been calculated as between 4.65ha and 25.97ha (*Chapter 5 Project description*). This represents less than 0.1% of the size of the spawning grounds of any of the species mentioned above. Therefore the magnitude of this impact is likely to be low.

12.6.35 The LSA contains such as small percentage of the spawning grounds for the relevant species it is unlikely that any overall change in the recruitment to fish stocks caused by the development could be detected indicating that the sensitivity of this receptor would be negligible. In conjunction with the significance prediction matrix (Table 12.5) the impact of the development on spawning grounds is likely to be of **negligible** significance.

MITIGATION IN RELATION TO IMPACT 6
No mitigation suggested

Residual effect

12.6.36 As no mitigation has been suggested the residual impact will remain at **negligible** significance.

Impact 7: Displacement/loss of nursery and feeding grounds

12.6.37 The LSA has been identified (using Coull *et. al.,* 1998 and Ellis *et. al*., 2010 data provided by Cefas) as within nursery grounds for blue whiting, cod, common skate, European hake, herring, ling, mackerel, tope, whiting, sprat, Norway pout, haddock and lemon sole. The development has the potential to result in a temporary disturbance and loss of nursery grounds for these species during the construction period.

12.6.38 The maximum working construction footprint of the marine phase of the development has been calculated as between 4.65ha and 25.97ha (*Chapter 5 Project description*) (see *Chapter 5 Project description*). This area represents less than 0.001% of the nursery grounds of the species listed above. It can reasonably be assumed that feeding grounds available to all species within the LSA are much larger than the nursery grounds. Therefore the magnitude of this impact has been assessed as being negligible.

12.6.39 Many of the species with nursery grounds that overlap with the study area have been identified as being sensitive and have some status under a number of different pieces of legislation and agreements. These include cod, common skate, European hake, herring, ling, mackerel, tope, whiting, sprat, Norway pout, haddock and lemon sole. As a result the sensitivity of fish to the impacts of displacement from and loss of nursery and feeding grounds is considered to be high. However the scale of the area where displacement may occur compared to the overall local resource of similar habitat is negligible. The sensitivity of the receptor to displacement as a result of the development within the local area is considered to be low. In accordance with Table 12.5 the impact of displacement/loss of nursery and feeding grounds in assessed to be of **negligible** significance.

MITIGATION IN RELATION TO IMPACT 7
Vessel movements will be kept to the minimum practical number and should be limited to defined transit corridors.

Residual effect and best practice

12.6.40 If the mitigation suggested above is implemented the residual impact will remain of **negligible** significance.

12.6.41 At present the magnitude of the impact is assessed using the greatest possible footprint of construction works to the benthic habitat. As the project develops one of the primary actions will be to reduce the size of this footprint.

<u>Potential effects during operation (including maintenance)</u>

Impact 1: Barrier to movement / interruption of known migratory routes.

12.6.42 The layout of the oyster devices will be in a linear formation parallel to the coastline. There will be a minimum spacing between each device of 20m (*Chapter 5 Project description*). The array will therefore form the greatest barrier to fish and shellfish migrating in an easterly or westerly direction. As the majority of the devices will be within 700m of the coastline it is unlikely that any fish or shellfish species will be migrating in this direction as it is perpendicular to the shoreline and they would soon hit land. Furthermore individuals of most species will be able to navigate around the devices and pass through the spaces between the Oyster WECs.

12.6.43 As identified in Impact 1 of the construction impacts salmon are the most likely species to be migrating through the site. This species is likely to migrate in a north or south direction. The only components of the array that will create a barrier to movement in this direction are the WECs. Because of the staggering of the devices, the cross-sectional area presented will be limited to a maximum of two WECs with a space in between. Each WEC device will be up to 3.5m wide and up to 15 high and therefore the physical barrier of maximum two devices will be approximately 105m^2. This area is insignificant when put into the context of the wider environment available for fish to migrate along the coast of Lewis. Therefore both the magnitude and the sensitivity of this impact are considered to be low and in accordance with Table 12.5 the impact of the project becoming a barrier or interrupting known migrator routes will be of **negligible** significance.

MITIGATION IN RELATION TO IMPACT 1
No mitigation suggested

Residual effect

12.6.44 As no mitigation has been suggested the residual impact will remain at **negligible** significance.

Impact 2: increase in substratum/benthic habitat

12.6.45 After construction is complete much of the offshore infrastructure will become colonised by marine organisms (*Chapter 9 Benthic ecology*), and therefore the available substratum and benthic habitat will become equivalent or even slightly increased from that seen in the baseline conditions.

12.6.46 Research conducted at offshore wind farms, indicates that the array structures could act as a refuge for some fish and prey species (Linley *et. al*., 2007). Furthermore the physical structure of the gap fillers situated under each Oyster WEC (*Chapter 5: Project description*) may provide suitable habitat for some species present within the LSA. In particular lobster may use holes created by the accropodes or the cages as burrows in which to reside.

12.6.47 In relation to the existing environment, the increase in available substrate/ benthic habitat caused by the development will be of low magnitude. Furthermore the degree to which organisms will colonise the offshore infrastructure and therefore the sensitivity of the receptor is likely to be within the low category when put in a context of the wider area and therefore in accordance with Table 12.5 the impact of increased substratum/ benthic habitat for fish and shellfish species is likely to be of **negligible** significance.

MITIGATION IN RELATION TO IMPACT 2
Design of the gap fillers (see *Chapter 5: Project Description*), based on knowledge gained from the Billia Croo project, will be modified to produce suitable benthic habitat for fish and shellfish species, particularly lobsters. It is anticipated that with an increase in habitat, over time the lobster population within the development site will also increase.

Residual effect

12.6.48 With the mitigation suggested above, the sensitivity of the receptor to the impact would be increased to medium and therefore the impact of increase in substratum/ benthic habitat would be of **minor beneficial** significance.

Impact 3: Disturbance/injury as a result of noise, vibration etc.

12.6.49 Kongsberg Maritime Ltd was commissioned to carry out a study into the likely impacts of noise created by the development on fish species (see Appendix 11.2). The assessment concluded that for the hearing specialist species, avoidance behaviour would only occur when an individual came within one metre of the devices. It is considered that the development will have **no impact** as a result of disturbance from underwater noise or vibration during operation.

MITIGATION IN RELATION TO IMPACT 3
No mitigation suggested

Residual effect

12.6.50 As no mitigation has been suggested the residual impact will remain at **no impact**.

Impact 4: Pollution from routine and accidental discharges.

12.6.51 Routine discharges are not planned during operation apart from the possible use of Fluorescein Dye to test the pipelines for leaks. This test will only occur occasionally and the dye will only be released to the marine environment if a leak in the pipelines is present. Accidental discharges are considered less likely to occur during operation than during construction and therefore the magnitude of the impact will be less than during construction (negligible: see impact 4 in **Potential i mpacts d uring c onstruction** above) and the sensitivity will remain the same (medium). Therefore this impact during construction is likely to be of **negligible** significance.

MITIGATION IN RELATION TO IMPACT 4
No mitigation suggested

Residual effect

12.6.52 As no mitigation has been suggested the residual impact will remain at **negligible** significance.

Impact 5: Changes in suspended sediment levels and turbidity.

12.6.53 There will be no drilling activities during the operational phase of the Oyster wave array development. In addition, as identified during the benthic surveys (*Chapter 9 Benthic ecology*) there is very little sediment which could potentially be bought into suspension. An assessment of the impacts on sediments and sedimentary structures during operation is provided in *Chapter 7: Physical environment and coastal process* and concludes that an impact of negligible significance may occur. It is therefore assumed that the magnitude of this impact is low and that the sensitivity of species likely to be present is also low (Table 12.10). Therefore it is likely that there will be an impact of **negligible** significance to marine organisms as a result of changes in suspended sediment during the operational phase of the development.

MITIGATION IN RELATION TO IMPACT 5
No mitigation suggested

Residual effect

12.6.54 As no mitigation has been suggested the residual impact will remain at **negligible significance**.

Impact 6: Displacement/loss of spawning grounds.

12.6.55 Once the construction phase of the development is complete much of the seabed area will return to a similar habitat to that described in the baseline. Therefore a much smaller area will be affected in the operational phase than in the construction phase of the project. The impact of displacement/loss of spawning grounds was assessed to be of negligible significance during the construction phase and will be less during the operational phase but will still fall within the category of **negligible** significance as the sensitivity and magnitude will remain the same.

MITIGATION IN RELATION TO IMPACT 6
No mitigation suggested

Residual effect

12.6.56 As no mitigation has been suggested the residual impact will remain at **negligible** significance.

Impact 7: Displacement/loss of nursery and feeding grounds

12.6.57 Once the construction phase of the development is complete much of the seabed area will return to a similar habitat to that which was observed in the baseline. Therefore a much smaller area will be affected in the operational phase than in the construction phase of the project but will remain for a longer duration. The impact of displacement/loss of from nursery grounds was assessed to be of negligible significance during the construction phase and will be similar during the operational phase falling within the category of **negligible** significance as the sensitivity and magnitude will remain broadly similar.

MITIGATION IN RELATION TO IMPACT 7
No mitigation suggested

Residual effect and best practice

12.6.58 As no mitigation has been suggested the residual impact will remain at **negligible** significance.

12.6.59 At present the magnitude of the impact is assessed using the greatest possible footprint of the operational array. As the project develops one of the primary actions will be to reduce the size of this footprint.

Impact 8: Collision risk

12.6.60 The Oyster WECs which will be installed (*Chapter 5 Project description*) move with the wave motion and there is little chance that any fish or shellfish could collide with the devices as they will be entrained within the water and therefore will move in a similar way and direction to the WECs. Therefore there is likely to be **no impact** in fish or shellfish due to collision with the WECs.

MITIGATION IN RELATION TO IMPACT 8
None suggested

Residual effect

12.6.61 As no mitigation has been suggested the residual impact will remain at **no impact**.

<u>Potential effects during decommissioning</u>

12.6.62 The impacts produced during decommissioning are expected to be of the same nature and magnitude as those predicted for the construction phase with the exception of drilling which will not occur during decommissioning. Therefore the impacts to fish and shellfish will at worst have the same significance as those assessed during construction.

Cumulative effects

12.6.63 The principal offshore activities which could result in in-combination effects with the Lewis Wave array are commercial fisheries and marine traffic, both of which create noise in the marine environment.

12.6.64 Current activities that may have an overlap with the Lewis Wave Array project are:

- Voith Hydro Wavegen 4MW Wave Energy Project– located at the mouth of the River Siadar
- Pelamis Wave Power – located in offshore waters west of Loch Roag

12.6.65 However it is unlikely that the construction phase of any of these projects will overlap with the construction phase of the Lewis wave array development.

12.7 Conclusions

12.7.2 Landings data indicates that a wide variety of fish and shellfish species have the potential to be present within the development site. The consultation process has also identified that Atlantic salmon, sea trout and European eel may all be present at the site during certain seasons. These species are afforded protection through various pieces of legislation and agreements.

12.7.3 In addition, a number of species are known to use the waters around north Lewis as spawning and/or spawning grounds (blue whiting, cod, common skate, European hake, haddock, herring, lemon sole, ling, mackerel, Norway pout, saithe, sandeel, sprat, tope and whiting).

12.7.4 A number of potential impacts associated with the construction, installation, operation, maintenance and decommissioning of the development on fish and shellfish have been assessed. The main key impacts to fish and shellfish identified in the assessment included loss of spawning and nursery grounds, noise and vibration from construction and increased habitat during operation.

12.7.5 Overall through the implementation of proposed mitigation strategies and commitments the impacts to fish and shellfish are considered to be negligible.

13 TERRESTRIAL AND INTERTIDAL ECOLOGY

13.1 Introduction

13.1.1 This chapter addresses the impacts of the development, relevant to terrestrial and intertidal ecology, with particular reference to the potential impacts associated with the pipelines which connect the on and offshore components of the project and associated onshore infrastructure, including the hydro electric power station and access tracks required.

13.1.2 For the purposes of the Environmental Statement (ES), intertidal ecology is combined with terrestrial ecology and not with benthic ecology. Nature conservation features have been defined as terrestrial flora and fauna, including mammals (which may be partially marine, e.g. otter) and reptiles, along with intertidal biotopes and species from strandline to low water spring tide.

13.1.3 The aims of this chapter are to:

- Outline the present state of the existing terrestrial and intertidal ecology and nature conservation features;
- Establish the likely outcome for these under the ‘do nothing’ scenario;
- Assess the implications of the development for these features;
- Recommend a range of mitigation measures to minimise the potential impacts;
- Assess cumulative impacts; and
- Consider the residual effects (after mitigation of impacts).

13.1.4 The study area for onshore works is shown on Figure 13.1 and is further discussed in Chapter 4 *Site selection* and Chapter 5 *Project description*. Within this chapter, the term development refers to the preferred intertidal and terrestrial pipeline route and hydro electric power station infrastructure.

13.1.5 This chapter deals solely with the potential impacts of the development on terrestrial and intertidal habitats and species to mean low water spring (MLWS), including nature conservation issues and the risk of spreading terrestrial and coastal invasive and/or non native species. Potential impacts on birds, marine mammals, marine benthos, and salmonid fish, are assessed in Chapters 10, 11, 9 and 12 respectively.

13.1.6 The aesthetic and landscape implications of onshore infrastructure are dealt with separately in *Chapter 17: Seascape, landscape and visual assessment*.

13.2 Summary of assessment on terrestrial and intertidal ecology

13.2.1 The study area is not designated for ecological features of conservation importance. Studies of the existing environment confirm the most sensitive ecological features were the blanket bog/wet heath habitat and watercourses, the latter of which was also important for otters. These features were considered during the development of site layout and consequently avoided as mitigation through design. Greatest impacts are anticipated to be associated with habitat loss of acid grassland, temporary disturbance of wet heath during upgrades to the access road, changes to the ecology of the intertidal zone and disturbance of otter. Following best practice and further mitigation identified within this chapter, no impact is predicted to be significant in Environmental Impact Assessment (EIA) terms.

13.3 Potential effects

13.3.1 The potential adverse effects of the development's pipelines landfall and onshore infrastructure on terrestrial and marine ecology relate to habitat disturbance or removal, death, injury or disturbance of fauna and flora and/or their supporting habitat, and the spread of invasive species. Indirect disturbance has potential to occur to the foreshore habitats and species with the receptor pathway of the offshore infrastructure due to a possible change in wave regime.

13.3.2 In particular, disturbance to protected species (including otter) may have legal implications (see Section 13.4.1 and *Chapter 6: Regulatory and Policy Context*).

13.3.3 Potential adverse impacts can be mitigated through best practice and habitat enhancement, with opportunities for mitigation discussed in each impact section.

13.4 Methodology

13.4.1 This EIA considers the likely effects of the development on terrestrial and intertidal ecology that may arise during the construction, operational (including maintenance) and decommissioning phases of the proposed scheme, particularly the pipelines and pipeline landfalls, and onshore infrastructure. The sections below describe the assessment methodology, including relevant legislation, policies and plans, consultation, data collection and surveys, and impact assessment criteria that were used to undertake the impact assessment.

Legislation, Guidelines and Policy Framework

13.4.2 This section identifies the legislation, policies, plans and guidance that are relevant to terrestrial and intertidal ecology and which have been considered in relation to the development.

13.4.3 The relevant legislation and policies are outlined in Table 13.1 and further detail is provided in Chapter 6: *Regulatory and Policy Context*.

Figure 13.1 Site layout and study areas.

Table 13.1 Relevant legislation, policy or plan – terrestrial and intertidal ecology
Legislation, Policy or Plan
Wildlife and Countryside Act (1981) as amended by the Nature Conservation (Scotland) Act (2004)
Nature Conservation (Scotland) Act (2004) (as amended)
Town and Country Planning (Scotland) Act 1997 (Section 57 (2))
Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2000;
Marine Works (EIA) Regulations 2007
The Electricity Act 1989;
Habitats Directive (Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora) as transposed into Scots law by the Conservation (Natural Habitats &c.) Regulations 1994 (the "Habitats Regulations"); and
The Conservation (Natural Habitats, &c.) Amendment (Scotland) Regulations 2007.
Water Framework Directive (Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy), as transposed into Scots Law by the Water Environment and Water Services (Scotland) Act (WEWS) 2003 and the Water Environment (Controlled Activities)(Scotland) Regulations 2011
The Environmental Impact Assessment (Scotland) Regulations 1999
Coastal Protection Act (1949) Section 34
Marine Scotland Act 2010
Western Isles Local Biodiversity Action Plan (LBAP) and National Biodiversity Action Plans (BAPs)
Western Isles Structure Plan (2003) and Local Plan (2008)
Scottish Government's Scottish Planning Policy (SPP) 2010
Scottish Government's National Planning Framework (NPF2) 2009
SEPA Policy 21 – Strategy for implementing actions under the UK Biodiversity Action Plan (UK BAP)
SNH Policy 0203– Wilderness in Scotland's Countryside
SNH Policy 0102 SNH's Policy on Renewable Energy
NPPG 14 (Natural Environment)
PAN 60 (Planning for Natural Heritage)
PAN 58 (Environmental Impact Assessment).
SNH, 2002, A Handbook on Environmental Impact Assessment, Guidance for Competent Authorities, Consultees and others

Development Plan Policy

13.4.4 Comhairle nan Eilean Siar (The Western Isles Council) Local Plan was adopted in 2008, and includes policies relating to the development and potential considerations for renewables developments.

13.4.5 The Western Isles Structure Plan, adopted in 2003, identifies the following policies relevant to the development and potential ecological considerations:

- SC9 Sustainable Management Practices (encouraging management practices and activities that meet sustainability objectives in the use of land, water and other natural resources);
- DM1 Location of Development (including provision of support to developments on moorland which do not result is excessive additional public expenditure and fulfil other criteria of sustainability);
- RM2 Land Management, Crofting and Biodiversity;
- RM8 International Natural Heritage Designations;
- RM9 National Natural Heritage Designations;
- RM10 Local Environmental Designations; and
- RM11 Habitats and Species.

Biodiversity Action Plans

13.4.6 The Western Isles Local Biodiversity Action Plan (BAP) has prepared plans for several habitats and species, none of which are likely to be affected by the proposed development due to their geographical location or habitat requirements. The UK BAP has Habitat Action Plans (HAPs) (for 'Blanket Bog, and 'Upland Heath') which are of relevance to the proposed development.

13.4.7 Table 13.2 lists the relevant National Biodiversity Action Plan Habitats and Species (excluding birds). All but *Fucus distichus* were identified within the study area.

Table 03.2 Habitats and Species for which action plans have been prepared within the National Biodiversity Action Plans that have been identified as potentially relevant to the study area.

National BAP species	National BAP habitats
Otter *Lutra lutra*	Blanket bog
Juniper *Juniperus communis*	Upland heath
Fucus distichus	Intertidal under boulder communities

Western Isles Species Priority List

13.4.8 As part of their biodiversity action planning work Western Isles Council have developed the Western Isles Species Priority List for conservation initiatives. The list identifies several priority animals and plants which may be encountered along the north-west Lewis coastline, including otter, Scottish scurvy grass *Cochlearia scotica*, juniper *Juniperus communis* and several eyebright *Euphrasia spp* species.

Scottish Natural Heritage (SNH) Priority Marine Features

13.4.9 The draft Priority Marine Features (PMFs) list contains habitats and species which SNH believe to be of greatest conservation importance in Scottish territorial waters[1]. Almost 40,000 marine species are known to occur in Scotland's inshore waters, out to 12 nautical miles. Otter is an SNH Marine Priority Species.

Guidance

13.4.10 The following guidance has been considered within this chapter. Where relevant to this development, wind farm guidance has been included. Full details of all references used for field surveys are provided in Appendices 13.1 and 13.2.

- SNH, 2002: A Handbook on Environmental Impact Assessment, Guidance for Competent Authorities, Consultees and others;
- Institute of Ecology and Environmental Management (2006) Guidelines for Ecological Impact Assessment in the United Kingdom (version 7 July 2006). http://www.ieem.org.uk/ecia/index.html;
- Institute of Ecology and Environmental Management (2006) Guidelines for Ecological Impact Assessment in the United Kingdom – Marine and Coastal (Final version 5 Aug 2010). http://www.ieem.net/ecia.asp;
- Comhairle nan Eilean Siar (CnES) 2010: Large Scale Wind Energy Developments.
- JNCC, (2010), Handbook for Phase 1 habitat survey - a technique for environmental audit, ISBN 0 86139 636 7;
- SEPA (2010) Land use planning system SEPA guidance note 4: Planning Guidance on wind farm developments (including guidelines for groundwater unit staff and ecologists when assessing the impacts of wind farms on groundwater and associated receptors);
- SR, SNH, SEPA & FCS (2010): Good practice during wind farm construction (version 1);
- SNH Scottish Wildlife Series: Otters and Development. Available from: http://www.snh.org.uk/publications/on-line/wildlife/otters/default.asp;

[1] http://www.snh.gov.uk/docs/B874876.pdf

- Department for Transport's Design Manual for Roads and Bridges; Available from: http://www.dft.gov.uk/ha/standards/dmrb/index.htm;
- SNIFFER (2009) WFD95 – A Functional Wetland Typology for Scotland;
- FCE, SNH (2010) Floating Roads on Peat;
- SEPA (2008) Engineering in the water environment good practice guide: construction of river crossings;
- CIRIA C648 (2006), Control of water pollution from linear construction projects;
- CIRIA Guidance note C692 Environmental Good Practice on Site Guide (3rd edition)
- CIRIA The Coastal and marine environmental site guide (C584)
- SEPA PPG 5 Works and maintenance in or near water; and
- SNH (2006) Constructed tracks in the Scottish Uplands.

Consultation

13.4.11 The Scoping Opinion is provided in Appendix 2.1. Table 13.3 outlines the responses relevant to this chapter.

Table 13.3 Issues raised by SNH and SEPA in the scoping opinion (Marine Scotland 2011)

Issue	Response
SNH requested otter surveys to be conducted in freshwater, terrestrial and marine environments, identifying information on survey methodology and mitigation for otters is available in the SNH publication 'Otters and Development' Royal Society for the Protection of Birds (RSPB) requested utilising historical knowledge from other planning applications such as Lewis Wind Power and Voith Hydro WaveGen as well as dedicated searches	Survey and literature review completed, and results and proposed mitigation confirmed with SNH
Marine Scotland Licensing Operation Team (MS-LOT) identified the need to establish which species (including European Protected Species, or those listed on Schedule 5 (animals) and 8 (plants) of the Wildlife and Countryside Act 1981 are present on and near the site, and where, before the application is considered for consent.	Results of Extended Phase 1 Habitat and Otter Survey and Intertidal Survey presented to SNH, who confirmed otter is the only species of relevance to the site. Survey results and proposed mitigation confirmed with SNH. SNH confirmed need for Habitats Regulations Appraisal (HRA) or European Protected Species Licence (EPS) for otters however details of final construction design

Table 13.3 Issues raised by SNH and SEPA in the scoping opinion (Marine Scotland 2011)	
Issue	**Response**
	will be discussed with SNH.
Scottish Environment Protection Agency (SEPA) requested the ES demonstrate how the layout and design avoids areas of peatland	Results of habitat surveys were fed into the project design to avoid blanket bog and wet heath habitats. Further mitigation is provided in Chapter 8: Soils, hydrology and hydrogeology
SEPA requested A Phase 1 habitat survey should be carried out for the whole site and the guidance 'A Functional Wetland Typology for Scotland' used to help identify all wetland areas. National Vegetation Classification should be carried out for any wetlands identified. Results of these findings should be included in the ES SEPA identified groundwater dependant terrestrial ecosystems (GWDTE) are specifically protected under the Water Framework Directive (WFD) and any potential impact to these will require further assessment	Extended phase 1 habitat survey undertaken, and results used to inform final site selection. Further consultation was undertaken with SEPA (21/02/2012) regarding groundwater dependant terrestrial ecosystems: The following was confirmed The access track should be a floating road over areas of deep peat, marshy grassland, or wet heath (as stated in the documentation). The hydro-election power station, and any other construction should not be on areas of marshy grassland or wet heath (as recommended in the Phase 1 habitat report) SEPA has advised any buried cableways should have mitigation to ensure they do not become preferential drainage conduits for areas of peat, marshy grassland, or wet heath. If construction other than a floating road on peat is proposed on possible GWDTEs further investigation and mitigation would be required. Construction details will be confirmed at a later stage in consultation with SEPA.
SNH identified the need to consider reptiles and amphibians in the Scoping Opinion, however clarified in following correspondence that the development site taken forward has no potential for amphibians and reptiles;	Justification made with the ES
SNH requested the Lewis Peatlands Special Area of Conservation SAC and Special Protection Area SPA are considered for potential impacts to qualifying habitats and	Following final site location, SNH have confirmed there is no potential impact to the Loch Dalbeg SSSI or Lewis Peatlands SAC

Table 13.3 Issues raised by SNH and SEPA in the scoping opinion (Marine Scotland 2011)	
Issue	**Response**
otter, with potential need for Habitats Regulations Appraisal (HRA). Loch Dalbeg Site of Special Scientific Interest SSSI should also be considered if onshore works are close to this site.	and SPA.

Data collection

13.4.12 The baseline conditions of all ecological elements, including conservation areas and protected species or habitats within or adjacent to the development, along with potential hydroelectric power station location and pipeline route areas have been determined from existing data sources.

13.4.13 The principal data sources relevant to the terrestrial and intertidal ecology are shown below in Table 13.4.

Table 13.4 Data sources			
Data source	**Coverage**	**Author(s)**	**Year**
Commissioned survey	Extended phase 1 habitat survey (Appendix 13.1)	Royal Haskoning	2011
Commissioned survey	Intertidal Survey (Appendix 13.2)	Royal Haskoning	2011
Commissioned survey	Coastal geomorphology survey (Appendix 7.3)	Royal Haskoning	2011
Website for data	www.Marlin.ac.uk	The Marine Biological Association of the UK	2012
Website for data	http://gateway.snh.gov.uk/sitelink/	Scottish Natural Heritage	2012
Website for data	http://data.nbn.org.uk/	National Biodiversity Network	2012
ES document for development in the vicinity	Voith Hydro WaveGen Project	Npower Renewables	2007
ES document for development in the vicinity	Stornoway Wind Farm	Amec	2011

Assessment of significance

13.4.14 The assessment of impact significance methods draws on published guidance, where applicable (e.g. IEEM's 'Guidelines for Ecological Impact Assessment in the UK', 2006 and SNH's 'A Handbook on EIA', 2005). Once identified, the ecological impacts are ranked according to the comparative severity of their impact on the ecological feature / receptor. In defining and predicting impact significance, consideration is given to a range of parameters including whether the impact is adverse or beneficial, impact magnitude, extent, duration, reversibility and timing / frequency. The degree of confidence of the predicted impacts (pre-mitigation and residual) is also discussed in the assessment where appropriate.

Nature and magnitude of effect

13.4.15 The effects (both adverse and beneficial) of the construction and operation of the development, and any potential cumulative effects associated with other proposals for the wider area, are assessed for their potential effect on the ecological interests. The effect magnitude is determined by the interaction between the scale of the effect in time, area and intensity and the sensitivity of the species being impacted. Guideline criteria for different levels of effect magnitude are given in Table 13.5 below.

Table 13.5 Criteria for assessing the magnitude of effects on terrestrial and intertidal ecology

Magnitude of effect	Definition
Total / Near Total	Would cause the loss of a major proportion or whole feature / population, or cause sufficient damage to a feature to immediately affect its viability.
High	Major effects on the feature / population, which would have a sufficient effect to alter the nature of the feature in the short-long term and affect its long-term viability. For example, more than 20% habitat loss or damage.
Medium	Effects that are detectable in short and long-term, but which should not alter the long-term viability of the feature / population. For example, between 10 - 20% habitat loss or damage.
Low	Minor effects, either of sufficiently small-scale or of short duration to cause no long-term harm to the feature / population. For example, less than 10% habitat loss or damage.
Negligible / None	A potential impact that is not expected to affect the feature / population in any way, therefore no effects are predicted.
Duration definitions	Long-term (more than 15 years) Medium-term (5 - 15 years) Short-term (< 5 years)

Valuation of receptors

13.4.16 Each key ecological receptor is described in terms of its nature conservation importance. In addition an assessment of the likely sensitivity of the feature / resource is also made. These methods are based on professional judgement and best practice guidance.

13.4.17 Examples of the criteria used to define the value of nature conservation receptors relevant to the development are outlined in Table 13.6 below.

Table 13.6 Criteria used to define the value of nature conservation receptors relevant to the development

Receptor sensitivity/ value	Guideline criteria
Very High (International importance)	Habitats or species that form part of the cited interest within an internationally protected site or candidate site (e.g. SAC, cSAC, pSAC, SPA, pSPA, Ramsar site etc.). A feature (e.g. habitat or population) which is either unique or sufficiently unusual to be considered as being one of the highest quality examples in a international / national context that the site is likely to be designated as an SAC / SPA. Species designated as European Protected Species (EPS).
High (National importance)	Habitats or species that form part of the cited interest within a nationally designated site (SSSI, ASSI, NNR, MNR). A feature (e.g. habitat or population) which is either unique or sufficiently unusual to be considered as being one of the highest quality examples in a national / regional context for which the site could potentially be designated as an SSSI.
Medium (Regional importance)	Habitats or species that form part of the cited interest of a Local Nature Reserve, or some local-level designated sites depending on specific site conditions. Viable areas of internationally or nationally important habitats (e.g. Annex I habitats, priority BAP habitats) or Annex II species present in quality and extent at a regional, or relevant biogeoclimatic zone (i.e. SNH natural heritage zone), level of importance. Population of a species which is either unique or sufficiently unusual to be considered as being of nature conservation value at up to a county context (e.g. Nationally Scarce). Sites supporting critical habitats for a regularly occurring, regionally significant number of a nationally important species (e.g. priority UK BAP).
Low (Local importance)	Sites meeting the criteria for Scottish Council area designation, Wildlife Sites, which may include amenity and educational criteria in urban areas. Sites containing viable areas of any priority habitat identified in the Local Authority LBAPs. Sites supporting viable breeding populations of species known to be Scottish LA rarities (e.g. included in the LBAP), and / or supplying critical elements of their habitat requirements. Any regularly occurring, locally significant population. Features / habitats or species which are not considered to qualify for non-statutory designation but which provide locally important semi-natural habitats in the context of the immediate surrounding area (e.g. species-rich hedgerows, small ponds, etc.). Populations of any species of conservation importance in the context of the immediate surrounding area.
Negligible (less than Local importance)	Commonplace feature of little or no habitat / historical significance. Loss of such a feature would not be seen as detrimental to the ecology of the area.

Significance of effects

13.4.18 Following the determination of nature conservation value and effect magnitude the significance of the effect is determined by combining the two. Table 13.7 illustrates the relationship between effect magnitude and nature conservation value. This table is for guidance only as in practice the assessment of effect significance involves judgment based on the nature of the potential impacts and detailed understanding of the sensitivity of the ecological features affected.

13.4.19 Significance is assessed factoring in the implementation of all mitigation by design and other mitigation measures identified to reduce predicted effects, creating the residual effect significance. Only those effects of moderate to major level are considered to be significant (i.e. considered to be “significant effects” in terms of the EIA Regulations). Although only significant effects require mitigation, lesser effects may also need to be addressed depending on specific circumstances.

13.4.20 Table 13.7 combines the definitions of magnitude with the level of sensitivity/value/importance of receptor to provide a prediction of overall significance of the effect.

Table 13.7 Significance prediction matrix

Magnitude of effect	Receptor sensitivity/value				
	Negligible (Less than local)	Low (Local)	Medium (Regional)	High (National)	Very High (International)
Total / near total	Minor	Moderate	Major	Major	Major
High	Minor	Moderate	Major	Major	Major
Medium	Negligible	Minor	Moderate	Moderate	Major
Low	Negligible	Negligible	Minor	Minor	Moderate - Minor
Negligible	Neutral - Negligible				

13.5 Existing environment

13.5.1 For the purpose of this chapter, the following terms apply:

- ‘Development area’ refers to the development boundary; and
- ‘Study area’ refers to the wider footprint within which the extended phase 1 habitat survey, intertidal survey and otter survey took place;

13.5.2 These areas are identified on Figure 13.2.

Designated sites

13.5.3 Table 13.8 outlines the terrestrial and coastal designated sites and habitats within, adjacent or close to the footprint of the development area. Designations relating to marine or ornithological features are discussed in *Chapter 9: Benthic ecology, Chapter 11*: *Marine mammals and basking sharks* and Chapter 10: *Ornithology*, with geological designations discussed in *Chapter 7*: *Physical environmental and coastal processes*. Designated sites and their proximity to the development are shown on Figure 13.2.

Table 13.8 Designated features			
Designated Site	**Features**	**Location**	**Value**
Lewis Peatlands Ramsar	• Blanket bog • Breeding bird assemblages • Dunlin (*Calidris alpina schinzii*), breeding	Covers the same area as the Lewis Peatlands SPA, 2.6km inshore of the development	High
Lewis Peatlands SAC	• Acid peat-stained lakes and ponds • Blanket bog • Clear-water lakes or lochs with aquatic vegetation and poor to moderate nutrient levels • Depressions on peat substrates • Wet heathland with cross-leaved heath • Otter (*Lutra lutra*)	Approximately 2.6 km inshore of the development	High
Loch Roag lagoons SAC	• Lagoons	Approximately 26km south west of the development	High
Traigh na Berie SAC	• Machair	Approximately 33.5km south of development	High
Loch Tuamister SSSI	• Standing open water and canals • Fen, marsh and swamp (Wetland)	Approximately 15.8km east South west of the development	Medium
Loch Scarrasdale valley bog SSSI	• Blanket bog	Approximately 9.5km to the east of the development Near to the eastern coast of Lewis	Medium
Loch na Cartach SSSI	• Eutrophic loch • Maritime cliff	Approximately 14.5km east of the development on the eastern coast of Lewis	Medium
Loch Dalbeg SSSI	• Mesotrophic loch	18.8km south west of the development	Medium

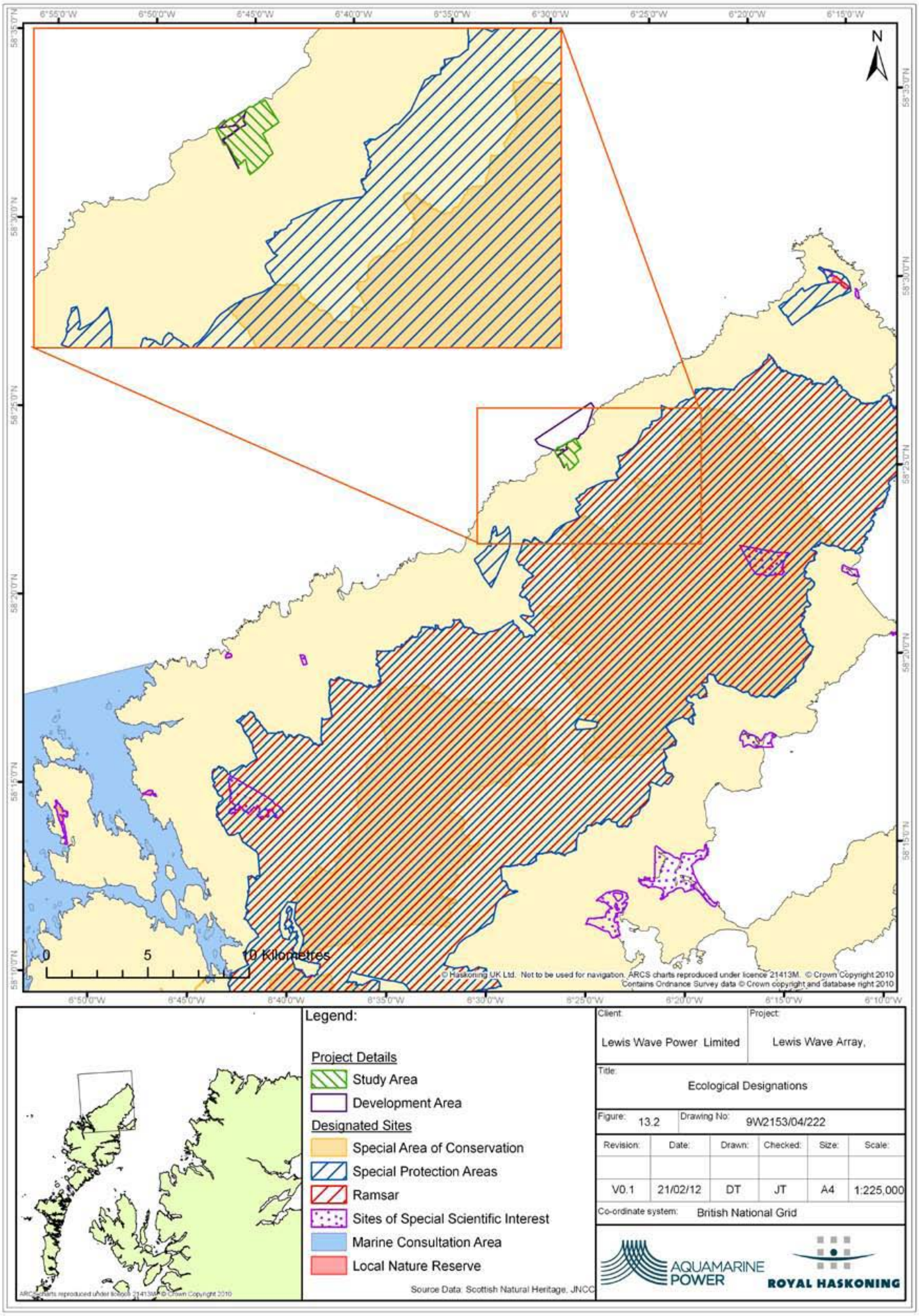

Figure 13.2 Ecological designations

13.5.4 There are no Local Nature Reserves (LNR), County Wildlife Sites (CWS) or Sites of Interest to Natural Science (SINS) within or adjacent to the study area.

13.5.5 The study area is undesignated and SNH have confirmed the development area does not have any significant connectivity with the Lewis Peatlands SAC/SPA or Ness and Barvas SPA nearby (Appendix 3.1).

<u>Terrestrial habitats and flora</u>

13.5.6 An extended phase 1 habitat survey was completed within the study area on 30th, 31st August and 2nd September 2011 Appendix 13.1). A summary of the terrestrial ecology of the study areas is described below, with two main habitat types across the study area: the wetter blanket bog, wet heath and marshy grassland communities to the south and east, and the dryer acid grassland communities on the coastal fridge and hilltop. A Phase 1 Habitat map is provided in Figure 13.3.

13.5.7 The underlying geology comprises Lewisian Gneiss, a hardrock. The permeability of Gneiss is low and groundwater flow is through fractures and unlikely to support the development of peat. The peat at the site is rainfall fed, and not groundwater fed. Therefore, however wetland species have been identified on site, additional National Vegetation Classification (NVC) survey work has not been undertaken to identify ground water dependant terrestrial ecosystems. Given the presence of peat across the majority site, Chapter 8: *Soils, hydrology and hydrogeology* considers mitigation regarding potential impacts to groundwater and surface water.

Blanket bog, marshy grassland and wet heath communities

13.5.8 Much of the southern (inland) part of the study area consists of a complex mix of blanket bog marshy grassland, exposed peat hag, and wet heath/acid grassland mosaic, with gradual transition between these habitats across the site. This area is very wet and spongy underfoot indicating the water table is at or close to the surface. Standing water is present, particularly in areas of peat gullying and erosion. Some areas of erosion are classed as active blanket bog, showing signs of re-generation, and supporting a significant area of vegetation that is normally peat forming. A large expanse of eroded peat hag (mapped as bare peat) was present within the site, with limited vegetation of ling heather and deer grass. Extensive sheep footprints were present across the bare peat indicating that grazing activities occur in this area, up to the stock fence which is present at the top of a ridge line (Figure 13.3).

13.5.9 A peaty dystrophic lochan is also present within this section of the study area, which flows via the Lambol Burn west to the sea. Evidence of historic (regenerated) and current (stacked) peat cutting is also present within this area.

13.5.10 The habitat complexity found during the survey is considerable with many different habitats encountered in a small area. The map in Figure 13.3 therefore shows the most dominant habitat classifications with further details of species present and features of interest (including wet bog pools and hollows) discussed in the target notes.

13.5.11 At the southern end of the study area there is a fenced off field complex which is slightly higher in altitude than the surrounding land and is dryer. This fenced area supports a series of small fields of acid and improved grassland. The lower fields in this area are however also very wet, especially near the Lambol burn.

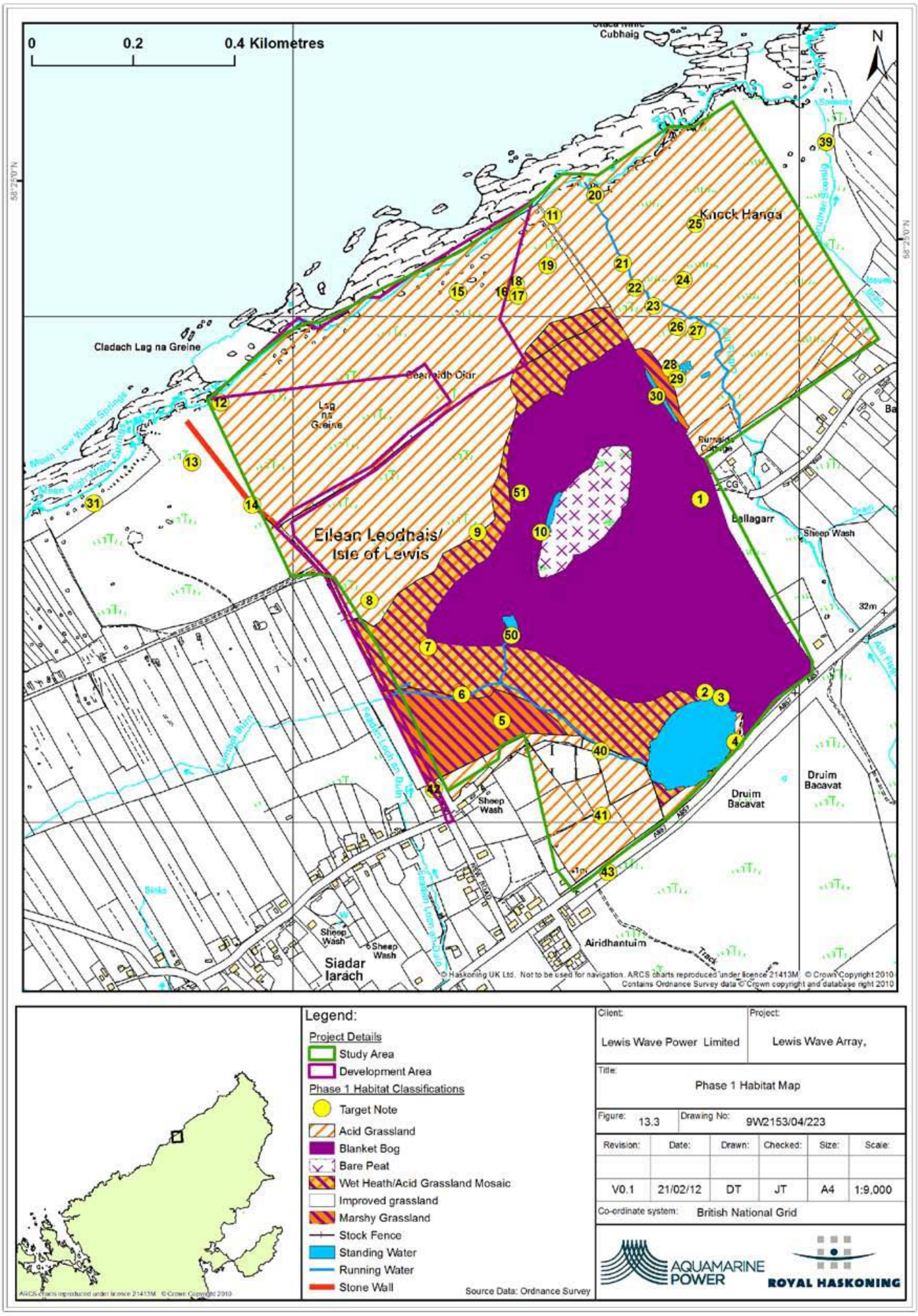

Figure 13.3 Phase 1 Habitat Map

Acid grassland communities

13.5.12 In the northern and coastal region of the study area the ground rises steadily uphill away from the sea to a height of about 30 metre (m) before decreasing in altitude towards wetter blanket bog habitat described above. This area is predominantly species rich acid grassland with some heath species also present, including ling heather, bell heather marsh lousewort, bog cotton and bog asphodel (in small numbers). As more than 75% of the habitat is acid grassland that is the classification assigned to this area in the Map (Figure 13.3). The seaward facing slope is exposed to strong winds off the Atlantic, and the vegetation is noticeably short and stout, with ericoids present as a low carpet layer understory beneath the grasses. Maritime indicator species present in the coastal fringe, include thrift *Armeria maritima*, suggesting coastal grassland is present, and merges into the acid grassland habitat as the terrain rises up from the shore.

13.5.13 Remains of historic "lazybeds" are present in the coastal margin, running down the slope towards the sea and lying perpendicular to the shore. This further suggests this area is well drained having been used historically for agriculture. The lazybeds area (marked as Lag na Greine on Figure 13.3 is not used for grazing, as a stock fence running parallel to the coastline prevents access by grazing animals. The restricted grazing in this area may contribute to species richness of the acid grassland community.

13.5.14 A narrow burn, the Allt Fisgro is set into a v shaped valley of varying steepness in the east of the study area, and flows north to the sea. The surrounding acid grassland is wetter than that to the south-west, and pools with *Sphagnum* or *Potomogeton* species are present in this area.

13.5.15 Further details of target notes are contained in Appendix 13.1.

Intertidal species habitats

13.5.16 The 35 kilometres (km) stretch of coast line, between Arnol and the Butt of Lewis which includes the study area, was described by Powell *et. al*. (1979) as a good example of fully exposed shelving rocky shore in north-west Britain.

13.5.17 The shores of the study area are characterised by small regions of bedrock, rock platform, rock platform with banks of gravel, rock platform with loose boulders and small areas of sand particularly in the northern part extent of the area of search (http://www.magic.gov.uk). Limited intertidal study work has previously been completed around Siadar Bay (within the area of search) as part of an EIA for the Voith Hydro WaveGen Wave Energy Project at Siadar. Fauna found during the survey included small mussels, limpets, edible periwinkle *Littorina littorea*, acorn barnacle *Semibalanous balanoides* and the beadlet anemone *Actinia equina*. The rocky shores to the north of Siadar Bay were found to be more exposed and subsequently support a more limited fauna and flora. No unusual or rare or protected species were found during this survey.

13.5.18 An intertidal survey was conducted at low water spring tide along the coastline facing the proposed oyster locations, using a number of methods and techniques, based upon those specified in the Countryside Council for Wales (CCW) report 'CCW Handbook for marine intertidal Phase 1 mapping' (Wyn *et al.*, 2000) and the 'Marine Nature Conservation Review: Rationale and methods' (Hiscock, 1996).

13.5.19 19 target notes within the study area were recorded during the intertidal survey. The study area was extended beyond the boundary of the intertidal area to provide a record of the shore beyond where any potential impact would be likely to occur (Figure 13.4).

Biotope mapping

13.5.20 16 different biotopes were recorded over the 23 different target notes (Table 13.9). The number of biotopes recorded at each target note was not limited to a single biotope at that location, many of the target notes encompass more than one biotope. The biotopes that were recorded during the survey are displayed in Figure 13.4.

Table 13.9 Intertidal biotopes found on site

Biotope	Description
IR.MIR.KR.Ldig.Bo	*Laminaria digitata* and under-boulder fauna on sublittoral fringe boulders
IR.MIR.KR.Ldig.Ldig	*Laminaria digitata* on moderately exposed sublittoral fringe bedrock
LR.FLR.Lic	Lichens or small green algae on supralittoral and littoral fringe rock
LR.FLR.Lic.Ver.Ver	*Verrucaria maura* on very exposed to very sheltered upper littoral fringe rock
LR.FLR.Rkp.Cor	Coralline crust-dominated shallow eulittoral rockpools
LR.FLR.Rkp.Cor.Cor	Coralline crusts and *Corallina officinalis* in shallow eulittoral rockpools
LR.FLR.Rkp.G	Green seaweeds (*Enteromorpha* spp. and *Cladophora* spp.) in shallow upper shore rockpools
LR.HLR.MusB.MytB	*Mytilus edulis* and barnacles on very exposed eulittoral rock
LR.HLR.MusB.Sem.Sem	*Semibalanus balanoides, Patella vulgata* and *Littorina* spp. on exposed to moderately exposed or vertical sheltered eulittoral rock
LR.MLR.BF	Barnacles and fucoids on moderately exposed shores
LR.MLR.BF.Fser.R	*Fucus serratus* and red seaweeds on moderately exposed lower eulittoral rock
LR.MLR.BF.FvesB	*Fucus vesiculosus* and barnacle mosaics on moderately exposed mid eulittoral rock
LR.MLR.BF.PelB	*Pelvetia canaliculata* and barnacles on moderately exposed littoral fringe rock
LS.LCS.Sh	Shingle (pebble) and gravel shores
LS.LMx	Littoral mixed sediment
LS.LSa.St	Strandline

13.5.21 No rare or protected species, habitats or biotopes were recorded during the intertidal survey, with the exception of occasional examples of under boulder communities, which although present, did not support biotopes considered rare or of conservation importance and were subject to movement due to the high energy of the site. Particular attention was made to determining presence/ absence of the species *Fucus distichus*, an SNH priority species and is likely to be sensitive to a change in wave exposure, however this species was not located within the study area or extended study area surveyed.

13.5.22 The level of exposure appears to dictate the floral and faunal distribution within the survey area. The northern stretch of the survey area, which is particularly exposed, exhibited low species diversity supporting only species that are robust and can survive high energy environments, such as mussels and barnacles. The fucoid seaweeds present in this location were found to be shorter, stouter and tougher in morphology than the same species in more sheltered regions of the study area. A large spray zone was also present here in which the tar lichen dominated and during the survey (conducted within 2 hours of the low spring tide), waves and spray were reaching the top of the cliff. This extremely high energy environment was encountered in the north of the study area and at two small exposed headlands - firstly at target note 18 and secondly to the south of the survey area at target note 22 (Figure 3.4).

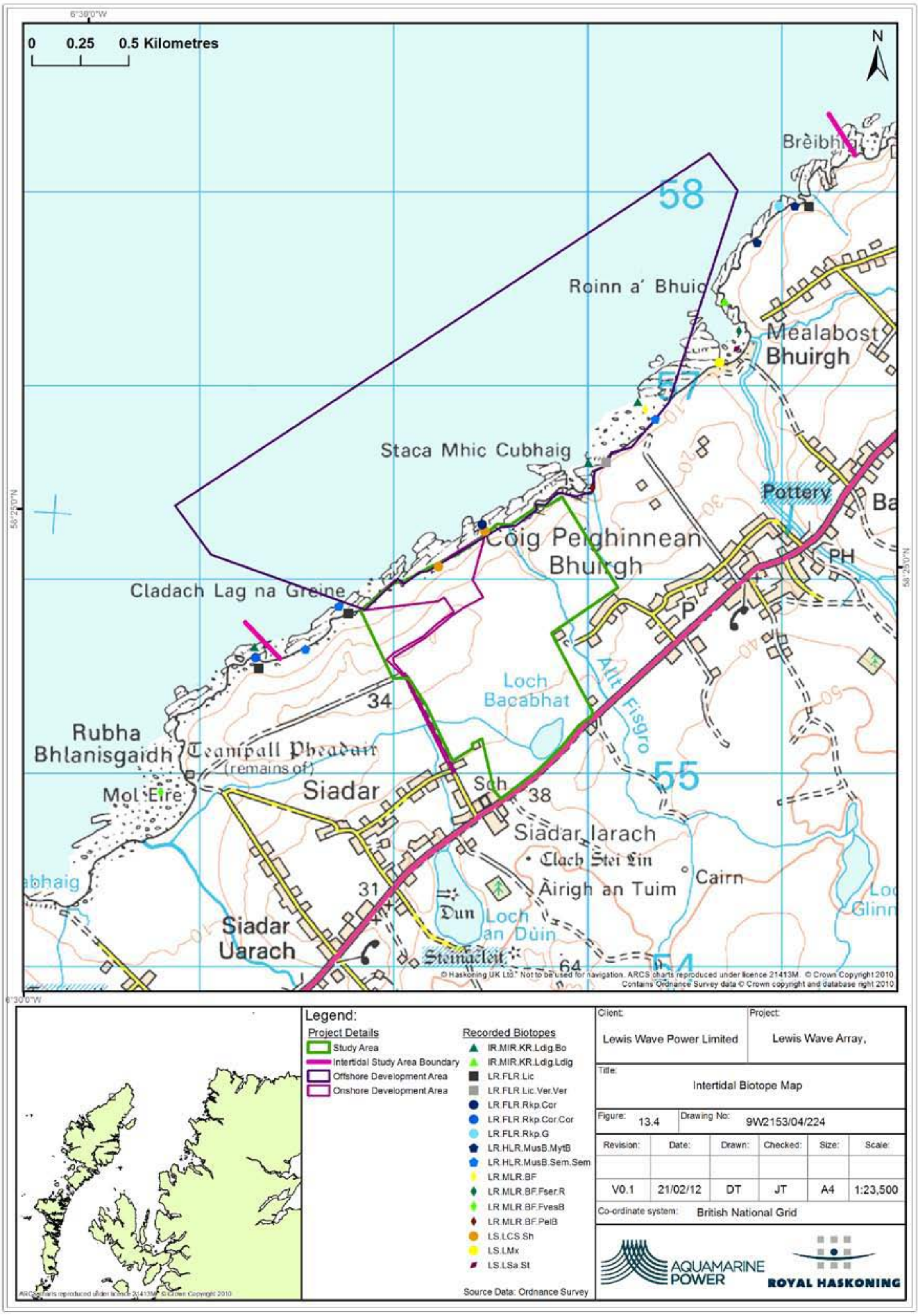

Figure 13.4 Intertidal Biotope map

13.5.23 In more sheltered areas boulders were present between areas of bedrock and here algal communities were dominant with kelps dominating the low shore and fucoids the mid shore. This is supported by the geomorphology report (Appendix 7.3) which concludes the protruding bedrock provides a degree of protection to the shore features from wave action. This type of medium exposure environment makes up the majority of the study area which exhibits high species diversity.

13.5.24 In the bay at just south of Roinn a Bhuic (Figure 13.4) a more sheltered habitat was found. Here sand and gravel had built up between the boulders creating a contrast to the rest of the survey area. This location was the only example on where the biotope LS.LMx (Littoral mixed sediment) within the survey area.

Eurasian otter

13.5.25 Otter is afforded European protection through Annex II and Annex IV of the Habitats Directive (Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora). Otters are protected in the UK through The Wildlife and Countryside Act 1981 (as amended) and The Conservation (Natural Habitats, &c.) Regulations 1994 (as amended in Scotland). It is illegal to intentionally or recklessly kill, take or injure an otter, intentionally or recklessly disturb an otter in its place of shelter and intentionally or recklessly damage, destroy or obstruct access to a place of shelter. SNH generally recommends that a European Protected Species (EPS) licence for disturbance will be required if a development will encroach within 30m of an otter resting site. This distance may be extended to 100 to 200 m for sites where breeding is suspected or confirmed.

13.5.26 Otter is a priority species in the UK Biodiversity Action Plan.

Otter in the Western Isles

13.5.27 Otter underwent rapid decline in the UK from the 1950s to the 1970s, and the species was largely lost from midland and south-eastern counties of England by the 1980s. Populations remained in Wales, southwest England, Northern Ireland and much of Scotland. Recent surveys indicate that UK-wide otter declines have now halted (Chanin 2003a). In Scotland, the percentage of sites where otter signs were found rose from 57% to 83% between the late 1970s and early 1990s (Chanin 2003b).

13.5.28 Otter is widespread in the Western Isles, which are generally considered to be a stronghold for the species. During 2004 a total of 29x ten km^2 were surveyed for otters within the Western Isles and 100% of these sites were found to be positive for the species (Strachan 2007). Strachan compared data from sites surveyed in both 2004 and during a previous survey in 1978 to 79. There was no significant difference and Strachan considered that the data are indicative of a stable population at or near carrying capacity.

13.5.29 Otter is a designated feature in the Lewis Peatlands SAC, 2.6km from the footprint of the development. The Lewis Peatlands is an expansive area of peat moor and lochs in the northern part of Lewis covering 27,945.6 hectares (ha). Strachan (2007) conducted research within the Lewis Peatlands SAC and concluded that due to low productivity in burns and lochs, otters travel across the peatlands to the coasts to feed. This was evidenced by crab shell and sea fish remains contained within spraints left within the SAC. The prey available to otters living within the SAC were therefore concluded to be marine fish, crustaceans, eels, salmon, sea trout, brown trout, dragonfly larvae (Strachan, 2007). The SAC otter feature was concluded to be in *favourable* condition (Strachan, 2007). Survey work conducted recently, as part of the Lewis Wind Farm (Lewis Wind Power 2011) process, identified frog (an introduced species to the islands) remains in spraints east of the SAC. Although otters can breed at any time of the year, females of the otter population of the Outer Hebrides usually give birth in late spring (April to May) and cubs tend to stay in the natal den for up to 3 months (SNH, Appendix 3.1)

13.5.30 NBN gateway shows records of otter on near the mouth of the Abhainn Bhuirgh and the Allt Grunndal, and on Abhainn Shiadarr (outwith the study area) and at some small lochans upstream of Allt Fisgro.

Site specific survey

13.5.31 An otter survey was undertaken across the study area (see Figure 13.5) in August 2011 and the survey methodology used conformed to SNH guidance (Scottish Wildlife Series: Otters and Development) and was designed to inspect potential resting site locations (i.e. burn banks, exposed peat faces or rock piles) throughout the core survey area.

13.5.32 A number of otter signs were recorded within the study area and in the surrounding region (Figure 13.5), with these signs centred on the burn located in the north eastern part of the study area. Spraint was located near the mouth of Allt Fisgro and again further upstream on the same burn. Further upstream, two small isolated (possible) covered lie ups were recorded close to the burn. Here evidence was found of flattened vegetation under overhanging grasses and turf, once in a natural hollow, and once behind a pothole. No tunnels were present, and although the surrounding watercourse and undercut peat hag were investigated, no further resting sites or signs of otter were recorded. No spraint was found at either potential resting site and therefore the evidence for these locations being lie ups is not conclusive. No evidence of breeding was found within the surveyed area.

13.5.33 The evidence recorded above is a strong indication that one or more otters use this water course on a regular basis. They may travel the entire length of the water course, either in search of food, or as a corridor to travel throughout the area, and possibly into the Lewis Peatlands SAC. Evidence of marine crustaceans in the otter spraints was noted, indicating that the burns may be used by animals accessing the coast to feed.

13.5.34 Several spraints and slides were located downstream (south west) of the study area, near the confluence of Abhainn Shiadarr and the Lambol burn, the latter of which flows through the study area. However no evidence of otter resting sites, or other signs, were recorded within the study area, along the Lambol Burn.

13.5.35 While carrying out the intertidal survey (Appendix 13.2), a number of otter spraints and fresh anal jelly were found near the mouth of the Abhainn Bhuirgh and the Allt Grunndal, watercourses approximately 1km north of the footprint of onshore works. These burns were visited on the 31st of August and again on the 2nd of September. These two burns are considerably wider than the two which travel through the study area and by the second visit the water level in both had risen considerably, although there had not been large quantities of precipitation. Spraint was also noted at the same locations in September 2010, during an early walkover survey of the coastline to identify potential bird and marine mammal vantage point locations.

13.5.36 The otter signs detailed above, coupled with the relatively undisturbed environment on the west coast of Lewis, indicate that although otter territories encompass much of the study area, suitable habitat was centred on the watercourses. Freshwater sources are important to local otters for washing fur, and provision of other habitat requirements, so it is considered likely that otters may use the streams within the study area as passages to the nearby Lewis Peatlands SAC.

13.5.37 Although otters will swim around the coastline it is less likely they will travel out to the depths where the devices will be located (minimum 200m off the coast, in depths of 10 to 15 metres). Otters show a strong preference for multiple short dives in shallow waters of 0 to 3 m of depth, with evidence suggesting deep dives are less successful for catching prey (Nolet et al., 1993). Given the exposure of the west coast of Lewis, it is most likely that otters will feed in the more sheltered embayments along the coastline.

Figure 13.5 Results of site specific otter survey

13.5.38 SNH have confirmed the otter survey represents a fair reflection of the way in which otters are using the area and that the coastal hinterland and the 2 water courses may form part of the navigational route used by otters between the Lewis Peatlands SAC (for which otters are a qualifying feature) and the sea (Appendix 3.1).

Reptiles

13.5.39 Slow worm is the only native reptile on the Western Isles. There is no record for slow worm on NBN gateway within the study area or surrounding habitats.

13.5.40 Following the results of the extended Phase 1 Habitat survey, the area for development of onshore powerhouse works is considered to be low potential for slow worms for the following reasons:

- The site is exposed, facing prevailing winds;
- Vegetation is characteristically stunted, offering little opportunity for shelter or thermoregulation;
- Habitat type relatively homogenous, is of limited variability offering little opportunity for varying habitat types; and
- Habitat contained limited resource opportunity for hibernation.

13.5.41 The area of access track upgrade is characteristically wet, and therefore also considered unsuitable for slow worms. SNH have confirmed this (Appendix 3.1).

13.6 Impact assessment

13.6.1 This section of the ES chapter assesses the possible impacts of the development on terrestrial and intertidal ecology during construction, operation and decommissioning.

13.6.2 Table 13.10 below contains calculations of the area of each habitat type that will be affected by the proposed development. This table is used throughout the impact assessment.

Do nothing scenario

13.6.3 The existing ecology is unlikely to change in the near future in either terrestrial or intertidal environments. The study area is unlikely to be developed due to its remoteness, with grazing and peat cutting activities likely to continue at low levels.

13.6.4 During a ‘do nothing scenario’ there is unlikely to be a major significant change to the terrestrial and intertidal ecology at the footprint on either island.

Table 13.10 areas of habitats to be disturbed or removed during construction of the onshore works															
Habitat	Compound (ha)	Access track (ha)	Access track temporary buffer(ha)	Temporary infrastructure (ha)	Onshore Pipelines + Installation buffer		HDD drilling rig areas		Shore access track		Total area of habitat affected (ha)		Total Area Of each Habitat surveyed (so within the phase1 survey area) (ha)	Percentage of total habitat in footprint affected by construction (ha)	
					Best case	Worst case	Best case	Worst case	Best case	Worst case	Best case	Worst case		Best case	Worst case
Acid grassland	0.99	0.42	0.42	0.60	0.32	5.84	0.09	0.18	0.16	0.46	3.00	8.91	61.88	4.86	14.41
Marshy grassland	0.00	0.06	0.06	0.00	0	0	0	0	0	0	0.12	0.12	4.03	2.91	2.91
Wet heath/ Acid grassland mosaic	0.01	0.10	0.10	0	0	0	0	0	0	0	0.20	0.20	15.92	1.26	1.26
Total Habitat affected (ha)	1.00	0.58	0.58	0.60	0.32	5.84	0.09	0.18	0	0	3.32	9.23	NA	9.03	18.58

Potential impacts during construction

Impact 1: Permanent physical loss of important terrestrial habitats and species

13.6.5 Damage and disturbance to sensitive terrestrial habitat receptors could occur through a number of sources associated with construction activities and the use of construction plant. Some of these activities can lead to physical damage to habitats, pollution (e.g. sedimentation, dust pollution and point pollution incidents), movement and physical disturbance of vegetation, temporary or permanent loss from over-casting of cut turves / excavated overburden. These impacts can lead to the loss of vegetation and/or changes in vegetation communities in response to changes in environmental conditions. The habitats which are considered particularly sensitive to damage during construction works include blanket bog (particularly areas of hollows and pool systems), along with wet heath and marshy grassland.

13.6.6 In addition, blanket bog, wet heath and marshy grassland can be affected through changes in hydrology related to the disturbance of soil and peat structure. The result of these changes can be the loss of plant species adapted to the hydrological regime present within these habitats. Details of the impacts and mitigation related to groundwater and water systems are further discussed in *Chapter 8 – soils, hydrology and hydrogeology*.

13.6.7 The onshore works have taken into consideration the results of the extended Phase 1 Survey to avoid areas of deep peat, blanket bog, wet heath habitat and waterbodies as mitigation through design.

13.6.8 The construction footprint for the compound is characterised by acid grassland on the coastal side of a slope which rises to 30m above sea level. This area is predominantly species rich acid grassland with some heath species also present, including ling heather, bell heather marsh lousewort, bog cotton and bog asphodel (in small numbers). As more than 75% of the habitat is acid grassland, this is the classification assigned to this area in the Phase 1 habitat map. The seaward facing slope is exposed to strong winds off the Atlantic, and the vegetation is noticeably short and stout, with the limited ericoids present as a low carpet layer understory beneath the grasses. Maritime indicator species present in the coastal fringe, include thrift *Armeria maritima*, suggesting coastal grassland is present, and merges into the acid grassland habitat as the terrain rises up from the shore.

13.6.9 Remains of historic "lazybeds" (*Chapter 18 Archaeology and cultural heritage* for further details) are present in the coastal margin, running down the slope towards the sea and lying perpendicular to the shore. This further suggests this area is well drained having been used historically for agriculture. Sheep have been observed grazing throughout the study area during survey work. .

13.6.10 Access will be gained to the compound via upgrading an existing track. This approach avoids impacting previously undisturbed habitat.

13.6.11 A small area of exposed peat and a couple of historic peat cuttings was recorded in the north east of the proposed pipeline location. These features were too small to map but have been target noted and a peat depth survey was commissioned to inform the hydrological impact assessment and proposed mitigation for construction of onshore works (*Chapter 8*: *Soils, hydrology and hydrogeology)*.

13.6.12 Table 13.7 above identifies the habitat loss to each type of vegetation within the footprint of the development.

13.6.13 The development will have **no impact** on designated sites or their features.

13.6.14 The construction footprint avoids all blanket bog habitat of the highest value for its fragility and BAP status. The majority of the development is within the low sensitivity acid grassland habitat with permanent removal of approximately 1ha for the compound 0.84ha for the construction of the access track (if the area of the existing track is removed from the calculations see *Chapter 5 Project description*) and in the worst case scenario 1.44ha for the shore access track(s). This amounts to a total of 1.74ha. A small area (0.04ha and 0.02ha) of the access track construction footprint will extend into medium sensitivity marshy grassland and wet heath/acid mosaic respectively, where upgrades to the existing track are to be made. The effect of the development is assessed to be of low magnitude on terrestrial habitats. Overall there is anticipated to be an effect of **minor ad verse** significance on terrestrial habitats. This is not significant in EIA terms.

13.6.15 Further assessment on hydrology is discussed in *Chapter 8: Soils, hydrology and hydrogeology*.

MITIGATION IN RELATION TO IMPACT 1

- Construction contractor will provide and implement a construction method statement that adopts the relevant good practise guidance set out in SNH Forestry Commission Guidance 'Floating Roads on Peat' and CIRIA Guidance note C692 Environmental Good Practice on Site Guide (3rd edition). In particular, vegetated turves and peat removed during compound excavation will be carefully stored and restored in appropriate locations as soon as possible after disturbance.
- Piles of peat turves will be bladed and kept moist to avoid drying out
- Peat turves will be stored within the compound construction footprint, a minimum 200m from the watercourses and sensitive habitats.
- Excavated peat turf will be removed as intact as possible, and disturbance and movement of the turvefs will be minimised.
- Best practice measures to encourage rapid stabilisation and re-vegetation of exposed peat will be implemented where required (e.g. using an appropriate nurse seed mix to stabilise the peat).
- Road surfaces will be inspected regularly during construction, and when dust is seen to be mobilised from the road, road spraying may be undertaken to reduce nutrient enhancement of adjacent vegetation.
- Following construction, any bare areas will be left to regenerate naturally or where appropriate re-seeded with an appropriate mix of native species of local provenance.
- All drainage designed within the scheme will be in compliance with The Water Environment (Controlled Activities) (Scotland) Regulations 2011 and all surface water will be managed in agreement with SEPA.

Residual impact

13.6.16 Following best practice mitigation, the effect of the development on permanent habitat loss remains as of **minor adverse** significance.

Impact 2: Temporary disturbance of important terrestrial habitats and species

13.6.17 There will be temporary disturbance of the habitats during construction of the development.

13.6.18 The construction zone for the access track is between 8 and 11m across, with the final access road approximately 4m across, allowing for between 2 and 3.5m of construction buffer either side of the road.

13.6.19 The onshore works will include a temporary laydown area of 0.6ha for storing vehicles and equipment during construction activities. Following construction this area will be re-turfed.

13.6.20 Two methods are under consideration for the laying of the pipes (see *Chapter 5: Project description* for further details):

Scenario 1 – Surface Laid: There will be a minimum two, maximum eight pipelines required for the development, each with a maximum construction corridor of 20m within the acid grassland, taking a minimum footprint of 3200m^2 (two pipes) and maximum 58400m^2 (eight pipes). A short track, 5m wide (not including construction buffer) will also be constructed from the compound area to the shore for plant to access the intertidal area, taking minimum 1600m^2 and maximum 4600m^2 of the acid grassland (Table 13.10).

Scenario 2 – Directional Drilling: the pipes will be directionally drilled from the compound area out towards the sea. This will not entail the surface laying of pipelines. To avoid disturbance or damage to the sensitive blanket bog habitat landward of the construction area for onshore works, the pipes will be installed from the sea (*Chapter 5*: *Project Description*). A maximum two areas each of 30m^2 would be required close to the shore (on the acid grassland) would be required for temporary HDD drilling activities and storage of equipment. Further laydown areas required for pipes are not assessed within this ES and will be addressed within the future online planning application.

13.6.21 Further assessment on hydrology is discussed in *Chapter 8: Soils, hydrology and hydrogeology*.

13.6.22 The temporary construction footprint avoids all blanket bog habitat, which is classed as being of the highest value. The majority of the development is within the low sensitivity acid grassland habitat with and a temporary disturbance of the 0.16ha buffer of medium sensitivity marshy grassland and wet heath/acid mosaic, where upgrades to the existing track are to be made (Table 13.10). The effect of the development is assessed to be of low magnitude on terrestrial habitats due to the small amount of temporary disturbance, and the short term nature of the disturbance. Overall there is anticipated to be an effect of **minor a dverse** significance on terrestrial habitats. This is not significant in EIA terms.

MITIGATION IN RELATION TO IMPACT 2
• Construction contractor will provide and implement a construction method statement that adopts the relevant good practise guidance set out in SNH Forestry Commission Guidance 'Floating Roads on Peat' and CIRIA Guidance note C692 Environmental Good Practice on Site Guide (3rd edition). In particular: • ,Monitoring of buffers around construction areas, and adherence to current construction best practice. • Following construction, any bare areas re-seeded with an appropriate mix of native species of local provenance. • Vegetated turves and peat removed during compound excavation will be carefully stored and restored in appropriate locations as soon as possible after disturbance. • Peat turf piles will be bladed and kept moist to avoid drying out • Peat turves will be stored within the compound construction footprint, a minimum 200m

from the watercourses and sensitive habitats.

- Excavated peat turves will be removed as intact as possible, and disturbance and movement of the turves will be minimised.

Residual impact

13.6.23 Following best practice mitigation, the effect of the development on temporary habitat loss remains as of **minor adverse** significance.

Impact 3: Temporary loss or disturbance of intertidal habitats and species

13.6.24 The predominant rock habitats of intertidal zone inform of the onshore works are characterised by hard Lewisian gneiss. The shore itself consists of bedrock outcrops, boulders and shingle.

13.6.25 As discussed in Chapter 5: *Project Description*, there is the need for a temporary nearshore pontoon to be constructed in this area. The pontoon is likely to be fixed to the intertidal zone on concrete blocks, and foundation works and a concrete access ramp may be required.

13.6.26 If pipes are surfaced laid, there may be a requirement for a JCB machine to level the shore area, by moving stone, cobble and boulder features to a storage area on the shore before being moved back to their location.

13.6.27 It is likely that if hydraulic pipes are not directionally drilled but are surface laid to the foreshore, colonisation will take place on the pipelines outer armouring in a similar zonation pattern to that currently present. There will be some associated direct disturbance and habitat loss during construction, but this will be temporary and short term as the pipes themselves act as hard substrata on the foreshore, and are themselves colonised.

13.6.28 This assessment of impact on the intertidal communities is based on a worst case scenario of eight hydraulic pipes surface laid on the foreshore. This will lead to temporary disturbance of some of the intertidal habitats within, between two and eight corridors of 20m width, of intertidal habitat. The exact location of the pipelines on the shore is not finalised.

13.6.29 It is important to note that the key determinant of shallow subtidal and intertidal communities tends to tends to be the ‘regular’ large wave events that the site is exposed to and that even exposed sites will be subject to a wide natural range of wave conditions from relatively calm to significant storm events. The intertidal ecology in the areas inshore of the development site is therefore characteristic of a wave exposed coastline, with a number of biotopes recorded (see Section 13.5 and Table 13.6), illustrating the range of substrata and degree of exposure to wave energy present at the site. The impacts identified will be highly localised and the species and habitats involved are of low to negligible sensitivity (Table 13.3), and do not include species or habitats of conservation importance, regionally or locally (in the context of the north-west coast of Lewis).

13.6.30 The marine communities on such extremely wave exposed shore are highly dynamic, typified by hardy opportunistic species often with short life histories. As a result the communities can change rapidly in response to seasonal effects and natural change and variation over time may be considerable.

13.6.31 Magnitude of effect is assessed to be low to medium, cumulating in an anticipated **negligible** to **minor adverse** impact on intertidal communities during operation of the devices.

Although under boulder communities are present, they do not themselves contain any species of conservation importance and the intertidal habitat is deemed to be of low to negligible sensitivity. No species or habitats of local, regional, national or European importance are expected to be lost or impacted and the shore itself is highly dynamic and changing. Within this context it is anticipated that impacts from construction will be short term, in similar in nature to regular natural change. A **minor adverse** effect is assessed to intertidal habitats and species during construction which is not considered significant in EIA terms.

MITIGATION IN RELATION TO IMPACT 3

- Construction contractor will provide and implement a construction method statement that adopts the relevant good practise guidance set out in CIRIA The Coastal and marine environmental site guide (C584) and include the following mitigation measures:
- Intertidal construction footprint on the shore will be kept as small as possible
- Construction activities, materials, machinery and vehicles will be limited to defined construction areas and routes, minimising the footprint to prevent disturbance of nearby habitat;
- Construction material will be removed from site; and
- Material removed from the intertidal habitat will be stored and replaced within the same intertidal zone

Residual impact

13.6.32 Following the implementation impact will remain of **minor adverse** significance.

Impact 4: Disturbance to otter

13.6.33 To minimise adverse impact to otter, the development has been located to avoid watercourses and areas of potential otter habitat. The construction building footprint will be approximately 275m from Allt Fisgro, at its nearest point, with the footprint for pipelines approximately 125m to Allt Fisgro at its nearest point.

13.6.34 The onshore works have been located in a part of the site which holds limited potential shelter or food resource for otters.

13.6.35 No areas of shelter resource for lie-ups are to be disturbed by the construction activities, and therefore no biological requirement for compensatory habitat or artificial holts to be created has been identified.

13.6.36 During construction, there is likely to be disturbance to otters in the vicinity of the study area. Disturbance during construction activities can take a variety of forms, including construction noise, increased human activity, injury or pollution of watercourses:

13.6.37 The need for a European Protected Species (EPS) Licence is not currently anticipated, however, as confirmed with SNH, this will need to be reconsidered once the final design of the development and a pre-construction otter survey has been undertaken. Although otters can breed at any time of the year, females of the otter population of the Western Isles usually give birth in late spring (April to May) and cubs tend to stay in the natal den for up to 3 months afterwards.

13.6.38 Abhainn Shiadarr, Abhainn Bhuirgh and Allt Grunndal link with lochan and burn networks within the Pentlands SAC and discharge into the sea at relatively sheltered embayments along the exposed coastline. The high number of otter signs recorded on these watercourses suggests these watercourses are primarily used by otters to access the coast for feeding. Allt Fisgro links with lochans and watercourses close to the SAC border, however, it is a smaller burn and the linkages from the other three larger watercourses and the SAC are greater. The Lambol Burn does not link directly with the SAC, and instead flows from a dystrophic lochan within the study area (Loch Bacabhat).

13.6.39 Although otters have been recorded on the site and it is likely otters active in the area, the footprint of development is not considered to be a resource rich area for otter habitat as discussed above. Few otters forage in areas of greater than 10m depth (Perrin *et al*., 2008) and so are unlikely to be displaced from prime forage areas.

13.6.40 Otters are mobile species and should be able to move away from areas of disturbance as the development site and wider area, particularly as other areas of the coastline/watercourses offer better feeding/ transit routes for otters between the coastline and the SAC.

13.6.41 Consequently any impacts to otters are anticipated as both temporary and transient, during construction. Otters are of international importance and therefore of high value, and although the potential for the construction activities to disturb otters is low, the impact is assessed to be of **moderate to minor adverse** significance.

MITIGATION IN RELATION TO IMPACT 4
Construction contractor will provide and implement a construction method statement that adopts the relevant good practise guidance set out in DMRB Volume 10 Section 1 Part 9 HA 81/99 (Nature conservation advice on relation to otters) and The SNH guidance 'Otters and Development'. Key measures to further mitigate disturbance to otters on site will include: • Capping all pipes, covering all trenches or providing a means for otter to escape should they enter a trench. • Strict speed limits will be adhered to on the access road during all phases of development, to reduce likelihood of road death. A proposed limit is 15mph. • Construction areas will be left in a safe condition during periods of inactivity, with chemicals and construction materials stored safely with appropriate bunding in accordance with SEPA's Pollution Prevention and Chemical Guidelines (PPG2 - Above ground oil storage tanks, and PPG5 – Works in, near or liable to affect watercourses). • Prior to the commencement of operations an otter survey will be undertaken, within the proposed footprint of construction plus a 50m buffer zone around it (200m buffer along any watercourse coastal area), to determine current use at the time of construction (otters may increase their use of the site in the interim period between the current survey and the commencement of construction). • If pipework is surface laid and work in the intertidal area confirmed, the outcomes of the otter survey will be discussed with SNH and otter mitigation measures for the site will be agreed with SNH prior to construction and will be detailed within the Environmental Management Plan (EMP) for the development; • A pollution management plan will be developed in consultation with SEPA and SNH in accordance with SEPA's PPC guidelines PPG 5 (Works in, near or liable to affect watercourses) and PPG 6 (working at construction and demolition sites). Both plans will be incorporated within the Construction Method Statement. • Any otter casualties noted during construction will be retained and SNH should be

MITIGATION IN RELATION TO IMPACT 4
notified. • Further information and advice is available from SNH Otters and Development[2,] Nature Conservation and Roads: advice in relation to otters (Grogan *et al.*, 2001), , and the Design Manual for Roads and Bridges (DMRB)[3];

Residual impact

13.6.42 The implementation of the best practice and mitigation will reduce the potential for disturbance to otters to be negligible, and the potential impact is therefore reduced to be of **negligible significance**.

<u>**Potential impacts during operation (including maintenance)**</u>

Impact 1: Temporary disturbance of important terrestrial habitats and species

13.6.43 During operation phase, maintenance to the hydro electric power station may be required. The hydro electric power station is adjacent to the existing road, and therefore there will be no disturbance to terrestrial habitats during access to this site. It is presumed that maintenance to the buried cabling would not be required. No detectable (negligible) effect on the regionally important (medium) habitat is predicted and the significance of effects is expected to be negligible. As best practice, maintenance at the hydro electric power station will adhere to a tight footprint to avoid damage to surrounding habitats.

13.6.44 There will be **negligible** significance of effect during operation in addition to the permanent habitat loss already discussed during construction.

MITIGATION IN RELATION TO IMPACT 1
Non required

Residual impact

13.6.45 Following mitigation the significance of effect of the impact of terrestrial habitat loss during operation and maintenance remains **negligible**.

Impact 2: Disturbance of important intertidal habitats and species

13.6.46 The prevailing wave direct is north easterly, and therefore a change in the wave energy reaching the intertidal zone is therefore likely to have greatest potential effect to the northern part of the survey area.

13.6.47 An assessment has been made of potential changes to wave and tidal energy inshore of the development in *Chapter 7: Physical Environment and Coastal Processes*. The potential magnitude of change to hydrodynamic regime is considered to be of potentially major in terms of coastal processes, as a result of decreased energy inshore of the devices, but low to medium magnitude in terms of intertidal ecology (see below).

[2] http://www.snh.org.uk/publications/on-line/wildlife/otters/default.asp

[3] http://www.dft.gov.uk/ha/standards/dmrb/index.htm

13.6.48 It is important to note that the key determinant of shallow subtidal and intertidal communities tends to tends to be the ‘regular’ large wave events that the site is exposed to and that even exposed sites will be subject to a wide natural range of wave conditions from relatively calm to significant storm events.

13.6.49 A potential reduction in the wave energy of the magnitude identified in *Chapter 7: Physical environment, and coastal processes*, may lead to changes to intertidal ecology. The intertidal ecology in the areas inshore of the development site is characteristic of a wave exposed coastline, with a number of biotopes recorded (see Section 13.5 and Table 13.6), illustrating the range of substrata and degree of exposure to wave energy present at the site. With a potentially significant decrease in the magnitude of wave energy inshore of the wave devices, it is anticipated that the species composition associated with a number of habitats could alter, with increases in algal cover anticipated and changes in the biotopes present. Although the changes outlines above are of considerable technical and scientific interest, as well as of some significance biologically. The impacts are highly localised and the species and habitats involved are of low to negligible sensitivity (Table 13.3), and do not include species or habitats of conservation importance, regionally or locally (in the context of the north-west coast of Lewis).

13.6.50 The marine communities on such extremely wave exposed shore are highly dynamic, typified by hardy opportunistic species often with short life histories. As a result the communities can change rapidly in response to seasonal effects and natural change and variation over time may be considerable.

13.6.51 Magnitude of effect is assessed to be low to medium, cumulating in an anticipated **negligible** to **minor adverse** impact on intertidal communities during operation of the devices.

13.6.52 Although under boulder communities are present, they do not themselves contain any species of conservation importance and the intertidal habitat is deemed to be of low to negligible sensitivity. No species or habitats of local, regional, national or European importance are expected to be lost, or to change substantially. However, the potential for changes in the wave energy present inshore of the devices may cause changes to ecology, and while the magnitude of these is unknown, is assessed as potentially being of between low and medium magnitude. Based upon negligible sensitivity and low to medium magnitude the significance of the impact is assessed as **minor** to **negligible**.

MITIGATION IN RELATION TO IMPACT 2
No mitigation

Residual impact

13.6.53 No mitigation is proposed; therefore the impact remains to be of minor to negligible adverse significance.

13.6.54 The potential changes to hydrodynamics identified above are based upon current best knowledge. The consequential impact on intertidal ecology, although assessed as minor to negligible based on the current ecology and magnitude of effect, are uncertain, given the absence of developments of similar scale or nature. It is proposed, therefore that monitoring of changes to ecology is included in post installation monitoring of the development, as part of Marine Scotland Licencing Operating Team’s (MS-LOT’s) stated policy to “deploy and monitor”. It is suggested that intertidal monitoring is the focus of monitoring of marine ecology, with a similar assessment made for Benthic Ecology (see *Chapter 9:Benthic ecology*). If significant change in the intertidal is observed from the phases 1 and 2 of development (see *Chapter 5: Project description*), it is suggested that it will then be assumed that changes of a similar nature may also be occurring subtidally and an appropriate subtidal monitoring plan then be established to run during phases 3 and 4.

Impact 3: Disturbance to otter

13.6.55 During operation and maintenance, the impacts to otters are reduced when compared to construction impacts. Most human disturbance and activity will be confined onshore to the compound, located a minimum 275m from Allt Fisgro and 160m from the coastline, in an area of acid grassland with limited potential for otter shelter.

13.6.56 The number of vehicle movements will decrease once construction is complete. Whilst there will be a periodic increase in vessel activity in the vicinity of the Oyster WECs during operational and maintenance tasks. It is felt that the additional vessel is unlikely to cause additional disturbance.

13.6.57 Few otters forage in areas of greater than 10m depth (Perrin et al., 2008) and so are unlikely to be displaced from forage areas by the presence of the WECS. In addition, the nearshore environment will be naturally noisy with breaking waves and rolling cobbles, and It is speculated that the Oyster WEC is likely to have low operation noise levels (Appendix 11.2).

13.6.58 Consequently any impacts to otters are anticipated as both temporary and transient, during operation. Otters are of international importance, however no impact anticipated during construction is deemed to have an effect on the population the potential for disturbance is therefore considered of negligible magnitude. Disturbance to otter during operation is therefore considered to be of negligible significance.

MITIGATION IN RELATION TO IMPACT 3

As best practice and to minimise any adverse impact to otters during all phases of the development, the following mitigation will be adhered to:

- Construction, operation and maintenance activities will maintain a strict footprint of works, and construction vehicles and equipment should not be active on, or stored by, the coastline for longer than is essential. This will minimise disturbance to the shore;
- Construction operation and maintenance work will be undertaken during agreed daylight working hours (excluding horizontal directional drilling works). Where artificial light is required, lights will be directed away from otter sensitive areas to allow them to migrate through the area undisturbed. During summer months, construction may continue later into the evening without the need for artificial lighting.
- Offshore operation and maintenance procedures manuals to include good practise guidance for boat operators and avoiding disturbance to otters during operation and maintenance activities.
- A speed limit of 15 miles per hour (mph) will be adhered to on the access road during all phases of development, to reduce likelihood of road death.

Residual impact

13.6.59 Following mitigation stated, the operation and maintenance activities are assessed to be of **negligible** significance to otters.

Potential impacts during Decommissioning Phase

13.6.60 A pre-decommissioning survey will be carried out to re-assess the habitats present in the terrestrial and intertidal environment. Mitigation measures would be similar to those outlined in the construction phase above and would involve employing best practice to minimise damage or disturbance to areas adjacent to onshore structures that were being dismantled. Access tracks will be left in place.

13.6.61 The acid grassland community will be restored following best practice methods to encourage rapid re-vegetation and stabilisation of bare soils/ peat through natural regeneration from the surrounding habitats and seeding using native species of local provenance where necessary.

13.6.62 Within the intertidal zone, pipes will be removed, and all other infrastructure to ground level.

13.6.63 The potential adverse effects associated with decommissioning relate primarily to disturbance of protected mammal species and the potential for impacts on watercourses. Impacts are likely to be much reduced in comparison with the construction phase.

13.6.64 Pre-decommissioning surveys would be undertaken for otters to determine the likely impact of disturbance to resting sites. Disturbance during decommissioning works would be minimised through the programming of potentially disturbing works where possible away from sensitive sites.

13.6.65 To prevent pollution of watercourses or coastal region whilst removing equipment, best practice, as outlined in each of the individual receptor assessments of construction impact, will be undertaken.

Cumulative Effects

Terrestrial habitats

13.6.66 The onshore works of the Lewis Wave Array has been designed to avoid the sensitive blanket bog and wet heath habitats, and will be constructed on acid grassland habitat commonly found in Scotland. There is not anticipated to be a cumulative impact on terrestrial habitat.

Intertidal habitats

13.6.67 Lewis Wave Power have assessed the potential for the development to affect the wave resource to the Voith Hydro WaveGen development at Siadar, and concluded no overlap would occur (Aquamarine Power Ltd, 2010). The Pelamis Wave Power Development, proposed in offshore waters west of Loch Roag has not yet assessed impacts to the intertidal communities, however the development is not anticipated to overlap with the Lewis Wave Power development. Due to the exposed and high energy nature of the north-west coastline of Lewis, there is not deemed to be a significant or measurable effect to intertidal communities, and therefore a cumulative impact with other developments is not anticipated.

Otter

13.6.68 The recently submitted ES for the Stornoway wind farm (Lewis Wind Power 2011) anticipated no significant effect on otters within the wind farm footprint or from the Lewis Peatlands SAC population during any phase of the development, due to the presence of adequate resources for otter within the site, strategic placement of infrastructure to avoid important areas for otters, mitigation by design and best practice. The ES for the proposed Voith Hydro WaveGen development at Siadar has not anticipated significant impacts on otter either. The Lewis Wave Array is not anticipated to have a significant impact on otters, due to avoiding watercourses and areas of high otter passage, and a barrier is not anticipated between the SAC population and the north-west coast of Lewis. There is therefore not considered to be a cumulative adverse effect on otters from this development.

13.7 Conclusions

13.7.1 The study area is not designated for ecological features, and no adverse impacts are anticipated to any feature of a designated site outwith the study area.

13.7.2 Studies of the existing environment confirm the most sensitive features were the blanket bog/wet heath habitat and watercourses, the latter of which was also important for otters. These features were considered during the development of site layout and consequently avoided as mitigation through design.

13.7.3 A number of potential impacts associated with the construction, installation, operation, maintenance and decommissioning of the development on terrestrial and intertidal ecology have been assessed. Greatest impacts are anticipated to be associated with habitat loss of acid grassland, temporary disturbance of wet heath during upgrades to the access road, temporary disturbance of the intertidal zone and disturbance of otter.

13.7.4 Overall through the implementation of proposed best practice, mitigation strategies and commitments the greatest impacts of the proposed development on terrestrial and intertidal ecology are considered to be of **minor adverse** significance.

14. SEASCAPE, LANDSCAPE AND VISUAL IMPACT ASSESSMENT

14.1 Introduction

14.1.1 This chapter sets out the Seascape, Landscape and Visual Impact Assessment (SLVIA) of the development. It considers impacts during the construction, operational and decommissioning phases of the project.

14.1.2 Landscape impacts consider changes to the character of the landscape (and in this case, also the seascape of the north-west coast of Lewis) which can include both physical alterations to the landscape, such as ground modification, removal of vegetation cover and other features which make a contribution to character, together with the perceptual qualities associated with the experience of that landscape, such as the sense of remoteness or naturalness associated with the landscape or seascape. Seascape/landscape and visual impacts are inter-related but considered separately in SLVIA. Visual impact assessment relates solely to the effect of a development on views and visual amenity. It considers the likely extent of visibility of a development and the impacts on people.

14.2 Summary of assessment

14.2.1 The SLVIA considers effects on two Local Coastal Character Areas and on seven representative viewpoints within a study area defined within approximately 5 kilometres (km) of the development. The SLVIA has been informed by computer-generated Zone of Theoretical Visibility (ZTV) mapping and visualisations and verified by field assessment.

14.2.2 The SLVIA predicts significant adverse effects on one Local Coastal Character Area – *Mealabost to Rubha na Caillich* – and on four of the seven representative viewpoints during the construction and operation of the development. Potential cumulative effects between the development and the consented 4 megawatt (MW) Voith Hydro WaveGen project at Siadar (shown in figures as the Siadar Wave Energy Project) were also assessed in the SLVIA. There is predicted to be a significant adverse cumulative effect likely to arise on the *Mealabost to Rubha na Caillich* Local Coastal Character Area. Although potential cumulative effects on the seven representative viewpoints were not considered to be significant, the SLVIA recognises that significant adverse cumulative impacts on views may occur along the coast for a limited number of receptors.

14.3 Potential effects

14.3.1 Potential landscape and visual impacts are likely to arise in association with the following features of the development:

- Construction of the development involving jack up barge/drilling rig and tug vessel positioning the offshore Oyster devices and construction of the pipelines and onshore hydro electric power station buildings and other ancillary development over a phased programme lasting 4 to 6 years. A construction compound would be located adjacent to the onshore development site. An existing track would be upgraded and approximately 0.5km of new hardcore track formed to provide access for construction and to the onshore facility during operation from the A857.

- 40 to 50 Oyster devices located approximately 0.3 to 0.75km offshore, set out in a linear arrangement parallel to the shore and extending some 3.2km end to end. The devices would be fixed to the seabed and protrude a maximum of 4.5m above sea level and the flap of the Oyster device would oscillate at a similar speed and timing to passing waves. It is likely that the majority of each device will be coloured yellow for marine safety reasons however the colour and marking of the Oyster devices will be made in agreement with the Northern Lighthouse Board (NLB).

- Common landing areas, used to connect the shore pipelines to sea, will be anchored to the shore/terrestrial area and are likely to be visible comprising a concrete covered set of pipelines (one high pressure and one low pressure) 0.9metres (m) in diameter. There may be up to 8 of these pipeline pairs.

- Shore pipelines may either be directionally drilled (and therefore not visible post construction) or may be laid on the ground surface. These pipelines are likely to be steel and are assumed to be painted dark brown or covered in concrete (see bullet point above). There are likely to be up to 8 x 0.9 diameter pipeline pairs (one high and one low pressure) in total between the Oyster devices and the onshore hydro electric power station (*Chapter 5: Project description*). The shore area will be levelled to accommodate the pipelines with a construction corridor of 20m allowed for each set of pipelines within the surf zone.

- Onshore hydro electric power station including two metal clad buildings up to 8m high and associated transformers and ancillary equipment up to 3.5m high. The onshore facility will include a control room, fuel tanks, pipeline landing pads and space for vehicular parking/turning and set down areas. The onshore site will be enclosed by a post and wire fence.

- Electricity connection to the grid will form a separate application and may comprise either an overhead wood pole line or a buried cable.

- Lighting of the Oyster devices for navigational safety purposes will be by two low mounted lights situated on the shore at either end of the array. There will be some lighting of the hydro electric power station buildings/compound.

- Periodic maintenance of the Oyster devices is expected to occur every 5 years, which may involve major intervention such as removal/replacement of components requiring cranes/winches and cleaning.

- Potential decommissioning of the development after a period of 20 years involving removal of the devices, seabed clearance of all infrastructure and removal of all onshore infrastructure with the exception of the access track which will remain.

14.3.2 The SLVIA has been based on assumptions made on the likely appearance of the development. The ZTV mapping set out in Figures 14.3 to 14.5 and the visualisations shown in Figures 14.6 to 14.12 are based on the generation of the principal components of the offshore Oyster devices and the two main buildings within the onshore hydro electric power station. Other components are described in the assessment but are not shown in the visualisations due to the outline nature of their design at this stage and due to their minimal landscape and visual impact.

14.4 Methodology

Introduction to SLVIA

14.4.1 The term SLVIA is used to refer to Seascape, Landscape and Visual Impact Assessment. This assessment process necessitates consideration of additional factors when applying the widely accepted process of landscape and visual impact assessment, outlined in the *Guidelines for Landscape and Visual Impact Assessment* (GLVIA) produced by the Landscape Institute and the Institute of Environmental Management and Assessment (2002) which principally focuses on the assessment of land based developments.

14.4.2 The term 'seascape' is commonly defined as an area where the sea is a key element of the physical environment and is perceived as such by people from land, sea and air. Defining the character of the coast and its relationship with both its hinterland and the sea is an important aspect of the impact assessment process for marine renewable developments as these can potentially affect these components of seascape. Seascape assessment is very strongly linked to landscape assessment and the two terms are used together as both are likely to be relevant when considering marine developments as these often have an onshore element and/or can affect the character of the coast and hinterland within a seascape.

14.4.3 Seascape/landscape impact assessment and visual impact assessment are separate although linked procedures. The assessment of potential effects on the landscape/seascape examines the effect on the physical landscape which may give rise to changes in its character and how this is experienced. Visual effects relate to the changes that may arise in the nature and composition of views and to people's responses to these changes and overall effects on visual amenity. This assessment sets out separate assessments for seascape/landscape and for visual interests.

14.4.4 Although SLVIA is used to refer to the assessment of impacts of a coastal or offshore development there is no specific guidance on the methodology to be used which addresses all marine renewable developments. GLVIA forms the principal assessment methodology and this has been supplemented to take account of the specific characteristics of the coast and sea, the scale and nature of this wave energy development and its potential impacts on seascape/landscape character and on views. It has been in informed principally by the following guidance:

- Guidelines for Landscape and Visual Impact Assessment (GLVIA), Landscape Institute and the Institute of Environmental Management and Assessment (2002)
- Scottish Natural Heritage, Guidance on Landscape/Seascape Capacity for Aquaculture, A.Grant in association with C. Anderson (2008)
- Scottish Natural Heritage, Visual Representation of Windfarms: Good Practice Guidance, Horner + MacLennan and Envision (2007)

14.4.5 The SLVIA has involved the following key stages of work;

- Identification of the key features of the development which would have potential to incur seascape/landscape and visual impacts;
- Computer-aided ZTV mapping to inform initial field work, mitigation in terms of siting and design of the development, to determine potential representative viewpoints and inform the visual assessment;
- Input to the detailed location of the onshore components of the development to minimise visual impact following ZTV mapping and initial field work;
- Consultation with Comhairle an Eilean Siar (Western Isles Council) and Scottish Natural Heritage (SNH) to confirm the scope of the SLVIA and to update information and requirements further to the Scoping Opinion;
- Field work to establish seascape/landscape character and to determine likely visibility and key viewpoints for detailed assessment;
- Generation of computer-aided visualisations showing the key onshore and offshore components of the development from representative viewpoints used in the assessment; and
- Impact assessment of the development including consideration of potential mitigation measures.

14.4.6 A study area of 5km from the onshore development has been defined based on the likely extent of visibility and potential visual significance given the size of the components of the development.

Consultation

14.4.7 Western Isles Council and SNH have been consulted on the seascape/landscape and visual aspects of the development. The Scoping Opinion received from Marine Scotland Licence Operating Team (MS-LOT) in August 2011, identified some landscape and visual issues to be considered in the EIA. Western Isles Council noted visual impacts in relation to the cultural heritage resource, recommending that the most sensitive cultural heritage assets and receptors should be identified within the study area and ZTV mapping used to consider the inclusion of these sites within the scope of the detailed visual assessment exercise.

14.4.8 SNH provided detailed advice on the approach and methodology for the landscape and visual assessment and this has been taken into account in the methodology adopted for the SLVIA.

14.4.9 Meetings were held with both the Western Isles Council and SNH during September and October 2011, principally to confirm the selection of assessment viewpoints, and other factors relating to the existing environment and the methodology to be adopted for the SLVIA.

Methodology for the assessment of seascape/landscape impacts

14.4.10 The assessment of seascape/landscape impacts considers the effect of the development on key components contributing to seascape/landscape character and the perceptual qualities associated with that character. This process involves making judgements on the sensitivity of seascape/landscape character and the magnitude of change incurred by the development.

14.4.11 Landscape and seascape character types have been defined within the study area within SNH published assessments and research studies although more detailed 'Local Coastal Character Areas' have been identified as part of the SLVIA. The sensitivity of each Local Coastal Character Area has been considered in relation to a development of this scale and nature as shown in the following Table 14.1:

Table 14.1: Sensitivity of seascape/landscape character

Sensitivity rating	Factors influencing sensitivity
High	Intricate coastal edge of with dramatic and/or diverse features such as cliffs, skerries, islands, highly patterned estuaries and narrow firths. Strongly contained small scale seascapes. Built and natural coastal landmark features. Seascapes with a notably scenic composition resulting from juxtaposition of diverse landscape, coast and sea or particularly wild, remote and rugged coasts.
Medium	Seascapes where some sensitivities are present for example where smaller features such as buildings or occasional more diverse coastal features are present but where a simpler coastal edge is also present, scale is generally increased and where there are no key landmark features
Low	Seascapes with a generally simple and even coastal edge and marine component with few features. Distinctly developed urban or semi-urban coasts and coastal areas with a larger scale would be less sensitive to this form of development.

14.4.12 The magnitude of change associated with the development was then categorised as **High**, **Medium**, **Low**, **Negligible** or **None** and considers the extent of likely change to seascape/landscape character. The following factors were considered to influence the magnitude of change on seascape/landscape character;

- Changes to the physical fabric of the seascape/landscape including removal of vegetation and ground modification;
- Direct or indirect changes to the perception of scale and openness of the seascape/landscape;
- Direct or indirect changes to the sense of remoteness, seclusion and/or naturalness that may be associated with the seascape/landscape;
- The compatibility of the proposed development with the character of the seascape/landscape including consideration of the contrast in scale and character between proposed structures and existing natural or built features characteristic of the area; and
- Changes to the setting the seascape/landscape may provide to landmark natural or built features.

Methodology for the assessment of visual impacts

14.4.13 Visual impacts relate to changes in views of the seascape/landscape and the effect of these changes on people (i.e. visual receptors). They include direct impacts of a development upon views of the landscape, coast and sea through intrusion or obstruction and the overall impact on visual amenity and the scenic composition of the view.

14.4.14 A series of computer-generated ZTV maps were produced at an early stage based on the 10m resolution Ordnance Survey Digital Terrain Model data and using a viewing height of 1.6m. The initial ZTV maps produced for the onshore component of the development were used as a design tool in selecting a less visually prominent site for the onshore component of the development. The ZTV maps in Figures 14.3 to 14.5 show worst case visibility based on the maximum height of the largest buildings within the onshore development (8m) and the potential greatest exposure of the Oyster devices above sea level (4.5m) and bare ground data (i.e. they do not take into account any screening effect of buildings).

14.4.15 The ZTV maps were used to verify the likely visibility of the development during field work undertaken during September 2011 and to identify representative viewpoints for detailed assessment. Seven key viewpoints were identified based on the likely accessibility and use of viewpoints and their relative proximity to the development given its scale and nature. The selection of assessment viewpoints was confirmed with The Western Isles Council and SNH. Computer-generated visualisations were produced to inform the visual assessment and to illustrate the development from each of these viewpoints and these are shown in Figures 14.6 to 14.12. Wireline visualisations have been prepared for each of the 7 viewpoints considered in the assessment. Photomontages have additionally been prepared for 4 of the closest viewpoints to the development.

14.4.16 Visual receptors likely to use these viewpoints were assigned a sensitivity rating dependant on their location and activity as shown in Table 14.2 below:

Table 14.2: Sensitivity of seascape/landscape character	
Sensitivity	**Factors influencing sensitivity**
High	Users of outdoor recreational facilities whose attention may be focussed on the landscape; people visiting landscape/coastal features with physical, cultural or historic attributes where landscape/seascape context is important; views from residential buildings.
Medium	People using roads and other transport routes.
Low	People engaged in work activities whose attention may be focussed on their work rather than the wider landscape.

14.4.17 The magnitude of visual change likely to be experienced at each viewpoint was then assessed and categorised as being either, **High, Medium, Low, Negligible** or **None.** This assessment took into account the following factors;

- The distance of the development infrastructure seen from the viewpoint and its size in relation to the scale of existing key features seen in the view;

- The context of the view – whether forming a suddenly revealed view of the sea from a road or footpath or a more sustained view from a residential property;
- The number of components likely to be visible in the view and the degree of visual prominence given their size, colour, form and movement;
- Aspect and orientation of the view and consideration of lighting effects during night-time;
- Whether the development would be seen in an open context, back-dropped by sea or seen within a more developed context; and
- The potential obstruction or intrusion of views and effects on existing visual foci.

14.4.18 Definitions of the magnitude of change in relation to views are set out in Table 14.3 although it should be stressed that these are examples and the full range of factors listed above will have been considered in terms of the specific details of the development and its particular context:

Table 14.3: Magnitude of change definitions for visual impact assessment

Magnitude of change	Definitions
High	Close views where the development will appear in the foreground of the view and where it may obstruct existing views or foci. The development would be a dominant and defining feature of the view.
Medium	The development (seen either partially or wholly) is clearly visible and may be seen against the sky or sea, or in a notably open location which increases its visibility. The development may detract from existing foci and may be a prominent feature, depending on its location, distance from the viewpoint and the context of the view.
Low	Only a small part of the development is visible and/or it is seen at distance. The development is noticeable but will form a minor element in the view where views are panoramic perhaps or where it is seen in a context of other built development which lessens its contrast and visibility.
Negligible	The development is barely perceptible, being seen at considerable distance and/or with only a small part or component being potentially present in the view.

Assessment of significance of seascape/landscape and visual impacts

14.4.19 Professional judgement was used to determine the significance of the development on landscape character and on views, taking into account the following factors;

- The nature of the impact, whether adverse or beneficial, direct or indirect, its longevity and whether impacts would be reversible;
- The sensitivity of the seascape/landscape or visual receptor
- The magnitude of change to the seascape/landscape or to views.

14.4.20 Table 14.4 combines the definitions of magnitude with the level of sensitivity/value/importance of receptor to provide a prediction of overall significance of the effect.

Table 14.4 Significance Prediction Matrix.				
Magnitude of Effect	Receptor Sensitivity/Value			
	Negligible	Low	Medium	High
High	Negligible	Moderate	Major	Major
Medium	Negligible	Minor	Moderate	Major
Low	Negligible	Negligible	Minor	Moderate
Negligible	Negligible	Negligible	Negligible	Minor

14.5 Guidelines and Policy Framework

14.5.1 There are currently no specific guidelines on the siting, design and assessment of smaller marine renewable developments such as wave and tidal devices. Marine Scotland has produced Regional Locational Guidance (2010) for wave and tidal developments. No constraints relating to seascape, landscape or visual issues were identified for the west of Lewis.

14.5.2 The development lies between the crofting settlements of Borve and Siadar on the western coast of Lewis. No national, regional or local designations apply to the landscape of the study area.

Outer Hebrides Local Development Plan – proposed plan (September 2011)

14.5.3 The Outer Hebrides Local Development Plan will replace the current Western Isles Structure Plan (2003) and Western Isles Local Plan (2008). Relevant policies include those relating to development proposals in 'Outwith Settlement Areas' (Policy 1) which will be assessed against all of the following:

- *A clearly justified and demonstrated need for the proposed development at a specific location;*
- *The capacity of the surrounding landscape to accommodate the development;*
- *Sensitive siting, scale and design to minimise impact on the open and rural character of the landscape, avoiding raised or high level locations to minimise visual impact.*

14.5.4 Policy 5: (Landscape) states that development proposals should relate to the specific landscape and visual characteristics of the local area, ensuring that the overall integrity of landscape character is maintained. The Western Isles Landscape Character Assessment will be taken into account in determining applications. Policy 19 sets out the Council's policies in relation to Energy Resources stating that proposals for onshore renewable energy projects (including land based infrastructures associated with offshore projects) will be required to demonstrate the following (amongst other requirements):

- *Appropriate location, siting and design including the technical rationale for the choice of site;*
- *No unacceptable adverse impact (including cumulative) on: landscape, townscape and visual aspects, natural, built and cultural heritage resources.......amenity and core paths;*
- *Acceptable decommissioning and site reinstatement arrangements.*

14.5.5 Other relevant policies relate to Countryside and Coastal Access (Policy 24) which states that proposed development must be located to ensure the Core Path network is kept free of obstruction and where possible avoid other routes identified in the Core Paths Plan. Core Paths are shown in Figure 14.1.

14.6 Existing environment

14.6.1 Landscape and seascape character is categorised within a study area extending approximately 5km from the proposed onshore components of the development; this considered to be the distance at which potential significant landscape impacts could occur given the extent of theoretical visibility and the size of the built infrastructure of the development.

14.6.2 Two Local Coastal Character Areas (Gabhsann to Mealabost and Mealabost to Rubha na Caillich) have been defined for the baseline of this assessment using the methodology set out in SNH's *Guidance on Landscape/Seascape Capacity for Aquaculture*. The descriptions of the landscape character types of the 'Boggy Moorland' and 'Crofting One' identified within the study area in the *Western Isles Landscape Character Assessment (SNH Review 92),* have informed the categorisation of these Local Coastal Character Areas. These Local Coastal Character Areas are shown on Figure 14.2 and described in the following text.

Local Coastal Character Area: Gabhsann to Mealabost

14.6.3 This Local Coastal Character Area extends from the crofting settlement of Gabhsann to the low headland at Mealabost north of the mouth of Abhainn Bhuirgh.

14.6.4 The hinterland of this Local Coastal Character Area comprises gently undulating peaty moorland interspersed with the crofting settlements of Gabhsann and Mealabost which feature small, often evenly spaced, houses and long fenced fields patterning drier slopes. Narrow burns cut through from the coast; these more substantial and contained in incised valleys close to settlement. Coniferous plantations occur on the north-eastern edge of Mealabost.

14.6.5 The coast comprises an even edge of low rocky cliffs. The coastal edge is often narrow with fenced crofting strips extending close to the top of cliffs. The foreshore is patterned with broken islets and an uneven and narrow wave cut rocky platform. Narrow inlets cut the shore; some of these incised and craggy. The sea is open and expansive with a very exposed character manifest in often huge powerful waves and the eroded nature of the coast. There is little maritime traffic in this area. An informal footpath is evident in places against the coast. This coast can feel secluded in its middle section away from the visual influence of settlement.

14.6.6 No components of the development would be located within this Local Coastal Character Area. There would be visibility of all the offshore Oyster devices and the onshore built development in the south-west of this area around Mealabost. The most north-westerly Oyster devices only will be visible intermittently further along the coast towards Gabhsann.

<u>Local Coastal Character Area: Mealabost to Rubha na Caillich</u>

14.6.7 This Local Coastal Character Area extends from the mouth of the Abhainn Bhuirgh to the headland of the Rubha na Caillich near the settlement of Bailie an Truiseil.

14.6.8 The hinterland of this coastal character area is characterised by long sweeping gentle slopes and features more concentrated areas of crofting settlement around Borve, Siadar and Baile an Truiseil which are situated close to the coast within the hinterland. Further away from the coast, this area merges gradually with the extensive low-lying boggy moorlands within the interior of north Lewis. Low skylines are formed by subtle ridges and these are 'toothed' with croft houses which stand out in this very open and generally low landscape. A rectangular field pattern overlies the gently undulating landform with narrow strips divided by post and wire fences and occasional stone walls. Small heaps of stones and clumps of flag pattern fenced crofting strips and the ribbed pattern of old lazy beds is evident in places. Roads and houses are predominantly set out on a grid pattern with the similar size of croft houses acting as a strong unifying feature.

14.6.9 The coast comprises a very low edge of soft eroded rock and earth. Long extensions of broken rock project into shallow water and banked up shingle beaches occur at the mouths of inlets. More jagged rocky outcrops fringe the cliff edge in places. Settlement is set back from the coastal edge and in some places screened by intervening subtle ridges with slightly steeper slopes forming the immediate hinterland in the Siadar area. A constructed footpath and grassy tracks intermittently align the coastal edge. This coast is very exposed and waves are often massive, rolling in across the expansive ocean. There are few focal features within the sea which has a long unbroken horizon although distant headlands and islands are visible to the south-west from this coast.

14.6.10 Both the onshore and offshore components of the development would be located within this Local Coastal Character Area and there would be extensive visibility of both across this area.

14.7 Seascape/landscape impact assessment

<u>Do nothing scenario</u>

14.7.1 Currently if the proposal does not proceed there would be minimal changes likely to occur to the character of the Local Coastal Character Area *Gabhsann to Mealabost*. There will be some change to the Local Coastal Character Area of *Mealabost to Rubha na Caillich* associated with the consented 4MW Voith Hydro WaveGen project at Siadar located within the shallow bay at the mouth of the Abhainn Shiadair and this is addressed in more detail within section 14.9 within the assessment of potential cumulative effects.

<u>Potential impacts during construction</u>

Local Coastal Character Area: Gabhsann to Mealabost

14.7.2 The onshore and offshore components of the development would not be located in this Local Coastal Character Area although there would be some limited visibility of both the offshore and onshore components of the development on the south-western edge of this area and intermittent visibility of some the Oyster devices extending along the coastal edge (see Figure 14.5).

14.7.3 This Local Coastal Character Area has an even coastal edge of low cliffs and narrow rocky coastal platform with few distinctive landform features. The sea is open and expansive with little marine traffic or activity. The immediate hinterland of the coast is settled in places although the middle section can feel secluded away from crofting fields and houses in the Gabhsann and Mealabost area. The exposure of this coast, where strong waves are common, can give an elemental feel. This Local Coastal Character Area would be of ***medium*** sensitivity to a development of this nature and size given its simple form, the expansiveness of the sea and absence of landmark features both on and offshore.

14.7.4 Both the onshore and offshore components of the development will be visible from the south western part of this Local Coastal Character Area. A small number of the offshore Oyster devices will be intermittently visible further along the coast to the north-east. Construction and installation activity to place the Oyster devices will be visible with drilling rig and other marine traffic evident. While the construction period will last between 4 to6 years, construction activity will be intermittent, occurring over 4 phases lasting approximately 9 to 10 months each. The detail of construction activity laying pipelines and building the onshore hydroelectric power station and ancillary development is unlikely to be readily appreciable from much of this Local Coastal Character Area. The magnitude of change incurred by the construction of the proposed development would be **low** given the temporary and indirect nature of impacts and the fairly limited extent of effects on this Local Coastal Character Area. There would be a **minor** adverse significance of impact during the construction phase.

Local Coastal Character Area: Mealabost to Rubha na Caillich

14.7.5 Both the offshore and onshore components of the development would be located within this Local Coastal Character Area and would be widely visible, separately and in combination, across the area.

14.7.6 This Local Coastal Character Area has an even and low rocky coastal edge with occasional extensions of fragmented rock and narrow inlets providing some diversity together with the often huge waves characteristic of this exposed west coast. The hinterland is well-settled and although inter-visibility between land and the coastal edge/sea is restricted in places, the presence of nearby crofts and fenced land limits any sense of remoteness. The sea is open and expansive and while distant promontories are visible, there are few landmark features. This Local Coastal Character Area would be of ***medium*** sensitivity to a development of this nature and size given the simple form of the coastal edge, the expansiveness of the sea and absence of landmark features both on and offshore but also taking into account the presence of crofting settlement in the immediate hinterland which features a distinct layout of small houses.

14.7.7 Direct physical impacts would occur within this Local Coastal Character Area during the construction phase. Excavation works for the onshore buildings and ancillary structures would be likely to involve temporary stockpiling of peat soils and substrates. Levelling works, rock excavation and directional drilling works will variously occur across the beach and immediate hinterland between shore and the onshore development as pipelines are laid. Construction activity will include offshore drilling rigs and other marine traffic and personnel positioning the Oyster devices over four phases lasting approximately 9 to10 months each and machinery and personnel constructing the onshore development. There would be disturbance to parts of the relatively unmodified coastal edge and the introduction of activity and temporary features, such as machinery and other traffic, intermittently over a period of 4 to6 years. There would be a **medium** magnitude of change to the character of this Local Coastal Character Area. The significance of impact would be **moderate** and adverse.

Potential impacts during operation

Local Coastal Character Area: Gabhsann to Mealabost

14.7.8 Both the onshore and offshore components of the development will be visible from the south western part of this Local Coastal Character Area. A small number of the offshore Oyster devices will be intermittently visible further along the coast to the north-east although as these would be seen at distances of over 1.5km, there would be unlikely to be a significant effect on the sense of seclusion and naturalness experienced within the less developed middle section of this coast. There would be a **low** magnitude of change to this Local Coastal Character Area and therefore a **minor** significance of effect during the operational phase.

Local Coastal Character Area: Mealabost to Rubha na Caillich

14.7.9 Both the offshore and onshore components of the development would be located within this Local Coastal Character Area and effects would therefore be direct. The Oyster devices would be aligned parallel to the coastal edge. They would introduce a series of obviously man-made structures to what is currently a largely unmodified coastal edge and sea. They would extend along much of the coast of this Local Coastal Character Area and would be contained to a degree by the low subtle promontory bounding the north side of the Abhainn Bhuirgh near Mealabost and the point of Rubha na Caillich to the south west. The broad linear alignment of the Oyster devices would relate to the evenness and simplicity of the coastal edge and they would form relatively small features (seen from the shore) sitting relatively low in the water thus limiting intrusion on the hinterland. The devices would appear small in relation to the expansiveness of the sea. The exposed nature of this coast with its frequently long huge rolling waves can give an elemental feel although the presence of nearby settlement, visible from parts of the coast, limits the sense of wildness. For some people the development may adversely affect their perception of the natural qualities of the sea while for others, the development may have a strong rationale related to its power thus reducing adverse impacts on the perceptual qualities of seascape.

14.7.10 The onshore development would comprise two metal-clad sheds together with transformers and other smaller structures and parking/storage areas accommodated in a post and wire fenced compound. The largest buildings on the site would be approximately 8m high and as such they would be larger, and different in form, to the characteristic small croft houses within this Local Coastal Character Area. The proposed onshore development would also be sited in an isolated position close to the coast, and although set down slightly on the seaward side of a ridge, its location would not conform to the existing pattern of croft houses clustered in a distinctive loose linear arrangement and generally set back from the sea. The offshore and onshore components of the development are together judged likely to result in a **medium** magnitude of change to this Local Coastal Character Area.

14.7.11 The overall impact on this Local Coastal Character Area is judged to be **moderate** and adverse. These impacts would occur over 20 years, the anticipated life span of the development.

Potential impacts during decommissioning

14.7.12 The decommissioning phase would principally affect the *Mealabost to Rubha na Caillich* Local Coastal Character Area. It would involve removal of the Oyster devices, pipelines and dismantling and removal of all visible buildings and infrastructure on shore with the exception of the access track. Impacts would continue to be **moderate** and adverse during the relatively short decommissioning phase.

14.8 Assessment of visual impacts

Potential visibility of the development

14.8.1 The ZTV maps in Figures 14.3, 14.4 and 14.5 show the likely extent of visibility for the offshore Oyster devices, the largest buildings within the onshore facility and the combined visibility of both offshore and onshore developments.

14.8.2 The offshore Oyster devices are located between 0.3km and 0.75 km from the shore (*see Chapter 5: Project description)*. The extent of visibility would be limited by a degree of containment provided by the subtle promontories north of Borve (at the mouth of the Abhainn Bhuirgh) and Rubha na Caillich to the south-west. Theoretical visibility is indicated on more distant headlands although beyond distances of over 3 to 4km the Oysters are likely to be barely perceptible because of their relatively small size.

14.8.3 All 50 Oyster devices would be seen close to the coast in sustained views from informal and intermittent paths. The extent of visibility of the Oyster devices would be limited inland by the low cliff edge of the coast and an intervening ridge of land which occurs between Siadar and Borve. There would be visibility of the majority of the devices from more elevated and open views within the settlements of Baile an Truiseil and Mealabost. Visibility of the Oyster devices will however be limited within Siadar and Borve due to screening by landform and additionally broken by intervening buildings. There will be glimpsed and distant views of the offshore devices from the A857. In areas where the Oyster devices can be seen, their partially white, partially yellow colouring (necessary for navigational safety and subject to agreement with NLB) will contrast with the sea and increase visibility. The devices will be partially submerged as they dip below waves and the ZTV maps and visualisations show the maximum extent of visibility above sea level. In close views the movement of the Oyster devices will be perceptible and they are likely to increase the amount of white foam already associated with breaking waves.

14.8.4 The onshore component of the development is sited on the lower part of a gently rolling ridge abutting the coast and situated between Siadar and Borve. The largest features on the site would be the two hydro electric power station buildings. The visibility of these buildings will be limited beyond 5km due to their relatively small size. The buildings will be most visible from the Borve and Mealabost area (Figure 14.4). They will be partially visible (upper walls/roof tops) in the Siadar area and from higher ground behind the settlement of Baile an Truiseil. The buildings will be seen intermittently in views from the A857 between intervening houses but with fuller views revealed from more elevated ground to the north-east of Mealabost. There would be sustained and close views of the onshore development from the coast between Mealabost and Baile an Truiseil.

14.8.5 Settlement and communications are strongly associated with the coastal edge in this part of Lewis and although the ZTV shows some visibility from higher ground further inland, these areas are largely unsettled and less frequented than the coastal areas and also lie beyond distances where potential significant visual impacts could occur given the size of the components of the development.

Assessment from key viewpoints

14.8.6 Representative viewpoints for detailed assessment were selected in consultation with The Western Isles Council and SNH. Seven viewpoints were selected in relatively close proximity to the development, where it was considered that potential significant visual effects could arise. These viewpoints are shown on the combined ZTV map in Figure 14.5.

Do nothing scenario

14.8.7 Currently if the development does not proceed there would be minimal changes likely to the existing visual amenity of the north-eastern part of the study area. The south western part of the study area will experience some change to the visual baseline associated with the consented Voith Hydro WaveGen 4MW Siadar Wave Energy Project located in the shallow bay at the mouth of the Abhainn Shiadair.

Potential visual impacts during construction

Viewpoint 1: A857 North-west of Mealabost

14.8.8 This viewpoint provides elevated views over the coast from the A857 when travelling south-west towards Mealabost. It would be principally experienced by drivers and some of these may be tourists visiting the north-west coast of Lewis and may also include cyclists. The sensitivity of receptors would be **medium**. Both the onshore and offshore components of the development would be visible from this viewpoint. The viewpoint lies approximately 3.4km from the onshore facility and 2.4km from the nearest offshore Oyster device.

14.8.9 This view is suddenly revealed at the top of a rise. It takes in the crofting settlements of Borve and Siadar and the sea, although the detail of the coastal edge is not seen due to partial screening by landform and the distance from the view. The expansive moorland interior of north-west Lewis forms a dark and low edge to the left of the view and the hills of south Lewis are faintly visible as a very distant backdrop ahead. The sea forms the key focus of the view.

14.8.10 There would be some limited visibility of construction activity associated with positioning of the Oyster devices offshore, although some of this will be partially screened by coastal properties within Mealabost. Construction activity centred on the onshore development may also be visible, particularly as yellow coloured machinery would be likely to stand out against the dark moorland backdrop. These activities would occur intermittently over 4 to 6 years and the magnitude of change would be **low** at this distance and given the transient nature of the view. The significance of the impact would be **minor** during the construction phase.

Viewpoint 2: Car park for coastal path, Mealabost

14.8.11 This viewpoint is located on the edge of a small car park close to the recently constructed section of coastal footpath at Mealabost. Both the onshore and offshore components of the development would be visible from this viewpoint. It is also representative of similar views likely to be obtained from some residential properties in the vicinity. Receptors are likely to comprise walkers using the coastal path and residents who would be of **high** sensitivity. The viewpoint lies approximately 2.0km from the proposed onshore facility and 0.9km from the nearest offshore Oyster device.

14.8.12 The view extends along the long even length of the coast. The coastal edge is low with a narrow rocky beach with small pockets of sand; splays of rock extend into the sea. The immediate hinterland to the coast comprises a simple open landscape of moorland and narrow linear fenced strips of grazing land. Houses within the crofting settlement of Borve form a distinct feature being aligned over a slight ridge in this very open landscape. Although distant headlands and islands are faintly visible in the distant to the south, the open expanse of the sea, its horizon and the breaking waves at its edge form the key focus of this view.

14.8.13 Offshore construction activity to position the Oyster devices, involving drilling rig, tug boat and other support vessels and personnel, would be visible in close proximity to the viewpoint. Pipeline laying would also be clearly visible although construction activity associated with the onshore buildings would be more distant and partially screened by landform. Visibility would be heightened by likely contrasts in the colour of machinery/vehicles and personnel seen against the dull backdrop of open moorland and sea. These effects would be temporary and occur intermittently over a period of 4 to 6 years. The magnitude of change would be **high** during times of maximum construction activity. The significance of the impact would be **major** during the construction phase.

Viewpoint 3: Borve

14.8.14 This viewpoint is located within the crofting settlement of Borve. The viewpoint is located approximately 0.9km from the proposed onshore facility and 1.4km from the nearest offshore Oyster device. This view is most likely to be seen by local residents who would be of **high** sensitivity.

14.8.15 The gently undulating ridge which extends between Borve and Siadar lies to the left of the view and this screens views to the sea. More open views of the sea occur in the centre of the view although the coastal edge is not visible. The housing and overhead wood pole lines in the foreground form key focal elements within the simple composition of this view.

14.8.16 There would be likely to be intermittent views of offshore construction activity involved in positioning a small number of the Oyster devices only due to the screening provided by the coastal edge and the rising landform to the south-west. The onshore development site lies in close proximity to the settlement of Borve (although it is hidden by the recently constructed house in this particular viewpoint) and construction activity related to this will be clearly visible from nearby properties and roads. The construction phase would occur intermittently over 4 to 6 years but with the construction of the onshore facility being undertaken in two phases, 9 to 10 months each. The magnitude of impact would be **medium**. The significance of the effect would be **major** during periods of maximum activity within the construction phase.

Viewpoint 4: Steincleit Stone Circle

14.8.17 This viewpoint is located at the Scheduled Ancient Monument (SAM) of Steincleit Stone Circle. The viewpoint provides elevated views over the development and lies approximately 1.9km from the onshore components and 2.6km from the nearest offshore Oyster device. The stone circle is promoted to visitors and is likely to attract both local people and tourists who would be of **high** sensitivity.

14.8.18 The simple, gently undulating moorland and rough grazing around Loch an Duin forms the foreground to this open and expansive view. The loch, with its crannog and dun, forms a key focus in the view together with the scattered pattern of small houses within Borve and Siadar, which stand out against the moorland, and the more distant backdrop of the sea. The Loch is additionally considered important in providing part of the setting to the SAM (*Chapter 18: Archaeology and Cultural Heritage*).

14.8.19 Construction activity would be visible offshore around the sites of 10 to12 Oyster devices. This would be seen at some distance and away from the key focus of the view which is towards Loch an Duin. Onshore low level construction activity and pipe laying would be unlikely to be visible from this area due to the screening provided by intervening houses and the rising landform at the coastal edge although there may be some visibility of higher level construction work as the sheds are erected, which would be likely to occur over a very short period. The magnitude of change would be **negligible** given the distance and limited visibility of components of the development. The significance of impact during the construction phase would be **minor**.

Viewpoint 5: A857 Siadar

14.8.20 This viewpoint is located on the A857 between the settlements of Siadar and Borve. The view would be principally experienced by drivers, some of these being tourists, and possibly also cyclists. Receptors would be of **medium** sensitivity. Both the onshore and offshore components of the development would be visible from this viewpoint. The viewpoint lies approximately 1.1km from the proposed onshore facility and 1.9km from the nearest offshore Oyster device.

14.8.21 The viewpoint lies on the north-eastern edge of Siadar and provides open views over fenced pastures in the foreground and more extensive gently undulating moorland, backed by the sea. Loch Bacabhat forms a point of interest close to the road.

14.8.22 Few of the offshore sites for the Oyster devices will be visible from this viewpoint and views of offshore construction activity will be limited. There is unlikely to be visibility of pipe laying works due to the screening provided by the intervening ridge against the coast. The onshore component of the development lies in relative proximity to the road and construction activity would be clearly visible but seen very intermittently as lower level works are likely to be screened due to the positioning of the onshore site lower down the ridge and on the seaward slope. The magnitude of change would be **medium** with the construction activity visible occurring in two phases of 9-10 months each. The significance of impact during the construction phase would be **moderate**.

Viewpoint 6: A857 south-west of Baile an Truiseil

14.8.23 This viewpoint forms the first views over the crofting settlements of Bailie an Truiseil and Siadar and the sea from the A857 when travelling north-east, revealed as views open out as the road reaches the top of a ridge. People experiencing this view will principally be drivers, who may include some tourists, and possibly cyclists. Receptor sensitivity would be **medium**. There is likely to be very limited visibility of the offshore Oyster devices from this viewpoint and only the top of the largest buildings within the proposed onshore development would be visible and seen at over 3km.

14.8.24 The view takes in the valley of the Abhainn Shiadar and the distinctive linear arrangement of small croft houses within Siadar located on the ridge in the backdrop, which are prominent in this open landscape. The bay at the mouth of the Abhainn Shiadar forms a key focus in the view.

14.8.25 There may be limited views of the drilling rig positioning some of the Oyster devices above the coastal edge. The onshore site is not visible from this viewpoint and any views of construction activity are likely to be limited to very brief periods involving erection of steel frames and roofs. The magnitude of change would be **negligible** given the distance and very limited duration of construction works. There would be a **negligible** significance of impact during the construction phase.

Viewpoint 7: Coastal edge close to Baile an Truiseil

14.8.26 This viewpoint is located on the south western side of the bay at the mouth of the Abhainn Shiadair. There is an informal coastal path in this area and the view is likely to be seen by local walkers who would be of **high** sensitivity. There would be no visibility of the onshore development as this would be screened by landform. Some of the offshore Oyster devices would be visible with the nearest device lying approximately 2.2km from the viewpoint.

14.8.27 The low rocky coast and the sea form the key focus of this view with the rhythmic indentation of inlet, bay and fragmented rocky extensions leading the eye around the coastal edge. The distinct 'toothed' profile of croft houses, prominently aligned on a ridge, is a feature within the immediate hinterland of the view.

14.8.28 No construction activity associated with the onshore development would be likely to be visible from this viewpoint. Offshore construction activity involved in positioning the Oyster devices and undersea pipelines would be seen although pipeline laying works onshore may not be visible due to screening by the curve of the coast. There would be a **low** magnitude of change. There would be a **moderate** impact during the construction phase.

Potential visual effects during operation

14.8.29 The description of the viewpoint, viewer sensitivity and composition of the view is set out in the above text assessing impacts during the construction phase and is not repeated in the following assessment:

Viewpoint 1: A857 North-west of Mealabost

14.8.30 The offshore Oyster devices would be partially screened by landform and by houses within Mealabost with up to 15 devices potentially being visible in the periphery of the view at over 2.4km distance. The onshore development would be more noticeable due to its central location in the view and proximity to the coastal edge which is a key focus. The olive-green cladding of the largest buildings on the site would however reduce their contrast with the backdrop of dark moorland and, together with the distance of 3.4km from the viewpoint, would minimise their prominence and apparent scale. The magnitude of change would be **low** when considering the distance, position and extent of the development structures likely to be seen in the view. The significance of the impact would be **minor** from this viewpoint during the operational phase.

Viewpoint 2: Car park for coastal path, Mealabost

14.8.31 The Oyster devices would be seen in close proximity to the viewpoint with the nearest device lying 0.9km distance. The partial yellow colouring of the devices would stand out against the duller sea surface and movement of the flap may also be discernable at this distance together with white foaming around the devices as they move with the waves. They will however sit low on the surface of the sea limiting intrusion on views along the coastal edge, to far headlands and islands and the sea/sky horizon. The onshore buildings would be more distant and partially screened by landform. The dull olive-green cladding will have a limited contrast with the surrounding dark moorland further reducing visual prominence. Navigational safety lighting on shore may be visible from this viewpoint. The magnitude of change would be **medium**. The significance of the impact would be **major** from this viewpoint during the operational phase.

Viewpoint 3: Borve

14.8.32 There would be limited and intermittent views of a small number of the offshore Oyster devices with the majority of devices being screened by rising landform adjacent to the coast. The yellow colouring of the devices will increase the visibility of the devices due to the contrast with the muted and often dark colour of the sea and coastal edge. The onshore site lies in close proximity to the settlement of Borve. Although the onshore development is hidden by the recently constructed house in this particular viewpoint, there are more open views in this area from nearby properties and roads where the development would be clearly visible. The principal buildings would appear large in these views and would interrupt the open sweep of the sea. The magnitude of impact would be **medium**. The significance of the effect would be **major** during the operational phase.

Viewpoint 4: Steincleit Stone Circle

14.8.33 There would be limited views of a small number of the offshore Oyster devices with the devices forming very small features seen at distances of over 2.6km in the expansive context of this view. The onshore development would be partially screened by housing in the middle ground of the view. The key focus of the view, that is Loch an Duin and the broad expanse of sea and the horizon, would not be affected by the development. The magnitude of change would be **negligible** given the distance and limited visibility of components of the development. The significance of impact during the construction phase would be **minor**.

Viewpoint 5: A857 Siadar

14.8.34 Few of the offshore Oyster devices will be visible from this viewpoint. The onshore component of the development lies in close proximity to the road and the buildings would appear large in comparison with the size of nearby housing in Siadar, although their full height is not appreciated due to the position of the onshore development site set slightly down the seaward-facing slope of the low ridge seen in the view. Lower level infrastructure on the site would be partially screened by the ridge. The buildings would be seen against a sea backdrop which would generally increase prominence. The magnitude of change would be **medium**. The significance of impact during the operational phase would be **moderate**.

Viewpoint 6: A857 south-west of Baile an Truiseil

14.8.35 There may be partial views of 1 to 3 offshore Oyster devices from this viewpoint although these would form very small and barely noticeable features due to their distance (over 3.2km) but also because of their closeness to the coastal edge and the broad context of the view. Theoretical visibility of the roof tops of the largest buildings within the onshore development site is indicated in the ZTV (Figure 14.4) although at a distance of over 3.2km from this viewpoint, and given the presence of intervening houses located on the ridge within Siadar which would provide a more immediate focus, the magnitude of change would be **negligible**. There would be a **negligible** significance of impact during the operational phase.

Viewpoint 7: Coastal edge close to Baile an Truiseil

14.8.36 The offshore Oyster devices would be visible only from this viewpoint as the onshore development is screened by landform. The Oyster devices would be noticeable because of the contrast of their bright yellow colour seen against the duller sea surface although they would form small features in the view due to them lying over 2.2km distance from the viewpoint. At this distance they would appear similar to small buoys. The magnitude of change would be **low**. The significance of the impact would be **moderate**. If constructed, the consented 4MW Siadar Wave Energy Project will be seen in this view and the breakwater structure would be likely to partially screen the smaller Oyster devices, reducing this effect. Cumulative effects are considered further in 14.9.

Potential visual effects during decommissioning

14.8.37 There would be no change to the significance of effects assessed for the operational phase during the decommissioning phase for each assessment viewpoint.

14.9 Cumulative impacts

14.9.1 Potential cumulative effects on seascape/landscape and on views could occur with the consented Voith Hydro WaveGen 4MW Siadar Wave Energy Development. This consented development is situated in the shallow bay at the mouth of Abhainn Shaidair. The principal features of this development comprise a 250m long breakwater structure sited approximately 0.35km offshore and a Control Building located in the immediate hinterland to the bay.

Cumulative effects on seascape/landscape

14.9.2 The development would be inter-visible with the consented Voith Hydro WaveGen 4MW Siadar Wave Energy Project, principally in the *Mealabost to Rubha na Caillich* Local Coastal Character Area. This is shown in the cumulative ZTV in Figure 14.13.

14.9.3 There would be cumulative effects on seascape/landscape character associated with the contrast in form of the offshore structures of the two developments which would be seen in close juxtaposition in the south-western part of this area. The onshore developments may both comprise metal-clad buildings and this would result in an accumulation of built development which is contrary to the pattern, scale and form of existing small scale croft houses in the area. Cumulative impacts would however be less obvious in the majority of this Local Coastal Character Area where inter-visibility is limited.

14.9.4 Overall cumulative impacts are judged to be **adverse m oderate** within the *Mealabost to Rubha na Caillich* Local Coastal Character Area. There would be **negligible** cumulative impacts on the *Gabhsann to Mealabost* Local Coastal Character Area.

Cumulative visual effects

14.9.5 Cumulative visual effects can occur when both developments are either seen simultaneously (in static views) or when seen sequentially (when travelling on a road or using a footpath for example). Theoretical inter-visibility between the two developments is shown on the Cumulative ZTV in Figure 14.13. There is no inter-visibility to the north of study area with more sustained areas of visual overlap more likely to occur in the Bailie an Truiseil area and in parts of Siadar.

14.9.6 There would be no cumulative effects from assessment viewpoints 1 to 3 considered in the SLVIA due either to the distance of the viewpoint from the development or because there is no inter-visibility of both developments. Cumulative effects could occur on the remaining viewpoints as follows:

- Viewpoint 4: Although some inter-visibility is indicated between the development and the consented Voith Hydro WaveGen 4MW Siadar Wave Energy Project in the ZTV in Figure 14.13 in this area, it is considered that at a distance of over 2km, the dull grey lattice of the breakwater structure would not be readily visible. Both developments would form relatively small features, widely separated and seen in expansive views which principally focus on the sea backdrop and its horizon and Loch an Duin in the foreground thus reducing visual impact. Cumulative impacts between the two developments would be negligible.

- Viewpoint 5: There may be glimpsed views between houses within Siadar of the breakwater of the Voith Hydro WaveGen 4MW Siadar Wave Energy Project on the far left periphery of the view (not shown on Figure 14.11). Cumulative impacts would be negligible taking into account the distance and degree of separation between the contrasting components of the two developments.

- Viewpoint 6: The consented Voith Hydro WaveGen 4MW Siadar Wave Energy Project would be visible from this viewpoint. The breakwater structure which extends into the sea would be more noticeable than the Oyster devices which are smaller and likely to be only partially visible close to the coastal edge. Cumulative impacts would be negligible from this viewpoint.

- Viewpoint 7: Some of the Oyster devices and the breakwater structure of the consented Voith Hydro WaveGen 4MW Siadar Wave Energy Project would be theoretically visible from this viewpoint. The position of the slipway to the breakwater structure in front of the Oyster devices would however be likely partially obscure and deflect views away from these the much smaller devices. There would be negligible cumulative impacts from this viewpoint. Figure 14.14 shows a cumulative computer-generated wireline visualisation from this viewpoint with the outline of the breakwater and Oyster devices likely to be visible. The slipway to the breakwater is not shown in this visualisation but would extend between the shore and the structure outlined in green.

14.9.7 Although there would be no significant cumulative effects from the representative viewpoints considered in the SLVIA, significant cumulative impacts could occur for people walking along the coast between Siadar and Mealabost, both in terms of simultaneous views where both developments are seen together and seen sequentially. There is no formal coastal route at present although a Core Path is identified along this section of coast in the Local Plan. The terrain along the coast is rough and boggy and the numbers of potential receptors is likely to be limited.

14.10 Mitigation

14.10.1 There is little scope for mitigation of the development due to technical requirements influencing the siting and design of both onshore and offshore components. No mitigation measures are possible to reduce the effects of the offshore Oyster devices due to technical and safety constraints. The following mitigation measures aimed at reducing the effects of the onshore development are possible within the constraints imposed:

MITIGATION IN RELATION TO SEASCAPE/LANDSCAPE AND VISUAL EFFECTS
• Buildings will be painted in an appropriate colour to help blend in with the surrounding rough grass moorland.

Residual effect

14.10.2 Although there would be some mitigation to close views of the onshore development from properties within Borve and Siadar and from the coast if the above measures were adopted, there would be no change to the significance of effects judged on Local Coastal Character Areas and on representative viewpoints in the assessment.

14.11 Conclusions

14.11.1 Table 14.5 summarises the potential significance of effects of the proposal on Local Coastal Character Areas defined within the study area:

Table 14.5: Summary of significance of effect on seascape/landscape character		
Local Coastal Character Area	**Construction phase**	**Operational phase**
Gabhsann to Mealabost	Minor	Minor
Mealabost to Rubha na Caillich	**Moderate**	**Moderate**

14.11.2 Table 14.6 summaries the potential significance of effects on the viewpoints assessed within the SLVIA:

Table 14.6: Summary of significance of effect on representative viewpoints		
Viewpoint	**Construction phase**	**Operational phase**
1. A857 north-west of Mealabost	Minor	Minor
2. Car park for coastal walk, Mealabost	**Major**	**Major**

Table 14.6: Summary of significance of effect on representative viewpoints		
Viewpoint	**Construction phase**	**Operational phase**
3. Borve	**Major**	**Major**
4. Steincleit Stone Circle	Minor	Minor
5. A857 Siadar	**Moderate**	**Moderate**
6. A857 south-west of Baile an Truiseil	Minor	Negligible
7.Coastal edge south-west of the proposal	**Moderate**	**Moderate**

14.11.3 All impacts identified in the SLVIA would be adverse. Impacts shown in bold within Tables 14.5 and 14.6 are considered to be significant. Construction impacts represent a worst case assessment at the peak of activity and taking into account the presence of drilling rig and other vessels positioning the Oyster devices. The construction works will be intermittent despite extending over 4 to 6 years. The construction works would incur a higher magnitude of change from some representative viewpoints (viewpoint 2 for example) as the drilling rig and other vessels would be likely to be more visible than the Oyster devices alone during the operational phase.

14.11.4 The moderate significance of effect judged for Viewpoint 7 within the visual impact assessment, would be reduced to a minor and not significant impact during the operational phase if the consented Voith Hydro WaveGen 4MW Siadar Wave Energy Project is constructed. This is due to the partial screening of the Oyster devices by the proposed breakwater structure which forms part of the consented development.

14.11.5 Significant adverse cumulative effects would be likely on the *Mealabost to Rubha na Caillich* Local Coastal Character Area if the consented Voith Hydro WaveGen 4MW Siadar Wave Project was built. While there would be likely to be no significant cumulative effects on the representative viewpoints considered in the SLVIA, significant adverse cumulative effects may occur on occasional walkers accessing the coast.

15 SHIPPING AND NAVIGATION

15.1 Introduction

15.1.2 This chapter describes the baseline conditions of the existing shipping and navigation network within the vicinity of the Lewis Wave Array. Also considered are further network links to the wider region.

15.1.3 An assessment of the potential impacts on shipping and navigation from construction, operation (and maintenance) and decommissioning of the development has been provided in this chapter and, where appropriate, mitigation measures are proposed. Cumulative impacts are also considered.

15.1.4 The geographical scope of this chapter covers the north-west coast of the Isle of Lewis.

15.1.5 This section has links with Chapters 15: *Commercial fishing,* 17: *Traffic and transport* and 22: *Tourism and recreation*.

15.1.6 Underpinning the information in this chapter is the Navigation Risk Assessment (NRA) which can be found in Appendix 15.1 (Anatec, 2012).

15.2 Summary of assessment on shipping and navigation

15.2.2 The NRA establishes the existing environment within the development site as one of low use by shipping and other vessels. As part of the NRA a hazard identification workshop was held. This not only identified the hazards, but also identified possible mitigations measures.

15.2.3 The impact assessment was guided by the NRA and assessed a number of potential impacts at construction, operation and decommissioning phases. Due to the low use of the area by vessels the magnitude of the majority of impacts was assessed as low, however as the implications of impacts occurring are severe possibly resulting in injury to personnel the sensitivity of the receptors are often considered high.

15.2.4 The greatest impacts were assessed to be of moderate adverse significance, however with easily implemented mitigation all moderate adverse impacts could be reduced to minor adverse or negligible significance. No cumulative or in combination impacts were predicted.

15.3 Potential effects

15.3.2 Guidance produced to aid the consenting process for marine renewables in Scotland (EMEC and Xodus Group, in draft) lists the potential impacts that wave and tidal energy developments may have on marine navigations as (only relevant impacts included):

- Danger of collision (between the development structure and ships, or between ships).
- Potential to cause changes to shipping movements which may result in instances such as 'crossing'.
- Potential for equipment parts to become detached from devices, posing a hazard - developers should pay particular regard to the buoyancy of device parts in regard to this potential hazard.
- Potential for any marker buoys, whether temporary or permanent – to become a navigational hazard in a strong tidal stream, due to semi-submergence in tidal flows.
- Increased journey times and distances as vessels have to travel around the structure.
- Reduced visibility, particularly during construction when barges and construction equipment may obstruct the views of other vessels.

- Search and rescue exercises will need to take into account the installation equipment on site.
- Increased boat traffic in the area due to activities such as construction, site servicing or decommissioning.

15.4 Methodology

15.4.2 Anatec Ltd. (hereafter referred to as Anatec) was commissioned by Lewis Wave Power to complete a Navigational and Safety Risk Assessment (NRA) for the development and the resultant report is provided in Appendix 15.1. As part of the NRA, Anatec established the baseline conditions for vessels using the water that surrounding the development. This included Automatic Identification System (AIS) tracking, use of the wildlife survey observer notes (see *Chapter 10: Ornithology* and *Chapter 11: Marine mammals and basking sharks* further detail of these surveys) and the collation of existing data (Table 15.2). Once the baseline was established the risks the development may pose to marine navigation were identified and used to inform the impact assessment (Section 15.6).

<u>Legislation, Guidelines and Policy Framework</u>

Guidance

15.4.3 The primary guidance used during this assessment was the Maritime and Coastguard Agency (MCA) Marine Guidance Notice 371 (MGN 371 M+F) Offshore Renewable Energy Installations (OREI) Guidance on UK Navigational Practice, Safety and Emergency Response Issues (2008). The assessment also uses the Risk Assessment Methodology developed by the Department of Energy and Climate Change (DECC, 2005)

Consultation

15.4.4 A Scoping Opinion was sought from statutory consultees (the details of which are set out in Appendix 2.1) in May 2011. Responses are detailed in *Chapter 3 Consultation*, while a short summary of the main points pertinent to shipping and navigation raised during this process, along with an explanation of how they were addressed, is provided in Table 15.1 below.

Table 15.1 Issues raised in the scoping opinion (Marine Scotland 2011)

Comments & information	Response
Marine Scotland Licensing Operation Team (MS-LOT) advised that the Environmental Statement (ES) should include the following details on the possible impact on navigation for both commercial and recreational craft. • Collision Risk • Navigational Safety • Risk Management and Emergency response • Marking and lighting of Site and information to mariners • Effect on small craft navigational and communication equipment • Weather and risk to recreational craft which lose power and are drifting • In adverse conditions • Evaluation of likely squeeze of small craft into routes of larger Commercial vessels	All these issues are considered within this chapter of the ES and within the NRA which is provided in Appendix 15.1.

Table 15.1 Issues raised in the scoping opinion (Marine Scotland 2011)	
Comments & information	**Response**
• Visual intrusion and noise	
The MCA commented that the ES should supply detail on the possible the impact on navigational issues for both Commercial and Recreational craft, viz. Collision Risk, Navigational safety, Visual intrusion and noise, Risk management and emergency response, marking and lighting of site and information to mariners, effect on small craft navigational and communication equipment.	All of these aspects apart from are considered within the NRA
The MCA and Northern Lighthouse Board (NLB) requested a Navigational Risk Assessment will need to be submitted as part of the Application	The Navigational Risk Assessment can be found in Appendix 15.1 and will be submitted as part of this ES.
The MCA advised that an anchor penetration study may be necessary, subject to the traffic volumes	The traffic volumes within the study area are very low.
The MCA informs that reference should be made to any Marine Environmental High Risk Areas (MEHRAS) established on adjacent coastlines	A summary of this information has been included in Section 15.5 Existing environment.
The MCA highlights that cumulative and in combination effects require careful consideration.	Considered is given to cumulative and in combination effects are considered in Section 15.6 and in section 15.15 in Appendix 15.1.
The MCA recommends consulting casualty information from the Marine Accident Investigation Board (MAIB) and Royal National Lifeboat Institute (RNLI)	Anatec Ltd consulted with the MAIB and the RNLI and the received data from both organisations that was used in the NRA (Section 11 Appendix 15.1)
The MCA states that navigational marking for array devices should be referred to the General Lighthouse Authority, in this case Northern Lighthouse Board (NLB), and the UK Hydrographic Office (UKHO).	Discussions are ongoing with the NLB and the final agreement on navigational marking for the array will be reached prior to installation
The MCA advises that 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.	The NRA includes data from many other sources than simply AIS, including manual observations. Following further discussions with the MCA, it was agreed that due to the lack of activity within the development area radar surveys were not required,
The MCA advised that the offshore human environment should also include recreational and other sport activities.	Consideration is given to recreational activity in both this Chapter, the NRA (Appendix 15.1) and in *Chapter 22 Tourism and recreation*
The MCA stated that particular consideration will need to be given to the implications of the site size and location on Search And Rescue (SAR) resources and Emergency Response & Co-operation Plans (ERCOP).	Consideration has been given to the emergency services within this impact assessment (Section 15.6 and Section 12 in Appendix 15.1).

Table 15.1 Issues raised in the scoping opinion (Marine Scotland 2011)	
Comments & information	**Response**
The MCA state that particular consideration will need to be given to third party approval of the devices and associated mooring arrangements	The design of the Oyster and their mooring arrangements will be subject to a verification process by an appropriate certification body (e.g. DNV) prior to construction.
The MCA inform that risk assessment techniques should be based on the principles of as low as reasonably practicable (ALARP).	The NRA uses these principals in the risk assessment (see Appendix 15.1)
The MCA are concerned about the risk to shipping from rogue devices and advise careful consideration due to low freeboard and shape.	The risk of this impact has been assessed as part of the NRA and the impact of such an event occurring has been assessed within Section 15.6 of this chapter.
The NLB advise that there is no requirement to install navigational lighting on the devices as this would be difficult to maintain and ineffective. The NLB would however require the upper section of each device to be painted yellow to improve its visual	The final design colour of the individual Oyster devices will be agreed with the NLB prior to installation.
The NLB anticipate that the various stages of development will be marked by buoyage, based on the guidance within International Association of Lighthouse Authorities (IALA) Recommendation O-139 and commensurate with the volume of traffic and degree of risk to navigation safety.	This advice will be followed and implemented during the construction phase
The NLB state that navigation warnings should be promulgated before commencement of any installation, operation, maintenance and decommissioning periods relating to the device.	This advice will be followed and implemented during the construction, operation and decommissioning phases.
The NLB inform that the UKHO should be notified of the position of each site in order that Admiralty Chart BA-2720 can be correctly updated	This advice will be followed and implemented.
The NLB inform that appropriate bulletins will be required stating the nature and timescale of any works carried out in the marine	This advice will be followed and implemented during the construction, operation and decommissioning phases.
The NLB All navigational marking and lighting of the site or its associated marine infrastructure will require the Statutory Sanction of the Northern Lighthouse Board prior to deployment.	Discussions are ongoing with the NLB and the final agreement on navigational marking for the array will be reached prior to installation
The NLB encouraged engagement with any other Offshore Renewable Energy Developers in order to work together to minimise the cumulative impact of site development in the vicinity.	Based on the NRA (Appendix 15.1) it is not thought that there is any significant potential for cumulative impacts on shipping and navigation from the development, cumulatively with other renewable projects.

15.4.5 Further to consultation through the scoping process, Anatec also consulted with the following organisations and details of their comments can be found in the NRA (Appendix 15.1):

- Local Inshore Fishermen – consulted during local stakeholder meetings as well as fishing representation at Hazard Workshop.
- Marine Scotland (Stornoway)
- Maritime & Coastguard Agency (Navigational safety branch in Southampton and local MCA in Stornoway)
- RNLI – Stornoway
- Local Port Authorities (Stornoway Port Authority and Comhairle nan Eilean Siar responsible for Loch Roag)
- RYA
- Scottish Canoe Association
- NLB

Data collection

15.4.6 The principal data sources relevant to the shipping and navigation used by Anatec to define the baseline (Appendix 15.1, Anatec 2012) are shown below in Table 15.2.

Table 15.2 Data sources used

Data source	Coverage	Author(s)	Year
AIS data	Ships and vessels carrying AIS	Anatec Ltd	2010-2011
Vessel recordings taken during coastal visual bird and marine mammal surveys	West of Lewis	Natural Research (Projects) Ltd	Sept 2010-present
Fishing vessel sightings data	UK	Marine Management Organisation (MMO)	2005-2009
Fishing satellite vessel monitoring	UK	Marine Management Organisation and Marine Scotland compliance	2006-2009
Recreational Data	UK	RYA and Cruising Association (CA)	2010
Maritime Incident Data	UK	RNLI	2001-2010
Maritime Incident Data	UK	MAIB	2001-2010
UK Admiralty Charts	Scotland West Coast	UKHO	
Admiralty Sailing Directions NP 66	West Coast of Scotland	UKHO	

Assessment of significance

15.4.7 The significance of the potential effect from the development is based on the intensity or degree of disturbance to baseline conditions and is categorised into four levels of magnitude, high, medium, low or negligible. The definitions of each of these are given in Table 15.3.

Table 15.3: Criteria for assessing the magnitude of effects on shipping and navigation	
Magnitude of effect	**Definition**
High	Total loss or very major alteration to internationally important shipping lanes ((i.e. International Maritime Organisation (IMO) Routeing)).
Medium	Loss or alteration to lower use navigable channels from baseline conditions.
Low	Minor shift from baseline conditions (i.e. impact on lower use coastal routes or on smaller vessels transiting the area (fishing and sailing)).
Negligible	Very slight change from baseline condition.

15.4.8 The sensitivity/value/importance of the receptor for each effect is characterised as one of four levels, high, medium, low or negligible. The definition of each level is given below in Table 15.4.

Table 15.4: Sensitivity of shipping and navigation	
Receptor sensitivity /value	**Site designations**
High	Feature of International importance, e.g. IMO routeing measure such as West of Hebrides Deep Water (DW) Route.
Medium	Feature of national importance, e.g., port approach channels, used by medium / large size vessels.
Low	Feature of regional importance, i.e. other notable navigable channels used by smaller vessels.
Negligible	Feature of local importance, i.e. coastal shipping / sailing routes used by smaller ships (yachts and fishing vessels), such as RYA sailing routes in Loch Roag

15.4.9 Table 15.5 combines the definitions of magnitude with the level of sensitivity/value/importance of receptor to provide a prediction of overall significance of the effect.

Table 15.5 Significance Prediction Matrix.				
Magnitude of Effect	Receptor Sensitivity/Value			
	Negligible	Low	Medium	High
High	Negligible	Moderate	Major	Major
Medium	Negligible	Minor	Moderate	Major
Low	Negligible	Negligible	Minor	Moderate
Negligible	Negligible	Negligible	Negligible	Minor

15.5 Existing environment

Navigational features

15.5.2 This section presents an overview of the baseline navigational features in the vicinity of the development.

15.5.3 The main navigational features in the vicinity of the development are presented in Figure 15.1.

15.5.4 The Oyster wave array is approximately 7 nautical miles (nm) south-east of the IMO recommended West of Hebrides Deep Water (DW) Route for deep draught vessels and laden tankers. There is a military practice area on the east coast of Lewis. There are no restrictions placed on mariners transiting the area at any time.

Overview of shipping and navigation

15.5.5 An overview of the shipping and navigation activity was obtained by analysis of AIS data from 2010 and 2011, combined with visual coastal surveys undertaken between September 2010 and September 2011 (See Appendix 15.1 for more detail).

15.5.6 The AIS data is displayed in Figures 15.1 and 15.2 which show that a consistent traffic level throughout the studied period (2010 to 2011) was using the Deep Water Route (DWR) approximately 10nm northwest of the development (Figure 15.1). Vessels using this route were mainly tankers, a few cargo ships on passage between Scandinavian ports and ports on the west coast of the UK/Ireland, as well as to a number of North Sea oil fields. The number of vessels using the DWR averaged just over one per day (Section 7 Appendix 15.1).

15.5.7 Vessels were also observed between 1 to 2.5nm north-west of the area in 2010 (Figure 15.2), where they transited a more coastal route along the west coast of Lewis. This near shore route was far more apparent in the 2011 data than in the 2010 data (Figure 15.3). The vast majority of vessels taking this inshore route were cargo ships carrying live fish and transiting between Lewis and the west coast of Scotland. The number of transits averaged approximately 1 vessel every two days and was more frequent during the winter period (Section 7 Appendix 15.1).

15.5.8 During the winter period, no vessels were observed within 2.5nm of the development. In the summer survey, three vessels were observed within 2.5nm. This traffic is analysed in more detail in Appendix 15.1.

15.5.9 Visual surveys confirmed the little activity close to the shore within the vicinity of the development, with all of the vessels tracked within 750metres (m) being fishing vessels.

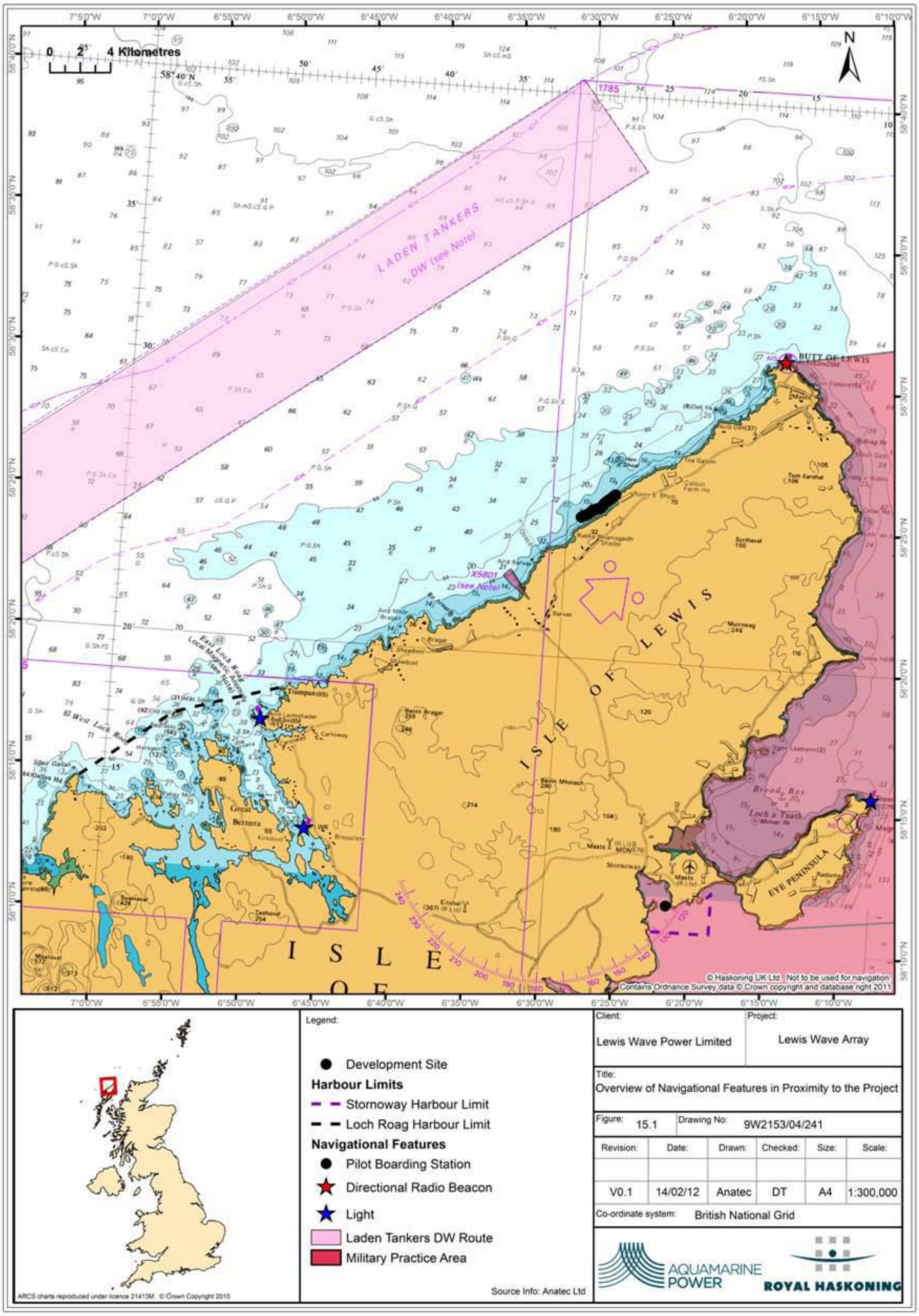

Figure 15 Overview of navigational features in proximity to the proposed development

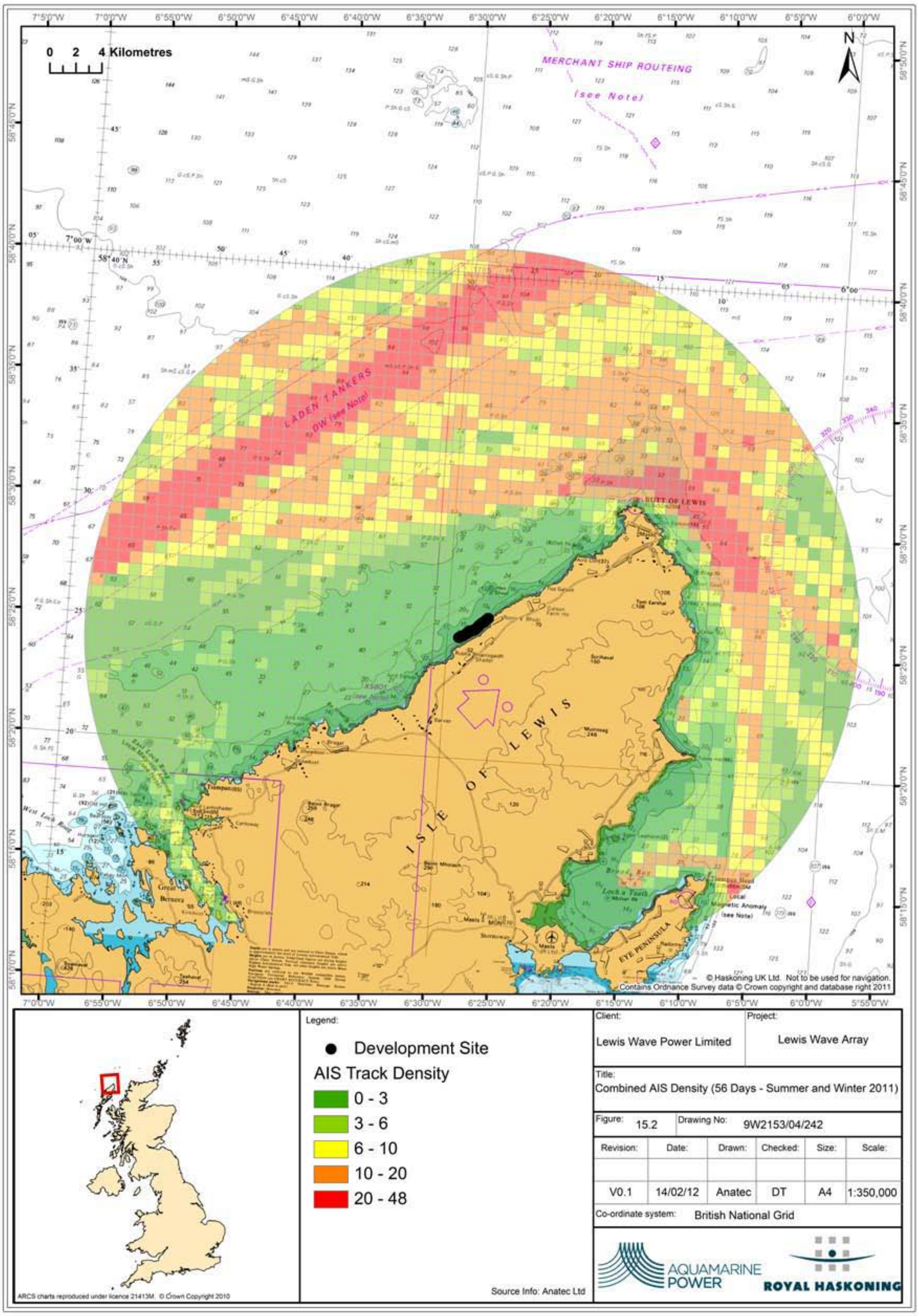

Figure 15.1 Figure 15.2 AIS density map (56 Days – Winter and Summer 2011)

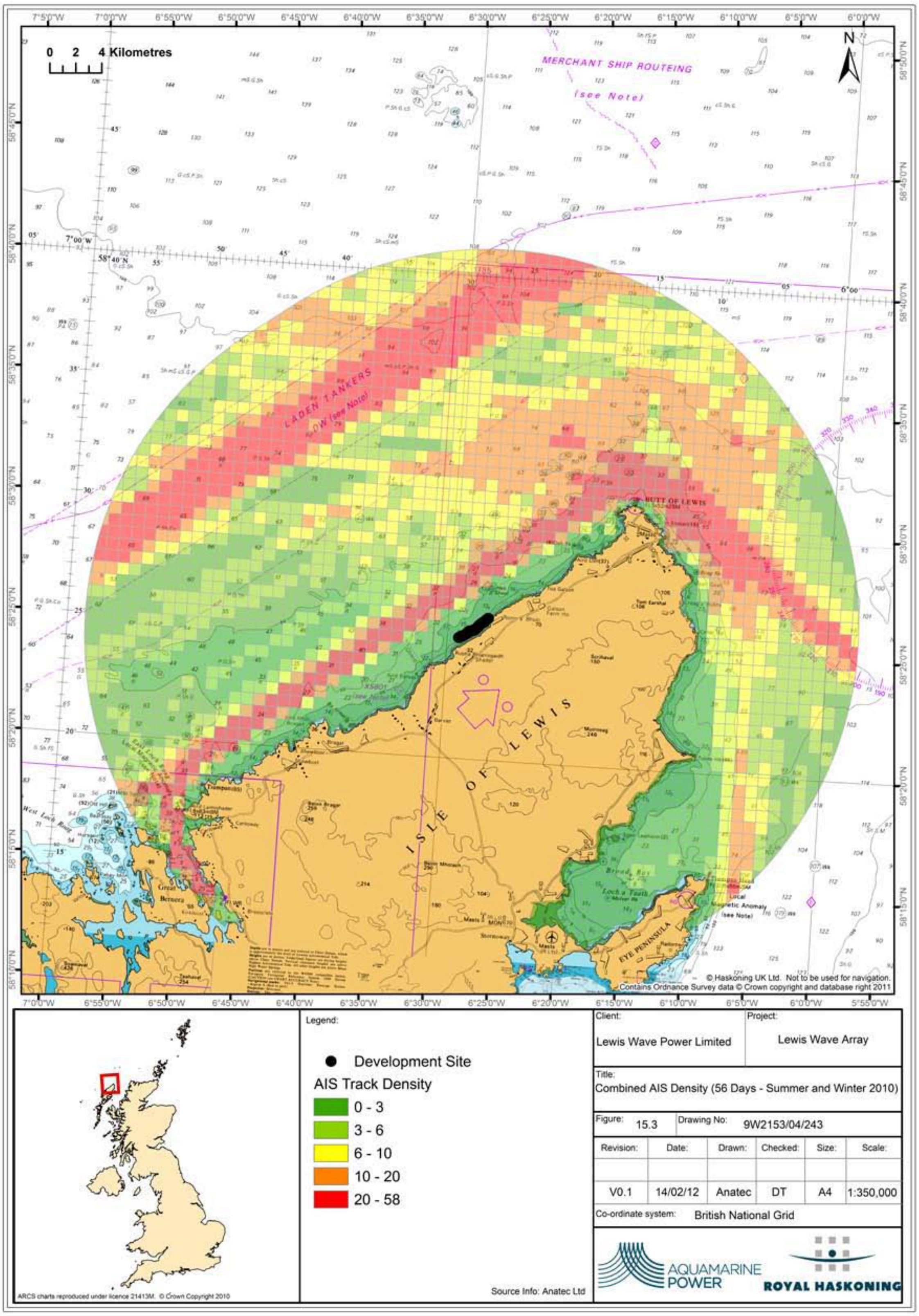

Figure 15.2 Figure 15.3 AIS density map (56 Days – Summer and Winter 2010)

Fishing vessel activity

15.5.10 Sightings data were obtained from Marine Scotland Compliance to augment and compare with satellite data obtained from the MMO (See Appendix 15.1 Section 9). A plot of the vessel sighting locations, colour-coded by gear type is presented in Figure 15.4. The vessel sighted closest to the proposed development area was approximately 1.5nm north-west of the location.

15.5.11 The main fishing type in the area shown in Fig 15.4, as identified by the sightings data, is demersal trawlers (38%) followed by potters/creelers (29%). 52% of vessels sighted were engaged in fishing, i.e., gear deployed, 45% were steaming (transiting to/from fishing grounds), and 2% were laid stationary (vessels at anchor or pair vessels whose partner vessel is taking the catch whilst the other stands by) (Section 9 in Appendix 15.1).

15.5.12 It should be noted that the satellite data provided by the MMO for the NRA includes one fishing vessel position within the vicinity of the proposed development which is not represented by the Marine Scotland Compliance data that is displayed in Figure 15.4. This vessel was recorded as having an unspecified gear type within the data and therefore it is not possible to ascertain what activity this vessel was undertaking within the proposed development site.

Recreational vessel activity

15.5.13 The RYA, supported by the Cruising Association, has identified recreational cruising routes, general sailing and racing areas in the UK. This work was based on extensive consultation and qualitative data collection from RYA and Cruising Association members, through the organisations' specialist and regional committees and through the RYA affiliated clubs. The consultation was also sent to berth holder associations and marinas.

15.5.14 A summary plot of the recreational sailing activity and facilities identified in the vicinity of the development is presented in Figure 15.5.

15.5.15 Based on the RYA published data, the development does not fall within any racing or sailing areas. In terms of facilities, the nearest marina and training centre is at Stornoway. The closest club is the Loch Clash Boat Club at Kinlochbervie.

15.5.16 A light use cruising route follows the coast of Lewis, passing the development at a distance of approximately 1.5nm, i.e. following the same route as observed to be used by the cargo and fishing vessels which take the more coastal route.

15.5.17 AIS data recorded the working boat, MV Lochlann, passing less than 0.05nm from the development (the activity is related to the benthic surveys carried out by Lewis Wave Power in August 2011) and the sailing vessel Northern Spirit passing approximately 1.7nm from the development.

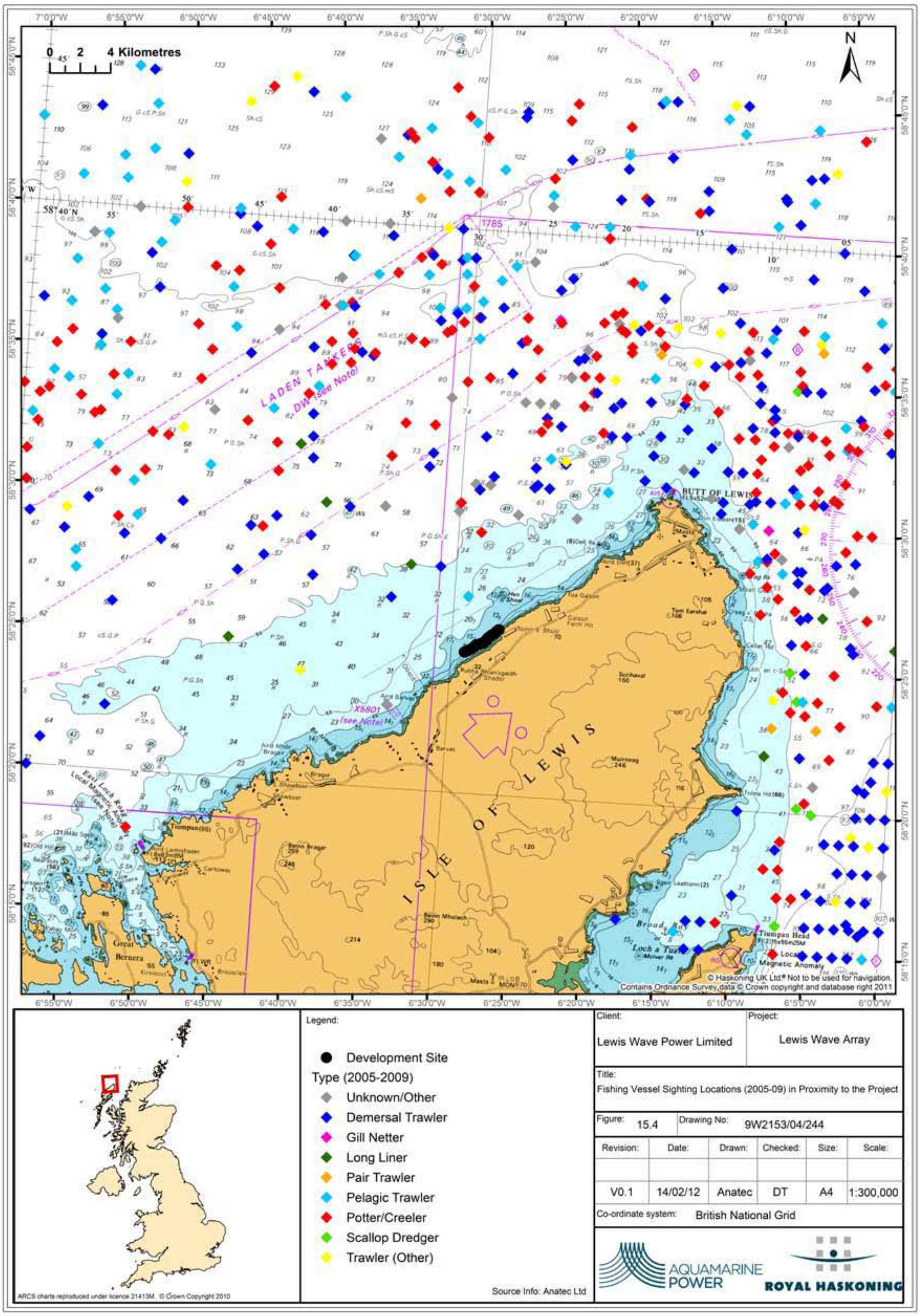

Figure 15.3 Fishing vessel sightings data by Gear type. Data Source: Marine Scotland Compliance

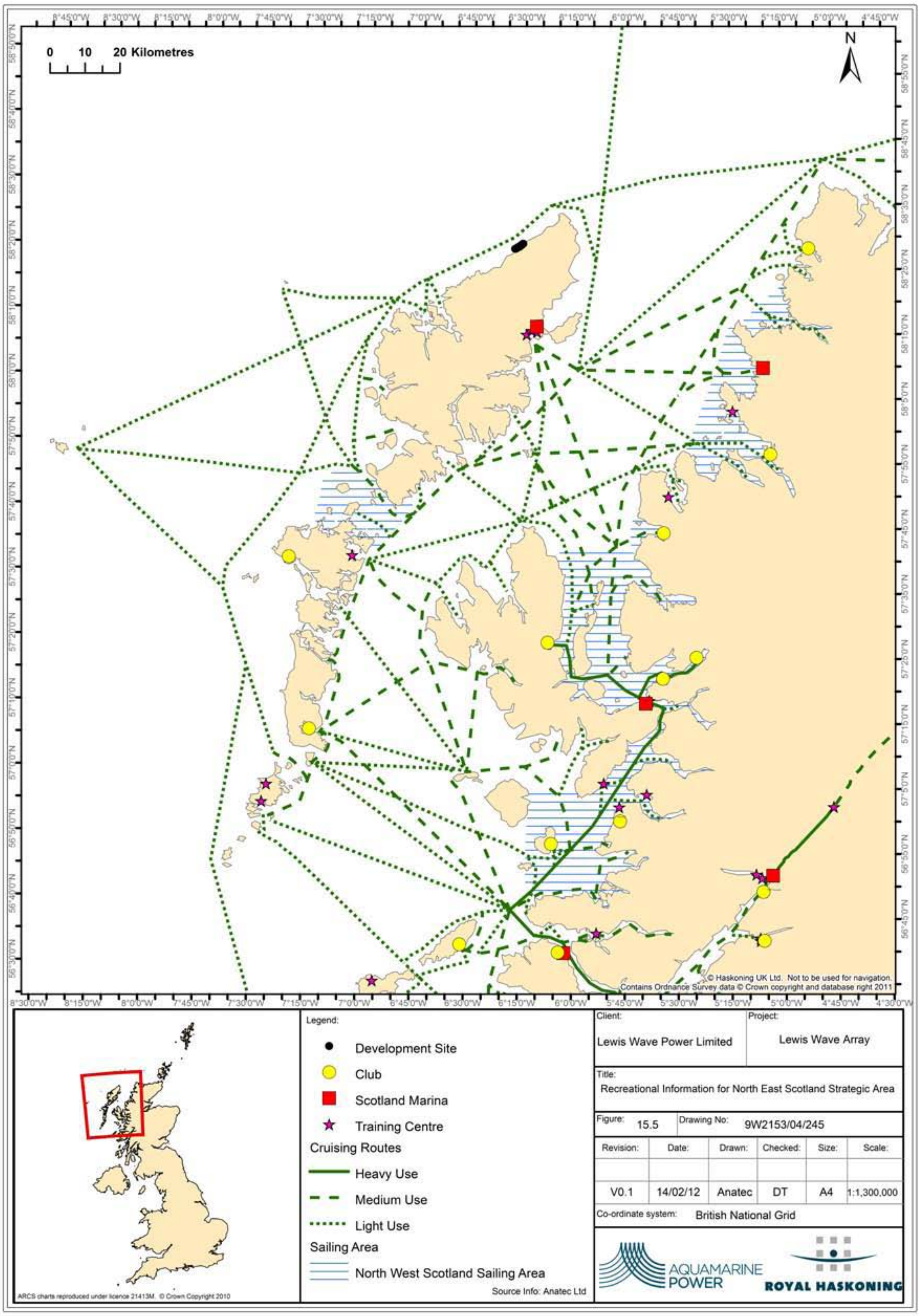

Figure 15.4 Recreational information for north-west Scotland strategic area

Review of historical maritime incidents

15.5.18 A review of historical maritime incidents was conducted as part of the NRA (Section 11 Appendix 15.1) this analysis was intended to provide a general indication as to whether the area of the development is currently a low or high risk area in terms of maritime incidents. If it was found to be a particular high risk area for incidents, this may indicate that the development could exacerbate the existing maritime safety risks in the area.

15.5.19 Maritime Accident Investigation Branch (MAIB) data provided for the NRA showed that a total of 3 unique incidents were reported in the area within 10nm of the development, corresponding to one incident approximately every 3 to 4 years. The closest incident to the site occurred approximately 6nm south-west of the area. RNLI data also provided to support the NRA revealed that 2 incidents within 10nm of the development had been reported to the RNLI, inspection of the MAIB and the RNLI data sets revealed one of the incidents was recorded in both data sets and the extra incident found in the RNLI data was a missing persons incident that happened nearly 10nm south of the development on the coastline. Overall the number of incidents in the vicinity of the development was very low.

Search and rescue

SAR Helicopters

15.5.20 A review of the assets in the vicinity of the development indicated that the closest SAR helicopter base is located at Stornoway, operated by Her Majesty's Coastguard (HMCG), approximately 13nm to the south-south-east of the development. This base has Sikorsky S92 helicopters with speeds of up to 145miles per hours (mph) (Appendix 15.1, Section 12).

RNLI Lifeboats

15.5.21 From the RNLI incident review it was identified that it would normally be a Stornoway RNLI vessel which would respond to an incident in the vicinity of the proposed development.

15.5.22 Crew and lifeboats are available on a 24-hour basis throughout the year. Stornoway RNLI, located 13nm south-south-east of the proposed development over land and approximately 40nm by sea, use the Severn class lifeboat, Tom Sanderson. The Severn class lifeboat has a maximum speed of 25 knots, range of 250nm and can operate in all weathers. All-weather lifeboats are fitted with the latest in navigation, location and communication equipment, including electronic chart plotter, VHF radio with direction finder, radar and global positioning systems (GPS).

Coastguard stations

15.5.23 Her Majesty Coastguard is responsible for requesting and tasking SAR resources made available by other authorities and for co-ordinating the subsequent SAR operations (unless they fall within military jurisdiction).

15.5.24 The development lies within the Scotland and Northern Ireland Region with the nearest rescue coordination centre being Stornoway Maritime Rescue Co-ordination Centre (MRCC).

Salvage

15.5.25 MCA charters four Emergency Towing Vessels (ETVs) to provide emergency towing cover in winter months in the four areas adjudged to pose the highest risk of a marine accident: the Dover Strait, the Minches, the Western Approaches and the Fair Isle Channel.

15.5.26 The Minches tug is within range of the development, although response times would depend upon its exact location at the time. The contract for these ETVs was due to end in September 2011 but has been extended by the MCA.

Marine Environmental High Risk Areas (MEHRAs)

15.5.27 Work has been undertaken to identify areas of high environmental sensitivity, which are also at risk from shipping (Protection of United Kingdom Waters from Pollution from Ships, undated). The development is within a cell that has been defined as being of medium risk with areas or high and very high risk to the south. The aim of the MEHRAs was to provide mariners with a tool to assist with route planning while also providing information on the sensitivity of the areas concerned. Therefore it is likely that larger vessels will aim to avoid areas of high and very high MEHRA scores.

Unexploded ordnance

15.5.28 There are no noted areas of unexploded ordinance or shipwrecks in the vicinity of the Project. Due to the nature of the bathymetry in the development area there is limited potential for residual artefacts or debris from wrecks to be trapped in the fissures of the bedrock (Appendix 15.1).

15.6 Impact assessment

15.6.2 The impact assessment is largely informed by the NRA provided in appendix 15.1 however this impact assessment differs to the NRA assessment (Section 13 of Appendix 15.1). The NRA evaluates the risk of events occurring and has a focus on what the risks are to the development whereas this assessment evaluates potential impacts that the development may have on the existing environment. The NRA has been used to inform the magnitude rating of each impact.

15.6.3 A list of potential impacts of wave and tidal development on shipping and navigation as identified by Xodus and EMEC (in draft) is provided in section 15.3. A number of these impacts will be of negligible magnitude to a receptor of negligible sensitivity and in accordance with Table 15.5 would have no impact. These impacts have not been included within the assessment below.

Do nothing scenario

15.6.4 Should the Lewis Wave Array not be developed it can be assumed that the baseline conditions described in Section 15.5 and Sections 7 to 12 in Appendix 15.1 would continue as described.

Potential impacts during construction

Impact 1: Collision between the development structures and vessels, or between vessels

15.6.5 During construction there is the possibility that a vessel transitting through the development site could collide with either a construction vessel or with infrastructure that has already been installed. During the most intense periods of construction there may be up to four construction vessels (*Chapter 5 Project description*) on site including a jack up barge that will have no mobility when jack up legs are deployed.

15.6.6 The baseline conditions described in section 15.4 *Existing environment* above and in Sections 7 to 12 in Appendix 15.1 indicate that the site is currently subject to very low use by any category of vessel, and only small fishing vessels use the site on a regular basis. This indicates that the main receptor to this impact will be fishermen.

15.6.7 The NRA identified and assessed the risk of a number of hazards that would fall within this impact, these are summarised in Table 15.6. Both hazards displayed below were ranked with the low risk or "broadly acceptable" Category (Section 13 Appendix 15.1) and therefore the magnitude of this impact is considered to be low.

Table 15.6: Criteria for assessing the magnitude of effects on shipping and navigation

Hazard title	Risk level out of a possible 25 (where 0 is no risk and 25 is high risk)	
	Most likely	Worst case
Transiting vessel collision with working vessel	2.5	3.8
Local vessel collision with working vessel	5	4.8

15.6.8 The results of a potential collision with either an installation vessel or with installed infrastructure could potentially have severe consequences and therefore the sensitivity of the receptor must be considered high. Therefore in accordance with Table 15.5 the impact of collision between the development structure and vessels, or between vessels is likely to be of **moderate adverse** significance.

MITIGATION IN RELATION TO IMPACT 1

The NRA undertaken by Anatec (see Appendix 15.1) identified a number of mitigation measures that could be implemented to reduce the hazards. Those relevant to construction Impact 1 are repeated below.

1. Use of certified vessels/jack-up suitable for operating in the predicted conditions;
2. Installation plans/procedures (use of local marine knowledge during development of plans/procedures);
3. Planning operation for summer months/operating philosophy and plans for bad weather;
4. Liaison/dialogue with local fishermen;
5. Site surveys to establish suitable locations for jack-up vessel;
6. Emergency response procedures, ERCoP plan developed in liaison with MCA and RNLI;
7. Hazard Workshop for construction/installation phase with key project personnel/vessel masters etc.;
8. Plans for any markings should operations require to be abandoned during the installation phase;
9. Establish safety/exclusion zone philosophy for installation phase;
10. Experience and lessons learned from other marine renewables projects, such as the testing of the oyster devices at the 2.4MW Oyster project at Billia Croo, Orkney, should also be reviewed prior to the work being commenced;
11. Weather forecasting and monitoring conditions continuously;
12. Procedures for down manning jack-up if severe weather is forecast;
13. Vessel on site tasked with monitoring shipping/fishing in the area to warn them of the operations;
14. Navigational warnings/broadcasts e.g., Navtex and information marked on UKHO charts;
15. Continued liaison with Harbour Masters, local coastguard and fishermen operating in the area.

Residual impact

15.6.9 Provided that the mitigation measures above are implemented the residual impact will be of **negligible** significance.

Impact 2: Increased journey times and distances as vessels have to travel around the development area.

15.6.10 As identified in the existing environment and in sections 7 to 12 in Appendix 15.1, the site currently experiences very low use and only fishing vessels have been tracked transitting through the development area. Therefore the magnitude of this impact is considered to be low. The development is not in a location where navigation is restricted by many obstacles and therefore in order to travel around the site vessels will not need to alter their route dramatically and as a result the sensitivity of the receptor is considered to be of low (the specific nature of this impact on commercial fishing vessels is discussed in section 16.6 of Chapter 16). Therefore in accordance with table 15.5 the impacts of increased journey times and distances as vessels have to travel around the development site is likely to be of **negligible** significance.

MITIGATION IN RELATION TO IMPACT 2
No mitigation suggested

Residual impact

15.6.11 As no mitigation has been suggested it is likely that the residual impact will be of **negligible** significance.

Impact 3: Increased pressure on search and rescue services

15.6.12 Due to increased maritime activity within the development site during construction there is the potential for an increase in the number of incidents that may involve search and rescue services.

15.6.13 During the NRA information provided by the MAIB and the RNLI indicated that a total of four separate incidents have been recorded within 10mn of the development site since 2001, this is considered to be a very low incident rate.

15.6.14 All of the four risks identified in the NRA, that could occur during, construction have the potential to result in an incident that may involve the emergency services. The greatest of these risks was “working vessel difficulties due to conditions i.e. jack up during installation”. This received a worst case risk score of 12 out of a possible 25 (See Appendix 15.1 Appendix A Hazard review workshop) which is categorised as “tolerable”. Taking this into account the magnitude of the impact has been considered to be medium.

15.6.15 The nearest SAR helicopter and RNLI lifeboats to the development are located at Stornoway, which is 14miles overland and 40nm by sea. If the alarm is raised it can be assumed that either of these services could respond very rapidly to an incident and return to station in minimal time. In addition, the RNLI has recently approved the placement of a new lifeboat station at Leverburgh on the Isle of Harris, 42nm south-west of the development over land, and approximately 54nm by sea. Due to these facts the sensitivity of the receptor, in this case the search and rescue services, is assessed as medium and therefore the impact of increased pressure on search and rescue services is considered to be of **medium adverse** significance.

MITIGATION IN RELATION TO IMPACT 3
Four hazards were identified in the NRA with the potential to occur during construction. The NRA also suggests mitigation measures which would decrease these risks these are provided below. By decreasing the risk of these hazards the impact of increased pressure on search and rescue services will be reduced: 1. Establishment of a safety zone around the construction area 2. Notices to mariners to be presented through appropriate media 3. Hydrographer broadcasts 4. Site marked on charts 5. Emergency response procedures to be developed with treatment sites identified Mitigation measures proposed to minimise the risk “working vessel difficulties due to conditions i.e. Jack up during installation” include 6. Recognised anchorages being identified 7. Surveys to be carried out of site where jack up will be working 8. Surveys of Loch Roag for suitability of anchorages for the Jack up 9. Emergency response planned to be developed for different weather conditions 10. Tug remains on site 11. Emergency evacuation procedure to be developed 12. Only construct in suitable weather windows

Residual impact

15.6.16 If the above mitigation is implemented it is likely that the magnitude of the impact would be reduced to low and therefore the residual impact would be of **minor adverse** significance.

Impact 4: Reduced visibility and noise disturbance impairing vessels navigational abilities.

15.6.17 The number of vessels currently using the development site is considered to be very low (Section 15.5 and Appendix 15.1) and is almost exclusively limited to small inshore fishing vessels. The maximum number of construction vessels on site during this stage of the development is likely to be four with only the jack up being of a large enough size to obscure the vision of anyone at the helm of a smaller vessel for a significant period of time. Therefore the magnitude of this impact will be low.

15.6.18 The development is not located within a confined waterway and therefore navigation around any construction vessels will not be restricted in any way and therefore the sensitivity of the receptor is considered to be low. The magnitude and sensitivity combine to give a **negligible** significance rating for this impact.

MITIGATION IN RELATION TO IMPACT 4
No mitigations suggested

Residual impact

15.6.19 As no mitigation is suggested the residual impact will be of **negligible** significance.

Potential impacts during operation (including maintenance)

Impact 1: Collision between the development structures and vessels, or between vessels

15.6.20 During operation there is the possibility that a vessel transiting through the development site could collide with either a maintenance vessel or with installed infrastructure such as the Oyster devices.

15.6.21 As previously stated in construction impact 1 the site of the development currently experiences very low use. The NRA identified and assessed the risk of a number of hazards that would fall within this impact (See Table 3.1 in Appendix A of the NRA Appendix 15.1) These are summarised in Table 15.7. All hazards displayed below were ranked with the low risk or "broadly acceptable" Category (Appendix 15.1, Section 13) and therefore the magnitude of this impact is considered to be low.

Table 15.7: Criteria for assessing the magnitude of effects on shipping and navigation

Hazard title	**Risk level out of a possible 25**(where 0 is no risk and 25 is high risk)	
	Most likely	**Worst case**
Recreational vessel e.g. yacht and/or angling vessel collides with structure	2.5	2.5
Transiting vessel (powered) collision with working vessel	3.5	5
Transiting vessel (drifting) collision with wave device	4.3	4.8

15.6.22 The results of a potential collision with either an installation vessel or with installed infrastructure (for example an Oyster device) could potentially have severe consequences and therefore the sensitivity of the receptor must be considered high. Therefore in accordance with Table 15.5 the impact of collision between the development structure and vessels, or between vessels is likely to be of **moderate adverse** significance.

MITIGATION IN RELATION TO IMPACT 1

During the NRA Anatec identified a number of mitigation measures that could be implemented to reduce the hazards identified below are those relevant to operational Impact 1.

- Planning maintenance activity for summer months, development of an operating philosophy and plans for bad weather;
- Emergency response procedures, ERCoP plan developed in liaison with MCA and RNLI;
- Experience and lessons learned from other marine renewables projects, such as the testing of the oyster devices at the 2.4MW Oyster development at Billia Croo,

MITIGATION IN RELATION TO IMPACT 1
Orkney, should also be reviewed prior to the work being commenced; • Hazard Workshop for operational phase with key project personnel/vessel masters etc. ; • Ongoing liaison and dialogue with local fishermen during major maintenance operations; • Plan maintenance operations around weather window; • Weather forecasting and monitoring conditions continuously; • Vessel on site tasked with monitoring shipping/fishing in the area to warn them of the operations; • Navigational warnings/broadcasts e.g., Navtex and information marked on UKHO charts; • Continued liaison with Harbour Masters, local coastguard and fishermen operating in the area. • Marking and lighting – devices painted yellow with numbering and Aquamarine Power logo and two onshore posts to provide light markings offshore to signal each end of the array. The final marking is to be agreed with the NLB prior to installation. • Navigational Aids to be installed and maintained as directed by NLB. • Site marked on hydrographic charts and Kingfisher charts as well as FishSAFE • Coordinates of site and devices provided to local fishermen and canoe / kayak clubs • Operating procedures in place • Monitoring of devices through control and instrumentation system

Residual impact

15.6.23 Provided that the mitigation measures above are implemented the residual impact will be of **negligible** significance.

15.6.24 There is an option to put in place a Safety/Exclusion Zone or equivalent voluntary agreement during the operational phase.

Impact 2: Equipment or parts becoming detached from devices and posing a hazard.

15.6.25 Loss of a device or part of a device was raised as a concern during consultation held as part of the NRA and at the Hazard Review Workshop (Appendix 15.1). This could present a hazard to local vessels as well as potentially the larger vessels (e.g. passing tankers) using the Deep Water Route to the west of the site in certain conditions.

15.6.26 In order to minimise the risk of an Oyster device being lost, the devices will be installed using foundation piles, with all equipment being designed and certified for the local conditions west of Lewis. The Oyster technology is currently being tested at the 2.4MW Oyster development at Billia Croo, Orkney. The performance of the devices is being monitored during this testing and any necessary adjustments or improvements will be made prior to deployment in Lewis.

15.6.27 A 'deploy and monitor' strategy will be used for the development. The devices will be installed in phases over several summer seasons from 2014 onwards and will be monitored using a SCADA system (see *Chapter 5 Project description* for more details). This will facilitate early identification and limit the consequences of any initial problems.

15.6.28 If, in the unlikely worst case scenario instance that the Oyster flap broke free from its foundation pile it would almost certainly be under extreme storm conditions where the storm surge would play a much bigger role than tidal currents. The most likely result would be that it would end up on the shore, but the location would be dependent on the size and direction of the waves and storm duration etc. If the storm was very short lived then there would be the possibility that the Oyster flap could break free from its foundation pile and as the waves reduced tidal currents could become the main factor in demining the direction of travel of the Oyster flap. This situation was considered very unlikely to occur in the NRA.

15.6.29 It is noted in the NRA that the devices inherent protection in high energy waves is that it is pushed under the water. The Oyster device which will be installed at Lewis has a flap constructed from Fibre Reinforced Polymer (FRP) which would not be visible on small vessels radars. However the type of material used means that it would not be expected to present a significant risk to shipping.

15.6.30 Given that in the NRA the risk of this impact occurring was considered to be within the broadly acceptable i.e. low risk category the magnitude of this impact is considered to be low. The potential impact to the impact to the IMO West of Hebrides Deep Water (DW) would initially indicate that the sensitivity of the receptor should be considered high in accordance with Table 15.4. However as stated above the Oyster flaps are made of FRP and would not be expected to present significant risk to shipping and therefore the sensitivity of the receptor is considered to be in the medium category. In accordance with Table 15.5 the impact of equipment or parts becoming detached from devices and posing a hazard during operation is likely to be of **minor adverse significance**.

MITIGATION IN RELATION TO IMPACT 2

1. The Anatec NRA identified the following mitigation:

- Lewis Wave Power will develop ERCoP which will have the provision to alert the Coastguard if there is a risk that a device has broken free from its foundations in order for navigational safety warnings to be issued to shipping in the area.
- Constant monitoring using SCADA system to ensure early detection of device malfunction.

Residual impact

15.6.31 If the mitigation measures suggested above are implemented it is likely that this impact will be reduced to **negligible** significance.

Impact 3: Increased journey times and distances as vessels have to travel around the development.

15.6.32 This impact is discussed for the construction phase (see Impact 2 in potential impacts during construction phase above) and was assessed to be of **negligible** significance. The operational phase will cover a period of 20 years whereas the construction period will be over a maximum of 5 years (see *Chapter 5 Project description*), also the area to be navigated around will be larger during the operation phase than that experienced in the construction phase and therefore the magnitude of this impact must increase to medium. The sensitivity of the receptor will remain low as identified in Impact 2 of potential impacts during construction.

15.6.33 Therefore in accordance with Table 15.5 the impacts of increased journey times and distances as vessels have to travel around the development is likely to be of **minor adverse** significance.

MITIGATION IN RELATION TO IMPACT 3
No mitigations suggested

Residual impact

15.6.34 As no mitigation is suggested the residual impact will be of **minor adverse** significance.

Impact 4: increased pressure on search and rescue services

15.6.35 The operational phase of the development will result in activities being conducted within the marine environment that carry a certain amount of risk. This impact is assessed for the construction phase of the development in Impact 3 of potential impacts during construction phase and was assessed as being of moderate adverse significance. During operation there will be far fewer maritime activities resulting in less time at sea by personnel and therefore the magnitude of the impact will be reduced to low.

15.6.36 The sensitivity of the receptor for this impact is considered to be medium (See impact 3 in construction impacts above for justification) and therefore the impact of increased pressure on search and rescue services during the operational phase is considered to be of **minor adverse** significance.

MITIGATION IN RELATION TO IMPACT 4

A number of hazards associated with pressure on search and rescue services were identified in the Anatec NRA with the potential to occur during the operational phase. The NRA also suggests mitigation measures which would decrease these risks, and these are provided below:

1. Mark devices clearly
2. Notices to mariners
3. Local notices
4. Hydrographer broadcasts
5. Designate the site as a no anchorage zone
6. Fisheries liaison
7. Update pilot books
8. Development of an emergency response plan and test with dummies
9. Method statements and risk assessments to be produced for any offshore activities
10. Life jackets and immersion suits to be worn by all offshore personnel during maintenance activities where possible
11. Adverse weather working policy to be developed
12. Marine safety management system in place
13. Only use experienced and trained crews for maintenance activities
14. Investigate policies and procedures for encouraging fishermen to not recover their gear in and around the devices

Residual impact

15.6.37 If the above mitigation is implemented it is likely that the magnitude of the impact would be reduced to negligible and therefore the residual impact would be of **negligible** significance.

Potential impacts during decommissioning

15.6.38 The impacts likely to occur during the decommissioning phase of the wave array are considered likely to be of the same nature and significance as those experienced during the construction phase (see above).

Cumulative impacts

15.6.39 The NRA has considered the existing shipping activity, and the two other wave energy developments proposed for the west coast of Lewis (Pelamis Wave Power off Bernera and the Voith Hydro WaveGen consented 4MW development at Siadar) concludes that from an impact on navigation perspective, no cumulative issues are anticipated. Furthermore the NRA predicts that there will not be any in-combination impacts in the vicinity of the development. Therefore it has been assumed that there will be no cumulative or in combination impacts to shipping and navigation as a result of the development interacting with other developments.

15.7 Conclusions

15.7.2 Due to the low use of the development site the magnitude of impacts to shipping and navigation have been considered low or medium. In some instances the sensitivity of the receptors have been considered high as the implications for impact occurring could be severe resulting in human injury or death.

15.7.3 The greatest impacts have been assessed as being of moderate adverse significance. Numerous mitigation measures have been suggested for all impacts that have been assigned this level of significance. If the suggested mitigation is implemented the impacts will be reduced and the largest residual impact has been assessed as being of minor adverse significance

16 COMMERCIAL FISHERIES

16.1 Introduction

16.1.1 This Chapter describes the existing environment with regard to the commercial fisheries operating in the vicinity of the development site, as well as the wider region which includes the seas that surround north Lewis.

16.1.2 The fishery resource within and around the development and those directly dependent upon this resource are considered. The catching sector supports a range of associated upstream activities such as vessel and gear suppliers, and downstream activities such as marketing, processing and distribution.

16.1.3 This chapter should be read in conjunction with *Chapter 12 Marine fish and shellfish* and *Chapter 15 Shipping and navigation*. Also accompanying this chapter is Appendix 16 which contains:

- Appendix 16.1 Minutes from meetings with the local fishing industry
- Appendix 16.2 Fishing Effort Map UK 2009
- Appendix 16.3 Fisheries questionnaires sent to fishermen
- Appendix 16.4 Fisheries questionnaires returned by the local fishing industry; and

16.1.4 Appendix 15.1 Navigation Risk Assessment West Lewis Oyster Wave Array (Technical Note) also provides information relevant to this Chapter and informs the impacts assessment.

16.2 Summary of assessment on commercial fisheries

16.2.1 Fishing activity off the north-west coast of Lewis is generally considered to be low, in comparison to the surrounding waters, and in terms of the UK average. Further consultation with the fishing industry has indicated that the development site is of low importance locally. The main species targeted with the study area are shellfish, in particular crab and lobster. The site is fished by up to four local vessels, which use the area on a regular basis.

16.2.2 The greatest impacts to commercial fisheries are likely to be as a result of the displacement of vessels from the development site, which in turn may have economic impacts upon the fishermen who use that area. However no impacts have been rated as having a higher significance than that of minor adverse.

16.2.3 Through close consultation with the local fishing industry and a commitment to work with the local fishermen, impacts on commercial fisheries can be mitigated and therefore the residual impacts are likely to be of negligible significance.

16.3 Potential effects

16.3.1 Guidance produced to aid the consenting process for marine renewables in Scotland (EMEC and Xodus Group, in press), includes a list of potential impacts that wave and tidal energy developments may have on commercial fisheries. Based on this guidance and knowledge of the site the possible impacts of the proposed development include:

- Loss of traditional fishing grounds;
- Increased pressure on new or existing fishing grounds as a result of displaced fishing effort;
- Physiological impacts on nearby fish farming operations;
- Danger and damage to gear;
- Obstruction to regular fishing vessel transit routes; and
- Pollution from routine and accidental discharges.

16.4 Methodology

16.4.1 This assessment follows the latest, appropriate, guidance on Environmental Impact Assessment (EIA) (EMEC and Xodus Group in press; Cefas, 2004 and IEMA, 2006) and draws experience from recent examples of similar renewable energy projects in the UK and Europe. A baseline for commercial fisheries within the study area (as defined below) was established through a desk based review and an impact assessment was then conducted to predict the potential impacts of the proposed development on that baseline environment.

16.4.2 The impact assessment uses a "Rochdale Envelope approach" to project description (See section 2.3 in *Chapter 2 Scoping and assessment methodology*), where uncertainties regarding aspects of the project description lead to the development of a realistic worst case scenario for each of the receptors assessed.

Defining the study area

16.4.3 The commercial fisheries study areas are defined in line with section 12.4 in *Chapter 12 Fish and shellfish* and consist of:

- The Local Study Area (LSA), which includes the development site and the area covered during surveys (see *Chapter 9 Benthic ecology* and *Chapter 11 Marine mammals*); and
- A Regional Study Area (RSA), which consists of ICES rectangle[1] 45E3.

16.4.4 Both the RSA and the LSA are displayed in Figure 12.1 in *Chapter 12 Fish and Shellfish*.

Legislation, Guidelines and Policy Framework

16.4.5 There is no specific legislation which governs the assessment or management of impacts on commercial fisheries from wave array developments. There are, however, guidelines

[1] ICES rectangle '30 min latitude and 1° longitude in size which is used by ICES (International Council for exploration of the Sea) for statistical and data gathering purposes.

commissioned by Marine Scotland to help developers with consenting, Environmental Impact Assessment (EIA) and Habitats Regulations Appraisal (HRA) for marine renewable energy developments in Scotland. A draft version of this document (EMEC and Xodus group, in press) is available online and highlights the following with regards to Commercial Fisheries.

16.4.6 "Developers must first define the use of the development area by fisheries and mariculture in order to identify and then assess the potential for an impact to occur as a result of a marine renewables development." The document also indicates that in order to compile a baseline the following should be identified:

- Fishing grounds within the vicinity of the development;
- Evidence and distribution of the major commercial fish and shellfish species in the area;
- The type of fishing that takes places within the area and the gear that is used;
- Seasonality of the fishing in the area;
- Fish landings data;
- Fishing effort data (the time spent fishing within an area);
- Fishing vessel movements (if these data are readily available); and
- Value of the fishing industry to the local economy.

Consultation

16.4.7 A Scoping Opinion was sought from statutory consultees (the details of which are set out in *Chapter 3: Consultation*) in May 2011. Responses are detailed in Appendix 2.1 (Scoping Opinion), while a short summary of the main points pertinent to commercial fisheries raised during this process, along with an explanation of how they were addressed, is provided in Table 16.1 below.

Table 16.1 Issues raised in the scoping opinion (Marine Scotland 2011)

Comments/ Information	Response
The Local Authority - Comhairle nan Eilean Siar (Western Isles) Planning Authority highlighted that "local information indicates up to 8 static gear vessels work the area concerned through the summer months." They were of the opinion that the development will "materially affect the extent of this fishing".	This opinion was formulated prior to the offshore development area being refined to its current location and size as set out in the Scoping Report (Lewis Wave Power Limited, 2011). At the time of the issue of the scoping opinion the "Search area" covered an area of approximately 55km^2 (see Figure 4.1 in Chapter 4 Site selection). The refined total working footprint of the project now covers an area of less than 2km^2 (Figure 12.1). Questionnaires sent to the local fishing industry as part of the baseline data collection indicate that four fishing vessels use the refined area.
MS-LOT indicated that "the developer should consult with local fishermen and a possible point	Lewis Wave Power has been in contact with Duncan MacInnes who has agreed to act as the link between

Table 16.1 Issues raised in the scoping opinion (Marine Scotland 2011)	
Comments/ Information	**Response**
of contact is the Inshore Fisheries Group coordinator for the Outer Hebrides".	the project and the Outer Hebrides Inshore Fisheries Group (IFG) and wider fishing industry. Duncan is also the secretary of the IFG.
The Scoping Opinion expressed the need to investigate the impact of congestion at piers and harbours effecting commercial fisheries.	The quay side facilities required by the proposed development are very different to that of a fish quay and no overlap in resource requirement is anticipated. Furthermore large vessels associated with the installation of the development will use recognised shipping lanes when approaching or leaving a pier or harbour and will therefore not create an additional impact. Displacement of vessels is discussed in Impact 2.

16.4.8 In order to facilitate a clear channel of communication between the fishing industry and Lewis Wave Power the local coordinator/secretary for the Outer Hebrides Inshore Fisheries Group (IFG) agreed to act as an interface between Lewis Wave Power and the fishing industry. The IFG coordinator/secretary has been in constant communication with all local fishermen who fish off the west coast of Lewis and throughout the project and has collated relevant information.

16.4.9 As part of the consultation process Lewis Wave Power attended two of the IFG meetings, the minutes for which are provided in Appendix 16.1

Data collection

16.4.10 The principal data sources used to compile the baseline for commercial fisheries are presented below in Table 16.2.

16.4.11 The Vessel Monitoring System (VMS) is a form of satellite tracking which uses transmitters on board fishing vessels to track and record information about that vessel including: the geographical position, vessel identification, date/time(UTC) of fixing of position and course and speed of the vessel. The system is a legal requirement on all fishing vessels that exceed 15m in overall length under EC Regulation 2244/2003 and Scottish SI 392/2004. Marine Scotland monitor and record the transmitted information at a dedicated Fisheries Monitoring Centres (FMCs).

16.4.12 Marine Scotland Compliance also use two Reims Cessna Caravan II F-406 aircraft (Watchdog Alpha and Watchdog Bravo), to conduct aerial surveillance work. As part of this work they record the position and gear type of any fishing vessels encountered. One of the aircraft is fitted with a visible light and infra-red video camera. This camera also has a laser illuminator which aids vessel identification in low and no light conditions.

Table 16.2 Existing data			
Data source	**Coverage**	**Author(s)**	**Year**
Landings data	ICES rectangle 45E3	Marine Scotland Science	2005-2010

Table 16.2 Existing data			
Data source	**Coverage**	**Author(s)**	**Year**
Effort data	ICES rectangle 45E3	Marine Scotland Science	2006-2010
Fisheries Questionnaires	Seven vessels with potential to fish the area.	Local Fishermen	2011
VMS data	ICES rectangles 45E3, E6E3	Marine Scotland Science	2006-2010
Surveillance date	ICES rectangles 45E3, E6E3	Marine Scotland Science	2006-2010
Data Collected as part of the NRA	North Western Isles	Anatec	2010-2011
Fishing vessel observation data collected as part of the Marine mammal and bird surveys.	LSA	Natural Research (Projects) Ltd	2010-2011

Assessment of significance

16.4.13 The significance of effects of the proposed development is based on the intensity or degree of disturbance to baseline conditions (as outlined in section **16.5 Existing environment**) caused by the project. This can be categorised into four levels of magnitude: high, medium, low or negligible. The definitions of each of these are given in Table 16.3.

Table 16.3 Criteria for assessing the magnitude of potential effects on fish and shellfish	
Magnitude of effect	**Definition**
High	A fundamental change to the baseline condition of the commercial fisheries.
Medium	A detectible change in the baseline condition resulting in the non-fundamental temporary or permanent effect on commercial fisheries.
Low	A minor change to the baseline condition of commercial fisheries (or a change that is short lived in nature).
Negligible	An imperceptible and/or no change to the baseline condition of commercial fisheries.

16.4.14 The sensitivity of the receptor for each effect is characterised as one of four levels, high, medium, low or negligible. The definition of each level is given below in Table 16.4.

Table 16.4 Criteria for assessment of sensitivity of fish and shell fish	
Receptor Sensitivity/ value	**Guideline criteria**
High	Environment is subject to major change(s) due to impact. For example, Impact on commercial fishing causing a long term (for the life of the

Table 16.4 Criteria for assessment of sensitivity of fish and shell fish	
Receptor Sensitivity/ value	**Guideline criteria**
	development) significant reduction in landings, or a permanent reduction of the fishing fleet (i.e. number of vessels) that operate within the study area.
Medium	Impact on commercial fishing activities that may cause; fishing fleets to permanently modify their fishing activities (e.g. modification of methods or gear), or, long term (for the life of the array) reduction in access to traditional fishing grounds, or greater transit times to grounds, or, temporary total loss of access to grounds. The total quantity of landings from the study area or the number of vessels in the fishing fleet will see small changes (less than an order of magnitude) in size.
Low	Environment responds in minimal way to effects such that only minor change(s) are detectable. For example commercial fishing activities that may cause; fishing fleets to temporarily modify their fishing activities (e.g. modification of methods or gear), or temporary reduced access to traditional fishing grounds. The total quantity of landings from the area or the number of vessels in the fishing fleet may not show a reduction that can be attributed to the development.
Negligible	An imperceptible change to the commercial fisheries baseline.

16.4.15 Table 16.5 combines the definitions of magnitude with the level of sensitivity/value/importance of receptor to provide a prediction of overall significance of the effect. The categories highlighted in red are considered to be significant in the context of the EIA.

Table 16.5 Significance prediction matrix.				
Magnitude o f effect	**Receptor sensitivity/value**			
	Negligible	**Low**	**Medium**	**High**
High	Negligible	Moderate	Major	Major
Medium	Negligible	Minor	Moderate	Major
Low	Negligible	Negligible	Minor	Moderate
Negligible	Negligible	Negligible	Negligible	Minor

16.5 Existing environment

Fishing effort

16.5.1 The VMS data shows that a variety of different fishing gears were used in the waters off the north coasts of Lewis and within the RSA between 2006 and 2010. Fishing activity of vessels over 15m in length was primarily focused on the eastern half of the RSA on the opposite side of Lewis to the LSA. Fishing effort off the west coast of Lewis also appears low when compared with ICES rectangle 46E3 located to the north of the RSA (Figure 16.1).

16.5.2 The single occurrence of a vessel over 15m in length within the study area is a potter which was recorded in the very northern edge of the LSA (Figure 16.1). Further VMS data provided by the Marine Management Organisation (MMO) for the Navigation Risk Assessment (NRA) indicates that a further vessel of unidentified gear type was present within the southern part of the LSA in 2009 (Figure 9.7 Appendix 15.1). Other vessels present in the Marine Scotland data within the vicinity of the LSA were also potters (Figure 16.1). A potter or creeler is a fishing vessel that uses pots (also known as creels) to catch mainly crustaceans such as crabs and lobsters. Due to reasons of confidentially Marine Scotland Science are unable to provide information regarding the identity of this vessel.

16.5.3 Work completed as part of the NRA, analysed data provided by the MMO which indicates that the majority of vessels that fish in the vicinity of the LSA are registered in the UK and that the majority of the larger fishing vessels that pass within the vicinity of the LSA (mostly at a distance of at least 2nm) are travelling to and from fishing grounds to the north of Lewis (Appendix 15.1)

16.5.4 The levels of fishing effort that occur within the RSA can be viewed in a UK context using a figure produced by Marine Scotland Science that is displayed in Appendix A16.2. This figure shows that fishing effort in the RSA (ICES rectangle 45E3) fell in the mid-range of the values (1000-2500 effort days) identified for fishing effort across the UK. The majority of this effort is likely to be from vessels fishing to the east of Lewis (Figures 16.1 and 16.2) however the resolution displayed in Appendix 16.2 does not allow this level of detail to be extrapolated from the figure. Further information regarding fishing vessel movements within the vicinity of the LSA and within the RSA is provided in Section 9 of Appendix 15.1.

16.5.5 Surveillance data (see section 16.4 for explanation of how this data are collected) illustrates similar trends to the VMS data. Figure 16.2 indicates that a number of different gear types were used within the RSA and that less effort was spent in the inshore waters off the west coast of Lewis that in the surrounding waters. No data points are positioned within the LSA and the closest sighting was that of a potter located approximately 1km to the north.

16.5.6 Work completed by Harrald *et.al.* (2010) further provides evidence that the majority of commercial fishing that occurs in the vicinity of the LSA is for shellfish. This study shows that shellfish of a value of between £10,000 and £50,000 were landed from within the vicinity of the LSA in 2009. However it is unclear from this study exactly where the landings were taken from or area covered by the landings.

16.5.7 Fishing effort data provided by Marine Scotland Science has been interrogated to indicate the current trends in fishing effort across the RSA. Figure 16.3 shows that days at sea by fishing vessels within the RSA decreased between 2006 and 2010.

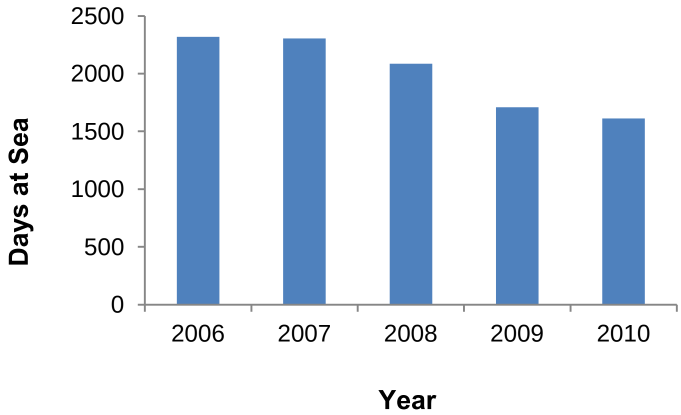

Figure 16.1 Total fishing effort within the RSA (ICES rectangle 45E3). Data source: Marine Scotland Science 2011a.

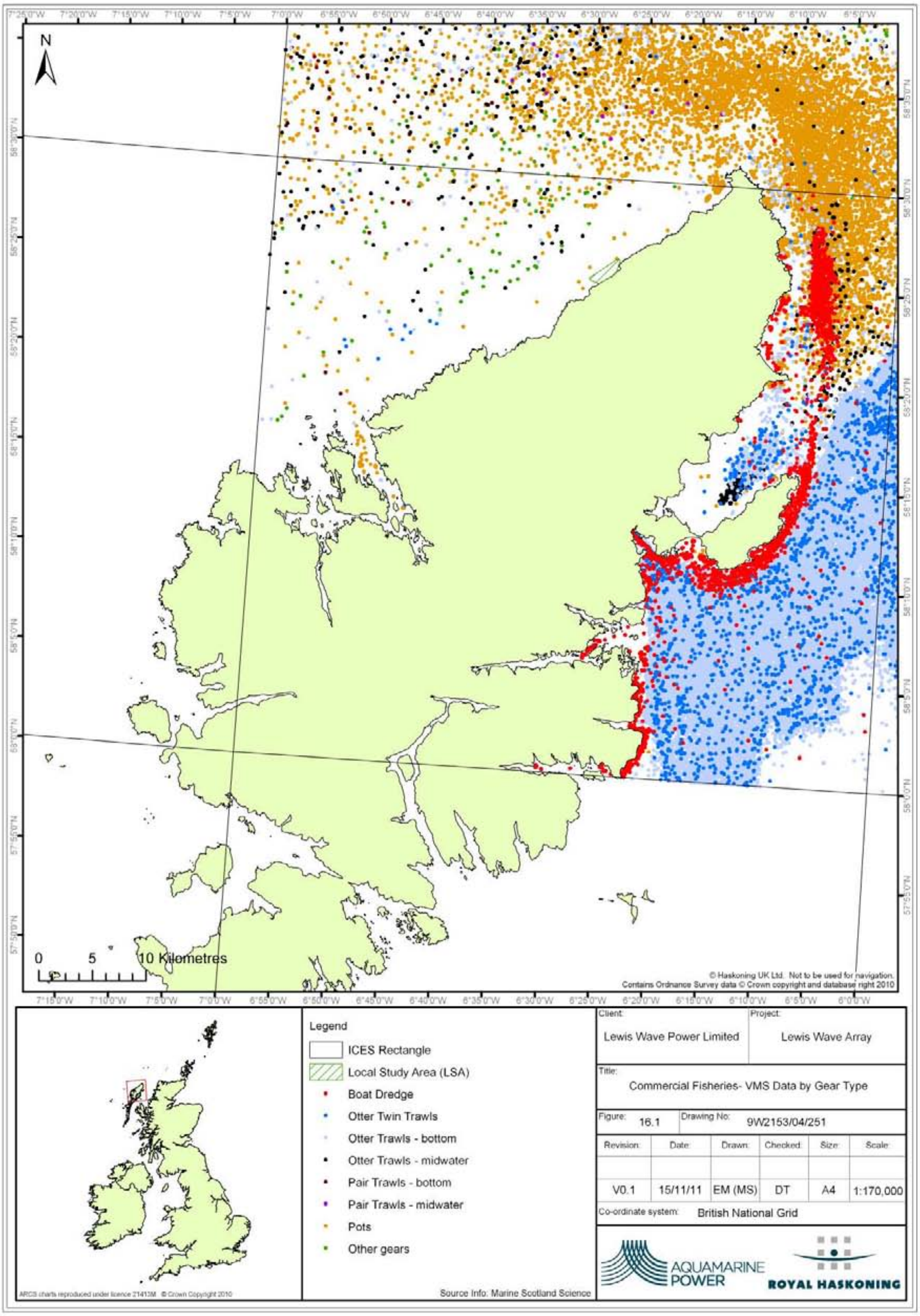

Figure 16.2 VMS data by gear type for ICES rectangles 45E3 and 46E3 between 2006 and 2010. Data Source: Marine Scotland Science.

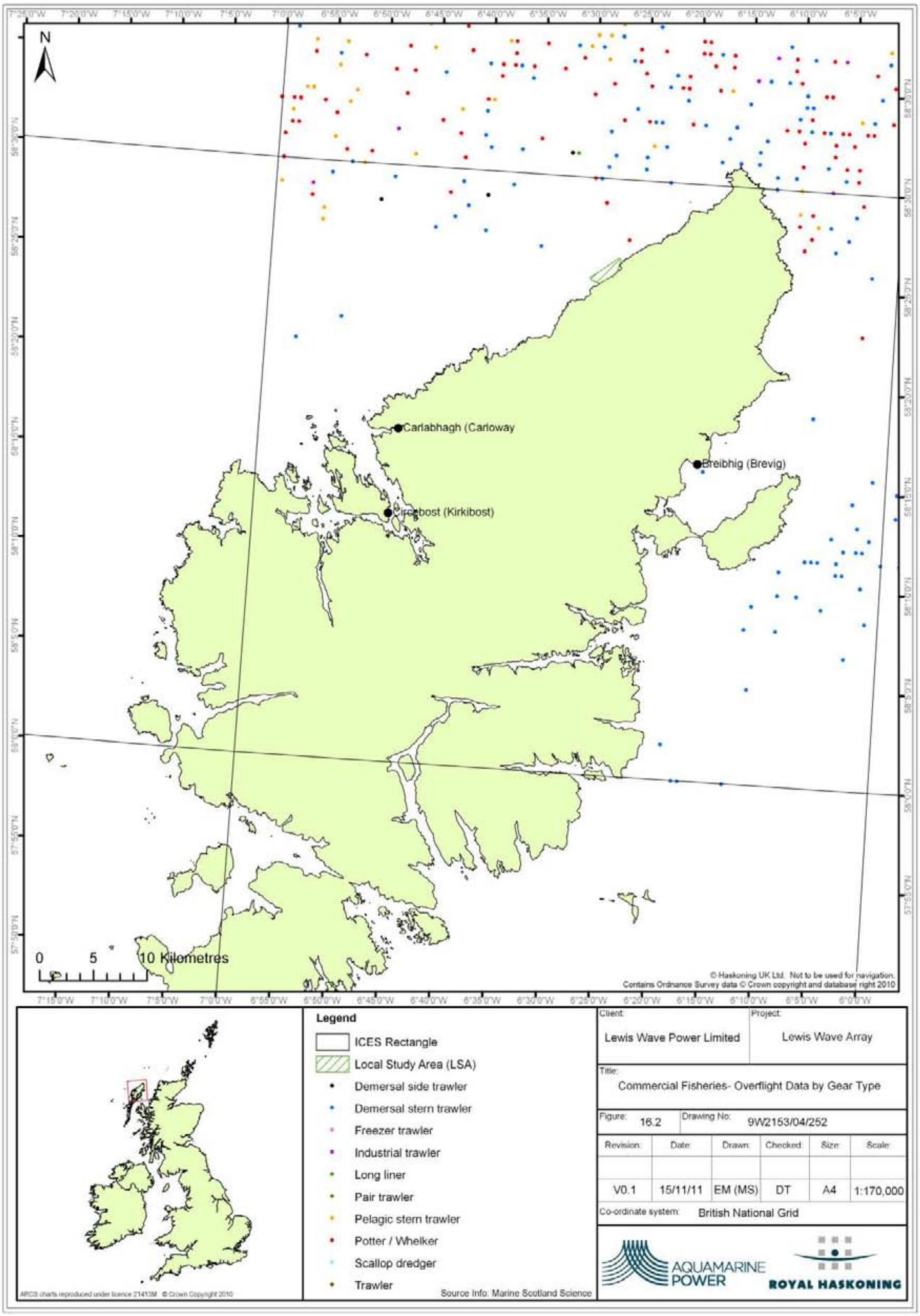

Figure 16.3 Surveillance by gear type for fishing vessels within Ices rectangles 45E3 45E6 between 2006 and 2010. Data Source: Marine Scotland Science

16.5.8 In contrast to the reduction seen in total fishing effort across the RSA, days spent potting within the RSA increased from a low point in 2008 through 2009 and into 2010 (Figure 16.4).

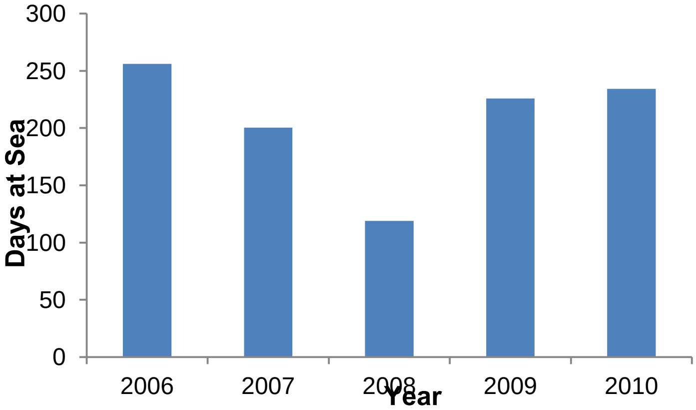

Figure 16.4 Potting/creeling e ffort within th e R SA (ICES r ectangle 4 5E3). data s ource: M arine Scotland Science 2011a.

16.5.9 Although VMS, surveillance and fishing effort data are useful in illustrating the overall trends in the fishing effort across the RSA they do have limitations; as previously explained in section 16.4. VMS data is only available for vessels over 15m in length and therefore will not provide a true representation of how much fishing effort occurs within the zone. Although surveillance data does include vessels under 15m, the data only provides small "snapshots" in time and will not provide a complete picture of fishing activity within the LSA. The effort data is only at the resolution of ICES rectangles which are '30 min latitude and 1° longitude in size. This does not allow interrogation of this data at a level appropriate to the size of the proposed development or LSA. To achieve an overall understanding of fishing activity within the LSA a number of consultations were held with the local fishing industry (See Chapter 4 Consultation). The main element of fisheries data collection from the consultation was through questionnaires sent out to the local fishermen.

Local fleet

16.5.10 At the start of the consultation process skippers of all fishing vessels that are known to fish in the vicinity of the development were sent questionnaires (Appendix 16.3). The following vessels were provided with questionnaires:

- Island Quest CY 435;
- Night Owl KY 454;
- Serene SY 6;
- Jacamar SY 16;
- Siarach SY 85 (has been sold but is being replaced with static gear vessel);
- Delta Dawn SY 309; and
- Carlsbay SY 873.

16.5.11 All of the issued questionnaires were returned. The returned questionnaires are presented in Appendix 16.4 and indicate that four vessels may currently fish within the LSA and that pots and static nets are the types of fishing gear that are used in the area with occasional rod and line fishing to catch bait potentially for use in pots. Through the questionnaires and through additional consultation with the coordinator of the Outer Hebrides IFG it was confirmed that potting for lobster *Homarus gammarus* and brown crab *Cancer pagurus* was the primary fishing activities within the LSA with velvet swimming crab *Necora puber* also landed. Occasionally static nets may be set to target craw fish or European spiny lobster *Palinurus elephas* but these may also catch skate (*Dipturus* spp.) and/or monk or angler (Lophiidae) as bycatch. Two vessels also indicated that they fish in the study area using rod and line methods; further consultation on this revealed that this was for mackerel and dogfish (*Squalidae*) to be used later as bait.

16.5.12 The questionnaires indicate that a maximum of up to 1280 pots may be set within the study area and this represents between 30% and 60% of a vessels total available fishing gear. This scenario is unlikely to ever occur as it represents a theoretical maximum. Data collected as part of the marine mammal surveys (see *Chapter 11 Marine mammals and basking sharks* for more details) indicated that fishing vessel activity close to the shore within the vicinity of the proposed development was very low (Section 8 Appendix 15.1) and only one single fishing vessel has been sighted within the LSA which has been recorded as actively potting on a number of occasions. The questionnaires indicate that all of the vessels that fish the area are under 10m and fish out of either Kirkibost (1 vessel), Carloway (2 vessels) and (Brevig (1 vessel) (Locations illustrated in 16.2) with one of the vessels indicating that they land catch at Bragar Bay landing slip. Fishing activity within the LSA is focused on the summer season when favourable sea conditions are more common, but fishing appears to occur from April through to October.

16.5.13 Due to an agreement with the local fishing community it is not appropriate to present details of the fishing habits of individual vessels in this Environmental Statement. Therefore it is not possible to identify which of the vessels identified by the IFG coordinator fish within the LSA. Details of all vessels that the questionnaires were sent to are provided in Table 16.6. Vessels that are likely to use the study area are between 6.2 and 9.95m in length and possess engines rated between 21 and 177KW.

Table 16.6 List of vessels that could potentially fish within the Local study area.

Vessel name	Overall length	Registered tonnage	Engine power (KW)	Vessel capacity units
Island Quest	6.2	1.79	21	25.1
Serene	7.25	1.66	42	40.3
Night Owl	7.7	3.89	63	49.1
Delta Dawn	8.22	7.72	68	58.5
Jacamar II	9.66	7.16	168	122.2
Carlsbay	9.95	7.4	177	120.4
Siarach III *	19.45	70	209.7	201.5

* This vessel has been sold but is being replaced with a potter

16.5.14 The results of the questionnaire and additional consultation with the fishing industry indicate that the LSA and therefore the development site do not support locally important fishing grounds.

Key species

16.5.15 Marine Scotland Science releases data on landings by species for all ICES rectangles within UK waters each year. These data were interrogated to gain an understanding in the trends that have occurred within the RSA over between 2006 and 2010. As it has been identified above that shellfish and in particular lobster, brown crab, velvet crab and European spiny lobster (see *Chapter 12 Fish and shellfish* for details of the landings and ecology of these species) are the main species (termed key species hereafter) targeted within the LSA; these are the focus of the data interrogation.

16.5.16 Landings from the RSA of the four shellfish key species identified above remained relatively constant between 2006 and 2010 (Figure 16.5) although a dip appears to have occurred in 2008 with recovery in 2009 and 2010. The value and live weight landed have remained relative to each other throughout this period indicating the price of these crustaceans has remained approximately constant over the five year period.

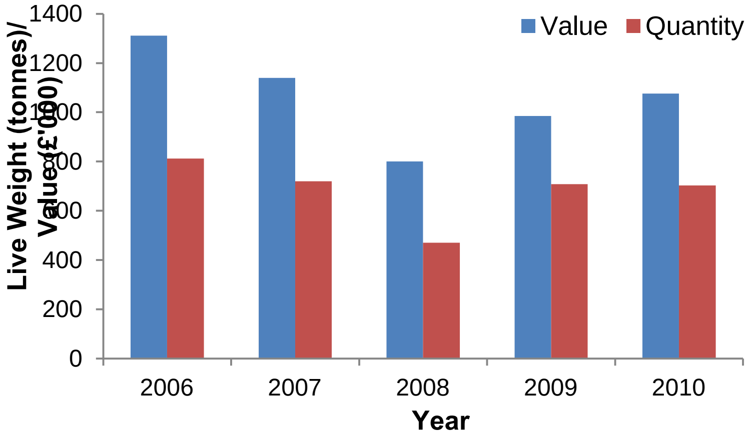

Figure 16.5 Value and quantity (live weight) of landings of lobster brown crab, velvet crab and crawfish from the RSA between 2006 and 2010. Source: Marine Scotland, 2011b

<u>Individual species</u>

16.5.17 This section of the commercial fisheries chapter should be read in conjunction with Section 12.5 of *Chapter 12 Fish and shellfish* as that section contains information about the ecology of the key species which is not repeated here.

Brown crab

16.5.18 The brown crab *Cancer pagurus* (also known as the edible crab) is targeted by vessels operating static gear (creelers) and are known to be landed from within the LSA as confirmed by consultation with local fishermen. All four of the vessels that potentially fish within the LSA target brown crab (Appendix 16.4) and this is likely to be the most numerous species caught there. Further information regarding brown crab can be found in Section 12.5 in *Chapter 12 Fish and Shellfish.*

16.5.19 Brown crab comprised 22.5% of the overall weight and 19% of the overall value of landings of all species from ICES rectangle 45E3 between 2006 and 2010 making it the third most important species in terms of weight landed (Appendix 12.1). Relative to other species landed from the RSA, the value of brown crab is high per unit weight and therefore it is the second most important species in terms of value landed from the RSA. However when compared to other key species the value of this species per tonne is relatively low (Table 16.7).

16.5.20 Brown crab landings from the RSA follow the same yearly pattern (Figure 16.6) as the overall landings of the key species seen in Figure 16.5. This is unsurprising as brown crab comprises 85% of the key species landed from within the RSA and therefore largely dictates the trend.

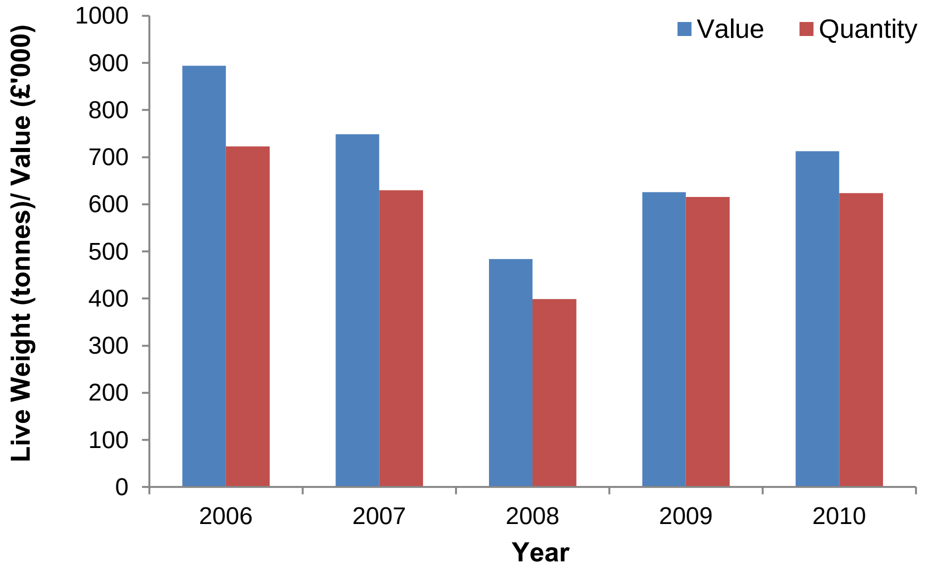

Figure 16.6 Landings by live weight and value of brown crab from ICES rectangle 45E3 between 2006 and 2010 by year. Source: Marine Scotland, 2011b

Table 16.7 Value per tonne of key species within RSA (ICES rectangle 45E3) as calculated from landings data provided by Marine Scotland Science

Species	Value per tonne
Crawfish	25,355
Lobster	10,698
Crab - Velvet (Swim)	1,935
Crab (C.P.Mixed Sexes)	1,158

Lobster

16.5.21 The common lobster *Homarus gammarus* is currently targeted within the LSA (as confirmed from consultation with local fishermen) and comprised less than 1% of the live weight landed from the RSA between 2006 and 2010. Due to the high value of lobster (Table 16.7) this constituted 6.4% of the value of landings from within the RSA. Landings of lobster from the RSA decreased between 2006 and 2008 but then increased in 2009 (Figure 16.7). It has been reported during consultation with the Western Isles Lobster hatchery that landings of lobster from the west coast of Lewis have been in decline since 2007.

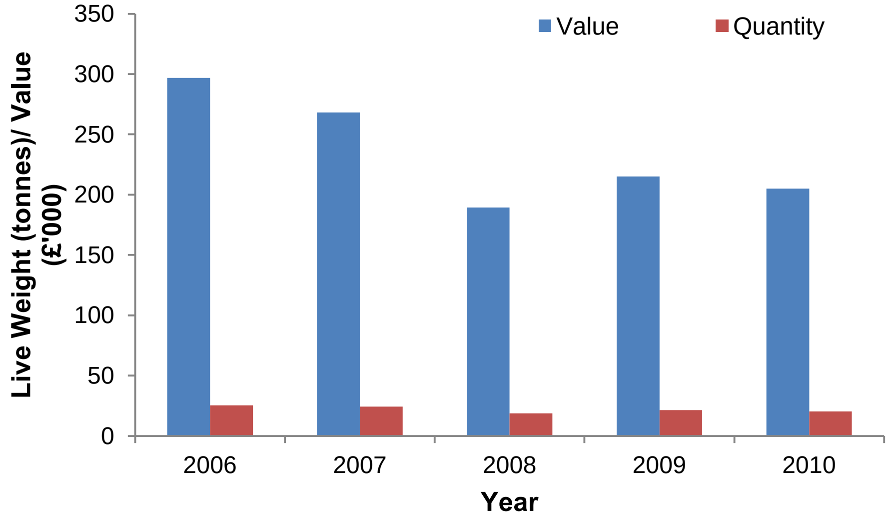

Figure 16.7 Landings by live weight and value of lobster from ICES rectangle 45E3 between 2006 and 2010 by year. Source: Marine Scotland, 2011b

16.5.22 Further information regarding the biology and ecology of lobsters can be found in section 12.5 of *Chapter 12 Fish and Shellfish*. Lobster is targeted by vessels operating static gear known as pots or creels. Potters are known to operate within the LSA and consultation with local fisherman revealed that all four of the vessels that fish the LSA specifically target lobster in that area.

Velvet crab

16.5.23 Velvet swimming crab *Necora puber*, is not likely to be specifically targeted within the LSA but is considered a valuable bycatch and is landed in the area. It is the fourth most landed species from within the RSA comprising 2.3% of the total live weight and 3.3% of the total value of all species. Landings of this species have remained relatively constant between 2006 and 2010 with a slight overall increase both in terms of value and quantity (Figure 16.8).

Figure 16.8 Landings by live weight and value of velvet swimming crab from ICES rectangle 45E3 between 2006 and 2010 by year. Source: Marine Scotland, 2011b

Crawfish

16.5.24 Crawfish or European spiny lobster *Palinurus elephas* are targeted within the LSA using static nets (Appendix 16.4). They may also be caught in pots set for common lobster *Homarus gammarus* (see above). Approximately 3 tonne of this species was landed from the RSA between 2006 and 2010, however due to its high value (Table 16.7) this made it the 8th most valuable species landed from the RSA.

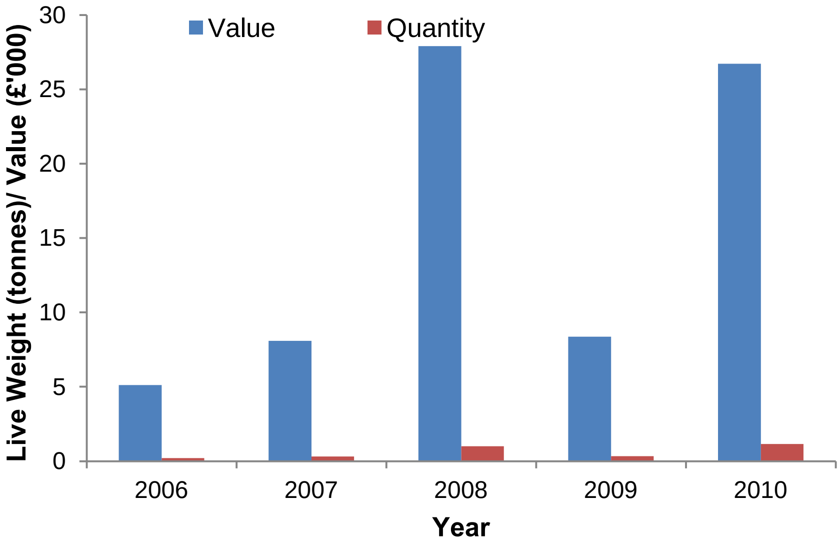

Figure 16.9 Landings by live weight and value of crawfish or European spiny lobster from ICES rectangle 45E3 between 2006 and 2010 by year. Source: Marine Scotland, 2011b

16.5.25 Yearly landings of this species from with the RSA are highly variable (Figure 16.9) ranging from 0.2 tonnes in 2006 to 1.15 tonnes in 2010.

Other species

16.5.26 The other species that may be landed from within the LSA include monkfish (*Lophiidae) and* dogfish (*Squalidae*). The landings of both of these species have significantly declined between 2005 and 2010 (Appendix 12.1).

Socio-economics

16.5.27 The 2009 economic survey of the UK fishing fleet (Seafish, 2011) calculated that the average income of a potting/creeling vessel between 10 and 12m in length was £93,707. This equated to an average crew member aboard these vessels generating an income of £25,830. These figures are calculated for vessels between 10-12m, no calculations are available for vessels under 10m which represents the length class of the vessels that fish within the study area. Therefore the income for the majority of local vessels may well be less than that stated in the study. Although this survey is the most recent it was conducted three years ago and therefore earnings may have increased in line with inflation and higher demand for seafood. The net profit of fishing vessels within the 10-12m size class was calculated to be £22,412.

European Union management plans

16.5.28 European Union management plans exist for a number of commercially exploited species within European waters (European commission fisheries website, 2011). However plans do not currently exist for any of the species fished commercially from the LSA.

Aquaculture

16.5.29 The nearest aquaculture is located in Loch Roag approximately 40km south of the LSA, by sea. The Loch supports a number of active marine fish farms and several shellfish farms which combine to give the loch one of the highest densities of fish farms anywhere in Scotland (Scottish Government, 2008). The development will require certain activities to be carried out within the Loch, however these will be subject to a separate marine licence which will applied for with a supporting environmental report which will assess the impacts to commercial fishing occurring within Loch Roag.

16.6 Impact assessment

Do nothing scenario

16.6.1 If the development is not realised, commercial fisheries within the LSA are likely to continue much as described in Section 16.5 Existing environment. Consultation with the local fishing industry does not indicate that an increase fishing pressure within the LSA either by increasing the number of vessels or the number of creels used is likely to occur in the near future. It is recognised that fishing pressure within the LSA would respond to the market forces, however such forces are difficult to predict.

Potential impacts during construction

Impact 1: Temporary loss of traditional fishing grounds

16.6.2 Commercial fishing within the LSA is almost exclusively carried out by small vessels that use pots/creels to catch crab and lobster. There is also a very small amount of effort spent using static nets or rod and line methods. Up to four boats use the LSA for commercial fishing during spring, summer and autumn with no vessels using the area during winter when access is prevented due to seasonal bad weather.

16.6.3 Installation of the development is likely to take place during the summer months in order to avoid any potential bad weather. This coincides with the period when the LSA experiences the greatest fishing effort.

16.6.4 Lewis Wave Power wishes to develop a voluntary agreement with local inshore fishermen. This will include a safety exclusion area around the immediate construction/installation activities implemented under The Construction (Design and Management) Regulations 2007 (CDM) and will discourage the entry of any vessel within the designated construction area.

16.6.5 The exclusion zone will be limited to the immediate construction/ installation area and will therefore only affect a very small part of the development site. Details of the exclusion zone will be confirmed following micro siting of the devices and consultation with fishermen. The construction period for the development is likely to continue for a maximum of five years (*Chapter 5 Project description*) and therefore the exclusion of fishing vessels from parts of LSA will occur over this period and then during operation.

16.6.6 The habitat across the LSA has been identified as being typical of the marine environment in the waters off the north-west coast of Lewis (Moore and Roberts 2011; *Chapter 12 Fish and shellfish* and *Chapter 9 Benthic ecology*). The LSA comprises approximately 2% of this area (surveyed by Moore and Roberts) that is considered to be uniform. The remainder of this area (98%) would be available to fishing activity displaced from the LSA during the construction phase. This combined with the fact that only a maximum of four vessels fish within the LSA means that the magnitude of the impact can be considered to be low.

16.6.7 Consultation with local fishermen has suggested that of the four vessels one vessel can deploy a maximum of 60% of its gear, two deploy up to a maximum of 50% of their fishing gear and one deploys up to a maximum of 30% of its fishing gear within the LSA. This data is however subjective and represents an over emphasis of the LSAs importance to local fishermen. The observation data on fishing vessel activity (Section 8 Appendix 15.1 and Table 16.2) recorded one fishing vessel within the LSA as actively potting on a limited number of occasions. The observations were gathered from 279 daylight hours of observation between September 2010 and September 2011 from two vantage points overlooking the site.

16.6.8 A common pattern of a potting fishery is for a fisherman to deploy their fleets of pots in contained areas to allow relative ease of access and servicing. The potters range over a large area of sea fishing favoured areas for a discrete period of time and then moving on to new grounds. This would explain the high potential deployment but low observed fishing activity.

16.6.9 The construction of the development may cause local fleets to permanently modify their fishing activities resulting in a slight change to landings and therefore in accordance with Table 16.4 the sensitivity of the local fishing fleet is considered to be within the medium category. Using the significance prediction matric (Table 16.5) the impact of temporary loss of traditional fishing grounds to commercial fisheries will be of **minor adverse** significance.

MITIGATION IN RELATION TO IMPACT 1:
By working with the local fishermen the exclusion zones will be reduced in both size and duration where possible.

Residual impact and best practice

16.6.10 If the mitigation suggested above is implemented it may be possible to reduce the significance of the impact to **negligible**.

16.6.11 At present the magnitude of the impact is assessed using the greatest possible footprint of construction works and for the longest possible duration. As the project develops the size of this footprint and/or its duration will be reduced where possible.

Impact 2: Temporary displacement from traditional fishing grounds

16.6.12 Four fishing boats have been identified as fishing within the LSA (Appendix A16.4). These can deploy up to a maximum of between 30% and 60% of their available fishing gear within the area. The LSA has been identified as typical of the habitat that exist of the north-west coast of Lewis (*Chapter 12 Fish and shellfish*), of which the LSA comprises approximately 2%. It can be assumed that the remainder of this area (98%) will receive additional fishing effort that has been displaced as a result of the construction of the proposed development. As described in Section 16.4, fishing effort off the northwest coast of Lewis is generally very low and therefore the surrounding habitat will easily absorb the additional effort without a discernable difference in the baseline environment. Thus the magnitude of this impact must be considered to be at worst low.

16.6.13 The local fishing fleet may need to temporarily modify their fishing activities during the construction period exploiting other adjacent areas in order prevent collision with construction vessels and avoid interactions with installed infrastructure. However, as the displaced effort would be small (four vessels) and the fishermen would need to make only small changes to their fishing activities the sensitivity of commercial fisheries to this impact can be considered to be medium or low. Therefore in accordance with Table 16.5 the effect of displaced fishing effort targeting new or other fishing grounds is likely to be at worst, of **minor adverse** significance.

MITIGATION IN RELATION TO IMPACT 2:
• By working with the local fishermen it may be possible reduce exclusion zones in both size and duration. This will reduce the amount of displaced fishing activity. • Good communication with the local fishing fleet will be maintained via the IFG throughout the run up to construction and during the construction period.

Residual impact

16.6.14 If the above mitigation is implemented it may be possible to reduce the impact of temporary displacement from traditional fishing grounds to **negligible** significance.

Impact 3: Danger to life and/or damage to gear due to construction

16.6.15 *Chapter 15 Shipping and Navigation* makes an assessment of the impact of "Collision between the development structures and vessels, or between vessels". This assessment incorporates commercial fishing vessels within the qualification of the impact. The impact is assessed as having a moderate adverse impact and a number of mitigation measures are suggested in line with the results of the NRA (Appendix 15.1). If the mitigations measures advised by Anatec Ltd. (Lewis Wave Power's advisor on shipping and navigation) are implemented a safety exclusion zone will be brought into effect around all construction activities. Lewis Wave Power hopes to achieve this by working with the local inshore fishermen to establish a voluntary exclusion zone around installation activities (see Impact 1 for further detail).

16.6.16 All fishermen who currently fish within the LSA will be informed of construction times and duration through the IFG coordinator and other appropriate channels of communication and therefore as no fishermen will be in close proximity to installation vessels **no impact** of danger to life and/or damage to gear due to construction is predicted.

MITIGATION IN RELATION TO IMPACT 3:
Good communication with the local fishing fleet will be maintained via the IFG throughout the run up to construction and during the construction period.

Residual impact

16.6.17 As no mitigation is suggested the residual effect will remain as **no impact**.

Impact 4: Obstruction to regular fishing vessel transit routes;

16.6.18 The development is not located within an area which is characterised by restrictions to navigation nor is there evidence to suggest that numerous fishing vessel movements currently occur along that particular stretch of the north Lewis coastline (Section 9 of Appendix 15.1 and Section 16.4 in the current chapter). Furthermore the development site is not on a transit route to any known fishing grounds (Appendix 15.1 and Figures 16.1 and 16.2). Therefore it is likely that there will be **no impact** caused to commercial fisheries by the development causing an obstruction to regular fishing vessel transit routes during construction.

MITIGATION IN RELATION TO IMPACT 4
No mitigation suggested

Residual impact

The residual effect will be **no impact.**

Impact 5: Changes in abundance of target species

16.6.19 The most likely pathway by which the development may impact upon the abundance of the key species targeted by commercial fisheries is by disturbance as a result of the construction activities. *Chapter 12 Fish and shellfish* makes an assessment the potential impact of substratum/ benthic habitat loss as being of negligible significance. Therefore the magnitude of changes in abundance of target species can be assumed to be negligible.

16.6.20 Of the four fishermen that fish within the LSA all target benthic crustacean species. Therefore the sensitivity of these fishermen to changes in abundance of these species is relatively high. However if the entire fishing industry is taken into consideration the sensitivity of this impact must be considered at worst within the medium category. Therefore, in accordance with Table 16.5 the impact of changes in abundance of target species is likely to be of **negligible** significance.

MITIGATION IN RELATION TO IMPACT 5
Gap fillers may be placed under the oyster WECs. The design of the gap fillers will draw on recent research and experience for the oyster project at Billia Croo, Orkney, to design the gap fillers to become suitable habitat for lobster and crab. It can be assumed that these species will increase in abundance within the proposed development site, with opportunities for over spill. This will have limited effect during the initial stage so of the construction but effects will increase with time and as more of the gap fillers are installed.

Residual impact

16.6.21 With the proposed mitigation implemented it is likely that the negligible impacts will become **no impact**.

Impact 6: Economic impact of the development.

16.6.22 Due to the subjective nature of the questionnaires and the low resolution of the data available to establish the baseline it is not possible to calculate a figure for the value of the LSA to commercial fishermen during the construction period when their activities are most likely to be disrupted.

16.6.23 It is however apparent that the LSA forms a small part of the available fishing area available to the local vessels. Therefore the sensitivity of the loss of the LSA as potential fishing grounds is considered to be low.

16.6.24 LWP is committed to continuing the positive dialogues that has been established with the local fishing vessels and will continue to consider ways to support and assist local fisheries.

16.6.25 A safety exclusion zone will be bought into effect around construction activities through either a voluntary agreement with local fishermen or under CDM regulations (See Impact 3 for further detail). The safety exclusion zone will be temporary in nature only occupying a small area of sea in the immediate vicinity of the construction vessels and installed infrastructure. The area from which no fishing can occur will be small and therefore the magnitude of this impact is considered to be low. In accordance with Table 12.5 Economic impact of the development to commercial fisheries during construction is likely to be of **negligible** significance.

MITIGATION IN RELATION TO IMPACT 5
No mitigation suggested

Residual impact

16.6.26 As no mitigation is suggested the residual effect will remain at **negligible** significance.

<u>Potential impacts during operation (including maintenance)</u>

Impact 1: Permanent loss of traditional fishing grounds

16.6.27 The baseline environment for commercial fishing within the LSA is detailed above in Section 16.5 and in Impact 1 in potential impacts during construction phase.

16.6.28 In response to the findings of the NRA (Appendix 15.1) Lewis Wave Power will seek to develop a voluntary agreement with local fishermen which will result in the removal all fishing activity from the development site for the duration of the development which is predicted to be 20 years (*Chapter 5 Project description*) and therefore the exclusion of the entire LSA will occur over this period. This will be of a greater size than the exclusion zones used during the construction phase.

16.6.29 As detailed above in Impact 1 in potential impacts during construction the habitat across the LSA has been identified as being typical of its surrounding area representing approximately 2% of the wider known region. The remaining 98% of this area would be available to fishing vessels excluded from the LSA during the operation phase. This large area combined with the fact that only four vessels fish within the study area means that the magnitude of the impact can be considered to be low.

16.6.30 As described above (Impact 1 in potential effects during construction) minimal fishing effort is currently focused on the LSA. However the few vessels that do fish within the area may deploy large amounts of their total gear there; and therefore the sensitivity of the relevant fishermen must be considered high. Nevertheless the sensitivity of the fishing industry to the impact when considered in its entirety can only be considered to be medium in line with the criteria described in Table 16.4. In accordance with Table 16.5 the impact of permanent loss of traditional fishing grounds to commercial fisheries will be of **minor adverse** significance.

MITIGATION IN RELATION TO IMPACT 1
No mitigation suggested

Residual impact and best practise

16.6.31 If the mitigation suggested above is implemented it may be possible to reduce the significance of the impact to **negligible**.

16.6.32 At present the magnitude of the impact is assessed using the greatest possible footprint of construction works and for the longest possible duration. As the project develops the size of this footprint and/or its duration will be reduced where possible.

Impact 2: Permanent displacement from traditional fishing grounds

16.6.33 As identified above in Impact 2 of potential impacts during construction the LSA comprises approximately 2% of a fairly uniform marine environment. It can be assumed that the remainder of this area (98%) will receive an additional fishing effort for the duration of operational phase of the development. As described in Section 16.4 fishing effort off the north-west coast is low and therefore the surrounding habitat will easily absorb the additional effort without a discernable difference in the baseline environment. Thus the magnitude of this impact must be considered to be at worst low.

16.6.34 The local fishing fleet will need to slightly modify their fishing activities during the operational period in order prevent collision with installed infrastructure and the exclusion zone. However, as the displaced effort would be small (four vessels) the sensitivity of local commercial fisheries can be considered to be medium or low. Therefore in accordance with Table 16.5 the effect of displaced fishing effort targeting new or other fishing grounds is likely to be at worst, of **minor adverse** significance.

MITIGATION IN RELATION TO IMPACT 2
No mitigation suggested

Residual effect and best practice

16.6.35 If the above mitigation is fully implemented it is likely that the impact of permanent displacement from traditional fishing grounds would be reduced to **negligible** significance.

16.6.36 At present the magnitude of the impact is assessed using the greatest possible footprint of construction works and for the longest possible duration. As the project develops the size of this footprint and/or its duration will be reduced where possible

Impact 3: Danger and damage to gear due to the operational array

16.6.37 As part of any future commitment to contribute funding to the Western Isles lobster hatchery a 'no fish' zone would be set up around the wave array in agreement with Outer Hebrides IFG. If fishermen adhere to the no-fish zone they are unlikely to endanger themselves or sustain any damage to gear during the period in which the array is operational. Therefore there will be **no impact.**

MITIGATION IN RELATION TO IMPACT 3
No mitigation suggested

Residual impact:

16.6.38 As no mitigation is suggested the impact will remain at **no impact**.

Impact 4: Obstruction to regular fishing vessel transit routes;

16.6.39 The development is not located within an area which is characterised by restrictive navigation nor is there evidence to suggest that numerous vessel movements occur along that particular stretch of the north Lewis coast line (Appendix 15.1). Furthermore there are no clear heavily used fishing grounds in such a location as a vessel would wish to transit the development site in order to access (Figures 16.1 and 16.2). Therefore it is likely that there will be **no impact** caused to commercial fisheries by the development causing an obstruction to regular fishing vessel transit routes.

MITIGATION IN RELATION TO IMPACT 4
No mitigation suggested

Residual impact

The residual effect will be **no impact.**

Impact 5: Changes in abundance of target species

16.6.40 It is likely that once construction of the development is complete much of the impacted area will be re-colonised and will return to a state similar to the current baseline (*Chapter 9 Benthic ecology* and *Chapter 12 Fish and shellfish*). The displacement of fishing effort from the LSA may have the effect of providing a refuge for targeted species. Lobster and crab are the only species that are currently targeted within the development site from which fishing will be removed. Furthermore it is possible that the 'gap fillers' and pipeline associated infrastructure may act as "artificial reefs" increasing productivity and growth of invertebrates (this point is discussed further in *Chapter 9: Benthic ecology*) upon which crab and lobster may feed. The possible increase in food availability and the cessation of fishing pressure may have the effect of increasing lobster and brown crab populations locally within the wave array (this point is discussed in more detail and the impacts are assessed in detail in *Chapter 9 Benthic Ecology.* Therefore the magnitude of this impact will be reduced from that seen during the construction phase (Impact 1 in potential impacts during construction) and should be considered in the low category.

16.6.41 The potential increase in population may then spill over into adjacent areas outside of the exclusion zones where fishermen may see an increasing their catch. Therefore in accordance with Table 16.4 the sensitivity can be considered low which would in accordance with Table 16.5 lead to a **beneficial** impact but would be of **negligible** significance.

MITIGATION IN RELATION TO IMPACT 5
Gap fillers may be placed under the oyster WECs. The design of the gap fillers will draw on recent research and experience for the oyster project at Billia Croo, Orkney, to design the gap fillers to become suitable habitat for lobster and crab. It can be assumed that these species will increase in abundance within the proposed development site, with opportunities for over spill. This will have limited effect during the initial stage so of the construction but effects will increase with time and as more of the gap fillers are installed.

Residual impact

16.6.42 If the mitigation suggested above is implemented the residual impact to changes in abundance of target species will be of either negligible or minor beneficial significance.

Impact 6: Economic impact of the development

16.6.43 Lewis Wave Power is currently in discussions with relevant parties regarding the possibility of contributing support to the Western Isles Lobster Hatchery. The wave array area may be suitable for use as a nursery ground for lobster which will be seeded by the hatchery and protect from fishing pressure and disturbance. Therefore the magnitude of this impact will be at worst within the low category but may be beneficial and the sensitivity will remain low (see impact 6 in potential impacts during operation)

16.6.44 In accordance with Table 16.5 the predicted economic impact of the proposed development on commercial fisheries is likely to be of **negligible** significance.

MITIGATION IN RELATION TO IMPACT 6
Use existing research[2] and research conducted at the Oyster project at Billia Croo, Orkney to inform design of the gap fillers to maximise their potential use by lobster and crab.

Residual impact

16.6.45 If the above mitigation is implemented, it is likely that the residual impact will be reduced to negligible significance and with a commitment to help fund the lobster hatchery this may become **negligible/minor beneficial.**

Potential impacts during decommissioning

16.6.46 The impacts caused during decommissioning are expected to be, at worst, of the same nature and magnitude as those during the construction phase. A decommissioning plan will be completed when the wave array nears the end of the operational phase to assess the impacts that will occur during wave array decommissioning.

Cumulative impact

16.6.47 The main cumulative impacts that may affect commercial fishermen will be: loss of traditional fishing grounds, increase in the effects of displacement, and increase in economic impact. All of which will be as a result of in combination effects with other wave developments within the area.

[2] http://www.sciencedaily.com/releases/2010/01/100118132130.htm

16.6.48 Voith Hydro Wavegen were awarded consent in 2009 to build a 4MW wave farm 400m off the shore of Siadar Bay approximately 1.5km south of the Lewis Oyster wave array. The Voith Hydro WaveGen projects were due to start in 2011 is now behind schedule. In addition, Pelamis Wave Power, has secured an agreement for lease from The Crown Estate to develop a 10MW wave farm near the Island of Bernera approximately 28km south of the Lewis Oyster wave array. Construction is targeted for 2015, and would consist of up to 14 Pelamis machines located between one and ten kilometres from the shore. The site itself is approximately 100 square kilometres in size, which allows Pelamis Wave Power to narrow the final location for the final wave farm, which will only occupy roughly two square kilometres once built.

16.6.49 Both these developments may act cumulatively with the Lewis Oyster wave array to reduce the area available to commercial fisheries. However relative to the overall area that would remain available to commercial fishermen it is unlikely these cumulatively would result in increase in the significance of the impacts as assessed above.

16.6.50 In order to build the three wave energy projects described above it will be necessary to upgrade local ports and harbours and associated infrastructure which may provide improved facilities for commercial fishermen. This may also lead to alternative employment for the fishermen.

16.7 Conclusions

16.7.1 Currently commercial fishing effort that occurs within the wider area (RSA) surrounding the development is considered low in terms of a national context. Furthermore within the development site commercial fishing is only conducted by up to four small fishing vessels that fish mainly for crustaceans (crab and lobster). Fishing effort within the vicinity of the development has remained fairly constant over previous years and shows no indication of either decreasing or increasing.

16.7.2 The development will require activities to occur within Loch Roag which contains a number of fish and shellfish farms. If appropriate a separate assessment will be made of the impacts to commercial fisheries and aquaculture which may occur as a result of these activities. This assessment will be in support of a separate application which will be submitted in order to gain consent to undertake the activities within Loch Roag.

16.7.3 The greatest impacts to commercial fishermen are likely to be as a result of exclusion from the development site. This may lead to possible reductions in landings by local vessels from the area and in turn lead to economic impacts. The significance of these impacts entirely depends on the size of exclusion zone and its duration. If both these variables are kept to the minimum safe and practical size and other mitigation measures are implemented it may be possible to reduce all impacts to commercial fisheries so that they are of negligible significance. Furthermore there is potential for adverse impacts to commercial fisheries to be offset by the beneficial socio-economic impacts discussed in *Chapter Socio-economics /local community*.

17. TRAFFIC AND TRANSPORT

17.1 Introduction

17.1.1 This chapter describes the existing traffic and transport network onshore within the vicinity of the Lewis Wave Array development. Also considered are further network links to the wider region.

17.1.2 An assessment of the potential impacts on traffic and transport from construction, operation (and maintenance) and decommissioning of the development has been provided in this chapter and, where appropriate, mitigation measures are proposed. Cumulative impacts are also considered.

17.2 Summary of assessment on traffic and transport

17.2.1 Low levels of traffic are currently recorded in the Isle of Lewis. Although offshore components of the development will be delivered to site mainly by sea, the onshore components will require an increase of Heavy Goods Vehicle (HGV) movements between Stornoway and the development site.

17.2.2 Details of traffic movements are highly dependant on the type of construction method used for laying of pipelines, and other elements of the project design. The methods planned for construction are under development and options for this are described in Chapter 5: *Project description.* It has been agreed with Comhairle nan Eilean Siar (the Western Isles Council) that due to the differences in the types and quantities of materials that would be transported between the construction methods a Traffic Statement will be produced following submission of this Environmental Statement. It will identify full details of construction, operation and maintenance traffic movements, and will include swept path analysis of the junction of the A857 and New Road in Siadar once the maximum size of vehicle is confirmed, to ensure adequate turning space is available. The most significant impact is anticipated to be the increase of HGV movements through Stornoway and turning at the junction of the A857 and New Road.

17.3 Potential impacts

17.3.1 The construction phase of the development will cause a short term increase in traffic movements in an area of existing relatively low traffic activity. As existing road networks are limited, this will have an impact to the day to day life of the local community, potentially affecting access to, for example, places of work, education, worship, health services and shops. An increase in vehicles on the local road network also has the potential to damage existing road surfaces and increase dust levels, which could affect existing air quality.

17.4 Methodology

17.4.1 There are no specific guidelines developed for wave energy development Environmental Impact Assessments (EIAs) with regards to impacts on traffic and transport. Consultation with the local community and key stakeholders is an important element of the Lewis Wave Array project and will be continued throughout the project.

17.4.2 Guidelines produced by the Department of Transport (2007) (*http://www.dft.gov.uk/publications/guidance-on-transport-assessment/*) state that:

> *"A detailed Traffic Assessment (TA) will be required where a proposed development is likely to have significant transport and related environmental impacts."*

17.4.3 The impact assessment for the development will be confirmed through the completion of a Traffic Statement (incorporating a Traffic Assessment) which will be submitted at the full planning application stage to Western Isles Council for the onshore works.

Legislation, Guidelines and Policy Framework

17.4.4 This section identifies the international, national and regional legislation, policies, plans and guidance that are relevant to traffic impact assessment. These have been considered in relation to the development and during the impact assessment process.

National Planning Policies

17.4.5 Pertinent points from relevant national, regional and local planning policies are briefly summarised below.

17.4.6 Scottish Planning Policy (SPP) - Development likely to affect trunk and other strategic roads should be managed so as not to adversely impact on the safe and efficient flow of strategic traffic. Developers must be prepared to offer mitigation measures where practicable.

17.4.7 Policy Advice Note 75 (PAN 75) Planning for Transport – identifies good practice and indicates that schemes in committed programmes and/or those in an advanced state of preparation where work is expected to begin in the plan period should be included in the local plan proposals map.

Structure Plan

17.4.8 The Western Isles Structure Plan (2003) contains the following relevant policies:

17.4.9 T1: Improving the Transport Infrastructure; and

17.4.10 T4: Road Safety, Highway Improvements and Traffic Management.

Consultation

17.4.11 A Scoping Opinion was sought in May 2011 and a short summary of the main points raised in relation to traffic and transport, along with an explanation of how they were addressed, is provided in Table 11.1.

Table 11.1 Issues raised in the scoping opinion (Marine Scotland 2011)

Information & Comments	Response
The following information is required: • The effect of the project on the existing roads network; • Any proposed access arrangements; • Transportation of materials to sites during the construction phase; • Details of any significant changes to traffic flows; • Details of a proposed management arrangements in terms of traffic and transport issues	The issues raised are addressed in part in this Chapter, and where appropriate, will be further assessed as part of a Traffic Statement, so be provided after submission of an application for outline planning consent.

Table 11.1 Issues raised in the scoping opinion (Marine Scotland 2011)

Information & Comments	Response
The ES should provide information relating to the preferred route options for delivering equipment etc. via the trunk road network. The EIA should also address access issues, particularly those impacting upon the trunk road network; in particular potential stress points at junctions, approach roads, borrow pits, bridges, site compound and batching areas etc.	The issues raised are addressed in part in this Chapter, and where appropriate, will be further assessed as part of a Traffic Statement, so be provided after submission of an application for outline planning consent.

17.4.12 Consultation was held with the Western Isles Council regarding the approach to assessment. The type and size of vehicles visiting the development site during construction phase are unknown and will depend upon the finalised project, options for which are discussed in *Chapter 5: Project description*. The terrestrial element of the application for the project is in the outline planning stage; therefore it was agreed with the Western Isles Council to produce a Traffic Statement with the detailed planning application once these details are confirmed.

17.4.13 The Traffic Statement will include the following details on the construction vehicles:

- Size;
- Weight;
- Number of axles;
- Construction Programme; and
- Swept Path Analysis.

17.4.14 The Traffic Statement will consider the route taken from Stornoway Harbour, through the town of Stornoway and onto the A857 to the development site.

17.4.15 Swept path analysis using topographical data will be used to assess the largest vehicle turning at the A875 junction with New Road, which leads to the access track for the development site. Swept path analysis may also be required at some points in Stornoway. Further consultation will take place with the Western Isles Council to identify the most suitable route through Stornoway.

17.4.16 The construction start date will be confirmed within the Traffic Statement, along with a strategy procedure for the movement of any abnormal vehicles and if applicable details of any road improvements required.

17.4.17 Details on operation and maintenance activities will be discussed within the Traffic Statement, along with a strategy for ensuring unplanned maintenance activities cause minimum disruption.

Data collection

17.4.18 The principal data sources relevant to the traffic and access are shown below in Table 17.2.

Table 17.2 Existing data			
Data source	**Coverage**	**Author(s)**	**Year**
Siadar 4MW wave development Environmental Statement (ES)	Stornoway to Siadar	Npower renewables & RWE group,	2007
Transport Scotland traffic counts	Stornoway and Port of Ness	Transport Scotland	2006
Western Isles Structure Plan	Western Isles	Western Isles Council	2003
Western Isles Local plan	Western Isles	Western Isles Council	2008
Web based mapping facilities	Scotland	Bing maps	2012

Assessment of significance

17.4.19 The significance of the potential effect as a result of the development is based on the intensity or degree of disturbance to baseline conditions and is categorised into four levels of magnitude, high, medium, low or negligible. The definitions of each of these are given in Table 17.3.

Table 17.3: Criteria for assessing the magnitude of effects on traffic and transport assets	
Magnitude of effect	**Definition**
High	A fundamental long term change to baseline traffic and transport conditions. For example change resulting in collision or displacement of transport resulting in limited access.
Medium	A non-fundamental but detectable temporary or permanent change in the condition of traffic and transport. For example a long term displacement of traffic resulting in significantly increased journey times
Low	A minor change to the baseline condition of traffic and transport (or a change that is temporary in nature). For example a short term displacement of traffic resulting in significantly increased journey times
Negligible	An imperceptible and/or no change to the baseline condition of traffic and transport facilities.

17.4.20 The sensitivity/value/importance of the receptor for each effect is characterised as one of four levels, high, medium, low or negligible. The definition of each level is given below in Table 17.4.

Table 17.4: Criteria for assessing the sensitivity or value of effects on traffic and transport assets	
Receptor sensitivity / value	**Site designations**
High	Traffic and transport are vital. For example, "lifeline" traffic links for which there are no alternatives.
Medium	Traffic and transport facilities are important e.g. major routes for which the alternative adds significantly to journey time and cost.
Low	Traffic and transport facilities are in regular use e.g. routes for which the alternative will provide a slight inconvenience
Negligible	Traffic and transport facilities are in low use e.g. rarely used routes or routes which are easily diverted

17.4.21 Table 17.5 combines the definitions of magnitude with the level of sensitivity/value/importance of receptor to provide a prediction of overall significance of the effect.

Table 17.5 Significance prediction matrix.				
Magnitude of effect	**Receptor sensitivity/value**			
	Negligible	**Low**	**Medium**	**High**
High	Negligible	Moderate	Major	Major
Medium	Negligible	Minor	Moderate	Major
Low	Negligible	Negligible	Minor	Moderate
Negligible	Negligible	Negligible	Negligible	Minor

17.5 Existing environment

17.5.1 This section of the ES describes the baseline condition of traffic and transport on the Isle of Lewis and also includes information about the transport links to the wider region including to mainland Scotland. The scope of this Chapter is therefore not defined by geographical area (as is the case with many of the other chapters) but is defined by the transport network associated with the Western Isles.

Facilities

17.5.2 The Western Isles are linked to mainland Scotland via several ferry terminals and airports. The main town is Stornoway on the east coast of Lewis, where the following transport services are present:

- Stornoway Airport (includes services to Stornoway, Benbecula, Inverness, Glasgow and Aberdeen), and serviced with taxi and car hire facilities; and
- Stornoway Harbour, including Caledonian MacBrayne ferry terminal.

Local road network

17.5.3 The A857 is the primary lifeline strategic road linking Port of Ness and the west coast of Lewis with Stornoway. The only other route of access is by sea. This road is the principal route for the communities along the north-west coast of Lewis to access the wider island, including places of work, places of worship, schools, shops, doctors, vets and all other facilities. This road has the ability to take standard European 40 tonne HGV (Npower renewables & RWE group, 2007). The A857 passes between two sections of the Lewis Peatlands Special Area of Conservation (SAC) which will be prone to vibration effects from HGVs using the road.

17.5.4 Transport Scotland traffic counts are available from one day in summer 2006 from just outside Stornoway on the A857 (NGR 140300, 939400) and one day in autumn 2006 from near the end of the A857 at Port of Ness (NGR 153300, 963600), to the north of the Development site (Table 17.6 source: Npower renewables & RWE group, 2007). Traffic movements are relatively light, with the number of HGVs travelling the A857 all the way to Port of Ness limited to ten movements per day.

Table 17.6 Transport Scotland traffic counts

Codes	Stornoway (15/05/06)	Port of Ness (02/10/06)
CC1 – Pedal cyclists	3	0
CC2 – twin wheeled motor vehicles	10	2
CC3 – cars	1534	298
CC4 – buses	54	13
CC5 – light goods vehicles	514	77
CC6 – rigid 2 axle HGVs	74	8
CC7 – Rigid 3 axle HGVs	30	2
CC8 – Rigid 4 axle HGVs	6	0
CC9 – Articulated 4 axle HGVs	0	0
CC10 – Articulated 5 axle HGVs	2	0
CC11 – Articulated 6 axle HGVs	3	0

New Road

17.5.5 New Road in Siadar is a minor road accessed from the A857. This exists for 260 metres (m) until it terminates. An unnamed road branches off and heads in a westerly direction before turning southwards and then in an easterly direction back to the A857. (Figure 17.1). The access road for the development will be extended from New Road to continue north-west for 543m from where New Road terminates. This will be executed by the upgrade and widening of the existing track until the point at which the track turns west away from the construction area. After this point a new access track approximately 530m in length will be built to the construction site. Once complete the access road will be composed of hardcore and will consist of a single track approximately 5m wide.

Bus services

17.5.6 Several bus services operate across Lewis and Harris from Monday to Saturday. Service W1 regularly operates between Port of Ness and Stornoway, passing through Siadar along the A857. Service W2 operates a circular route, via Callanish, Carloway, Shawbost and Barvas, and includes travel along the A857 to Stornoway Local buses (*http://www.cne-siar.gov.uk/travel/busservice/current/indexlh.asp*).

Stornoway Harbour

17.5.7 Stornoway Harbour is the main port facility for all goods imported to and exported from the Lewis and Harris (*http://www.stornoway-portauthority.com/home.html*). The port offers two Ro-Ro linkspan facilities, and over 1000 vessel movements are recorded annually, comprising of commercial vessels, daily car passenger and freight ferries, cruise liners and yachts.

Ferry capacity

17.5.8 Caledonian MacBrayne ferry services operate to Ullapool on the Scottish mainland, with further services to the Western Isles through Harris from Uig on the Isle of Skye, or Berneray from North Uist (*http://www.calmac.co.uk/destinations/lewis.htm*). The ferry from Ullapool to Stornoway takes 2 hours and 45 minutes, with a capacity of 123 cars and 970 passengers. There is an average 2 crossings a day. An additional ship, MV Muirneag currently provides a single early morning service from Ullapool to carry freight lorries to Stornoway, however a replacement vessel is in advanced stages of planning.

17.6 Impact assessment

17.6.1 As part of this assessment, it was assumed that the volumes of construction traffic would be of a similar type to those used for the 2.4 megawatt (MW) Oyster project at Billia Croo, Orkney (Table 17.7) however as the scale of the Lewis Wave Array project is larger, an estimate of four times the volumes is assumed At this stage of the project data regarding construction traffic movements can only be estimated assuming the full complement of construction traffic given in Table 17.7. It should be noted that this data relates only to the hydro electric power station and pipeline works; it was assumed that all materials and equipment associated with the Oyster devices installations would be delivered directly to site or to barges moored in Loch Roag, to the south of the site.

17.6.2 The impact assessment provided here is based on currently available information known to date. As discussed in Paragraph 17.4.3, a full Traffic Statement will be written in consultation with the Western Isles Council once traffic movements for the development are defined more fully and will be based on all activities proposed for the Lewis Wave Array.

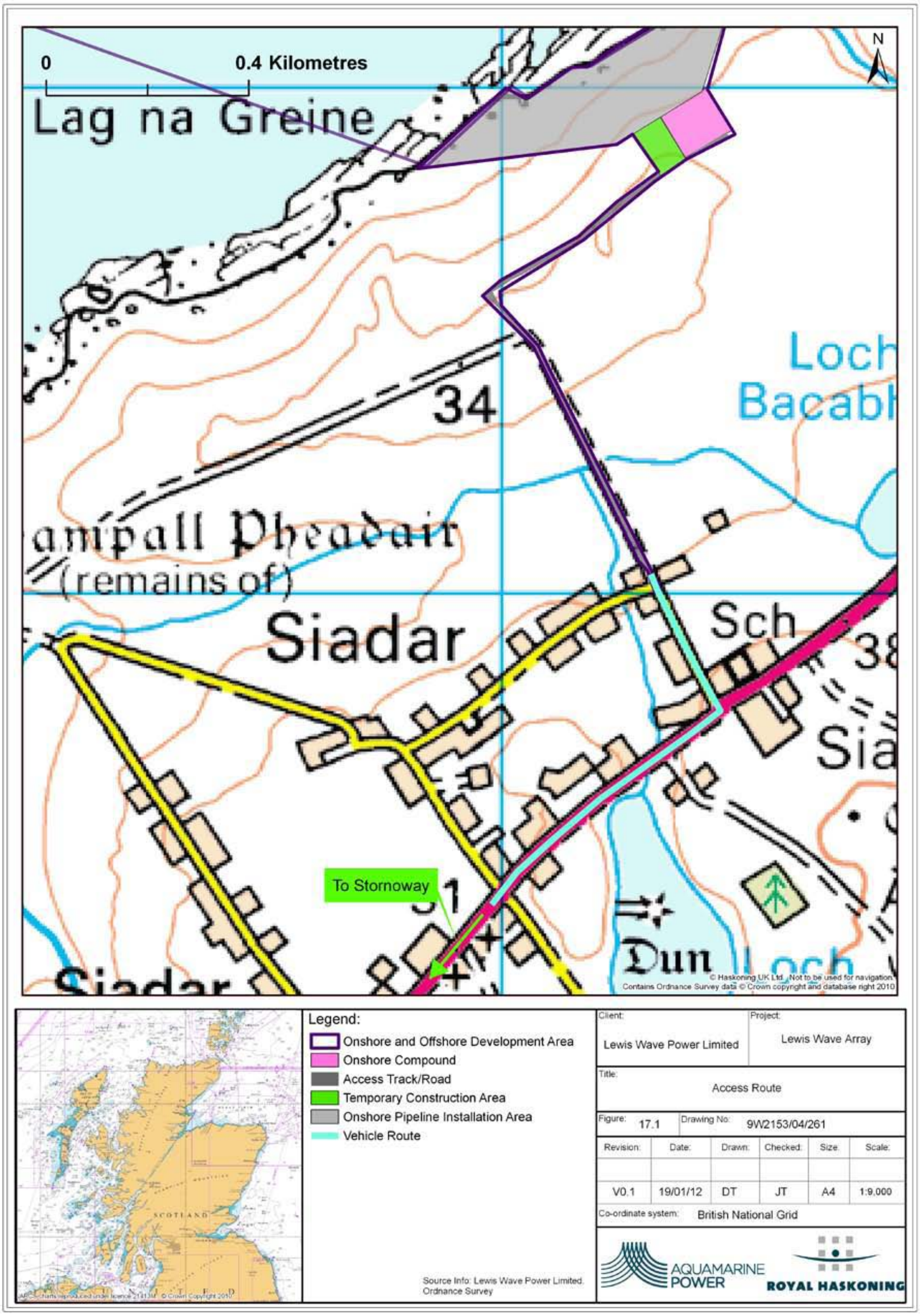

Figure 17.1 Site layout and Access routes

Table 17.7 Estimated traffic movements generated during construction (based on Billia Croo movements multiplied by four)		
HGV delivery of	**Vehicle**	**Total movements**
Imported Granular Fill	6 wheel tipper	1080
Sand	6 wheel tipper	16
Cement	Artic	48
Formwork	Artic	8
Reinforcement	Artic	4
Concrete	6 wheel tipper	120
Fuel	6 wheel tipper	32
Misc materials	Artic	20
Misc materials	6 wheel tipper	68
Export surplus spoil	6 wheel tipper	880
15 tonne excavator	Lowloader	16
Site cabin	Artic	36
Container	Artic	8
Mobile mixer	Lowloader	36
Crane	Crane	56
Total estimated number of movements		**2428**
Total number of movements per month (estimating over first 9 months when majority of construction activities will occur)		**270**
Number of movements per day (based on 30 days per month)		**9**

17.6.3 It is anticipated that the onshore construction works will comprise two phases (see *Chapter 5*: *Project description*). The first phase will include the upgrade of and extension to New Road, the installation of pipelines for the connection (through either surface laid or horizontal directional drilling (HDD) of boreholes) and the main civil engineering works including the construction of the first 3MW hydro electric power station building. The second phase will comprise works associated with the construction of the second 37MW hydro electric power station.

17.6.4 Construction phase 1 for onshore works will commence in August 2013 and is anticipated to last for nine months. Phase 2 of the will commence in May 2014 and will commence for ten months (see Chapter 5: *Project description*).

Do nothing scenario

17.6.5 Under a 'do nothing' scenario it is expected that the transport network will continue as it does currently. The Western Isles face socio-economic challenges in relation to de-population and maintenance of viable rural communities and is therefore a priority area for development (see *Chapter 21 Socio-economics and local community* for more details). There is currently a trend of increasing tourism within the Western Isles. This trend is likely to continue; however, the speed of increase is unlikely to cause a significant change to the existing transport levels during the life span of the development.

Potential impacts during construction

Impact 1: Increase in road traffic resulting in congestion and degradation of roads

17.6.6 It is assumed that construction vehicles will travel to Stornoway by ferry, and will travel through Stornoway via the A857 to the turn off with New Road.

17.6.7 Initial consultation with Western Isles Council has identified the majority of normal load vehicles will be able to pass through Stornoway to New Road. Once details of required construction vehicle types, numbers and movements are confirmed, further consultation will take with the Western Isles Council to ensure the best route through Stornoway to the development site and a Traffic Statement will be produced (paragraph 17.4.3).

17.6.8 Consultation will take place with the local community prior to construction to ensure disruption along the access route to New Road is minimised.

17.6.9 Construction activities will be temporary, over a period of 19 months, from August 2013 to February 2015 however the majority of HGV movements will be concentrated within the first nine months when the majority of the construction will occur (*Chapter 5 Project Description*). Components for offshore infrastructure will be transported to the site by sea, therefore reducing the number of HGV movements where possible. It is assumed that at most approximately 10 HGVs will travel the A857 per day. All traffic movements will occur during the daytime.

17.6.10 The largest loads are anticipated to be for the infrastructure required for HDD equipment and an abnormal load may be required if this method of pipeline installation is chosen in the final design (see *Chapter 5*: *Project Description* for more information). The junction of the A857 onto New Road may require upgrades to ensure safe turning of vehicles, and will be subject to swept path analysis.

17.6.11 As the A857 is a lifeline road for the local communities along the north-west coast of Lewis, it is classed as being of high sensitivity. Construction will be short term and temporary in nature. The numbers of HGV movements currently travelling along the A857 to Port of Ness are low (see Table 17.5) and any increases during construction are anticipated to be of low magnitude, and short term. The impact of increased road traffic causing disruption and degradation of the roads is therefore anticipated to be of **moderate adverse** significance.

MITIGATION IN RELATION TO IMPACT 1

- Construction contractor will provide a construction method statement which will include measures to minimise road disruption whilst construction is undertaken along New Road and the access track will be.
- The contractor will provide a construction traffic management plan, which will ensure that the increase in traffic on Lewis does not significantly affect to the normal A857 traffic.

  Further mitigation measures, if required, will be determined in discussions with the relevant roads Department (Western Isles Council)

Residual effect

17.6.12 The Traffic Statement developed in consultation with Western Isles Council will provide a thorough assessment of the access requirements during construction and how disruption to existing traffic movements will be minimised. It is assumed that with the mitigation outlined in place that the significance of this impact can be reduced to **minor adverse**.

Impact 2: emissions from on road traffic

17.6.13 Offshore components of the development will be delivered by sea where possible, which will reduce the number of vehicles travelling across Lewis during construction.

17.6.14 The increase in HGV movements across the Isle of Lewis and in particular through the settlement of Siadar has potential to degrade local air quality.

17.6.15 Development control guidance (EPUK (2010) *Development Control: Planning for Air Quality, 2010 Update)* states that air quality assessments are likely to be considered necessary where proposals would significantly alter the traffic composition on local roads, for instance, increase the number of HGV's by say 200 movements or more per day. And/or where proposals generate or increase traffic congestion on roads with more than 10,000 Annual Average Daily Traffic (AADT). Due to existing low traffic flows on the A857 and the predicted number of HGV movements generated during construction (Table 17.6) it is likely that emissions from construction traffic on the A857 will be **negligible**.

17.6.16 Emissions from construction traffic will add to the existing background Nitrogen oxide (NO_2) and particle (PM_{10}) concentrations; however, these emissions are predicted to be small. Existing air quality in the area is good with NO_2 and PM_{10} background concentrations well below Air Quality Sub (AQS) Objectives. Residential properties along new road are considered to be sensitive receptors however the existing air quality is considered good, with strong winds blowing in from the Atlantic and therefore sensitivity of the area is considered to be negligible. . The impact will be local and temporary – lasting for the duration of construction only (majority completed over nine months). Overall construction traffic is predicted to have a **negligible** significant effect on local air quality.

17.6.17 Once full details of traffic movements are confirmed, the Environmental Health Department of the Western Isles Council will be consulted to ensure the development does not cause a significant impact.

MITIGATION IN RELATION TO IMPACT 2
No further mitigation required

Residual effect

17.6.18 No further mitigation is anticipated and the level of significance remains **negligible**.

Potential impacts during operation (including maintenance)

Impact 1: Increase in road traffic resulting in congestion and degradation of roads

17.6.19 The improvements to the access track between the A857 and the development site will improve the access for the local community once construction activities are completed by providing an improved road surface with suitable drainage to reduce flooding (see *Chapter 8*: *Soils, hydrology and* h*ydrogeology*).

17.6.20 There is not anticipated to be large movements of HGVs to the development site under normal operational conditions, unless emergency maintenance activities are required to onshore equipment. Engineers and site personnel will be required to access the site by car/small van on a continuous 24 hour basis, however movements will be limited to a few cars/vans a day on average and car parking facilities will be provided within the site, therefore having minimum disruption on the day-to-day lives of the local community in Siadar.

17.6.21 The types of vehicles required to facilitate operational and maintenance activities would be:

- Private small cars/ vans used by permanent staff;
- 20 to 40 foot (ft) flat-bed open trailers for transporting equipment to/from site for planned maintenance activities; and
- 20 to 40ft flat-bed open trailers for transporting equipment to/from site for unplanned maintenance activities.

17.6.22 Engineers and other staff working at the development site from outside the Isle of Lewis will either arrive in Stornoway by air, using hire a car to travel across the island, or will arrive by ferry with their own transportation.

17.6.23 Activities during operation and maintenance will be included within the Traffic Statement, including a plan for any emergency maintenance required, and any mobilisation of HGVs during operation and maintenance activities will be discussed with the Western Isles Council.

17.6.24 It is anticipated that activities during operation and maintenance will require negligible increase in traffic movements on a road network of high sensitivity, therefore significance of this impact is assessed to be of **minor adverse** significance.

MITIGATION IN RELATION TO IMPACT 1
No further mitigation required

Residual effect

17.6.25 No further mitigation is anticipated and the level of significance remains as **minor adverse**.

Potential impacts during decommissioning

17.6.26 Decommissioning activities will require further HGV movements to remove the equipment from site. Consultation will take place with the Western Isles Council and local community at the time of decommissioning to ensure the most appropriate route is used, and to confirm any further mitigation required, and a further traffic assessment will be undertaken, taking into account the road conditions and traffic movements at the time of decommissioning.

Cumulative impacts

17.6.27 Other notable developments include the AMEC Stornoway Wind Farm and the consented Voith Hydro 4MW WaveGen development at Siadar and the Pelamis Wave Power Development off Bernera.

17.6.28 Plant and equipment for the AMEC Stornoway Wind Farm will be delivered to Arnish Point, south of Stornoway, and it is unlikely that the construction route will be similar to that for the Lewis Wave Array development.

17.6.29 Given its nearby location, it is likely the construction route for the Voith Hydro 4MW WaveGen development near Siadar will be the same as for the Lewis Wave Array development. At this stage it is not planned that construction for both projects will take place at the same time, therefore a cumulative effect is not predictive; however, the two projects are likely to cause an extended period of disruption to local residents and the wider community. The construction vehicle route for the Voith Hydro 4MW WaveGen project plans to access the area of construction via Baile an Truiseil just south of Siadar, and therefore if any cross-over for the two projects occurs it is likely to be the A857.

17.7 Conclusions

17.7.1 Details of traffic movements are highly dependant on the type of construction method used for laying of pipelines, and other elements of the project design. The methods planned for construction are under development and options for this are described in the *Chapter 5: Project description*. It has been agreed with Western Isles Council that due to the differences in the types and quantities of materials to be transported between the construction methods a Traffic Statement will be produced following submission of this Environmental Statement, identifying full details of construction, operation and maintenance traffic movements, and will include swept path analysis of the junction of the A857 and New Road once the maximum size of vehicle is confirmed, to ensure adequate turning space is available. The most significant impact is anticipated to be the increase of HGV movements through Stornoway and turning at the junction of the A857 and New Road.

18. ARCHAEOLOGY AND CULTURAL HERITAGE

18.1 Introduction

18.1.1 This chapter considers the potential impacts of the Lewis Wave Array development upon cultural heritage assets. Cultural heritage assets are here taken to comprise all assets that may be of archaeological or historical interest and adverse impacts considered include both physical damage and impacts upon setting.

18.1.2 Baseline studies have been prepared for the onshore and offshore elements of the wave array and are presented as appendices (Appendices 18.1 and 18.2 respectively). Assets are referred to by numbers issued in the course of this study, prefixed by 'A'.

18.2 Summary of assessment on cultural heritage resources

18.2.1 The assessment has considered potential physical impacts upon assets within the application area and setting impacts upon designated or nationally important assets within 1km of the proposed development site. Baseline studies comprising desk-based assessment and site visits have been completed and the results of these inform the impact assessment.

18.2.2 The results of the baseline studies have fed into the design of the project and impacts have been avoided as far as reasonably practicable, with the result that just two recorded assets will be impacted upon by the development. These comprise an area of lazybeds (ridges formed to increase the cultivable depth of soil and improve drainage) that will be partially removed during construction and a scheduled monument, the setting of which will be slightly impacted by the development. Previously unrecorded archaeological features may be disturbed during construction, though the potential for this to occur is considered low. Impacts have been assessed as being of minor or lesser significance following the implementation of mitigation.

18.3 Potential impacts

18.3.1 Developments such as the proposed wave farm may have the following impacts:

18.3.2 *Direct physical impacts.* These may comprise disturbance or removal of cultural heritage assets during construction, either where assets lie within the construction footprint and are hence unavoidably impacted upon or as secondary impacts, eg. as a result of plant movement or anchoring of construction vessels.

18.3.3 *Indirect physical impacts.* Degradation of waterlogged deposits owing to changes in hydrology or changes in coastal processes, resulting in increased erosion leading to loss of deposits/features or increased deposition leading to protection of assets from physical damage, for example.

18.3.4 *Setting impacts.* These are most likely to occur directly as a result of visual intrusion resulting in a loss of cultural significance. Indirect setting impacts are highly unlikely to occur as a result of this type of development.

18.4 Methodology

18.4.1 The assessment has proceeded as follows:

- Baseline data gathering (desk-based assessment, walkover survey and site visits);
- Identification of potential impacts; and
- Assessment of impacts.

Legislation, Guidelines and Policy Framework

18.4.2 The assessment has been undertaken with reference to the following legislation:

- Marine (Scotland) Act 2010;
- Protection of Wrecks Act 1973;
- The Protection of Military Remains Act 1986;
- Ancient Monuments and Archaeological Areas Act 1979;
- Merchant Shipping Act 1995;
- Valetta Convention;
- ICOMOS; and
- UNESCO.

18.4.3 The following guidance has been referred to:

- Institute for Archaeologists (IfA) guidelines: Standard & Guidance for Archaeological Desk Based Assessment (2011);
- Historic Scotland Managing Change: Setting (2010)
- Joint Nautical Archaeology Policy Committee (JNAPC) Code of Practice for Seabed Development (2008);
- COWRIE Historic Environment Guidance for the Offshore Renewable Energy Sector (2007);
- COWRIE Guidance for Assessment of Cumulative Impacts on the Historic Environment from Offshore renewable Energy (2008);
- COWRIE Guidance for Offshore Geotechnical Investigations and Historic Environment Analysis: guidance for the renewable energy sector (January 2011);
- The Crown Estate (2010). Offshore Renewables Protocol for Archaeological Discoveries;
- The Crown Estate (2010). Round 3 Offshore Renewables Projects Model Clauses for Archaeological Written Schemes of Investigation; and

- Towards a Strategy for Scotland's Marine Historic Environment (Historic Scotland 2009)

Consultation

18.4.4 The Scoping Opinion is provided in Appendix 2.1. Table 18.1 outlines the responses relevant to this chapter.

Table 18.1 Issues raised in the scoping opinion (Marine Scotland 2011)

Comments & information	Response
Historic Scotland identified potential for setting impacts upon scheduled monuments located along the west coast of the island.	This comment was based on an indicative search area that took in a substantial part of the coastline and which has now been refined to a smaller proposed development site. The potential impacts of the proposed development upon the setting of scheduled monuments within the refined area have been assessed.
The Western Isles Council requested that a desk-based assessment and walk-over survey of the application area be undertaken The impact assessment should consider the following and provide appropriate mitigation proposals: • Direct physical impacts resulting from construction; • Indirect physical impacts resulting from construction and operation, including changes in coastal processes; and • Setting impacts upon both designated and undesignated assets, including changes in historic landscape character.	A desk-based assessment and walk-over survey has been undertaken, the results of which are provided in Appendices18.1 & 18.2. Early drafts of the reports were provided to the Western Isles Council archaeologist for comment and approved (e-mail dated 13th January 2011). The potential impacts identified have been considered and assessed as appropriate (Section 18.3 & 18.6) and mitigation measures proposed (Section 18.6). The mitigation measures have been agreed with the WIC archaeologist.

Data collection

18.4.5 The principal data sources relevant to the archaeology and cultural heritage are shown below in Table 18.2.

Table 18.2: Existing data

Data source	Coverage	Author(s)	Year
Historic Scotland GIS datasets (http://data.historic-scotland.gov.uk/pls/htmldb/f?p=2100:10:0::NO:::)	Scotland	Historic Scotland	2011
Western Isles Council Historic Environment Record	Western Isles	CnES	2011
National Monuments Record of Scotland (NMRS)	Scotland	RCAHMS	2011

Table 18.2: Existing data

Data source	Coverage	Author(s)	Year
Aerial photographs held by NMRS	Scotland	Various	1946-1995
Maps held by National Library of Scotland	Scotland	Various	Various
Seazone	UK waters	UK Hydrographic Office	2011
Ministry of Defence records of losses at sea		MoD	2011
Receiver of Wreck (RoW)		RoW	2011
Coastal Erosion Assessment for Lewis: A report for Historic Scotland	Lewis	Burgess, C and Church M	1997

18.4.6 The above data sources were augmented by walkover survey and inspection of available geophysical and bathymetric data gathered in 2011 as part of the current project (Appendix 18.1).

Study areas

18.4.7 Two study areas have been used in the gathering of data (Figure 18.1):

- Study Area: the land within the development area, which is substantially larger than the final application area. Data for this area was gathered in order to inform the design of the development, identify assets within the construction footprint and to inform the assessment of archaeological potential
- Outer Study Area: This extends 1km from the study area. Data has been gathered in order to inform the assessment of the applications archaeological potential and identify assets that may be subject to setting impacts.

Figure 18.1Archaeologucal study areas and Archaeological Assets

Assessment of significance

18.4.8 The significance of the effect imposed by the development is based on the intensity or degree of disturbance to baseline conditions and is categorised into four levels of magnitude, high, medium, low or negligible. The guideline definitions of each of these are given in Table 18.3

Table 18.3: Criteria for assessing the magnitude of impacts on cultural heritage assets

Magnitude of effect	Definition
High	Total loss or major alteration of the cultural heritage asset or The setting of the asset is altered in such a way that its cultural significance is substantially reduced
Medium	Loss of, or alteration to, one or more key elements of the cultural heritage asset or The setting of the asset is altered noticeably reducing the surrounding's contribution to cultural significance
Low	Slight alteration of the cultural heritage asset or The setting of the asset is altered slightly reducing the surrounding's contribution to cultural significance
Negligible	Very slight or negligible alteration of the cultural heritage asset or The setting of the asset is altered very slightly reducing the surrounding's contribution to cultural significance

18.4.9 The sensitivity/value/importance of the receptor for each effect is characterised as one of four levels, high, medium, low or negligible. The guideline definition of each level is given below in Table 18.4 and Table 18.5

Table 18.4: Sensitivity of cultural heritage assets to physical impacts

Receptor sensitivity/ value	Cultural heritage Importance	Site designations
High	National	Scheduled monuments, Category A listed buildings, and undesignated cultural heritage assets and historic buildings of national importance; also Designated Wrecks or known maritime losses and obstructions where the position is known and positively identified. In addition targets of high potential identified in the geophysical and geotechnical data are considered be of high sensitivity pending further investigation to establish their

		level of significance.
Medium	Regional	Category B listed buildings and undesignated cultural heritage assets and historic buildings of regional importance. Known maritime losses whose position is either unknown or where positive identification is tentative, and targets of medium potential identified in the geophysical and geotechnical data are considered be of medium sensitivity pending further investigation to establish their level of significance.
Low	Local	Category C(S) listed buildings and undesignated cultural heritage assets and historic buildings of local importance; In addition targets of low potential identified in the geophysical and geotechnical data are considered be of low sensitivity pending further investigation to establish their level of significance.
Negligible	-	A badly preserved or extremely common type of archaeological site or building of little value at local, regional or national levels; or targets identified through the assessment of geophysical and geotechnical data that may be of some archaeological interest but that is likely to represent a natural feature

Table 18.5: Criteria for assessment of sensitivity of a cultural heritage asset to impacts on its setting

Receptor sensitivity/value	Guideline criteria
High	The asset has a clearly defined setting that is readily appreciable on the ground and is vital to its character and value or the appreciation thereof. The asset will generally be readily appreciable on the ground
Medium	The asset's character and value and the appreciation thereof relate to some extent to its setting. The asset will generally be appreciable on the ground.
Low	The asset's surroundings have little relevance to its character and value or the appreciation thereof. The asset is difficult to identify on the ground or its setting is difficult to appreciate on the ground.
Negligible	The asset is imperceptible in the landscape and its character and value or the appreciation thereof does not relate to its surroundings.

18.4.10 Table 18.6 combines the definitions of magnitude with the level of sensitivity/value/importance of receptor to provide a prediction of overall significance of the effect.

Table 18.6: Significance prediction matrix.				
Magnitude o f impact	Receptor sensitivity/value			
	Negligible	Low	Medium	High
High	Negligible	Moderate	Major	Major
Medium	Negligible	Minor	Moderate	Major
Low	Negligible	Negligible	Minor	Moderate
Negligible	Negligible	Negligible	Negligible	Minor

18.5 Existing environment

Onshore

18.5.1 Full details of the baseline conditions are presented in Appendix 18.1. A summary is provided here.

18.5.2 The study area is typical of this part of Lewis, taking in an extensive area of grazing with areas of bog, within which recorded cultural heritage assets predominantly relate to post-medieval agriculture, comprising lazybeds, enclosures, banks and the ruins of abandoned buildings. In this instance, two of the buildings are small mills and small pits associated with the processing of seaweed are also present. A cist (a stone-lined grave, generally of Bronze Age date) recorded in the 1990s but was not found to be evidenced on site (Appendix 18.1). In addition to these recorded assets, there is the reputed location of burials associated with a cattle raid.

18.5.3 A peat survey has been carried out (*Chapter 8: Soils, hydrology and hydrogeology*). This has demonstrated that in the area of the construction and hydro electric power plant compounds the peat is no more than 1m in depth and this is generally the case in the onshore pipeline area. In contrast, the peat in the vicinity of the Lambol Burn where crossed by the access track is 3m in depth. Given the proximity of Norse settlement (Siadar and Mealabost Bhuirgh, as demonstrated by place name evidence) the palaeoenvironmental evidence preserved in this deep peat has the potential to inform understanding of the development of the landscape and agriculture during the Norse period.

18.5.4 Given the archaeological background of this part of Lewis and the size of the study area, it is concluded that there is a moderate potential for previously unrecorded archaeological assets to be present within the study area as a whole. This potential relates primarily to prehistoric assets, which are most likely to be masked by lazybeds and peat.

18.5.5 In the outer study area, which extends 1km from the study area, there are four scheduled monuments, comprising Teampull Pheadair, chapel (SM 5341), Loch an Duin dun (SM 5364), Clach Stei Lin, stone circle and enclosure (SM 5901) and Steinacleit, homestead and field system (SM 90284). As scheduled monuments these are all considered to be of national importance. Neither Teampull Pheadair nor Loch an Duin dun will have intervisibility with the proposed development and are not considered further.

18.5.6 Clach Stei Lin (SM 5901) is thought to comprise the remains of a slighted stone circle (only one stone remains standing) and a later enclosure. It is located on a rise some 350m to the south east of the inner study area. The setting of the site can be defined as the rise upon which it is located (Àirigh an Tuim) as the monument may well have been sited here in order to render it prominent in the wider landscape. This is no longer readily apparent because of its condition, but the rise contributes to the monument's rather limited sense of place and hence associative value, as it provides expansive views to the west over the sea. The modern bungalows of Airidhantuim are prominent in the foreground of these views. The inner study area is clearly visible from Clach Stei Lin. The onshore elements of the proposed development will lie at least 350m from the monument, beyond the Airidhantuim bungalows.

18.5.7 Steinacleit (SM 90284) comprises the remains of a massively built prehistoric settlement and enclosure. It has been partially excavated but remains ill-understood and it has been suggested that it represents the remains of a chambered cairn. However, the interpretation favoured by Historic Scotland has been applied here. It is located on a rise overlooking Loch an Duin to the north west and the dun and crannog are clearly visible on the loch. The standing stone Clach an Truiseil is visible to the west and Clach Stei Lin would once have been visible to the north. The location provides generally striking views across the loch to the sea, with the scattered houses of Siadar in the middle distance. The monument's setting may therefore be defined as the rise upon which it is located and the area around Loch an Duin as these are the areas that the occupants presumably farmed. Furthermore the intervisibility with the dun and Clach an Tuiseil contribute to the contextual and associative values of the monument as this helps the visitor appreciate the chronological depth of the landscape. The views to the sea are relevant to its associative value as the monument appears to be placed to overlook the sea and this contributes to its sense of place. Steinacleit lies some 600m to the south of the inner study area. The upper parts of the hydro electric power plant buildings will be visible beyond the modern housing of Siadar at a distance of 1.8km, whilst a small number of the Oyster devices will be visible at a distance of some 2.5km. ..

Offshore

18.5.8 No previously recorded cultural heritage assets are present within the offshore boundary of the study area and there is very limited potential for unrecorded assets to be present (Appendix 18.2). The seabed here is composed of exposed bedrock, reflecting the high energy environment. Superficial deposits, which will have included former land-surfaces, have been scoured away by currents. There is limited potential for residual artefacts or debris from wrecks to be trapped in the fissures in the bedrock.

18.6 Impact assessment

18.6.1 Indirect physical impacts upon waterlogged deposits have been discounted. The onshore elements of the wave array will not affect the hydrology of the area (Chapter 8 *Terrestrial hydrology*) and there is therefore no scope for such impacts to occur. Likewise, indirect impacts as a result of changes in coastal processes have been discounted. Owing to the high energy regime, sedimentological changes or changes in the level of erosion occurring are highly unlikely to result from the installation of the Oyster devices, it's supporting infrastructure and its operation (*Chapter 7: Physical Environment and Coastal Processes*). Hence there is negligible potential for cultural heritage assets to be impacted upon as a result of such changes.

18.6.2 The potential for setting impacts to occur as a result of the tops of the Oyster devices being visible from the onshore assets has been considered. However, this has been discounted as no assets are present along the shoreline where this might result in a substantive change in cultural value.

18.6.3 Mitigation is embedded in the design of the development as follows:

- The development has been designed in order to avoid the removal/disturbance of cultural heritage assets as far as reasonably practicable.

- The development's design minimises potential impacts upon deep peat.
- The onshore elements have been placed in order to reduce their visibility from designated assets in the surrounding area and to minimise visibility in the landscape generally.
- Known assets such as lazy bed areas not directly impacted, banks and ruins will be fenced off during construction in order to prevent secondary impacts due to the movement of plant.

Do nothing scenario

18.6.4 In the do nothing scenario, the onshore baseline would remain essentially unchanged. The assets present are essentially stable, undergoing very slow degradation as a result of natural processes. The only exception to this are features located on the shoreline itself. Such features are likely to be lost to erosion.

18.6.5 Any offshore assets, which are likely to be restricted to residual artefacts trapped in fissures in the bedrock, are likely to remain stable.

Parameters for assessment

18.6.6 The assessment has been undertaken based on the Rochdale envelope (Chapter 5 *Project description*), which provides a range of parameters for the development, with the assessment being based on a worst case scenario involving the maximum land take for the development using directional drilling to install the shore pipelines. It has been assumed that the directional drilling will be undertaken using onshore rigs located within the lazybeds. Figures for land take are presented in Table 18.7.

Table 18.7: calculations of the total area of land "taken" by the development.

Parameter	Minimum Area (m^2)	Maximum area (m^2)
Onshore pipeline area	3200	58400
Hydro-electric power plant compound	10000	10000
Temporary construction area	6000	6000
Access road construction/widening	13879	13879
Shore access track	1600	4600
Directional drilling platforms	900	1800
Total with surface laid option	**34679**	**92879**
Total with directional drilling option	**35579**	**94679**

Potential impacts during construction

Impact 1: Removal of areas of lazybeds

18.6.7 The construction of the onshore compound and temporary construction compound will remove approximately 0.6ha of lazybeds. Horizontal directional drilling may be used to install the shore pipelines. This may be undertaken from up to two locations within the onshore pipeline installation area, each of which would have a footprint of 30 x 30m. These would almost certainly lie within the lazybeds, resulting in the removal of up to 0.2ha. The construction of the pipelines (if surface laid and maximum eight at 20m width) and access road will remove further areas of the lazybeds.

18.6.8 Lazybeds are very common in coastal areas of Lewis, and in some areas they continued to be maintained well into the 20th century. They are, however, an important part of the historic environment as they contribute to the 'time depth' of the landscape and aid in an appreciation of the changing methods of agriculture and patterns of settlement on Lewis and sense of place. It is considered that they are of low sensitivity to impacts.

18.6.9 The greater part of the lazybeds will remain. However, given that the lines of lazybeds will be visibly broken by the pipelines, if they are to be surface laid it is considered that this will constitute an impact of medium magnitude. It is concluded that the removal of parts of the lazybeds will constitute an adverse impact of **minor** significance.

MITIGATION IN RELATION TO IMPACT 1
The extents and form of the lazybeds will be recorded through rectification of aerial photographs**.**

Residual effect

18.6.10 Following mitigation there will remain an appreciable loss to the historic landscape, and it is concluded that the residual impact will remain of **minor** significance. The impact's effect will be permanent. This is not significant in the terms of the EIA regulations.

Impact 2: Potential impact upon previously unrecorded archaeology

18.6.11 The construction of onshore elements may result in the removal or disturbance of previously unrecorded archaeological sites. This potential relates to prehistoric and early historic assets. Although the potential for the development area is considered to be low, the area affected by the construction footprint is relatively small and it is considered that the potential for unrecorded assets to be affected by construction is **low**.

18.6.12 It is not possible to meaningfully assess impacts upon unknown assets, as both the sensitivity of the asset and the magnitude of the impact are unknown.

MITIGATION IN RELATION TO IMPACT 2
Evaluation trenching in the construction area will be undertaken in order to establish the archaeological potential more fully than is possible from non-intrusive studies. Further work will be undertaken as appropriate.

Residual effect

18.6.13 The implementation of the programme of works will allow for the preservation by record of archaeological assets. Although such features will be excavated and hence removed, there will be no palpable loss to the historic environment and a gain in terms of knowledge. It is therefore concluded that the programme of works will completely mitigate any impacts upon unrecorded archaeology.

Potential impacts during operation (including maintenance)

Impact 1: Impact upon the setting of Clach Stei Lin stone circle and enclosure

18.6.14 The tops of the buildings within the onshore compound will be visible from Clach Stei Lin. They will be seen against the backdrop of the sea and in combination with numerous modern cottages. Clach Stei Lin's cultural significance resides in its potential as a data source; it is poorly understood and its intended relationship with its surroundings, beyond the surrounding cultivable land is not clear. Indeed, it is far from certain whether it had any such relationship. It is a relatively slight feature and as such is not widely visible in the landscape. It is concluded that it is of low sensitivity to setting impacts.

18.6.15 The cultural significance of the asset will be unaffected, by this slight change to its surroundings. It is concluded that the impact will be of negligible magnitude and **negligible** significance. This is not significant in the terms of the EIA Regulations.

MITIGATION IN RELATION TO IMPACT 1
No mitigation is proposed in relation to this impact.

Residual effect

18.6.16 No mitigation is proposed. The impact is considered to be of **negligible** significance and will cease upon decommissioning.

Impact 2: Impact upon the setting of Steinacleit prehistoric settlement and enclosure

18.6.17 The tops of the buildings within the onshore compound will be visible from Steinacleit. They will be seen against the backdrop of the sea and in combination with numerous modern cottages. Steinacleit's cultural significance resides in its potential as a data source, but it also has value as a readily appreciable prehistoric feature. Its visual relationships with other cultural heritage assets in the area, in particular the standing stone at Clach an Tuiseil, also lend it contextual value, as these allow the visitor to appreciate it as a part of the broader prehistoric landscape, rather than experiencing it in isolation. The visual relationships with other assets contribute to its significance, regardless of the precise interpretation of its origins. Therefore it is considered to be of high sensitivity to impacts upon setting.

18.6.18 The development will be visible from Steinacleit (SLVIA Viewpoint 4), but will not interfere with the appreciation of visual relationships with other assets or landscape features and the closest elements will be seen beyond modern housing. The cultural significance of the asset will be unaffected by this slight change to its surroundings. It is concluded that the impact will be of negligible magnitude and **minor** significance. This is not significant in the terms of the EIA Regulations.

MITIGATION IN RELATION TO IMPACT 2
No mitigation is proposed in relation to this impact.

Residual effect

18.6.19 No mitigation is proposed. The impact is considered to be of **minor** significance and will cease upon decommissioning.

Potential Effects during decommissioning

18.6.20 It is considered that there is no potential for impacts during the decommissioning phase; such impacts might occur as a result of ground disturbance, but, following construction mitigation, any archaeology present in areas that will be disturbed during decommissioning will have been removed.

Cumulative Effects

18.6.21 No cumulative effects have been identified.

18.7 Conclusions

18.7.1 The potential impacts upon both the physical fabric and setting of cultural heritage assets have been considered. Following embedded mitigation, which has resulted in the design of the development avoiding impacts as far as reasonably practicable, all predicted impacts are considered to be of minor or lesser significance. Such impacts are not significant in the terms of the EIA Regulations. These impacts comprise the loss of an area of lazybeds, the disturbance of currently unrecorded archaeological features/deposits and a slight change to the setting of two scheduled monuments. Mitigation in the form of a programme of archaeological works has been proposed in order to address the first two, while no mitigation is proposed in relation to the setting impacts.

19 ONSHORE NOISE

19.1 Introduction

19.1.1 This Chapter of the Environmental Statement (ES) addresses potential noise and vibration impacts caused by the Oyster wave array (including the hydro electric power station, surface laid pipelines, horizontal directional drilling (HDD) and associated infrastructure) on human receptors only. Noise and vibration effects on ecological receptors are addressed in other relevant Chapters within the ES, see *Chapter 11: Marine Mammals*. This chapter presents a qualitative assessment of noise and vibration levels from the on-shore aspects of the development.

19.2 Summary of assessment on onshore noise

19.2.1 The potential for onshore noise and vibration impacts associated with the development are mainly limited to the construction aspects of the development. The construction of the hydro electric power station during concrete pours and the onshore pipeline connection using HDD are the elements expected to give rise to impacts of moderate significance. The distance between the construction site and the nearest noise sensitive receptors, along with active consultation with the local community landowner and neighbours, will ensure that noise levels will be appropriately managed. It is recommended this would be controlled most effectively by reaching a Section 61 'prior consent' agreement with local authority.

19.2.2 The operational noise arising from the hydro electric power station is considered not significant due to the distance to nearby Noise Sensitive Properties (NSPs). Vibration impacts associated with the operational aspect of the development are limited to the infrequent passage of vehicles to conduct maintenance at the onshore site; producing levels of vibration which is not significant.

19.3 Potential effects

19.3.1 Potential noise and vibration effects from the development on human receptors may arise as a result of the construction activities associated with the surface laid and/or HDD pipeline installation and the hydro electric power station. Additional impacts may arise as a result of the movement of construction related vehicles on surrounding local roads.

19.3.2 Construction related vehicle movements will pass along the A857, along New Road in Siadar Iarach and west towards the onshore site and construction area shown in Figure 5.2, *Chapter 5 Project description*. There are a number of potential NSPs situated along New Road which may be temporarily affected by construction related traffic movements. Improvements to the access route from the A857 and along New Road to the onshore site will be undertaken. These improvements will affect noise levels in the vicinity in the short-term, but improvements to the road surface will serve to reduce noise and vibration in the medium to long term by providing an improved road surface.

19.3.3 The main construction area for the hydro electric power station and landfall will be located approximately 430 metres(m) from the nearest isolated NSP (Burnside Cottage) and approximately 800m from a small number of NSPs along New Road in the nearby village of Siadar. Due to the distance from the onshore site it can be concluded that these aspects of the development will have limited impact on human receptors. There is a potential requirement for night-working to complete aspects of the construction phases such as concrete pours or HDD, which may have a potential adverse effect on NSPs, although this will be minimised through prior warning of affected residents and the application of Best Practice during construction.

19.3.4 Any vibration effects associated with the scheme are likely to occur due to the movement of construction related vehicles on the surrounding roads. Vibration from the movement of construction-related vehicles along the preferred route will be caused primarily by the interaction of the vehicle's tyres with the road surface and the condition of the road surfaces will have a direct effect on the amount of vibration induced. The planned improvements to the road surface will reduce the level of vibration caused by construction vehicles by providing an improved road surface.

19.3.5 Any vibration produced by the HDD works for the pipelines is likely to be not significant at the closest receptor 430m away and is not considered to be a potential source of adverse impact.

19.3.6 Secondary effects may occur such as re-radiated noise caused by engine noise when heavy vehicles are forced to accelerate or labour up-hill close to residential properties. This may cause short-duration vibration of loose fixtures and fittings attached to the outer fabric of buildings, such as door handles, window panes etc; the levels of noise/airborne vibration involved are unlikely to result in vibration of internal fixtures or fittings. Re-radiated noise does not give rise to levels sufficient to be a concern with regards to building damage and the effects are confined as a potential disturbance to amenity.

19.3.7 There are unlikely to be significant operational impacts as the separation distance between the hydro-electric power station and NSPs, combined with the proposed construction of the building to house the equipment will be sufficient to suitably attenuate any noise emissions. The noise levels within the building will be required to comply with The Control of Noise at Work Regulations (2005) in order to protect personnel therefore noise break-out from the building is expected to be low.

19.3.8 Decommissioning of the Oyster wave array and onshore infrastructure may give rise to similar effects as those described for the construction, but over a shorter time period, omitting the excavation works and concrete pours expected for the foundation work for the hydro electric power station. Therefore the decommissioning works are expected to be similar to but lesser to those effects proposed for the construction

19.4 Methodology

<u>Legislation, Guidelines and Policy Framework</u>

19.4.1 A range of legislation is in place to control noise levels at International, European Union (EU) and United Kingdom level. The control of noise from construction activities, in Scotland, is achieved through the following Instruments:

19.4.2 Control of Pollution Act 1974 [COPA]; Section 60 the Act provides the local authority with powers to serve noise abatement notices on construction operations in order to minimise or prevent noise disturbance to local residents. Section 61 of the Act, provides a means whereby a contractor and local authority can reach agreement on suitable controls to minimise or prevent noise disturbance including such things as controlling hours of operation, the setting of specific noise limits or other appropriate controls. The written agreement is termed a 'prior consent' and it will be a defence against subsequent enforcement action for the contractor to show that he was working within the terms of the consent. The Act also defines the principles of best practice in construction operations, termed Best Practicable Means (BPM). The contractor will be expected to apply these principles to all construction operations. Failure to apply BPM or to work within the terms of a prior consent may leave a contractor open to local authority enforcement action and prosecution for causing noise disturbance.

19.4.3 Scottish Statutory Instrument (SSI) 2002/104 *The Control of Noise (Codes of practice for construction and open sites) (Scotland) Order 2002*; this instrument approves the use of British Standard 5228 (Parts 1 – 5, 1992 – 1997) for the control of noise and vibration from such sites (these documents have been superseded by BS 5228-1&2 in 2009).

19.4.4 British Standard (BS) 5228-1: 2009 Code of practice for noise *and vibration control on construction and open sites*; this Standard is guidance and carries no legal enforceability but is regarded as best practice in respect of assessing and controlling noise from construction operations. It provides guidance on the causes of noise from construction operations, methods for calculating noise levels at potentially noise sensitive premises (NSPs) and suggests suitable methods for mitigating the adverse effects of noise. It does not specify permissible noise levels from construction activities, but does discuss the setting of suitable limits based on examples of controls applied to previous construction activities. The Annexes of the Standard also provide generic source noise levels for typical items of plant equipment used on construction sites.

19.4.5 The UK Department of Transport guidance *Calculation of Road Traffic Noise* [CRTN] is the generally accepted method for calculating the noise arising from the movements of free-flowing traffic on roads, down to speeds of 20 km.h^{-1} and 50 vehicles per hour (or 1000 vehicles per 18-hour day [06:00 – 00:00]). This guidance is of relevance to the noise from construction-related vehicle movements on the A857. CRTN is applicable in Scotland and is widely used in the calculation of road traffic noise in Scotland and throughout the UK.

19.4.6 The Highways Agency guidance *Design manual for roads and bridges* [DMRB], Volume 11, Section 3, Part 7 "Noise and vibration" provides guidance on the assessment of noise and vibration from road traffic, including assessment of air-borne or re-radiated noise. The guidance suggests that short-term changes in noise of 25% in total traffic, approximately equivalent to a 1dB change in noise, may be perceived by local residents whilst longer term gradual increases in noise of 3dB, approximately equivalent to a doubling of total traffic levels, may be required for audible effects to occur. For the purposes of this assessment, it was conservatively assumed that changes in traffic noise of 1dB would be used to define potentially significant changes in noise. The guidance also provides advice on the assessment of air-borne and ground-borne vibration but states that the percentage of people potentially 'bothered' by air-borne vibration (re-radiated noise) from road traffic is 10% lower than for the equivalent noise exposure. With regard to ground-borne vibration, the guidance provides indicative vibration levels for perception by humans, described in terms of the peak particle velocity (PPV).

19.4.7 British Standard 6472-1:2008 *Guide to evaluation of human exposure to vibration in buildings. Part 1: vibration sources other than blasting*. This document provides advice on the potential effects of vibration on humans within dwellings. It is referenced with regard to potential ground-borne vibration from construction-related traffic moving on the A857 on Lewis.

19.4.8 British Standard 4866:2010 Mechanical vibration and shock — Vibration of fixed structures — Guidelines for the measurement of vibrations and evaluation of their effects on structures; this document provides advice on the levels of vibration associated with building damage, including cosmetic damage. It is referenced with regard to potential ground-borne vibration construction-related traffic moving on the A857 on Lewis.

Consultation

19.4.9 A Scoping Opinion was sought from statutory consultees in August 2011. The response from the Comhairle nan Eilean Siar (Western Isles Council) Planning Authority considered that '*Noise from land based construction is likely to be addressed through normal planning conditions with significant effects not expected*'. The willingness to conduct noise monitoring if considered necessary, was duly noted and welcomed by the Authority.

Data collection

19.4.10 Due to the predicted low significance of the impact of noise and vibration on the local community a desk based study of predicted ambient noise levels within the development site, pipeline and hydro electric power station and surrounding area was deemed sufficient.

19.5 Assessment of significance

Construction noise and vibration assessment methodology

19.5.1 The assessments of noise and vibration from the movement of construction related vehicles and of noise from the construction operations of the hydro electric power station, HDD and/or the surface laid pipelines, were generally qualitative, as no detailed information was available regarding the numbers or types of vehicles or equipment involved. In undertaking this qualitative assessment it was accepted that construction activities can give rise to elevated noise levels sufficient to cause adverse reaction by local residents, even where the noise levels can not be accurately quantified.

19.5.2 It was assumed that the majority of construction activities and all vehicle movements will occur during the day time. However, there may be requirements, due to operational constraints, for night time or extended periods of construction operations (e.g. concrete pours).

19.5.3 Onshore construction (hydro electric power station and pipeline works) traffic movements have been assessed. The noise assessment has considered estimated levels of construction traffic, based on the Aquamarine Power development at Billia Croo, Orkney. As the Billia Croo development was smaller, the traffic movements have been multiplied by four. The estimated complement of construction traffic is proved in Table 19.1.

Table 19.1 estimated traffic movements generated during construction (based on Billia Croo movements multiplied by four)

HGV delivery of	Vehicle	Total movements
Imported Granular Fill	6 wheel tipper	1080
Sand	6 wheel tipper	16
Cement	Artic	48
Formwork	Artic	8
Reinforcement	Artic	4
Concrete	6 wheel tipper	120
Fuel	6 wheel tipper	32
Misc materials	Artic	20
Misc materials	6 wheel tipper	68
Export surplus spoil	6 wheel tipper	880
15tonne excavator	Lowloader	16
Site cabin	Artic	36
Container	Artic	8
Mobile mixer	Lowloader	36
Crane	Crane	56

Table 19.1 estimated traffic movements generated during construction (based on Billia Croo movements multiplied by four)		
HGV delivery of	**Vehicle**	**Total movements**
Total estimated number of movements		**2428**
Total number of movements per month (estimating over first 9 months when majority of construction activities will occur)		**270**
Number of movements per day (based on 30 days per month)		**9**

19.5.4 The onshore construction works will comprise of two phases. The first will involve the upgrade and extension of the road, the installation of shore pipelines for the connection (through either surface laid trenching or HDD of boreholes) and the main civil engineering works including the construction of the initial hydro electric power station for up to 3MW of electricity generation. The second phase will comprise works associated with the construction of the larger (40MW) hydro electric power station.

19.5.5 The first phase will commence in August 2013 and is anticipated to last for 12 to 15 months. Phase 2 of the onshore construction works will commence in May 2014.

19.5.6 The assessment of vibration from construction related traffic movements on the A857 and access roads is qualitative as the generation and subsequent propagation of both air-borne noise and ground-borne vibration depend on a number of variables which are unknown at this stage.

19.5.7 As discussed previously in Section 19.4, there is no statutory, or other, defined criteria for setting acceptable noise limits, to assess the significance of relative changes in noise levels. As the assessment of noise associated with construction vehicle movements was qualitative, it is not meaningful to attempt to define noise criteria for the qualitative assessment.

19.5.8 The setting of such noise limits is difficult, partly due to the subjectivity of noise level changes according to the perception of the listener, but also because the impact will depend on the nature of the existing noise situation.

19.5.9 PAN 56 states that “For noise of a similar character, a change of 3dB(A) is the minimum perceptible under normal conditions, and a change of 10dB(A) corresponds roughly to halving or doubling the loudness of a sound”. This is based upon research which has shown that whilst in a laboratory situation a 1dB change in noise level might be perceptible to the average listener, in an outdoor situation a 3dB change in environmental noise levels is generally the least perceptible change, whilst a 5dB change in noise limits is clearly perceptible and a 10dB change in noise levels would be perceived as a doubling or halving of noise.

19.5.10 It is also generally accepted that construction activities are inherently noisy. Annex C of BS 5228-1 discusses possible approaches to setting noise controls; one of these is to set a 65dB L_{Aeq} limit for construction noise measured at noise sensitive premises, as being an acceptable limit, with relatively lower noise levels for evening, weekend and night time periods; the suggested levels are presented in Table 19.2.

Table 19.2 Suggested acceptable construction noise limits:

<table>
<tr><th rowspan="2">Assessment period</th><th colspan="3">Acceptable noise level, in decibels (dB L_{Aeq})</th></tr>
<tr><th>Category A[A]</th><th>Category B[B]</th><th>Category C[C]</th></tr>
<tr><td>Night-time (23.00−07.00)</td><td>45</td><td>50</td><td>55</td></tr>
<tr><td>Evenings, Weekends and Public/Bank Holidays[B]</td><td>55</td><td>60</td><td>65</td></tr>
<tr><td>Daytime (07.00−19.00) and Saturdays (07.00−13.00)(D)</td><td>65</td><td>70</td><td>75</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="4">NOTE 1 A significant effect has been deemed to occur if the total LA_{eq} noise level, including construction, exceeds the threshold level for the Category appropriate to the ambient noise level.</td></tr>
<tr><td colspan="4">NOTE 2 If the ambient noise level exceeds the threshold values given in the table (i.e. the ambient noise level is higher than the above values), then a significant effect is deemed to occur if the total LA_{eq} noise level for the period increases by more than 3dB due to construction activity.</td></tr>
<tr><td colspan="4">NOTE 3 Applied to residential receptors only.</td></tr>
<tr><td colspan="4">A) The ambient noise levels are predicted to be within the Category A levels and so, for the effect to be deemed significant the predicted noise levels during construction, operation or decommissioning will be greater than the Category A values. In the event that the noise levels are below these levels, there will be no significant noise impact.</td></tr>
<tr><td colspan="4">B) Category B: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are the same as category A values.</td></tr>
<tr><td colspan="4">C) Category C: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are higher than category A values.</td></tr>
<tr><td colspan="4">D) 19.00–23.00 weekdays, 13.00–23.00 Saturdays</td></tr>
</table>

19.5.11 It has been estimated that, as a result of the low levels of traffic and activity at the project site, surface pipeline work, HDD, and hydro electric power station construction, the existing ambient day time noise levels are similar to those in Category A of Table 19.2 and it is suggested that these are the acceptable values against which subsequent monitoring of construction noise should be assessed. It is worth noting that PAN 56 suggests that 66dB L_{Aeq} is approximately equivalent to normal conversational speech at 1 metre, which provides a meaningful 'everyday' context against which predicted construction noise levels might be judged.

19.5.12 The significance of the effect imposed by the development is based on the intensity or degree of disturbance to baseline conditions and is categorised into four levels of magnitude, high, medium, low or negligible. The definitions of each of these are given in Table 19.3.

Table 19.3 Magnitude of the impact	
Magnitude of impact	**Description**
High	Steady noise level changes greater than, or equal to, 10dB whereby the ambient noise may be perceived to have doubled. Changes in the range of 5 to 9.9dB may be of high magnitude if they contain particularly annoying characteristics, significant low-frequency or tonal noise, or if the noise impacts are long-lasting (greater than a few weeks for example).
Medium	Noise level change is potentially clearly audible, in the range of 5 to 9.9dB, but may be tolerable in the short-term. Changes in the range of 3 to 4.9dB may be of medium magnitude if they contain particularly annoying characteristics, significant low-frequency or tonal noise, or if the noise impacts are long-lasting (greater than a few weeks for example).
Low	Noise level change is potentially just audible, in the range of 3 to 4.9dB. Changes in the range of 1 to 2.9dB may be of low magnitude if they contain particularly annoying characteristics, significant low-frequency or tonal noise, or if the noise impacts are long-lasting (greater than a few weeks for example).
Negligible/no impact*	Changes in steady noise of less than 3dB, or changes of less than 1dB if noise is particularly intrusive.

19.5.13 In addition to defining the magnitude of any impacts, it is necessary to consider the relative sensitivity of the human receptors potentially affected by changes in noise. These descriptors are presented in Table 19.4.

Table 19.4 Sensitivity of the receptor	
Receptor sensitivity	**Description**
High	Existing ambient noise is particularly low or affected location is an area of particular tranquillity whereby external noise effects may be considered unacceptable.
Medium	Existing ambient noise is already affected by intermittent external noise, either natural or anthropogenic whereby short-term noise effects may be tolerable.
Low	Existing ambient noise is already affected by regular or elevated external noise, either natural or anthropogenic whereby medium- to long-term noise effects may be tolerable.
Negligible/no impact	Existing ambient noise is already affected by regular external noise, either natural or anthropogenic whereby noise effects may not be significantly perceived.

19.5.14 By combining the magnitude of impact with the receptor sensitivity it is then possible to arrive at the significance of effect of the impact on the receptor. The resulting significance of effect of the impact is presented in Table 19.5.

Table 19.5 Impact significance matrix

Magnitude of impact	Receptor sensitivity			
	Negligible	Low	Medium	High
High	No significant effect	Moderate	Major	Major
Medium	No significant effect	Minor	Moderate	Major
Low	No significant effect	Negligible	Minor	Moderate
Negligible/No impact	No significant effect	No significant effect**	No significant effect**	No significant effect**

** As with Table 10.2, this table differs slightly from that presented in other chapters as the definition of "no noise impact" does not change according to the sensitivity of the receptor.

19.6 Baseline description

Noise Sensitive Premises (NSPs)

19.6.1 Noise sensitive premises are defined in British Standards (BS) 5228 (BSI, 2009) as being 'any occupied place outside a site used as a dwelling (including gardens), place of worship, educational establishments hospital or similar institution, or any other property likely to be adversely affected by an increase in noise level'. The local Primary school is due for closure prior to construction activities commencing, and is therefore not considered further. In the case of this development the potentially affected NSPs are:

- Burnside Cottage;
- Properties along New Road, including Sheep Wash; and
- Properties along the A857.

19.6.2 The NSPs are approximately 400 to 800m from the main construction area and consequently predicted noise levels at these locations will not be significant.

19.6.3 The sensitivity/value/importance of the receptor for each effect is characterised as one of four. Table 19.5 combines the definitions of magnitude with the level of sensitivity/value/importance of receptor to provide a prediction of overall significance of the effect.

19.7 Existing environment

19.7.1 The development area is situated along the north-western coastline of Lewis where the ambient noise climate is dominated by natural source sounds such as those produced by the Atlantic Ocean, meteorological associated effects, wildlife and watercourses. Locally the noise climate will be influenced by the small settlements that exist along this coastline including those at Labost, Brager, Arnol Siadar, High Borve, Mealabost Bhuirgh and Dail bho Dheas.

19.7.2 The A858 and the A857 are the only main roads in the area and they both maintain a relatively low traffic flow throughout the day, therefore their contribution to the overall acoustic environment is less than that arising through natural sources of noise (Npower Renewables &

RWE group, 2007). All other roads are generally single track or private with very low traffic movements. Other modes of transport including aircraft and motor boat activities do not have a discernable effect on ambient noise levels.

19.7.3 As part of the Environmental Impact Assessment for the Siadar Wave Energy Project, baseline noise conditions were assessed at several sensitive receptors (dwellings at Siadar); the major findings of which were that the dominant noise originated from the ocean and effects of the wind.

19.8 Impact assessment

Do nothing scenario

19.8.1 The do nothing situation would result in no change to the existing ambient noise situation.

Potential impacts during construction

Impact 1: Noise and vibration impacts associated with the movement of construction-related vehicles along the A857 and access roads

19.8.2 All construction materials for the onshore infrastructure will be transported by road. The preferred transportation for the Oyster devices and probably the pipelines will be by vessel. Construction traffic will pass a number of NSPs along the A857 and through the village of Siadar. The sensitivity of the receptors is considered low to medium.

19.8.3 Noise and vibration effects may occur as a result of the movement of additional construction related vehicles on the A857 and through the access road to the construction site. Vibration effects associated with the movement of construction related vehicles on the A857 will principally comprise ground-borne vibration, caused by the interaction of the vehicle tyres with the road and low frequency airborne noise, caused by engine noise re-radiating through loose fixtures or fittings in properties.

19.8.4 Heavy goods vehicles already travel along the A857, so the levels of air-borne noise and ground-borne vibration are not expected to increase, just the potential frequency of occurrence and duration. The improvements to the access route will reduce the level of noise and vibration from passing construction-related vehicles by providing an improved road surface reducing the magnitude of noise and vibration impacts. The magnitude of this is therefore expected to be **low**.

19.8.5 In accordance with the assessment methodology described in Section19.4.5, Chart 4 in CRTN was used to assess the change in heavy goods vehicle traffic on the A857 that would be required to produce a potentially significant 1dB change in noise levels. Based on existing total 12 hour traffic flows of 1054 vehicles of which 76 (or 7.2%) were heavy goods vehicles, it was calculated that the number of heavy goods vehicles would need to increase by 73, to a relative proportion of 13.2%, in order to give rise to a 1dB increase in noise levels.

19.8.6 Examination of the construction traffic figures presented in Table 19.1, in the context of a construction phase which last for a duration of weeks, it is highly unlikely that this level of increase would occur. It would be more reasonable to expect that, at most, 10 to 20 additional heavy goods vehicles would travel on this road per day, conservatively assuming all construction traffic arrives along A857 and that all such traffic movements would occur during the daytime only.

19.8.7 As the data indicates, 76 heavy goods vehicles already travel on the A857, the few extra vehicles associated with construction traffic are predicted to give rise to a **low** magnitude. Receptors close to the A857 route are of **medium** sensitivity.

19.8.8 It was therefore predicted that the effect of the noise or vibration impact associated with additional construction-related vehicle movements on the A857 will be of **minor** significance.

MITIGATION IN RELATION TO IMPACT 1
No specific mitigation required, but best practice measures are suggested (see 22.8.10 and 22.8.11)

Residual effect and best practice

19.8.9 The residual impact associated with this aspect of the noise and vibration assessment will be **minor** significant.

19.8.10 As best practice and to assist in reducing minor impacts, construction related traffic is limited to daytime periods only.

19.8.11 Routine noise measurements may also be conducted to verify adopted noise limits are achieved

Impact 2: Noise levels associated with the construction of the hydroelectric power station and surface laid or HDD pipeline installation

19.8.12 The construction phase 1 will involve the construction of the initial 3MW hydro electric power station, the construction of the access road and the horizontal directional drilling works or surface laid pipelines works.

19.8.13 This phase of work is expected to last for 12 to14 months and there is a possibility of working hours of 24 hours a day, 7 days a week to be required. It is most likely that working hours will be limited to 12 hours per day, including Saturdays.

19.8.14 The construction of the hydro electric power station building will require foundations to be excavated and concrete pours undertaken. The noise impacts of these works are considered to be of **low** significance. During concrete pours works may be required to continue throughout the night, therefore the noise impact of these works are considered to be of **moderate** significance.

19.8.15 For the HDD works noise levels will be largely produced by a generator once the surface is broken and typical noise levels will be temporarily increased at nearby NSPs. The noise impact of these works is also considered to be of **minor** significance. There may be a possibility for HDD works to be conducted for 24 hours, although these activities would be agreed in advance.

MITIGATION IN RELATION TO IMPACT 2
• Mitigation measures for construction noise will be agreed with the Western Isles Council through the planning process. • The control of noise from construction operations will be achieved through the application by the principal Contractor for a Section 61 ‘prior consent’ in accordance with the guidance set out in the Control of Pollution Act 1974. Additional best practice measures are suggested (see 22.8.16)

Residual effect and best practice

19.8.16 With the application of appropriate mitigation and control measures, it is expected that the impact of noise from construction activities would result in an effect of **minor** significance. Best practical means (BPM) in construction operations may include:

- Education and awareness-raising of construction operatives with regard to the prevention of local community noise disturbance.
- Minimising the idling of vehicles in proximity to the residential properties.
- Avoiding excessive revving of plant equipment engines.
- Extra care taken in handling and placing materials.
- Ensuring that as much as possible the most modern plant equipment is used and fitted with appropriate noise attenuation.
- Ensuring proper maintenance and operation of plant equipment and vessels.

<u>Potential impacts during operational (including maintenance)</u>

Impact 1: Noise associated with movement of vehicles associated with hydro electric power station maintenance

19.8.17 The onshore facility will be maintained by on site personnel resulting in the use of the A857 road by one to two vehicles of small size and therefore the noise associated with this impact is likely to be of **negligible** magnitude. With receptors of **low** sensitivity this impact will have **no significant effect** on human receptors.

MITIGATION IN RELATION TO IMPACT 1
No mitigation required

Residual effect

19.8.18 As no mitigation is required, the impact of maintenance activities will remain of minor significant effect.

<u>Potential impacts during decommissioning</u>

19.8.19 The potential noise impacts during the decommissioning phase of the scheme are expected to be similar in nature to the impact described for the construction phase, although the foundations constructed for the power station building are not expected to be excavated, therefore removing the potentially noisiest activity compared to the construction phase Decommissioning works are expected to be over a shorter timescale, with no significant noise or vibration effects during the day and moderate to major adverse noise impacts if undertaken during the night.

19.8.20 The sensitivity of the receptor is likely to remain at the same level as during the construction phase; however this is dependant on any changes which may occur to ambient noise levels and NSPs in advance of the decommissioning phase and should be reassessed if necessary. However, no significant changes are anticipated, so we do not expect that the significance of effect of these impacts will differ from those of the construction phase.

<u>Cumulative effects</u>

19.8.21 There are no known projects or developments with the possibility to give rise to cumulative effects.

19.9 Conclusions

19.9.1 The assessment has shown that no significant onshore vibration impacts will occur. The improvements to the access road to the onshore site will serve to reduce the levels of vibration caused by the passage of construction-related traffic.

19.9.2 The control of noise disturbance through the application by the principal contractor for a Section 61 prior consent (Control of Pollution Act 1974) as well as the implementation of conventional Best Practical Means (BPM) in construction operations was predicted to result in no greater than an occasional **minor** impact. As a further control measure, a noise measurement strategy could be implemented if required to verify if noise limits are achieved during construction activities.

19.9.3 Similar impacts were predicted for decommissioning activities as for the construction activities. Minor to moderate impacts were predicted for the decommissioning activities; the same mitigation measures will be applied to those measure being used for construction activity resulting in no greater than a predicted minor noise impact.

20 WATER QUALITY

20.1 Introduction

20.1.1 This Chapter of the Environmental Statement (ES) describes water quality of terrestrial, coastal and marine water features, and bathing and shellfish water quality within the vicinity of the development.

20.1.2 This Chapter provides a baseline description of these parameters, followed by an assessment of the significance of the effects resulting from the construction, operation and decommissioning of the proposed development. Finally, an assessment of the effects resulting from cumulative interactions with other existing or planned projects is presented. Potential mitigation measures and outline monitoring plans are also considered as appropriate.

20.1.3 This chapter is intrinsically linked with, and should be read in conjunction with Chapter 8*Soils, hydrology and hydrogeology* in order to gain a full overview of baseline conditions and potential impacts. Also of relevance to marine water quality is Chapter 7 *Physical environment and coastal processes*.

20.2 Summary of assessment

20.2.1 A desk based review of the existing environment revealed that all water bodies within the vicinity of the development site have been assessed by the Scottish Environment Protection Agency (SEPA) as being of “good ecological status” and have been awarded a “pass” in chemical analysis. There are no designated shellfish waters within the immediate vicinity of the development and the nearest bathing waters are located over 80km from the development site at Achmelvich on mainland Scotland.

20.2.2 The greatest potential impacts to water quality could occur during construction in the marine environment as a result of potential pollution from vessels and construction activities. Once details on vessels are confirmed, a risk assessment will be conducted to minimise risk of transporting marine non-native species to the site.

20.3 Potential effects

20.3.1 Guidance produced to aid the consenting process for marine renewables in Scotland (EMEC and Xodus group, in draft) lists the potential impacts that wave and tidal energy developments may have on water quality as:

- Resulting in direct or indirect impact on ecology.
- Pollution from routine and accidental discharges
- Alteration of groundwater flows and levels, e.g., through alteration of drainage.
- Alteration of natural stream flows, i.e., through the construction of tracks.
- Permeability of the onshore assets will be altered once onshore buildings are in place.
- Water crossings impacting the flow and sediment transport of surface streams.
- Hard standing of buildings could impede existing drainage.
- Increase of surface runoff and change in speed of response in rainfall events.
- Disruption of potable groundwater.

20.3.2 Impacts to terrestrial water bodies are assessed in *Chapter 8 Soils, hydrology and hydrogeology*, with marine effects assessed in this chapter.

20.4 Methodology

Defining study areas

20.4.1 Water quality is considered over two spatial scales:

- Far-field – the coastal area surrounding the development site over which remote effects may occur and interact with other activities; and
- Near-field – the footprint of the development that resides in the marine and terrestrial environment (see *Chapter 5 Project description* and in particular Figure 5.2).

Legislation, Guidelines and Policy Framework

20.4.2 No specific legislation or published guidance is available regarding accidental or non-routine pollution events associated with marine renewable energy developments, however the following does apply:

- 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).

20.4.3 The Water Framework Directive (WFD) (Directive 2000/60/EC 'establishing a framework for Community action in the field of water policy') is designed to produce an integrated approach to the protection, improvement and sustainable use of Europe's water bodies, which requires surface freshwater and ground water bodies, such as lakes, streams, rivers, estuaries, and coastal waters to be ecologically sound by 2015. In Scotland, water quality under the WFD is monitored out to 3 nautical miles (nm) in coastal waters.

20.4.4 SEPA is responsible for monitoring water quality and reports the data against Environmental Quality Standards (EQS), which are designed to protect the environment and human health, targeting areas that need improvement. EQS have been developed for the WFD under the requirements of the Dangerous Substances Directive (Directive 76/464/EEC on pollution caused by certain dangerous substances discharged into the aquatic environment of the Community), which classifies substances as List I and List II (depending upon toxicity within aqueous environments).

20.4.5 Standards for List I substances have been defined in 'daughter' Directives to the Dangerous Substances Directive. These will be incorporated into the revised WFD, which will also incorporate the Bathing Waters Directive (Directive 2006/7/EC 'concerning the management of bathing water quality and repealing Directive 76/160/EEC') (to be revised by the WFD in 2015) and the Shellfish Waters Directive (2006/113/EEC 'on the quality required of shellfish waters') (to be revised by the WFD in 2013).

20.4.6 Monitoring of bathing waters is undertaken by SEPA. Bathing water quality is assessed by the standards listed in the Bathing Waters Directive, which is implemented through the Bathing Waters Regulations 2008. The Bathing Waters Directive sets a number of microbiological and physicochemical standards that bathing waters must either comply with ('mandatory' standards) or endeavour to meet (stricter 'guideline' standards). The two main standards used to assess the quality of bathing water are total coliforms and faecal coliforms, both of which are indicators of sewage pollution.

20.4.7 The WFD EQS have also been guided by legislation set out within the Convention for the Protection of the Marine Environment in the North East Atlantic of 1992 (further to earlier versions of 1972 and 1974), known as the Oslo and Paris Convention (OSPAR).

Consultation

20.4.8 A scoping opinion was sought from both statutory and non-statutory consultees (Lewis Wave Power limited, 2011) in May 2011. Responses are detailed in Appendix 2.1, Scoping Opinion, and a short summary of the main points pertinent to water quality raised by SEPA during this process, along with an explanation of how they were addressed, is provided below (Table 20.1).

Table 20.1Comments/ Information raised in the scoping opinion (Marine Scotland 2011)

Comments/ Information	Response
SEPA advised that *"Depending upon the scale and nature of the works, there may be a need to carry out hydrodynamic modelling to predict the impacts of construction activities on water quality, as well as coastal processes in the longer term. If large scale works are proposed then any potential impacts from suspended sediment should be compared to natural background levels and water quality standards (e.g. Shellfish Waters Directive)".*	A full assessment of the impacts to the hydrodynamic regime and potential for changes to coastal processes caused by the development can be found in *Chapter 7 Physical Environment and Coastal processes* and an assessment of the impacts to onshore hydrology can be found in *Chapter 8 Soils, hydrology and hydrogeology*
SEPA also advise *"that if large scale works are proposed then any potential impacts from suspended sediment should be compared to natural background levels and water quality standards (e.g. Shellfish Waters Directive)".*	This potential impact is considered in *Chapter 7 Physical Environment and Coastal processes*
SEPA state that "*Options for the subsequent disposal and beneficial reuse of the material should be submitted".*	Options for the subsequent disposal and beneficial reuse of the material will be submitted as part of the pollution and sediment management plans which will be incorporated into the Construction Method Statement and will be agreed by SEPA and the local authority.
SEPA recommend that "*sensitive water uses, such as bathing waters and shellfish growing waters, and associated potential impacts should be assessed. The proximity to existing discharges and designated areas (i.e. estuarine abstractions and cooling water discharges), should also be assessed*"	These features have been assessed below
SEPA recommend that the "*ES should assess risks of introduction of marine non-native species and we encourage the developer to draw up a protocol or method statement to remove the risk of introducing marine non-natives into this area either during the development of this project or during the construction, operational, maintenance or decommissioning phases of the project. Given that the accidental introduction of marine non-native has been highlighted as a risk for water body degradation we recommend that controls should be included for marine non-native species in line with Water Framework and Marine Strategy Framework Directive objectives."*	Risk assessment to be drawn up when vessel details are known. Pathway with greatest risk is considered to be from ballast water.

Data collection

20.4.9 The principal data sources relevant to water quality are shown below in Table 20.2.

Table 20.2 Table Existing data

Data source	Coverage	Author(s)	Year
Water Basin management plan	Scotland	SEPA	2011
Water Framework Directive	Scotland	SEPA	2011
Map of Designated Shellfish Waters	Scotland	Scottish Government	2009
Information regarding Designated shellfish waters	Scotland	SEPA	2011
Information regarding Designated bathing waters	Scotland	Scottish Government	2011

Assessment of significance

20.4.10 The significance of the effect imposed by the development is based on the intensity or degree of disturbance to baseline conditions and is categorised into four levels of magnitude, high, medium, low or negligible. The definitions of each of these are given in Table 20.3.

20.4.11 The approach to assessing the potential effects on water quality arising from the development is based on a comparison of the predicted changes to the relevant water quality parameters against the criteria established as environmental quality standards (EQS) within the relevant European Directives (discussed above in Legislation, Guidelines and Policy Framework). Where EQS do not exist, the impact is assessed with reference to background conditions.

20.4.12 Impacts have been assessed in line with the guidance presented in Chapter 2 *Scoping and Assessment Methodology*. Impacts have been assigned a level of significance of effect (from major to negligible). The assignment of significance includes consideration of the natural variability of the coastal and nearshore system and the inherent uncertainty within a dynamic environment. A qualitative impact assessment using expert judgement considers the likely significant effects of the development on water and sediment quality. Where applicable the qualitative assessment is backed up by the use of previously gathered empirical data alongside modelling completed as part of the resource assessment (as discussed previously within *Chapter 7 Physical Environment and Coastal Processes*) within the Sound.

20.4.13 The magnitude of the effect for each effect is characterised as one of four levels, high, medium, low or negligible. The definition of each level is given below in Table 20.3.

Table 20.3 Criteria for assessing the magnitude of effects on water quality

Magnitude of effect	Definition
High	Prolonged / widespread disturbance or pollution of marine ,coastal, ground or surface waters resulting in temporary or permanent consequential changes to water quality (as defined by toxicity level, time scale and persistency in the marine or coastal environment).

Table 20.3 Criteria for assessing the magnitude of effects on water quality	
Magnitude of effect	**Definition**
Medium	Short-term disturbance or pollution of marine, coastal, ground or surface waters resulting in temporary consequential changes to water quality.
Low	Detectable disturbance or pollution of a section of marine, coastal, ground or surface waters of very short duration, but with no consequential changes to water quality.
Negligible	An imperceptible and/ or no change to the baseline water quality.

20.4.14 The sensitivity/value/importance of the receptor for each effect is characterised as one of four levels, high, medium, low or negligible. The definition of each level is given below in Table 20.4.

Table20.4Sensitivity of water bodies	
Receptor sensitivity/value	**Site designations**
High	• Water body, or sites dependant on water body, designated under international or national legislation (e.g. Ramsar Sites, SPA, SAC, SSSI). • Water body, or sites dependant on water body, containing Habitats Directive Annex 1 water dependant habitats, or sites supporting populations of international important water dependant species. • Water body with “excellent [A] “water quality. • Water body of significant recreational or amenity value.
Medium	• Water body with “good” water quality. • Water body of moderate recreational or amenity value.
Low	• Locally designated sites of varied quality containing water dependant habitats/species. • Water body has an unnatural sedimentary/morphological regime. • Drainage channel or ditch with poor water quality. • Water body of low recreational or amenity value.
Negligible	• Undesignated sites of varied quality containing water dependant habitats/species. • Seriously polluted water system. • Water body of no recreational or amenity value.

20.4.15 Table 20.5 combines the definitions of magnitude with the level of sensitivity/value/importance of receptor to provide a prediction of overall significance of the effect. The boxes shaded red represent those impacts which may be considered significant within an EIA.

Table 20.5Significance Prediction Matrix.				
Magnitude o f Effect	**Receptor Sensitivity**			
	Negligible	**Low**	**Medium**	**High**
High	Negligible	Moderate	Major	Major
Medium	Negligible	Minor	Moderate	Major
Low	Negligible	Negligible	Minor	Moderate
Negligible	Negligible	Negligible	Negligible	Minor

20.5 Existing environment

Coastal water bodies

20.5.1 The coastal water body, Gallan Head to Butt of Lewis (SEPA water body identification number 200476) was classed by SEPA as having high overall status with high confidence in 2008, with an overall ecological status of High and an overall chemical status of Pass (SEPA 2008). However, confidence in the data underpinning many parameters was low (Table 20.6). Pressure upon this water body is currently limited to point source pollution from sewage disposal, however anthropogenic influence is low for this area.

Table 20.6Complete classification for water body Gallan Head to Butt of Lewis (200476)in 2008 as provided by SEPA		
Parameter	**Status**	**Confidence**
Overall status	High	High
Pre-HMWB status	High	High
Overall chemistry	Pass	Low
Priority substances	Pass	Low
Overall ecology	High	High
Physico-chem High	High	Low
Dissolved oxygen	High	Low
Dissolved inorganic nitrogen	High	Low
DIN (field salinity)	High	Low
DIN(laboratory salinity)	High	Low
Biological elements	High	High
Benthic invertebrates	High	Low
Imposex assessment	High	Low
Benthic invertebrates (IQI)	High	Low
Alien species	High	Low
Phytoplankton	High	Low
Macroalgae	High	High
Macroalgae (FSL)	High	Low
Macroalgae (RSL)	High	High
Specific pollutants	Pass	Low
Hydromorphology	High	Medium

Morphology	High	Medium
Water quality	**High**	*No confidence level given*

Designated shellfish waters

20.5.2 There are no designated shellfish waters located on the north-west coast of Lewis, the nearest to the site is located in the southern part of, Loch Roag, approximately 30km to the south of the development site.

Designated bathing waters

20.5.3 There are no designated bathing waters located in on the Western Isles and therefore the development will not affect any of these designations. The nearest bathing water is located over 80km from the development site at Achmelvich on mainland Scotland.

River water bodies

20.5.4 The Lambol Burn is a small watercourse, currently culverted, under the access track to the development site. In addition, Allt Fisgro is located north of the development footprint (Figure 5.1).

20.5.5 No watercourses that run through the development site have been assessed by SEPA. However, SEPA have assessed and provided data for the Abhainn Shiadair (River Siadar) and the Abhainn Bhuirgh (River Borve) on the SEPA website (SEPA RBMP interactive map).

20.5.6 The Abhainn Shiadair (SEPA water body identification number 20803) located 1.4km to the south of the development site has been assessed by SEPA and was classified as having an overall status of Good with High confidence in 2008 with overall ecological status of Good and overall chemical status of Pass. At that time no pressures were identified on this water body.

20.5.7 The Abhainn Bhuirgh (SEPA water body identification number 20803) located less than 300m from the offshore parts of the development site and 1.5km from the onshore parts of the development was also assessed by SEPA in 2008. This river was classified as having an overall status of Good with High confidence in with overall ecological status of Good and overall chemical status of Pass. At that time no pressures were identified on this water body. This water body is upgradiant and outside of the catchment of the onshore development site, and is therefore not considered to be at risk.

Groundwater bodies

20.5.8 The development is located in a groundwater body that encompasses both Lewis and Harris (SEPA water body identification number 150030). In 2008 SEPA classified this water body as having an overall status of Good with High confidence. The quality of the groundwater was classified as Good with High confidence and the quantity of groundwater has been classified as Good with High confidence. There is was no trend for pollutants for this water body. SEPA have established an ongoing programme of monitoring in order to identify pressures on water bodies and there are currently no pressures identified on this water body.

20.6 Impact assessment

20.6.1 The impact assessment for terrestrial water bodies is considered in Chapter 8: *Soils, hydrology and hydrogeology*. This chapter considers the impact assessment on the marine environment.

Do nothing scenario

20.6.2 If the development is not realised it can be assumed that water quality within the vicinity of the development will remain as described in Section 20.5 Existing environment.

Potential impacts during construction

Impact 1: Marine pollution from construction

20.6.3 There is potential for pollution to occur from spills or leaks of fuel, oil and lubricants during construction and from construction materials that may enter the water column from the array itself, from drilling activities, grouting and from the vessels used. Contamination from accidental spillages is likely to enter the environment either through the dissolved phase or as low solubility, slick forming organics (Faber Maunselland Metoc Plc., 2007).

20.6.4 Impacts and mitigation during construction relating to watercourses which flow into the sea are assessed in Chapter 8: *Soils, hydrology and hydrogeology* in impacts 3 and 8. Both are considered to be of minor adverse significance reduced to negligible significance with appropriate mitigation.

20.6.5 There is a potential loss of grout to the sea during the pile and anchor grouting operations and flushing out of the grout hoses. The grout used to secure the piles within the sockets will be a non-toxic cement based grout which will have little influence on the water quality. The amount of grout being pumped into the socket will be monitored from the surface and by divers and it is predicted that approximately $1m^3$ of grout may be lost from each operation equating to a total maximum loss of $50m^3$. The grout used to secure anchors into the seabed will be a rapid curing Hilti mortar which has been classified in accordance with Directive 67/548/EEC and Directive 1999/45/EC as"R51/53 Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment" and "52/53 Harmful to aquatic organisms, may cause long-term adverse effects in the aquatic environment" (Hilti, 2011).It is anticipated that only very small amounts of this grout will be lost to the Marine environment (Table 5.5 in *Chapter 5 Project description*).

20.6.6 If horizontal directional drilling (HDD) technique is used to install the shore pipelines (See *Chapter 5 Project description* for detail) drilling fluids (likely to be bentonite or a similar fluid) and cuttings will enter the marine environment at the point of break through or at the location in which the drilling starts (depending on whether the bore holes are drilled from an onshore or an offshore location). Bentonite his highly soluble in water and will rapidly disperse due to the high energy condition at the site. The Material Safety Data Sheet (MSDS) for bentonite does not indicate that this substance is likely to cause significant harm to water quality.

20.6.7 Construction vessels have the potential to effect water quality in the marine environment through spills or leaks of oil and fuel. The impact from small oil spills or leaks will be localised to the immediate vicinity of the spill and spilt oil or fuel will quickly disperse in the dynamic waters off the west coast of Lewis.

20.6.8 The risk of pollution events will be minimised by following standard good practice, such as the Pollution Prevention Guidelines (PPG) issued by SEPA (e.g. PPG 5: Works and maintenance in or near water). Additionally all vessels associated with the development will comply with International Maritime Organisation (IMO)/Maritime Coastguard Agency (MCA) codes for prevention of oil pollution and, where appropriate, will have onboard Ship Oil Pollution Emergency Plans (SOPEPs) (i.e. vessels over 400GT). As discussed in *Chapter 5 Project Description*, Lewis Wave Power Ltd is committed to using environmentally friendly chemicals whilst still maintaining performance.

20.6.9 Due to the high energy nature of the marine environment, any vessel or marine construction related pollution will be quickly dispersed and are unlikely to impact the intertidal environment or water quality of the Gallen Head to Butt of Lewis water body. Best practice measures will be adopted during construction to minimise risk of pollution to the marine environment.

20.6.10 Installation contractors will put in place appropriate Site Environmental Management Plans and Pollution Control and Spillage Response Plans that will be agreed with the relevant statutory bodies prior to offshore construction activities commencing. These will augment any associated vessels own Environmental Management Plans which will already be incorporated in their procedures. These plans will act to reduce the potential for accidental pollution and in the unlikely event of a pollution incident, will ensure a rapid and appropriate response.

20.6.11 Given these management strategies and controls it is expected that even should a spill occur, its scale and the nature of the contaminant will result only in a temporary and localised impact of low magnitude to the receptor of medium sensitivity value (See Table 20.4), resulting in the impact of contamination by accidental spillages being of **minor adverse** significance to water quality.

MITIGATION IN RELATION TO IMPACT 1
• Lewis Wave Power will develop its own Emergency Response Plan which will address the response to accidental / non-routine events, including pollution related events. • All vessels associated with the Lewis proposed development will comply with IMO/MCA codes for prevention of oil pollution and, where appropriate, will have onboard SOPEPs (i.e. vessels over 400 Gross tonnes (GT)). • All contracted vessels will carry oil and chemical spill mop up kits. • As far as possible vessels with an established track record of operating in similar waters where the conditions can become severe over a short period of time will be employed. They will also be familiar with operating conditions in the area and will adhere to all appropriate navigational standards and practices. • Installation and major routine (planned) maintenance activities will only take place in instances where Lewis Wave Power are confident that there is limited risk of bad weather to avoid incidences leading to an increased risk of accidental/non routine events. • Hydraulic and accumulator modules are designed to be isolated if necessary. Any problems will result in the problem module being isolated from the rest of the system before it is retrieved; this will prevent the release of hydraulic fluid into the water.

Residual impacts

20.6.12 Following mitigation the residual impact will be reduced to **negligible** significance.

Impact 2: Introduction of marine non-native species

20.6.13 The devices will be made of Fibre Reinforced Polymer (FRP) (a hard substrate), and will be situated on hard substrate in relatively shallow waters, essentially becoming an extension of the reef. It is therefore not considered that they will act as a 'stepping stone' for marine non-native species.

20.6.14 There is a potential for vessels used during construction activities to transport marine non-native species in ballast waters. The risk of this is greatest with the use of installation vessels such as jack-up barges, which are used at a number of locations internationally, and the level of risk depends on previous locations of these vessels and whether they are mobilising from areas with species present which may pose a risk as marine non-natives at the development site or en route.

20.6.15 The coastal waters around the development site are considered to be of medium sensitivity, and the risk of transporting marine non-natives could be as high as medium magnitude, depending on vessels are travelling from. This constitutes an anticipated impact of **moderate** significance.

MITIGATION IN RELATION TO IMPACT2
• Once the vessels for construction are confirmed, a risk assessment will be conducted taking account of vessel activities, previous locations, and planned routes that could introduce marine non-native species to the area. The assessment and measures indicated by the assessment will be agreed with Marine Scotland. • If the risk assessment identifies a concern, further consultation with be undertaken with Scottish Natural Heritage (SNH) and SEPA, with the aim of compliance with Water Framework and Marine Strategy Framework Directive objectives.

Residual impacts

20.6.16 Following the mitigation stated above, the likelihood of transporting marine non-natives to the site is reduced to negligible magnitude, reducing the impact to **negligible** significance.

Potential impacts during operation (including maintenance)

Impact 1: Marine pollution due to accidental spillage

20.6.17 During the operational phase of the development, the main potential impact on water quality is expected to result from accidental spillages of materials during maintenance of the WEC devices. Paints, resins and lubricants that have been selected for use in construction and during operation are low in Volatile Organic Compounds (VOCs), surface tolerant epoxy coatings that have low toxicity to the marine environment.

20.6.18 The hydraulic fluid contained within the pipeline system will be fresh water with an additive to increase the lubricity of the working fluidand a defoaming agent (see *Chapter 5 Project description* for more details). The use of hydraulic additives at the Lewis site is subject to on-going performance testing of the range of products in Oyster 800 at the Billia Croo site in Orkney. The additive is likely to be a product called Eco Stack-Magic which is biodegradable has low toxicity levels and has is not classified as dangerous to the environment under EU regulations.The defoaming agent is likely to be a product called Antifoaming agent 70 which is a Biodegradable fluid that has been assessed as having no bioaccumulation potential and negligible ecotoxicology (Houghton, 2008). Lewis Wave Power is committed to using the most environmentally friendly hydraulic additives possible whilst maintaining performance standards of the Oyster hydraulics.

20.6.19 The unexpected nature of pollution incidents means that it is difficult to predict the probability of their occurrence or the scale of contaminant releases. However, given low levels of on-site activity and commitment to best practice, the risk of pollution during maintenance can be expected to be low.

20.6.20 Contractors will be required to adhere to standard good practice guidance such as Construction Industry Research and Information Association (CIRIA) Guidance note C692 (good practice on site) and SEPA PPG 5.

20.6.21 Any use and discharge of chemicals during maintenance will be subject to controls as part of consent requirements and it is expected that even should a spill occur, its scale and the nature of the contaminant will result only in a temporary, localised negligible magnitude effect to the medium value receptor, resulting in an impact of **negligible** significance. In a high energy marine environment, contaminants can be expected to rapidly disperse.

MITIGATION IN RELATION TO IMPACT1
No mitigation suggested

Residual impacts

20.6.22 As no mitigation is required, the residual impact will remain of **negligible** significance.

Impact 2: Introduction of marine non-native species

20.6.23 The devices will be made of hard substrate, and will be situated on hard substrate in relatively shallow waters, essentially becoming an extension of the reef. It is therefore not considered that they will act as a 'stepping stone' for marine non-native species.

20.6.24 It is unlikely that jack-up barges, or larger vessels travelling any significant distance, will be required during operation and maintenance activities. Therefore the magnitude of risk of transporting marine non-native species to the site, or wider Western Isles area, during this phase is considered to be negligible. The coastal waters around the development site are considered to be of medium sensitivity. This constitutes an anticipated impact of **negligible** significance.

MITIGATION IN RELATION TO IMPACT2
No mitigation is considered necessary

Residual impacts

20.6.25 As no mitigation is considered necessary, transporting marine non-natives to the site will remain of **negligible** significance.

Potential impacts during decommissioning

20.6.26 The potential impacts experienced during decommissioning are anticipated as largely similar in significance to those predicted to occur during the constructions phase. However, it is anticipated that the following will differ during the decommissioning phase.

- The access track which will be widened during the construction phase is likely to be left in situ after the project has been decommissioned. This will reduce any potential impacts to the Lambol burn that may otherwise have occurred if the access track was dismantled.
- As no HDD or drilling activities will be required during decommissioning there will be no potential for drilling fluids or cuttings to enter the marine environment during this stage of the project

20.6.27 A full decommissioning plan will be produced and agreed with the regulatory authority prior to decommissioning activities commencing.

Cumulative impacts

20.6.28 This development has been designed to maximise the distances from fresh water bodies and no cumulative effects are anticipated to freshwater bodies.

20.6.29 There the potential for impacts associated with pollution to the marine environment to overlap with similar impacts created by the Voith Hydro WaveGen 4MW development at Siadar. The Environmental Statement for the Voith Hydro WaveGen 4MW development at Siadar assesses possible impacts of pollution as being of minor (Npower and RWE 2008) adverse significance which is in the same category as the impacts likely to be caused during this development. Given high energy nature of the environment and the distance between the two projects (1.4km) it is unlikely that the two projects will interact sufficiently to cause impacts of greater than minor significance to marine water bodies.

20.7 Conclusions

20.7.1 The existing water bodies within the vicinity of the proposed development are all considered by SEPA to be in good condition and therefore must be considered to be of medium sensitivity to impacts caused by the proposed development. Anticipated impacts include pollution to both freshwater and marine environments and have been assessed to of no more than minor adverse significance. Once details on vessels are confirmed, a risk assessment will also be conducted to minimise any risk of transporting marine non-native species to the site. With appropriate mitigation it is anticipated that all impacts can be reduced enough to become non-significant.

21. SOCIO-ECONOMICS / LOCAL COMMUNITY

21.1 Introduction

21.1.1 This chapter provides information on the potential socio-economic effects of the Lewis Wave Array. This includes potential implications of the project on existing employment, education, health, community at Siadar and the wider community in Lewis and the surrounding Western Isles. Specific impacts in relation to commercial fisheries, traffic and transport, onshore noise and tourism and recreation are discussed in Chapters, 16, 17, 19 and 22 respectively.

21.1.2 The potential effects of the development on these existing activities and conditions are then assessed in terms of their significance. Where required, mitigation measures are proposed in order to avoid or minimise any adverse effects.

21.1.3 Lewis Wave Power recognises the importance of marine industries to local communities in both social and economic terms. Full details of consultation already undertaken, and planned for the future, is discussed in *Chapter 3 Consultation*.

21.2 Summary of assessment on socio-economics and local community

21.2.1 The development of the 40MW Lewis Wave Array will bring with it minor beneficial socio-economic benefits. A number of local jobs will be created along with an increase in spend on local services during the construction and operation of the project. There will also be ongoing spend on local services associated with operation and maintenance.

21.3 Potential Impacts

21.3.1 Installation, maintenance and decommissioning of the wave array will make use of the local supply chain on Lewis, where appropriate. The development will help support the local economy and play a role in job creation.

21.3.2 Local businesses will benefit from increased local spend (e.g. accommodation, restaurants, shops, transport operators), particularly during the installation phase, but continuing through operation to decommissioning.

21.3.3 The development will support the case for the High Voltage Direct Current (HVDC) upgrade from Beauly to Stornoway and will strengthen the local electricity grid across Lewis, improving the security and stability of electricity supply across Lewis. However, this will depend on the work that the distribution and transmission operators require as part of the grid connection agreement.

21.3.4 Lewis Wave Power is working with Highlands and Islands Enterprise (HIE), Energy North and Comhairle Nan Eilean Siar (Western Isles Council) to maximise the benefits of the project to the local community, including the identification of opportunities for local employment and strengthening the local supply chain.

21.4 Methodology

<u>Legislation, Guidelines and Policy Framework</u>

21.4.1 Statements of Scottish Government policy in the National Planning Framework (NPF), the Scottish Planning Policy (SPP), Designing Places and Circulars can be material considerations to be taken into account in development plans and development management decisions.

21.4.2 Certain elements of the SPP are particularly relevant to the potential socio-economic impacts of the development. The SPP recognises that the coast of Scotland is a major focus for economic activity, recreation and tourism, and that the sustainable development of coastal areas is an important contributor to sustainable economic growth. It also states that renewable energy generation will contribute to more secure and diverse energy supplies and support sustainable economic growth.

21.4.3 The Scottish Government Economic Strategy (Scottish Government, 2011) sees the 'green' economy as being central to the growth of Scotland's economy. This includes the start up and growth of Scottish business, encouraging and supporting key manufacturing industries and supporting innovation and technology transfer to grow high value and high skills businesses with the potential for expansion. 'Going for Green Growth: a Green Jobs Strategy for Scotland' (Scottish Executive, 2005) sets out how this priority should be delivered through sustainable economic development.

21.4.4 The Scottish Government believes that a thriving renewables industry in Scotland has the potential to develop new indigenous industries, particularly in rural areas; to provide significant export opportunities and to enhance Scotland's manufacturing capacity. The planning system has a key role in supporting Scotland's economic competitiveness and employment market. The scope for developments to contribute to national or local economic development priorities should be a material consideration when considering policies and decisions.

21.4.5 This policy context indicates that socio-economic assessment for the development of the wave array should focus on the potential for the development to contribute to sustainable economic development.

Consultation

21.4.6 Discussions have been undertaken with the Western Isles Council prior to this assessment. The full Scoping Opinion is provided in Appendix 2.1. A summary of the responses from the Western Isles Council with regards to socio-economics are presented in Table 21.1.

Table 21.1 Key consultation responses

Comments & information	Response
The Western Isles Council planning authority, recommended the evaluation of direct jobs created in the local community by the Lewis Wave Power project, as well as its support of the development of local expertise where it does not already exist in the community. It was recommended that the Environmental Impact Assessment (EIA) seek to indicate any planned commitments towards local fabrication, research and monitoring in connection with the project.	The final design of the project is still under development and therefore full details of employment opportunities cannot be confirmed, however indications of employment and other support to the local community is discussed within this chapter.
The Western Isles Council recommended that the socio-economic assessment includes the topic of energy supplied by the development and how it may be sold into the local and wider Scottish energy supply chain.	Aquamarine at an appropriate time will take full consideration of local supply chins including an Outer Hebrides Energy Supply Company

Table 21.1 Key consultation responses	
Comments & information	**Response**
The Western Isles Council further advised that the socio-economic assessment should break down the variety of benefits to and impacts within the local economy as well as wider impacts outwith the Western Isles.	This is addressed in Section 21.6 of this chapter.

Data collection

21.4.7 The principal data sources relevant to the socio-economics and local communities are shown below in Table 21.2.

Table 21.2 Existing data			
Data source	**Coverage**	**Author(s)**	**Year**
Socio-economic impact assessment of Aquamarine Power's Oyster Projects	Orkney	SQW consulting	2009
Local Plan	Western Isles	Comhairle nan Eilean Siar	2008
Local Development Plan	Western Isles	Comhairle nan Eilean Siar	2011
Scottish Government Economic and Community Benefit Study	Western Isles	Halcrow	2009

Assessment of significance

21.4.8 The significance of the effect potential from the development is based on the intensity or degree of disturbance to baseline conditions and is categorised into four levels of magnitude, high, medium, low or negligible. The definitions of each of these are given in Table 21.3.

Table 21.3: Criteria for Assessing the Magnitude of effects on Socio-economics and local communities	
Magnitude of Effect	**Definition**
High	A fundamental change from the baseline condition of socio-economics and/or local communities.
Medium	A detectable change resulting in the non-fundamental temporary or permanent condition of socio-economics and/or local communities.

Table 21.3: Criteria for Assessing the Magnitude of effects on Socio-economics and local communities	
Magnitude of Effect	**Definition**
Low	A minor change to the baseline condition of socio-economics and/or local communities.
Negligible	An imperceptible and/or no change to the baseline condition of socio-economics and/or local communities.

21.4.9 The sensitivity/value/importance of the receptor for each potential effect is characterised as one of four levels, high, medium, low or negligible. The definition of each level is given below in Table 21.4.

Table 21.4: Sensitivity of Socio-economic Assets 4	
Receptor Sensitivity/ Value	**Site designations**
High	Economic baseline is subject to major change(s) due to impact from the development
Medium	Economic baseline clearly responds to effect(s) in quantifiable and/or qualitative manner.
Low	Economic baseline responds in minimal way to effects such that only minor change(s) are detectable.
Negligible	Economic baseline responds in minimal way to effect such that only very minor change(s) occur, which may or may not be detectable, or no changes at all.

21.4.10 Table 21.5 combines the definitions of magnitude with the level of sensitivity/value/importance of receptor to provide a prediction of overall significance of the effect.

Table 21.5 Significance Prediction Matrix.				
Magnitude of Effect	**Receptor Sensitivity/Value**			
	Negligible	**Low**	**Medium**	**High**
High	Negligible	Moderate	Major	Major
Medium	Negligible	Minor	Moderate	Major
Low	Negligible	Negligible	Minor	Moderate
Negligible	Negligible	Negligible	Negligible	Minor

21.5 Existing environment

Local community

21.5.1 The Western Isles Local Plan (Comhairle nan Eilean Siar, 2008) states that the Western Isles face socio-economic challenges in relation to de-population and maintenance of viable rural communities. The Western Isles as a whole is one of the highest priority areas in Scotland for new development due to demographic and economic trends, and relatively low incomes.

21.5.2 The most recent mid-year population estimates (for 2010) (Comhairle nan Eilean Siar, 2011a) for the Western Isles, gives a population of 26,190. This shows an increase of 0.04% (10 persons) since the mid-2009 estimates. This increase can be attributed to a positive 'net civilian migration' of 165, along with deaths (372) exceeding births (217) giving a negative 'natural change' of -155.

21.5.3 In June 2010 the median age in the islands was estimated to be 46 years compared to the Scottish average of 41 years (Comhairle nan Eilean Siar, 2011a), with the median ages for males and females estimated to be 44 years and 47 years, respectively. Figure 21.1 shows the age group breakdowns by sex. This shows the high proportion of the population that is out with the working age group (36% for males; 48% for females; 42% in total). Hallaitken (2007) suggests that the overall size of the population is less important than achieving a healthier balance in terms of age and gender. Increasing the number of younger workers and women in the population will improve the balance of the community, helping to reduce the average working age and contribute to natural population growth.

Figure 21.1: Age group breakdown in the Outer Hebrides, 2010 (data source: Comhairle nan Eilean Siar, 2011a)

21.5.4 The population of the Western Isles is ageing. The greatest decline by age group has occurred in the 30 to 44 year category (from representing 20.5% of the population in 2000 to 18.6% in 2010). The greatest increase by age group has occurred in the 45 to 64 year category (from representing 26.7% of the population in 2000 to 30% in 2010). The continuing trend is for young adults to leave the islands for further education or employment purposes.

21.5.5 The only large town in the Western Isles is Stornoway with approximately 5,530 people and it is the only settlement which can really be described as having any 'urban' characteristics. Around 30% of the total population of the Western Isles, some 8,000 people, live within Stornoway or the immediately vicinity encompassing Laxdale, Sandwick and Newmarket. The remaining population is scattered over 280 small townships.

Community Perception

21.5.6 There is limited information regarding the local community's perception of wave power. The European Committee (EC) (2012) reports the findings of a public survey in relation to the development of the Wave Hub project in Cornwall. 82% of respondents expressed strong support for the Wave Hub; just 3% said it should not go ahead and 15% remained undecided. 70% thought it would provide economic benefits for the region and 73% felt it would enhance employment opportunities.

Industry and employment

21.5.7 There have been well-documented long-term declines in many of the traditional employment sectors in the Western Isles e.g. Harris Tweed industry, the fishing industry and farming/ crofting. There is also evidence that a lack of opportunities (employment and education) means that most young people are disadvantaged if they remain in rural areas. The predominance of temporary or seasonal employment may be preventing young people from developing 'sustainable careers'. A further barrier to sustainable careers may be the cost of accessing transport in remote areas, which may exclude less affluent individuals from accessing the widest range of employment opportunities. Employment opportunities in rural areas tend to require low skills levels, pay low wages, and do not offer progression towards a career (Hallaitken, 2007).

21.5.8 Based on the 2001 census information, the main sectors of employment, other than the public sector, in the area of Westside and Carloway (Galson to Barvas to Garynahine) were manufacturing (14.1% compared with 9.0% in the wider Western Isles) and construction (12.2% compared with 10.5%). Unemployment at these locations was 5.6%, compared with 5.0% in the Western Isles (*www.cne-siar.gov.uk/eds/documents/AREAProfiles.xls*).

21.5.9 The potential for exploiting the significant renewable energy resources in the Western Isles provides one of the few opportunities for sustainable and high value economic growth (Hallaitken, 2007). Western Isles Council wishes to capitalise on the significant renewable energy generation potential in and around the Western Isles e.g. wind and wave resources (Comhairle nan Eilean Siar, 2011b). Significant investment has already started through the development of the BiFab deep water quay at Arnish Point, Lewis (*http://www.bifab.co.uk/view/arnish.aspx*). The Western Isles Council has the potential to service and support further onshore and offshore activities (Comhairle nan Eilean Siar, 2011b).

21.5.10 Halcrow (2009) discusses a recommendation to develop a wave energy zone off the west coast of Lewis. It is estimated that this could be provide an installed capacity of around 30MW by 2015, with potential for more generating capacity thereafter if and when the technology becomes more cost competitive.

21.5.11 The Western Isles are currently dependant on imported fossil fuels as a source of energy, which accounts for two thirds of all energy consumption. Given the rising price of fossil fuels, fuel poverty is now a real issue for many of the islands' inhabitants (Halcrow, 2009).

21.6 Impact assessment

Do nothing scenario

21.6.1 This section addresses the 'Do Nothing' scenario (i.e. what impacts and changes to these activities would be expected if the proposed scheme does not go ahead) in relation to socio-economics and local communities.

21.6.2 The levels of traditional industry (e.g. fishing and farming) can be expected to remain at the current low levels or continue to decline.

21.6.3 The continuing trend is for young adults to leave the Western Isles for further education or employment purposes (Comhairle nan Eilean Siar, 2011a). This can be expected to continue in the absence of significant employment opportunities and local investment.

Potential impacts during construction

Impact 1: Direct capital expenditure (project development, manufacture and assembly)

21.6.4 The development is a major undertaking, with substantial total capital costs. The manufacture of the Oyster devices, pipelines and hydro electric power station requires substantial infrastructure and many of the parts for the Oyster devices will require specialised suppliers. However there are significant opportunities for manufacturing capital expenditure to benefit Lewis and the wider Western Isles. Where possible if local expertise is available at a competitive rate, Lewis Wave Power will employ local contractors as it has done thus far during site selection and collection of environmental data (e.g. employment of local bird surveyor and local Gaelic translator).

21.6.5 All onshore works will be constructed on site and there is an option to assemble pipework and piles onshore too. However all Oyster devices are likely to be floated into place and will not be assembled onshore. Whilst this is likely to be mainly carried out by specialist contractors there will be opportunities for local businesses to work with those contractors.

21.6.6 There is an opportunity for at least some of the manufacturing to be carried out in Lewis, subject to tendering of appropriate works. Therefore the sensitivity of socio-economics to this impact can be considered to be medium, and an impact of long term temporary **moderate beneficial** significance is anticipated should some of the manufacturing be carried out in Lewis.

MITIGATION IN RELATION TO IMPACT 1
No mitigation required.

Residual effect

21.6.7 No mitigation is required and therefore the residual impact is expected to remain **moderate beneficial** significance.

Impact 2: Indirect capital expenditure (marine services and onshore construction)

21.6.8 It is believed that local marine contractors could benefit from contracts during installation with a further requirement for crew for operation on work boats and guard boats. During offshore construction and installation activities there will be use of local vessels and dive teams where available and where appropriate. On similar projects to date Aquamarine Power (of which Lewis Wave Power is a wholly owned subsidiary) have used a combination of specialist contractors and local resources such as vessels and their crew. The number of vessels and crew required will fluctuate based on the stage of the project, i.e. installation of three Oyster devices in the early stages to up to 15 per year in the latter stages of construction.

21.6.9 Onshore construction will use local contractors where possible and cost competitive. There will be a combination of specialist contractors (likely to be sourced from outside the Western Isles) and local resource and expertise. It is likely that contractors will be needed for civil engineering works, ground works, building construction, road construction, mechanical services, electrical services, utility providers, painting and decorating, joinery and carpentry. Again the nature of the work is likely to be for one to three years in the first instance and the number of contractors required on site will vary. During the first 3MW phase of development (commencing in 2014) it is likely that at peak construction times there would be 12 to 14 civil engineer contractors, 12 to 14 electrical engineers, four mechanical engineers, two joiners and a project team managing the site work. It is likely that in the second phase of development local contractors would continue to be used but overseen by a specialist team.

21.6.10 Other local services which would be required by the development include suppliers of hardware, local farming supplies, chandlery etc. Lewis Wave Power will purchase any item that is easily sourced and of competitive value.

21.6.11 With continued provision of local logistical support combined with the onshore and offshore contract work mentioned above, it is thought that the economic contribution to Lewis of the construction phase would be significant. This may result in temporary detectable change in the socio-economics of the area and therefore this impact can be considered to be of medium magnitude.

21.6.12 The indirect effects of capital expenditure are likely to be felt by a number of local businesses. As there are only a small number of businesses on Lewis, the socio-economics in the area can be considered to be of medium sensitivity.

21.6.13 Therefore an impact of long term **moderate beneficial** significance is anticipated.

MITIGATION IN RELATION TO IMPACT 2
No mitigation required

Residual effect

21.6.14 No mitigation is required as the residual impact is expected to remain of moderate beneficial significance.

Impact 3: Indirect economic benefits (employment, accommodation and services)

21.6.15 The development will be among the first wave arrays in Scotland. Scottish Government (Marine Energy Group, 2009) figures state that marine renewables could support over 12,000 jobs and be worth £2.5 billion to the economy by 2020. This development is envisaged as one important step to achieving that goal.

21.6.16 A number of specific employment opportunities will be created by the project, including:

- Survey Work – Local employment for ornithological and marine mammal surveys;
- Local boats and crew are being used wherever possible and this will continue throughout the project; and
- It is possible that local construction firms will be employed in the construction of the onshore works for civil engineering works, ground works, building construction, road

construction, mechanical services, electrical services, utility providers, painting and decorating, joinery and carpentry.

21.6.17 Construction workers employed by the project will spend up to several years on Lewis, depending on the type of vessels used for installation. These workers will use local travel facilities (e.g. hire cars), accommodation, restaurants and shops. As a result, local spend will increase on a temporary basis. The project will continue to benefit the local economy through indirect spend on accommodation, food and sundries.

- Offshore construction workers employed by the project will spend up to 11 months in Phase 1, and over three years in Phase 2 on Lewis, depending on the type of vessels used for installation. Onshore construction workers will spend up to 17 months on Lewis. These workers will use local travel facilities (e.g. hire cars), accommodation, restaurants and shops. As a result, local spend will increase on a temporary basis. The project will continue to benefit the local economy through indirect spend on accommodation, food and sundries. Predictions cannot be made at this stage on what the exact spend in the local economy for this project will be. However, the spend on a 2.4MW Oyster project which is mid way through completion in Orkney in the first 12 months of the project starting is estimated at £100,000 on travel and £100,000 on accommodation and subsistence

- Provision of services to the construction teams at the 2.4MW Oyster Project in Orkney is estimated as worth approximately £200,000 to the local economy during the first year of the project.

- This provides an indication of the type of spend in the local economy associated with an Oyster project. It is important to note that this project was significantly smaller in size to the 40MW wave array project proposed for Lewis and therefore the spend in Lewis is likely to be higher than that spent on the smaller 2.4MW project in Orkney.

21.6.18 Accommodation is in short supply during the summer months and it is important that a short term increase in demand from construction workers does not damage the longer term demand for holiday accommodation. Consultation with the local tourist board will be important to ensure that this opportunity is maximised.

21.6.19 The socio-economic benefits arising from the development are likely to result in temporary detectable change in the socio-economics of the area and therefore this impact can be considered to be of medium magnitude.

21.6.20 As employment on Lewis is limited, the socio-economics can be described as being of medium sensitivity.

21.6.21 Therefore the increased employment opportunities and the increased local spend overall will be of **moderate beneficial** significance.

MITIGATION IN RELATION TO IMPACT 3
No mitigation required

Residual effect

21.6.22 As no mitigation is required, impacts will remain of **moderate beneficial** significance in the short term.

Potential effects during operational phase (including maintenance)

Impact 1: Effects on employment

21.6.23 During operation it is likely that there would be between three and five full time members of the Lewis Wave Power team based in Lewis, with further technical staff travelling to site for short visits as required.

21.6.24 There will be employment opportunities associated with maintenance of the array components, both on and offshore. In some cases local contractors may be employed to undertake non-specialist works. This is not likely to alter the baseline condition dramatically (and therefore magnitude of pressure is low), however, given that there is limited employment in the area and the extra employment will be quantifiable the receptor can be considered to be of medium sensitivity.

21.6.25 As such, the impact on employment will be long term and of **minor beneficial** significance.

MITIGATION IN RELATION TO IMPACT 1
No mitigation is required

Residual effect

21.6.26 No mitigation is required as it is predicted that any long term benefits for employment will be of **minor beneficial** impact.

Impact 2: Community benefits

21.6.27 Lewis Wave Power will seek to involve local businesses when possible to maximise the potential benefits to the local community. This is not likely to alter the baseline condition dramatically (and therefore magnitude of pressure is low), however, given that the support to the local community will be quantifiable the receptor can be considered to be of medium sensitivity.

21.6.28 The energy supplied by the project is likely to exceed the demand required and some will therefore be exported.

21.6.29 Consequently, the significance of impact of community benefits is assessed to be long term **minor beneficial**.

MITIGATION IN RELATION TO IMPACT 2
No mitigation is required

Residual effect

21.6.30 No mitigation is required as it is predicted that long term community benefits will be of **minor beneficial** significant effect.

Potential effects during decommissioning

21.6.31 During decommissioning there will be similar impacts to those outlined during the construction phase, albeit on a smaller scale (as some infrastructure is likely to be left in situ and therefore less work will be required). The decommissioning work is expected to have a minor positive effect on socio-economic and local community condition.

Cumulative effects

21.6.32 Other developments which Lewis Wave Power is aware of include Stornoway Wind Farm by Lewis Wind Power and the consented 4MW Voith Hydro WaveGen project at Siadar and the Pelamis Wave Power project at Bernera. The construction periods are likely to be different for each project and therefore a cumulative impact is not expected.

21.6.33 During the operational phase of the Lewis Wave Array beneficial cumulative impacts may be experienced. If all the projects noted above are built there will be opportunities for employment and other community benefits.

21.6.34 Consequently, the cumulative impact on socio-economics and local communities will be of long term minor beneficial.

21.7 Conclusions

21.7.1 The development of the wave array will bring with it **minor to moderate beneficial** socio-economic benefits. A small number of local jobs may be created along with a temporary increase in spend on local services during the construction and operation of the project. There will also be ongoing spend on local services associated with operation and maintenance.

21.7.2 The energy supplied by the project is likely to exceed the demand required and some will therefore be exported.

22. TOURISM AND RECREATION

22.1 Introduction

22.1.1 This chapter provides information on tourism and recreational activities within the immediate vicinity of the development and across the wider area including the Isle of Lewis and other Western Isles.

22.1.2 The potential effects of the development on these existing activities and conditions are then assessed in terms of their significance during construction operation and decommissioning phases. Where required, mitigation measures are proposed in order to avoid or minimise any adverse effects.

22.1.3 This Chapter of the Environmental Statement (ES) should be read in conjunction with Chapter 21 Socio-economics / local community and Chapter 14 Seascape, landscape and visual impact, Chapter 15 Shipping and navigation and Chapter 17 Traffic and transport as all three are inherently linked.

22.2 Summary of assessment

22.2.1 Tourism and recreation are vitally important to the economy of the Western Isles. The development is not expected to have any significant long term adverse effect on existing marine and coastal activities, or on visitor numbers or visitor experiences. Adverse impacts are most likely to occur during the construction phase of the development; however these have been assessed as negligible and are therefore unlikely to cause a noticeable impact on tourism and recreation.

22.2.2 The development will create a new point of interest for visitors to Lewis and the Western Isles in general, increasing the islands' profile for renewable energy. This may have minor beneficial impacts on tourism and recreation during operation which in turn may benefit the local community.

22.3 Potential impacts

22.3.1 The development will introduce a new visual aspect to the local area around Siadar which has the potential to affect visitors' perceptions and enjoyment of an area. The landscape, seascape and views around the Siadar coastline are intrinsic to the areas' ability to attract tourists and visitors.

22.3.2 During construction and decommissioning, vessels and Oyster Wave Energy Convertors (WECs) will be moored within Loch Roag (approximately 23km south of the development site) which may affect tourism and recreation activities within the Loch. A separate application will be made for a licence to conduct mooring operations within Loch Roag.

22.3.3 During installation of the wave array, access issues could arise where onshore movements of heavy construction plant may cause temporary congestion on narrow roads in particular the A857. In the interests of efficiency and safety, installation activities may involve some restriction of public access to both marine and terrestrial areas where construction is underway. Depending on location, this could have the potential to affect sailing, water sports, wildlife watching and visits to sites of cultural heritage.

22.3.4 Visitors and local residents may also be disturbed whilst participating in recreational activities (e.g. walking, wildlife watching, sailing, kayaking, etc.) as a result of the noise generated during construction works.

22.3.5 There is potential for the project to have a positive effect on tourism by becoming a point of interest to tourists. With increased awareness of climate change and the opportunities for gaining first-hand experience of the evolution of new technologies, the attraction of marine devices could be potentially strong in the short-term from both a professional and tourist visitor alike.

22.4 Methodology

22.4.1 This assessment follows the latest, guidance on Environmental Impact Assessment (EIA) (Including EMEC and Xodus Group *in press* and IEMA, 2006), as appropriate, and draws on experience from recent examples of similar renewable energy projects in the UK and Europe. A baseline for tourism and recreation was established through a desk based review and an impact assessment was then conducted to predict the potential impacts of the development on that baseline environment.

22.4.2 The impact assessments use a "Rochdale Envelope approach" (See *Chapter 2 Scoping and assessment methodology*) where any uncertainty regarding aspects of the project description leads to the use of a range of values to create "an envelope" or uses the realistic worst case scenario to assess each impact.

Legislation, Guidelines and Policy Framework

22.4.3 Under the EIA Regulations an EIA should include a 'description of the likely significant effect… of the proposed development on human beings, the landscape and the interaction of these with each other and wildlife, the air, soils and climate'

22.4.4 The Countryside (Scotland) Act 1967 along with the 1991 Natural Heritage (Scotland) Act, establishes SNH with responsibilities for facilitating the enjoyment of natural heritage (SNH, 2009). The Marine (Scotland) Act (2010), Part Three, makes provision for the development of marine planning at a regional and national level, which may see relevant changes introduced in respect of the use of sea areas.

22.4.5 Guidance to help developers with consenting, EIA and Habitats Regulations Appraisal (HRA) for marine renewable energy developments in Scotland is currently being developed (EMEC and Xodus, *in press*). This guidance addresses tourism and recreation within a section entitled "Other Sea and Land users".

22.4.6 Statements of Scottish Government policy in the National Planning Framework (NPF), the consolidated Scottish Planning Policy (SPP) (including 'Open space and recreation') and Scottish Government Circulars all provide material considerations to be taken into account in development plans and development management decisions. Scottish Government policy recognises that the coast of Scotland is a major focus for economic activity, recreation and tourism, and that the sustainable development of coastal areas is an important contributor to sustainable economic growth.

Defining the study area

22.4.7 In order to establish a baseline for tourism and recreation three study areas have been established which are displayed in Figure 22.1. The first includes the Western Isles and is termed the Regional Study Area (RSA) the second considers Lewis and is termed the Wider Study Area (WSA) and the third considers the coastal environment of north-west Lewis from Cárlabhagh (Carloway) in the southwest to Rubha Robhanais (the Butt of Lewis) in the northeast and is termed the Local Study Area (LSA).

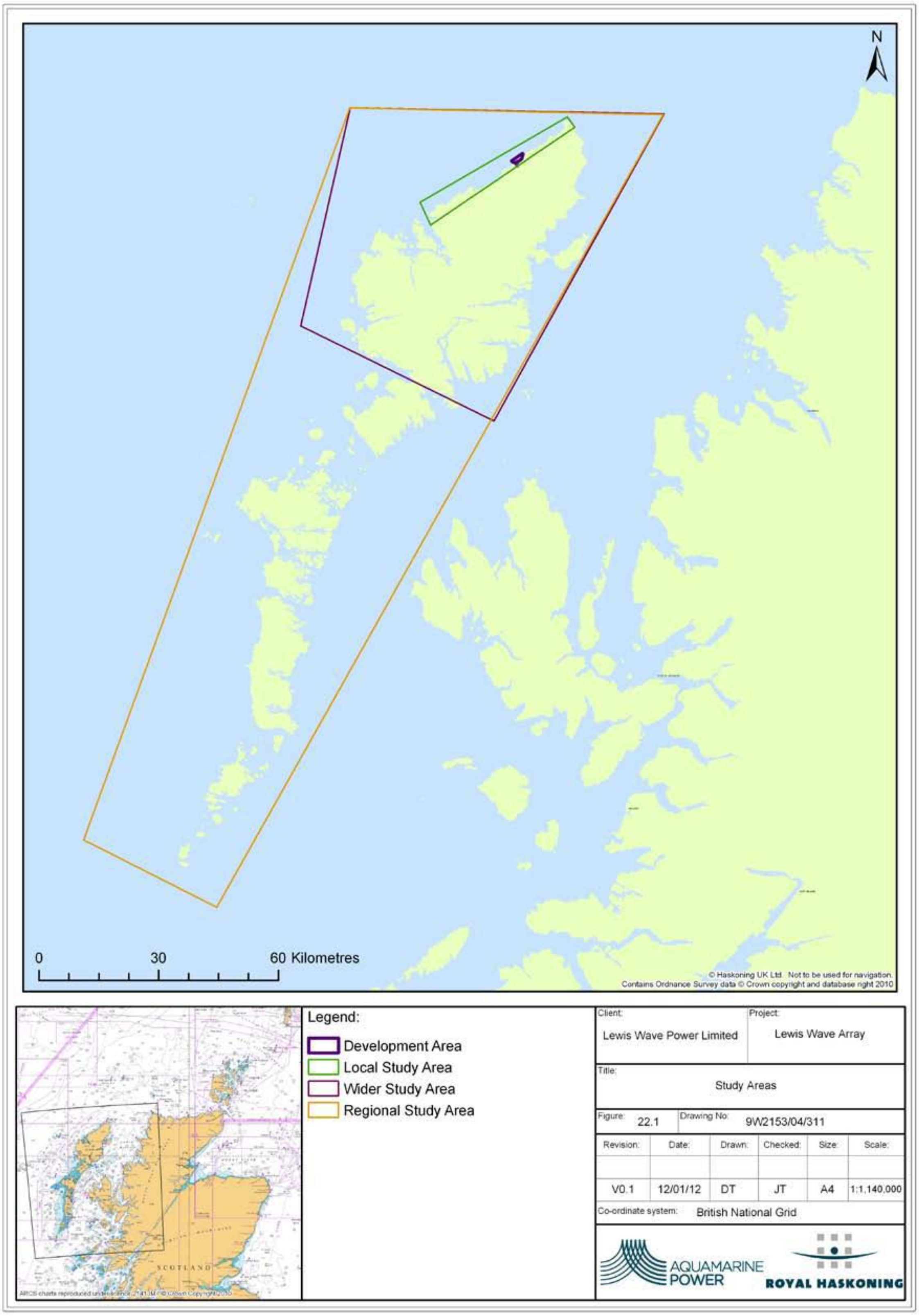

Figure 22.1 Tourism and Recreation Study areas.

Consultation

22.4.8 A Scoping Opinion was sought from both statutory and non-statutory consultees (Lewis Wave Power, 2011) in May 2011. Responses are detailed in Appendix 2.1, and a short summary of the main points pertinent to tourism and recreation during this process, along with an explanation of how they were addressed, is provided below (Table 22.1).

Table 22.1 Comments & information raised in the scoping opinion (Marine Scotland 2011)

Comments & information	Response
The Scottish Canoe Association (SCA) identified the need to address whether kayakers/canoeists transiting the proposed development site would need to navigate around the seaward side of the array or whether they would be able to pass inshore of the array.	The Navigational Risk Assessment concludes that canoeists can transit the site inshore or offshore of the array as required (Appendix 15.1).
Surfers against Sewage raised the potential for adverse effects on the surfing industry or adverse effects on the surf resource.	This opinion was formulated based on the scoping report (Lewis Wave Power, 2011) where the "Area of search" overlapped with known surf spots. The proposed development site has since been greatly reduced in size and no longer overlaps with any known surf hotspots. During consultation with the Outer Hebrides Surfing Association (OHSA) held on the 13th of September 2011 the OHSA confirmed that the proposed development area is not an area of interest to surfers.
The Royal Society for the Protection of Birds (RSPB) had concerns regarding impacts to birds and other wildlife particularly as a result of pile driving operations during construction.	As the construction plan for the proposed development has progressed it has been established that no pile driving activities will be necessary as piles will be drilled and then grouted in place (*Chapter 5 Project description*). Impacts to wildlife are addressed in Chapters 10, 11, 12 and 13.
The Royal Yachting Association (RYA) raised the issue of recreational boating activity and the proper marking of the array site.	This opinion was formulated based on the scoping report (Lewis Wave Power, 2011) where the "Area of search" overlapped with RYA sailing routes. The proposed development site has since been greatly reduced in size and no longer overlaps with any known sailing routes. Based on the RYA published data, the development does not fall within any Racing or Sailing Areas. Should sailing vessels approach the area they will need to navigate around the proposed development site. The site has been the subject of a full NRA and will be appropriately marked (Appendix 15.1).

Data collection

22.4.9 A desk-based assessment has been carried out to establish a baseline for tourism and recreation within the three scales of study area using information drawn from publicly available literature and data.

22.4.10 The principal data sources relevant to tourism and recreation are shown below in Table 22.2.

Table 22.2 Existing data sources		
Data source	**Coverage**	**Reference**
Office for National Statistics	UK	www.statistics.gov.uk
Visit Scotland Research Statistics	Scotland	www.visitscotland.org
Outer Hebrides Tourist Association	Outer Hebrides	www.hebridean-tourism.org/
Explore Scotland Website	Scotland	www.explorescotland.net

Assessment of significance

22.4.11 The significance of the effect imposed by the development is based on the intensity or degree of disturbance to baseline conditions and is categorised into four levels of magnitude, high, medium, low or negligible. The definitions of each of these are given in Table 22.3.

Table 22.3: Criteria for assessing the magnitude of effects on tourism and recreation Assets	
Magnitude of Effect	**Definition**
High	A fundamental change to the baseline condition of tourism and/or recreation.
Medium	A clear change resulting in the non-fundamental temporary or permanent condition of tourism and/or recreation
Low	A minor change to the baseline condition of tourism and/or recreation (or a change that is temporary in nature).
Negligible	An imperceptible and/or no change to the baseline condition of tourism and/or recreation.

22.4.12 The sensitivity/value/importance of the receptor for each effect is characterised as one of four levels, high, medium, low or negligible. The definition of each level is given below in Table 22.4.

Table 22.4 : Sensitivity of tourism and recreation features	
Receptor Sensitivity/Value	**Site designations**
High	Environment is subject to major change(s) due to impact. For example the loss of an attribute(s) in its entirety or significant loss of the quality or integrity of an attribute(s) which would have a long term or lasting, damaging effects on the tourist industry and recreation. This would imply a substantial reduction in the number of people participating in an activity and have resultant effects on local business.
Medium	Environment clearly responds to effect(s) in quantifiable and/or qualitative manner. For example the loss of part of an attribute(s) or loss of the quality or integrity of an attribute(s) which would have an effect on the tourist industry and recreation. This would imply a reduction in the number of people participating in an activity and resultant effects on local

	business.
Low	Environment responds in minimal way to effects so that only minor change(s) are detectable. For example a slight change to an attribute(s) or the quality or integrity of an attribute(s). Theses impacts are normally temporary or reversible and are unlikely to have effects on local businesses.
Negligible	Environment responds in minimal way to effect such that only negligible change(s) occur which may or may not be detectable, or no changes result at all.

22.4.13 Table 22.5 combines the definitions of magnitude with the level of sensitivity/value/importance of receptor to provide a prediction of overall significance of the effect. The red coloured squares correspond to those impacts which may be considered to be significant within the EIA.

Table 22.5 Significance prediction matrix.

Magnitude of effect	Receptor sensitivity/value			
	Negligible	Low	Medium	High
High	Negligible	Moderate	Major	Major
Medium	Negligible	Minor	Moderate	Major
Low	Negligible	Negligible	Minor	Moderate
Negligible	Negligible	Negligible	Negligible	Minor

22.5 Existing environment

22.5.1 The rugged coastline, sandy beaches and remoteness of the Western Isles are features that attract visitors to the area (Dunbar *et. al.,* 1997). According to the Outer Hebrides Tourism Update, visitors to the Western Isles grew from 180,000 in 2002 to 196,000 in 2006 (+ 8.9%). Tourism is an increasingly important industry in the Western Isles, and tourism related sectors contribute approximately 10% of its employment. In 2010 it was estimated that UK residents made around 100,000 trips to the Western Isles, staying 640,000 nights and spending £33million. It was also estimated that overseas visitors to the islands of Scotland (including the Western Isles) made around 200,000 trips, staying for 680,000 nights and spending £44m (Visit Scotland, 2011).

22.5.2 Tourism in Lewis is dominated by outdoor activities including cycling, hiking, mountaineering, angling, surfing, wildlife watching, golf and the visiting of ancient monuments, archaeological sites, heritage sites and sites of Gaelic culture (Dunbar *et. al.*, 1997).

22.5.3 Visitor numbers for the top Western Isles tourist attractions during 2010 calculated by Visit Scotland are presented in Table 22.6. Four of the top five attractions are located on Lewis (and therefore within the WSA) and three of the top five are located on the north-west coast of Lewis (and therefore within the LSA).

Table 22.6 visitor numbers to the top tourist attractions in the Outer Hebrides. Data source visit Scotland.

Attraction	Number of visits in 2010
An Lanntair, Stornoway	218,344
Calanais Visitor Centre, Calanais	33,328
Taigh Chearsabhagh Museum Arts Centre, North Uist	30,158

Table 22.6 visitor numbers to the top tourist attractions in the Outer Hebrides. Data source visit Scotland.	
Attraction	**Number of visits in 2010**
Garenin Blackhouse Village, Carloway	19,384
Black House Arnol, Bragar	13,442

22.5.4 The Na Gearrannan Blackhouse village which was the fourth most visited attraction in the Western Isles (Table 22.6) is located approximately 23km south-west of the proposed development site (Figure 22.2). The Arnol Blackhouse, which is the fifth most visited tourist attraction in the Western Isles, is located approximately 9.5km south west of the development.

22.5.5 Other top tourist attractions within the LSA, include and the standing stones at Calanais (Callanish) located approximately 26km south-west of the development site, Rubha Robhanais (the Butt of Lewis) located 12km north of the development site, and the Cárlabhaigh (Dun Carloway) Broch located 22km south-west of the development site (Figure 22.2).

22.5.6 There are no recognised tourist designations within the development site.

Local study area

Cultural heritage sites

22.5.7 This section of the chapter should be read in conjunction with *Chapter 18 Archaeology and cultural heritage* where further detail on the cultural heritage sites is provided.

22.5.8 Within the vicinity of the development site there are a number of cultural heritage sites that are of potential interest to local visitors and tourists. The largest standing stone in Scotland the Clach an Truseil (Clach an Trushal) is located approximately 2km south-west of the development to the south of Siadar. A chambered cairn and Steinacleit are located next to Loch an Duin, approximately 1.5km south of the development.

22.5.9 Other popular cultural heritage sites on the north-west coast of Lewis include: The Dun Mara Iron Age fort and the St. Moluag's Church both located more than 10km north of the proposed development. The Ness Heritage Centre in the village of Tabost (Harbost), the Harbour View Gallery and the 10 Callicvol (which is a collection of books, maps, documents and photographs relating to the Highland, Island and Border areas of Scotland) all located in the far north of Lewis are also visited for the local art collections (www.isle-of-lewis.com).

Local craft

22.5.10 The Morvern Gallery (approximately 5km south of the proposed development site) features a variety of local craft and a café and the Borgh Pottery at Bhuirgh (Borve), 1km north-east of the development site sells hand-made ceramics.

Walking

22.5.11 Among the walks that Lewis can offer, there is a western coastal walk from Na Gearrannan (Garenin) to Dhail Bearg (Dalbeg) both of which are some distance to the south of the proposed development site (Figure 22.2). The walk follows the coastline through moorland, croftland and onto sandy beaches. There are no designated paths through the proposed development site; there is however a rough path that follows the coast from Siadar Bay to the south of the proposed development site which is used by locals. The path peters out before reaching the proposed development site where access is made difficult by fences that reach down to the cliff top.

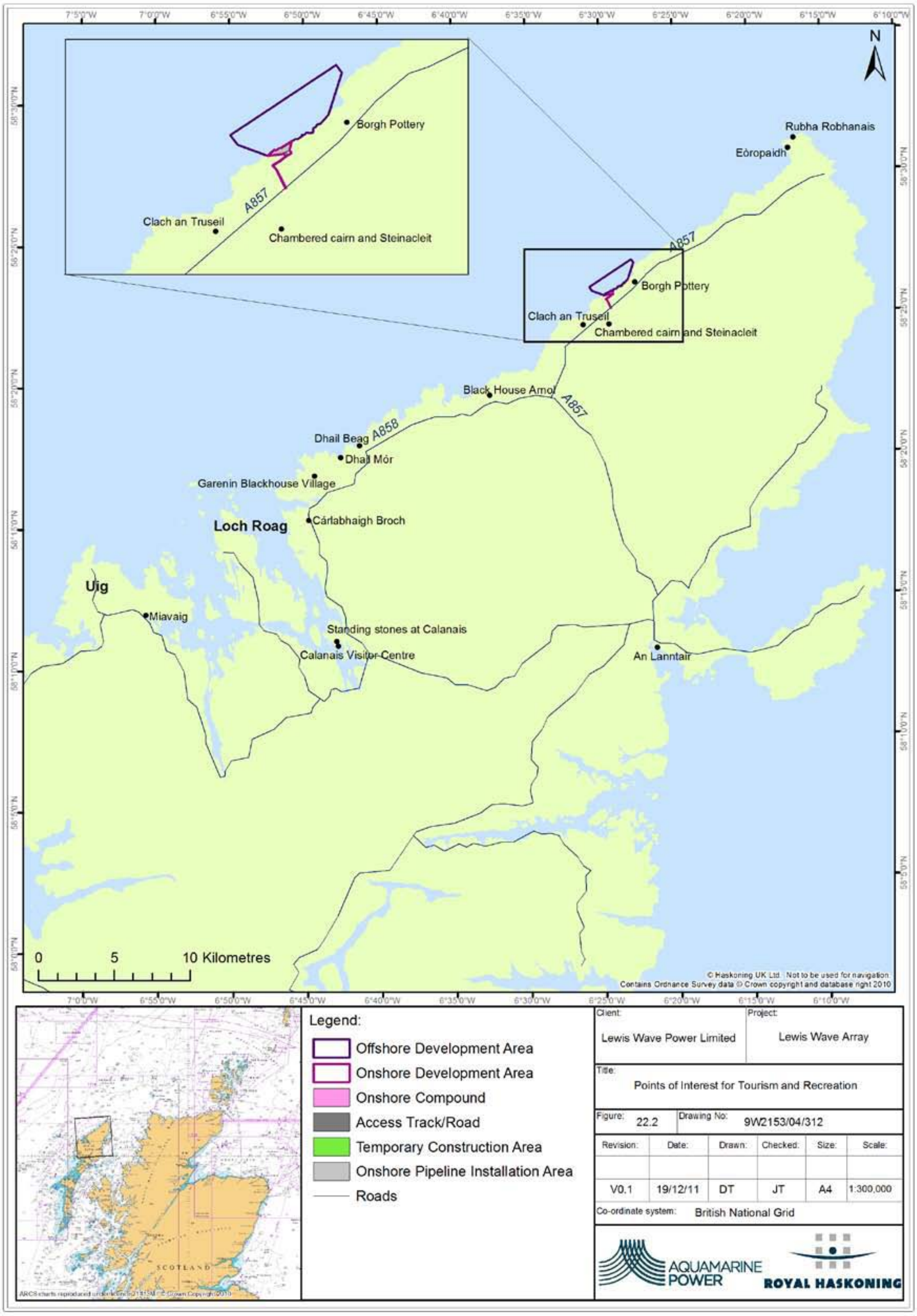

Figure 22.2 Points of interest for tourism and recreation

Wildlife

22.5.12 The fringe of the west coast of Lewis has numerous sandy beaches, and much of the island is made up of peat bog, the favoured habitat of a variety of rare breeding birds which are an attraction to bird watching enthusiasts. Rubha Robhanais (the Butt of Lewis) at the northerly tip of the island (Figure 22.2), is home to many seabirds, and is known location for watching whales, dolphins and porpoises. Wildlife watching tours are provided in the form of boat trips run by a company called Seatrek that operate around the Loch Roag, the Uig coast and beyond.

Surfing

22.5.13 The west coasts of the Western Isles experiences the full impact of the North Atlantic swells and has some of the most consistent surf in Europe. Several surfing sites are located along the north-west coast of Lewis. The Stormrider Guide Europe – Atlantic Islands (2007) indicates that there are three breaks within the LSA; located at Dhail Mór (Dailmore) approximately 19km south-west of the development (Figure 22.2), Dhail Beag (Dailbeag) approximately 18km south-west of the development and Eòropaidh approximately 12km to the north of the proposed development (Figure 22.2). Consultation with the Outer Hebrides Surfing Association (OHSA) has revealed that surfing activity is also known to occur at Borve located just to the north of the development and local surfers are known to occasionally use breaks on the south of Siadar Bay located just to the south of the development. No surfers have been observed within the development site during the marine mammal and bird surveys that have been conducted for the current project between September 2010 and November 2011 (For further information on the marine mammal surveys see *Chapter 11 Marine mammals and basking shark*), though surfers have been observed at Bragar bay, east of Labost. In addition the OHSA have confirmed that the development site is not suitable for surfing.

22.5.14 Surf Lewis and Hebridean Surf are two companies based in Stornoway that offer surfing lessons and surfing equipment hire. The beaches that Surf Lewis use most frequently on the west coast are Eoropaidh, Dalmore and Cealagbhal (Port Ness) located at the top of the north east coast.

22.5.15 The coastline is not specifically designated bathing water under the Bathing Water Directive 2006/7/EC. During wildlife observation surveys, three swimmers were observed in the sea approximately 1km south of the mouth of Abhainn Bhuirgh at Mealabost.

Sailing

22.5.16 Due to its position on the Atlantic the north-west coast of Lewis is an exposed area in which to sail and for that reason it is generally only attempted by more experienced sailors. With very few sheltered anchorages and limited places to shelter from prevailing south westerly winds the area is not ideally suited to small or less seaworthy vessels. In contrast, Loch Roag, located approximately 23km south of the development, provides numerous anchorages that are relatively sheltered even in storm conditions, with pontoons provided at Miavaig which are available to sailing boats (www.visithebrides.com). There is an identified RYA sailing route west of the Hebrides, which transits the length of the LSA and there are also two routes that join this route from Loch Roag (Harrald and Davies, 2010) all of which experience light recreational use.

Kayaking

22.5.17 Wilderness tours offer sea kayaking trips for experienced sea kayakers that make use of Loch Roag[1]. These trips do not venture as far north as the development site as the stretch of coastline is very exposed and often experiences extreme wave conditions. For these reasons it is not expected that the development site is used often by sea kayakers and none were observed during the marine mammal surveys that have been conducted for the project from September 2010 to February 2011.

Diving

22.5.18 Rubha Robhanais (the Butt of Lewis) which is the northern most point of Lewis and is located approximately 17km north of the development (Figure 22.2) is the location for spectacular scenic diving. There are lots of rocky reefs, inlets and coves many of which are still to be discovered[2] . No dive boats have been seen within the development site during the marine mammal surveys and it is not thought that any recreational diving currently takes place within the development site. There are recorded dive sites within Loch Roag, approximately 23km to the south of the development (Figure 22.2); however these are not thought to experience high levels of activity.

Fishing

22.5.19 Locally, the Carloway Angling Club offers a variety of fishing on the River Carloway and associated lochs, while the Barvas Estate offers salmon fishing. Trout fishing in North Lewis lochs is also very popular with many lochs offering inexpensive high quality trout fishing. No lochs or salmon rivers are present within the development site shown in (*Chapter 5 project description*). Loch Roag will be used for storage of vessels and WECs during the construction phase and this may have some interaction with recreational fishing interests within the Loch. If appropriate an assessment of the impacts of these associated activities will be undertaken as part of a separate application for a license to moor vessels and WECs within the loch (for more information please refer to Chapter 5 *Project Description*).

Accommodation

22.5.20 Accommodation within the vicinity of the development includes the Borve Country House Hotel located approximately 1.5km east of the development on the eastern side of Borve and the White House Bed and Breakfast located approximately 1.3km south of the proposed development.

22.6 Impact assessment

22.6.1 This section of the ES chapter assesses the possible impacts of the development on tourism and recreation during construction, operation and decommissioning.

Do nothing scenario

22.6.2 If the development is not realised, it is likely that the existing environment with regard to tourism and recreation would continue as described in Section 22.5 Existing environment above. The rising trend in visitor numbers to the Western Isles is expected to continue as more UK residents holiday in the UK rather than traveling abroad due to the global economic

[1] www.wildernessscotland.com/adventures_itinerary.php?tripID=151

[2] http://www.gooddive.com/uk-diving/isle-of-north-uist-diving.htm.

downturn. This may be offset to an extent by a drop in foreign visitors also due to the global economic downturn.

Potential impacts during construction

Impact 1: Disturbance to tourism and recreational activity

22.6.3 The waters off the north-west coast of Lewis are very exposed and subject to both large waves and high winds. In addition there are limited safe harbours and anchorages for recreational vessels. The development site is not used regularly by recreational vessels. An RYA sailing route of light use is located offshore of the development site at a distance of approximately 2km, however, this is unlikely to be affected by the development.

22.6.4 Airborne noise generated during the installation of the marine devices and associated infrastructure will potentially have direct and indirect effects on recreation and tourism, although the effects will only be short term and limited to a small area. The main sources of construction noise will include:

- Vessel movements;
- Movement of machinery/device components;
- Installation of machinery/device components; and
- Installation of onshore infrastructure e.g. the hydro electric power station.

22.6.5 The main direct effects of installation noise will be related to general disturbance that will be experienced by visitors to the coast within the immediate vicinity of the development site. However this area lacks beaches and easily accessible shoreline and has not been identified as experiencing high coastal and marine recreational activities. The Installation noise may have limited but adverse effects on marine wildlife and seabirds. For an in-depth assessment of this topic, see *Chapter 10 Ornithology* and *Chapter 11 Marine mammals and basking shark*. This could potentially have an indirect small effect on those wishing to observe marine wildlife and on bird watchers.

22.6.6 Disturbance will be short-lived and given that no particularly noisy works are to be undertaken, effects will be confined to small areas around works site and along the access track (See *Chapter 5: Project description*), areas not specifically identified as wildlife watching locations.

22.6.7 During the consultation process the Scottish Canoeing Association raised the question of whether sea kayakers/canoeists transiting the wave array site would be able to pass inshore of the Oyster devices or whether they would be forced to navigate around the seaward side of the array. The Navigational Risk Safety Assessment completed as part of the project has concluded that sea kayakers and canoeists will be able to transit the proposed development site passing either inshore or offshore of the development (Appendix 15.1).

22.6.8 Following consultation with OHSA it has been established that the development site does not provide suitable conditions for surfing and it is not thought that the development will affect current known surfing activities.

22.6.9 Existing recreational activity at the development site has been identified as being very minimal compared with that of Loch Roag located approximately 23km to the south of the development site. As part of the development vessels and WECs will be moored within the Loch and an assessment of the impacts to tourism and recreation will be carried out as part of a separate application (See *Chapter 5 project description*).

22.6.10 There may be short term, occasional disruption to tourists and visitors travelling along the A857 to tourist attractions and sites for recreation north of Siadar. An impact assessment and mitigation for this disruption is provided in *Chapter 17 Transport and traffic,* which anticipates that with appropriate consultation and mitigation, the impact of construction traffic will be reduced to be not significant in EIA terms. As this is a lifeline road link for the north of the island, a Traffic Statement will be completed once construction activities are confirmed, and this will inform the Traffic Management Plan will be implemented prior to and during construction to maintain access and minimise disruptions to tourists visiting north Lewis's attractions, such as those listed in Section 22.5. The Traffic Management Plan will also take account of large events on Lewis.

22.6.11 Access to the fields and to the coastal areas surrounding the development site will be maintained throughout all phases of the development. The only restrictions will be within the development boundary area shown in *Chapter 5 Project description* (Figure 5.2), which for health and safety reasons will be inaccessible to the public. However, this will not restrict access to any recreational activities.

22.6.12 The Lewis, and in particular, the north-west coast of Lewis, boast a relatively undisturbed natural environment. The wildness and landscape character brings many visitors to the area and is a driving factor for the tourism and recreation industry which also provides socioeconomic benefits (see *Chapter 21 Socio-economics and local community* for further details). The development offshore will be relatively unobtrusive and rarely seen from the onshore and marine tourist routes and areas. Onshore the structures will be kept as unobtrusive as possible.. Given the sensitivity of tourism and recreation has been assessed as low.

22.6.13 It is not anticipated that that a significant number of tourists or potential visitors will be deterred from travelling to any of the study areas as a result of the development and as any impacts at the array site will be limited in scale (both temporal and spatial) the magnitude of this impact at the wave array site will be low.

22.6.14 In accordance with Table 22.5 the impact of disturbance to tourism and recreational activity is considered to be of **negligible** significance.

MITIGATION IN RELATION TO IMPACT 1
The installation will be designed to minimise unnecessary noise. The development will undertake appropriate traffic management measures (see Chapter 17: Traffic and Transport) and associated mitigation, with consideration given to public events on Lewis. To minimise displacement of tourism activities during construction activities the following safety procedures will be implemented: • Notice of the activities would be promulgated through the UKHO Maritime Safety Information system (i.e. Notices to Mariners (NMs) and Radio Navigational Warnings (NavWarns/WZs)) and will occur just prior to and during the maintenance works • Installation vessels will comply with the COLREGS in that they would display the appropriate lights and marks for vessels engaged in such activities • Presence on site of manned vessels capable of monitoring and advising the other marine traffic using the area,

Residual effect

22.6.15 Assuming mitigation is in place, disturbance of recreational activity will be of **negligible** significance.

Impact 2: Displacement of tourism and recreational activity

22.6.16 In the interests of efficiency and safety, installation activities will involve some restriction of public access to areas where construction is underway. This may displace a very small amount of coastal activities such as walking and wildlife watching from around the development site.

22.6.17 Recreational angling vessels will also be restricted in their access to the development site or areas around installation vessels during construction for health and safety reasons (See *Chapter 15 Shipping and navigation* for more details).

22.6.18 Any disruption to traffic along the A857 may inconvenience tourists accessing the north of the island and its associated tourist attractions, including those detailed in Section 22.5. A full assessment of impacts on road users and the associated mitigation measures are provided in *Chapter 17 Transport and traffic*.

22.6.19 All of the above effects will be temporary in nature and are only expected to create minor changes to the baseline conditions. Consequently the magnitude of this impact will be at worst **low**.

22.6.20 Existing activity within the direct footprint of the array and of the onshore works is very limited and it is not expected that construction will entirely prevent any activity from taking place, but rather, displace it temporarily. For example, recreational vessels will still be able to transit the north-west coast of Lewis, but may need to set a slightly different course. Displacement will only last for the duration of works and sensitivity of the receptor is considered to be low. As a result of these short term temporary effects the impact is considered to be of **negligible** significance.

MITIGATION IN RELATION TO IMPACT 2
Appropriate mitigation measures are proposed in *Chapter 17 Traffic and transport* and within the Navigation Safety Risk Assessment. (Appendix 15) No specific mitigation measures are proposed to minimise impact upon the tourist industry.

Residual effect

22.6.21 If the above mitigation is implemented it is likely that residual impact of displaced tourism and recreation will remain of **negligible** significance..

<u>Potential impacts during operation (including maintenance)</u>

Impact 1: Creation of a point of interest for visitors

22.6.22 There is potential that the array could have positive effect on tourism and recreation by becoming a minor visitor attraction. This has been noted from other similar installations such as SeaGen in Strangford Lough (Northern Ireland). With increased awareness of climate change and the opportunities for gaining first-hand experience of the evolution of new technologies, the attraction of marine devices could result in some additional visitors (both renewable energy professionals and tourists) being drawn to view the development. Interest may decrease as wave and tidal power become more commonplace.

22.6.23 As the first large wave array in the Scotland, the development will be subject to significant press coverage and the profile of Lewis is expected to benefit from being broadcast widely among many organisations within and beyond the UK.

22.6.24 As the devices will not be clearly visible to land-based observers, the level of attraction will depend on the provision of good quality interpretative materials in the vicinity of the site. The project's role as a tourist attraction will be of a **low** magnitude and the receptor (tourism and recreation) of a **low** sensitivity resulting the impact being of **negligible or minor positive** significance.

ENHANCEMENT IN RELATION TO IMPACT 1
No specific mitigation measure is proposed

Residual effect

22.6.25 The impact of creating a point of interest for visitors will remain as negligible or **minor beneficial** effect.

Impact 2: Disturbance of tourism and recreational activity

22.6.26 Operation of the development is not expected to impede tourists travelling across Lewis or activities in the vicinity of the development site. In addition the vessels and WECs located in Loch Roag during the construction period will have been removed and only occasional operation and maintenance vessel activity will remain. Therefore the magnitude of this impact will be within the low category and the sensitivity of the receptor will also be low. Therefore in accordance with Table 22.5 the impact of tourism and recreation activity during operation will be on **negligible** significance.

MITIGATION IN RELATION TO IMPACT 1
The Oyster wave array will be appropriately buoyed and charted as an underwater obstruction and annotated, as discussed further in the Navigational Safety Risk Assessment (Appendix 15.1). No additional specific mitigation is proposed.

Residual effect

22.6.27 The residual impact on the disturbance to recreational activities once the wave array is operational will be of **negligible** significance.

Potential impacts during decommissioning

22.6.28 During decommissioning there will be similar impacts to those outlined during the construction phase, albeit on a smaller scale. The decommissioned project is expected to have no significant effect on tourism, recreation or socio-economic conditions following adherence to Traffic Management Plans and Navigational Safety Risk Assessments.

Cumulative impacts

22.6.29 At the time of writing two other wave energy developments are being considered within the vicinity of the Lewis wave array. These are the consented 4MW Siadar wave energy project proposed by Voith Hydro WaveGen and the Bernera Wave Farm proposed by Pelamis Wave Power. If all three (including the Lewis Wave Power development) of these projects are built then Lewis would become an area of attraction for people interested in wave power technology and renewables. This may lead to an increase in visitor numbers to the Island and therefore a **minor beneficial** cumulative impact may occur.

22.6.30 Due to the distance between the Lewis Wave Power site and the Pelamis Wave Power site (approximately 25km) it is unlikely that these two developments would interact to produce adverse cumulative impacts on tourism and recreation. The Lewis Wave Power site may act cumulatively with the Voith Hydro WaveGen site at Siadar to produce minor adverse impacts on tourism and recreation if construction times overlap as they are in close proximity to one another.

22.7 Conclusions

22.7.1 Tourism and recreation on Lewis are closely linked as many tourists visit the area to partake in outdoor recreational activities such as walking, kayaking, sailing, surfing and visiting of ancient monuments. The development site currently provides very little opportunity for tourism and recreational activities and as a result the greatest impacts on tourism and recreation are predicted to be of negligible.

22.7.2 The development will create a new point of interest for Lewis, increasing the islands' profile for new and innovative renewable energy which could potentially have impacts of minor beneficial significance to tourism and the local community. The benefits will be further enhanced with the development of the two other wave energy projects currently being considered in the area.

23. SUMMARY OF IMPACTS, MITIGATION, GOOD PRACTICE AND MONITORING

23.1 Introduction

23.1.1 The purpose of this chapter is to provide a summary of impacts mitigation, good practice, monitoring and management measures proposed within this Environmental Statement (ES).

23.1.2 Section 23.2 identifies all impacts assessed within the ES.

23.1.3 Section 23.3 lists the commitments made and summarises the mitigation measures proposed by Lewis Wave Power throughout the ES.

23.1.4 Environmental monitoring requirements prior to installation and post installation are discussed in more detail in Section 23.4.

23.1.5 Management procedures are identified in Section 23.5.

23.2 Summary of impacts

23.2.1 Table 23.1 summaries each impact assessed within Chapters 7 to 22 of the ES and identifies the sensitivity of the receptor and the magnitude of any predicted effect.

Table 23.1 Summary of impacts for all receptors							
Chapter no.	**Chapter title**	**Phase**	**Potential Impact**	**Magnitude**	**Sensitivity**	**Significance**	**Residual significance**
7	Physical environment and coastal processes	Construction	Impacts on hydrodynamic regime	negligible	negligible	negligible	negligible
7	Physical environment and coastal processes	Construction	Impacts on sediments and sedimentary structures	negligible	negligible	negligible	negligible
7	Physical environment and coastal processes	Construction	Impacts on geological and geomorphological formations	minor	negligible	negligible	negligible
7	Physical environment and coastal processes	Operation	Impacts on hydrodynamic regime	minor - major	negligible	negligible	negligible
7	Physical environment and coastal processes	Operation	Impacts on sediments and sedimentary structures	minor	negligible	negligible	negligible
7	Physical environment and coastal processes	Operation	Impacts on geological and geomorphological formations	minor	negligible	negligible	negligible
7	Physical environment and coastal processes	Decommissioning	similar impacts to construction but less magnitude				
8	Soils, hydrology and Hydrogeology	Construction	Change in surface water runoff patterns	high	low	moderate	negligible
8	Soils, hydrology and Hydrogeology	Construction	Generation of turbid runoff or runoff containing suspended sediments	medium	low	minor	negligible
8	Soils, hydrology and Hydrogeology	Construction	Spills and leaks of oil, fuel and other potentially polluting substances	medium	low	minor	negligible

Table 23.1 Summary of impacts for all receptors							
Chapter no.	**Chapter title**	**Phase**	**Potential Impact**	**Magnitude**	**Sensitivity**	**Significance**	**Residual significance**
8	Soils, hydrology and Hydrogeology	Construction	Drainage and dewatering of peat	high	low	moderate	minor
8	Soils, hydrology and Hydrogeology	Construction	Peat slips	high	low	moderate	negligible
8	Soils, hydrology and Hydrogeology	Construction	Carbon loss	medium	low	minor	negligible
8	Soils, hydrology and Hydrogeology	Construction	Increase in pH of peatland	high	low	moderate	negligible
8	Soils, hydrology and Hydrogeology	Construction	Drilling fluids causing contamination of watercourses	medium	low	minor	negligible
8	Soils, hydrology and Hydrogeology	Operation	Flooding or surface ponding	medium	low	minor	minor beneficial
8	Soils, hydrology and Hydrogeology	Operation	Spills and leaks of oil, fuel and other potentially polluting substances	medium	low	minor	negligible
8	Soils, hydrology and Hydrogeology	Decommissioning	similar to construction				
9	Benthic ecology	Construction	Habitat loss	low	negligible	negligible	negligible
9	Benthic ecology	Construction	Increased suspended sediments / smothering	low	negligible	negligible	negligible
9	Benthic ecology	Construction	Risk of pollution incident during installation	low	low	negligible	negligible

Table 23.1 Summary of impacts for all receptors							
Chapter no.	Chapter title	Phase	Potential Impact	Magnitude	Sensitivity	Significance	Residual significance
9	Benthic ecology	Operation	Habitat alteration	medium	negligible	negligible	negligible
9	Benthic ecology	Operation	Impacts due to accidental pollution incident during operation	low	low	negligible	negligible
9	Benthic ecology	Decommissioning	similar to construction				
10	Ornithology	Construction	disturbance of terrestrial birds	low	low	negligible	negligible
10	Ornithology	Construction	disturbance of seabirds	negligible	negligible	negligible	negligible
10	Ornithology	Construction	habitat loss	low	low	negligible	negligible
10	Ornithology	Operation	disturbance of seabirds	negligible	negligible	negligible	negligible
10	Ornithology	Operation	collision and entrapment of diving seabirds	negligible	negligible	negligible	negligible
10	Ornithology	Operation	marine pollution and contamination	negligible	negligible	negligible	negligible
10	Ornithology	Decommissioning	Vessel disturbance	negligible	negligible	negligible	negligible
10	Ornithology	Decommissioning	habitat reinstatement	negligible	negligible	negligible	negligible
11	Marine mammals and basking sharks	Construction	Potential injury and disturbance caused by noise	negligible	high	minor	minor
11	Marine mammals and basking sharks	Construction	Collision risk with construction vessels	negligible	high	minor	minor

Table 23.1 Summary of impacts for all receptors							
Chapter no.	**Chapter title**	**Phase**	**Potential Impact**	**Magnitude**	**Sensitivity**	**Significance**	**Residual significance**
11	Marine mammals and basking sharks	Construction	Accidental release of contaminants	negligible	high	minor	minor
11	Marine mammals and basking sharks	Construction	Indirect impacts of changes to prey resource	negligible	high	minor	minor
11	Marine mammals and basking sharks	Operation	Potential disturbance caused by operational noise	negligible	high	minor	minor
11	Marine mammals and basking sharks	Operation	Collision risk with maintenance vessels and WECs	negligible	high	minor	minor
11	Marine mammals and basking sharks	Operation	Accidental release of contaminants	negligible	high	minor	minor
11	Marine mammals and basking sharks	Operation	Indirect impacts of changes to prey resource	negligible	high	minor	minor
11	Marine mammals and basking sharks	Decommissioning	similar to construction				
12	Fish and shellfish	Construction	Physical barrier to movement / interruption of known migratory routes.	negligible	low	negligible	negligible
12	Fish and shellfish	Construction	Substratum/benthic habitat loss	negligible	high	minor	minor
12	Fish and shellfish	Construction	Disturbance/injury as a result of noise, vibration.	low	low	negligible	negligible

Table 23.1 Summary of impacts for all receptors

Chapter no.	Chapter title	Phase	Potential Impact	Magnitude	Sensitivity	Significance	Residual significance
12	Fish and shellfish	Construction	Pollution from routine / accidental discharges.	negligible	low	negligible	negligible
12	Fish and shellfish	Construction	Changes in suspended sediment levels and turbidity.	negligible	low	negligible	negligible
12	Fish and shellfish	Construction	Displacement from/loss of spawning grounds.	low	negligible	negligible	negligible
12	Fish and shellfish	Construction	Displacement/loss of nursery and feeding grounds	negligible	low	negligible	negligible
12	Fish and shellfish	Operation	Barrier to movement / interruption of known migratory routes.	low	low	negligible	negligible
12	Fish and shellfish	Operation	Increase in substratum/benthic habitat	low	low	negligible	beneficial (minor)
12	Fish and shellfish	Operation	Disturbance/injury as a result of noise, vibration etc.	/	/	no impact	no impact
12	Fish and shellfish	Operation	Pollution from routine and accidental discharges.	negligible	low	negligible	negligible
12	Fish and shellfish	Operation	Changes in suspended sediment levels and turbidity.	/	/	no impact	no impact
12	Fish and shellfish	Operation	Displacement from/loss of spawning grounds.	low	negligible	negligible	negligible
12	Fish and shellfish	Operation	Displacement/loss of nursery and feeding grounds	negligible	low	negligible	negligible

Table 23.1 Summary of impacts for all receptors							
Chapter no.	**Chapter title**	**Phase**	**Potential Impact**	**Magnitude**	**Sensitivity**	**Significance**	**Residual significance**
12	Fish and shellfish	Operation	Collision risk	/	/	no impact	no impact
12	Fish and shellfish	Decommissioning	similar to construction				
13	Terrestrial and intertidal ecology	Construction	Permanent physical loss of important terrestrial habitats and species	low	medium -	minor	minor
13	Terrestrial and intertidal ecology	Construction	Temporary disturbance of important terrestrial habitats and species	low	medium	minor	minor
13	Terrestrial and intertidal ecology	Construction	Temporary disturbance of important intertidal habitats and species	low	medium	minor	minor
13	Terrestrial and intertidal ecology	Construction	Disturbance to otter	low	high	moderate/ minor	negligible
13	Terrestrial and intertidal ecology	Operation	Temporary disturbance of important terrestrial habitats and species	negligible	medium	negligible	negligible
13	Terrestrial and intertidal ecology	Operation	Disturbance of important intertidal habitats and species	low	medium	minor	minor
13	Terrestrial and intertidal ecology	Operation	Disturbance to otter	negligible	negligible	negligible	negligible
13	Terrestrial and intertidal ecology	Decommissioning	Pre-decommissioning surveys required to assess				

Table 23.1 Summary of impacts for all receptors							
Chapter no.	**Chapter title**	**Phase**	**Potential Impact**	**Magnitude**	**Sensitivity**	**Significance**	**Residual significance**
14	Seascape, landscape and visual assessment	Construction	Local Coastal Character Area: Gabhsann to Mealabost	low	medium	minor	minor
14	Seascape, landscape and visual assessment	Construction	Local Coastal Character Area: Mealabost to Rubha na Caillich (Localised impact)	medium	medium	moderate	moderate
14	Seascape, landscape and visual assessment	Operation	Local Coastal Character Area: Gabhsann to Mealabost	low	medium	minor	minor
14	Seascape, landscape and visual assessment	Operation	Local Coastal Character Area: Mealabost to Rubha na Caillich (Localised impact)	medium	medium	moderate	moderate
14	Seascape, landscape and visual assessment	Decommissioning	Local Coastal Character Area: Mealabost to Rubha na Caillich (Localised impact)	medium	medium	moderate	moderate
14	Seascape, landscape and visual assessment	Construction	Viewpoint 1: A857 North-west of Mealabost	low	medium	minor	minor
14	Seascape, landscape and visual assessment	Construction	Viewpoint 2: Car park for coastal path, Mealabost (Localised impact)	high	high	major	major
14	Seascape, landscape and visual assessment	Construction	Viewpoint 3: Borve (Localised impact)	medium	high	major	major
14	Seascape, landscape and visual assessment	Construction	Viewpoint 4: Steincleit Stone Circle	negligible	high	minor	minor
14	Seascape, landscape and visual assessment	Construction	Viewpoint 5: A857 Siadar (Localised impact)	medium	medium	moderate	moderate

Table 23.1 Summary of impacts for all receptors

Chapter no.	Chapter title	Phase	Potential Impact	Magnitude	Sensitivity	Significance	Residual significance
14	Seascape, landscape and visual assessment	Construction	Viewpoint 6: A857 south-west of Baile an Truiseil	negligible	medium	negligible	negligible
14	Seascape, landscape and visual assessment	Construction	Viewpoint 7: Coastal edge close to Baile an Truiseil (Localised impact)	low	high	moderate	moderate
14	Seascape, landscape and visual assessment	Operation	Viewpoint 1: A857 North-west of Mealabost	low	medium	minor	minor
14	Seascape, landscape and visual assessment	Operation	Viewpoint 2: Car park for coastal path, Mealabost (Localised impact)	medium	high	major	major
14	Seascape, landscape and visual assessment	Operation	Viewpoint 3: Borve (Localised impact)	medium	high	major	major
14	Seascape, landscape and visual assessment	Operation	Viewpoint 4: Steincleit Stone Circle	negligible	high	minor	minor
14	Seascape, landscape and visual assessment	Operation	Viewpoint 5: A857 Siadar (Localised impact)	medium	medium	moderate	moderate
14	Seascape, landscape and visual assessment	Operation	Viewpoint 6: A857 south-west of Baile an Truiseil	negligible	medium	negligible	negligible
14	Seascape, landscape and visual assessment	Operation	Viewpoint 7: Coastal edge close to Baile an Truiseil (Localised impact)	low	high	moderate	moderate
14	Seascape, landscape and visual assessment	Decommissioning	impacts to viewpoints will be same as for operational				

Table 23.1 Summary of impacts for all receptors							
Chapter no.	**Chapter title**	**Phase**	**Potential Impact**	**Magnitude**	**Sensitivity**	**Significance**	**Residual significance**
15	Shipping and navigation	Construction	Collision between the development structures and vessels, or between vessels	low	high	moderate	negligible
15	Shipping and navigation	Construction	Increased journey times and distances as vessels have to travel around the proposed development.	low	low	negligible	negligible
15	Shipping and navigation	Construction	Increased pressure on search and rescue services	medium	medium	medium	minor
15	Shipping and navigation	Construction	Reduced visibility and noise disturbance impairing vessels navigational abilities.	low	low	negligible	negligible
15	Shipping and navigation	Operation	Collision between the development structures and vessels, or between vessels	low	high	moderate	negligible
15	Shipping and navigation	Operation	Equipment or parts becoming detached from devices and posing a hazard.	low	medium	minor	negligible
15	Shipping and navigation	Operation	Increased journey times and distances as vessels have to travel around the proposed development.	medium	low	minor	minor
15	Shipping and navigation	Operation	increased pressure on search and rescue services	low	medium	minor	negligible
15	Shipping and navigation	Decommissioning	similar to construction				
16	Commercial fisheries	Construction	Temporary loss of traditional fishing grounds	low	medium	minor	negligible

Table 23.1 Summary of impacts for all receptors							
Chapter no.	**Chapter title**	**Phase**	**Potential Impact**	**Magnitude**	**Sensitivity**	**Significance**	**Residual significance**
16	Commercial fisheries	Construction	Temporary displacement from traditional fishing grounds	low	medium/ low	minor	negligible
16	Commercial fisheries	Construction	Danger to life and/or damage to gear due to construction	/	/	no impact	no impact
16	Commercial fisheries	Construction	Obstruction to regular fishing vessel transit routes	/	/	no impact	no impact
16	Commercial fisheries	Construction	Changes in abundance of target species	negligible	medium	minor	no impact
16	Commercial fisheries	Construction	Economic impact of the development.	low	low	minor	negligible
16	Commercial fisheries	Operation	Permanent loss of traditional fishing grounds	low	medium	minor	negligible
16	Commercial fisheries	Operation	Permanent displacement from traditional fishing grounds	low	medium/ low	minor	negligible
16	Commercial fisheries	Operation	Danger and damage to gear due to the operational array	/	/	no impact	no impact
16	Commercial fisheries	Operation	Obstruction to regular fishing vessel transit routes	/	/	no impact	no impact
16	Commercial fisheries	Operation	Changes in abundance of target species	low	low	negligible	minor (beneficial)
16	Commercial fisheries	Operation	Economic impact of the development.	low	low	negligible	minor (beneficial)

Table 23.1 Summary of impacts for all receptors							
Chapter no.	**Chapter title**	**Phase**	**Potential Impact**	**Magnitude**	**Sensitivity**	**Significance**	**Residual significance**
16	Commercial fisheries	Decommissioning	similar to construction				
17	Traffic and transport	Construction	Increase in road traffic resulting in congestion and degradation of roads	low	high	moderate	minor
17	Traffic and transport	Construction	emissions from on road traffic	negligible	negligible	negligible	negligible
17	Traffic and transport	Operation	Increase in road traffic resulting in congestion and degradation of roads	negligible	high	minor	minor
17	Traffic and transport	Decommissioning	Consultation required at the time to determine need for mitigation and further traffic assessment				
18	Archaeology and cultural heritage	Construction	Removal of areas of lazybeds	medium	low	minor	minor
18	Archaeology and cultural heritage	Construction	Potential impact upon previously unrecorded archaeology	low asset potential	N/A	N/A	N/A
18	Archaeology and cultural heritage	Operation	Impact upon the setting of Clach Stei Lin stone circle and enclosure	negligible	low	negligible	negligible
18	Archaeology and cultural heritage	Operation	Impact upon the setting of Steinacleit prehistoric settlement and enclosure	negligible	high	minor	minor
18	Archaeology and cultural heritage	Decommissioning	No impacts				
19	Onshore noise	Construction	Noise and vibration impacts from construction vehicles on A857 and access roads	Low	medium	minor	minor

Table 23.1 Summary of impacts for all receptors							
Chapter no.	**Chapter title**	**Phase**	**Potential Impact**	**Magnitude**	**Sensitivity**	**Significance**	**Residual significance**
19	Onshore noise	Construction	Noise levels associated with the construction of the hydroelectric power station and surface laid or /HDD pipeline installation	low to medium	medium	moderate to minor	minor
19	Onshore noise	Operation	Noise associated with movement of vehicles associated with hydro electric power station substation maintenance	negligible	low	minor	minor
20	Water quality	Construction	Marine pollution from construction	low	medium	minor	negligible
20	Water quality	Construction	Introduction of marine non-native species	medium	medium	moderate	negligible
20	Water quality	Operation	Marine pollution due to accidental spillage	negligible	medium	negligible	negligible
20	Water quality	Operation	Introduction of marine non-native species	negligible	medium	negligible	negligible
20	Water quality	Decommissioning	similar to construction				
21	Socio economics and local community	Construction	Direct Capital Expenditure (Project development, manufacture and assembly)	medium	medium	moderate beneficial	moderate (beneficial)
21	Socio economics and local community	Construction	Indirect capital expenditure (marine services and onshore construction)	medium	medium	moderate (beneficial)	moderate (beneficial)
21	Socio economics and local community	Construction	Indirect economic benefits (employment, accommodation and services)	medium	medium	moderate (beneficial)	moderate (beneficial)
21	Socio economics and local community	Operation	Effects on Employment	low	medium	minor (beneficial)	minor (beneficial)

Table 23.1 Summary of impacts for all receptors							
Chapter no.	**Chapter title**	**Phase**	**Potential Impact**	**Magnitude**	**Sensitivity**	**Significance**	**Residual significance**
21	Socio economics and local community	Operation	Community benefits	low	medium	minor (beneficial)	minor (beneficial)
21	Socio economics and local community	Decommissioning	similar to construction				
22	Tourism and recreation	Construction	Disturbance to tourism and recreational activity	low	low	negligible	negligible
22	Tourism and recreation	Construction	Displacement of tourism and recreational activity	minor	low	negligible	no impact
22	Tourism and recreation	Operation	Creation of a point of interest for visitors	low	low	negligible/ positive (minor)	negligible/minor (beneficial
22	Tourism and recreation	Operation	Disturbance of tourism and recreational activity	low	low	negligible	negligible
22	Tourism and recreation	Decommissioning	similar to construction				

23.3 Mitigation Measures

23.3.1 Mitigation measures are provided to limit, but not necessarily to eliminate, the environmental effects of the development.

23.3.2 Mitigation measures and good practice measures have been outlined in each chapter of the ES in relation to each specific impact.

23.3.3 The proposed mitigation measures are summarised below.

Chapter 7: Physical environment and coastal processes

23.3.4 No mitigation is proposed.

Chapter 8: Soils, hydrology and hydrogeology

Mitigation of changes in surface water runoff patterns, generation of turbid runoff or runoff containing suspended sediments and flooding or surface ponding

23.3.5 Surface water runoff and drainage patterns are likely to be altered at the onshore site as a result of widening of the existing access track (New Road), construction of a new section of access track and excavation of foundations for the hydro electric power station and the onshore compound. This change in surface water runoff has the potential to result in increased flooding or surface ponding. Some construction activities onshore could also lead to turbid runoff entering the fresh or coastal water bodies. The following measures will be taken to mitigate impacts:

a. The construction contractor will develop and implement a construction method statement which adheres to the relevant best practice within Design Manual of Roads and Bridges (DMRB), Construction Industry Research and Information Association (CIRIA), Scottish Environment Protection Agency (SEPA) guidance and in particular Scottish Natural Heritage (SNH) and Forestry Commission Scotland (FCS) guidance on floating roads and construction on peat.

b. Construction activities will be planned for drier periods were practicable. Meteorological Office forecasts will be consulted as well as flood warnings issued by SEPA in order to determine where heavy rainfall may present a risk to the construction phase. Any construction work will stop when rain exceeds a certain threshold, to be determined as part of the Environmental Management Plan (EMP).

c. Construction of the access track side verges will use, where possible, any excess peat from the excavation of foundations for buildings. Low verges will be constructed, where possible, to allow surface water to drain naturally and diffusely where it arises reducing the likelihood of surface water ponding. This method of draining floating roads will preserve the local hydrology, which supports the ecology and habitat.

d. In areas where the floating road (access track) is constructed parallel to the contours of the slope good practice guidance will be followed. Runoff will be intercepted, appropriately managed and discharged to the down slope area of the peat, where it will follow natural drainage patterns.

e. Use of low permeability backfill around trenches will reduce the likelihood of causing any change in surface water runoff patterns.

f. Cut-off drains will be installed around buildings in order to intercept any uncontaminated surface runoff and to divert it to ensure natural drainage pattern are preserved.

g. Care will be taken to avoid interference with the sheep dip disposal locations. If drainage patterns are unchanged there is no risk that potentially polluting substances contained in the sheep dip could result in pollution of the Lambol Burn.
h. Where appropriate, for example where construction is taking place on steeper land, silt traps will be used to capture suspended solids. Settlement ponds, attenuation areas or other appropriate methods will be used where required.
i. Stockpiling of any soils will be minimised and located away from surface water features, where practicable.

23.3.6 During operation and maintenance of the onshore site the following measures will be taken to minimise impacts on flooding or ponding:

a. The river crossing will be designed based on the identified catchment using a storm return period of 1 in 200 years to allow for climate change (Scottish Planning Policy, 2010). The crossing shall allow for additional capacity to allow for any build up of deposits.
b. The river crossing shall be carried out in accordance with the Water Framework Directive 2007, Controlled Activities Regulations (The Water Environment (Controlled Activities) (Scotland) Regulations 2005) and relevant authorisations will be obtained from SEPA.

Mitigation for spills and leaks of oil, fuel and other potentially polluting substances

23.3.7 Spills and leaks of potentially polluting substances could occur during any construction, operation or maintenance activities onshore, especially where vehicle movements are undertaken and in the temporary construction compound, where oil and fuel are likely to be stored. The following measures will be taken to reduce any impacts to local habitats and watercourses:

a. SEPA Pollution Prevention Guidance (PPG) will be followed to reduce the likelihood and magnitude of any spills and leaks. Specifically PPG) 1: General guide to the prevention of pollution, 2: Above ground oil storage, 5: Works and maintenance in or near water, 6: Working at construction and demolition sites, 7: Safe Storage – the safe operation of refuelling activities and 21: Pollution incidence response planning and Construction Industry Research and Information Association (CIRIA) C532 will be followed.
b. Oil, fuel and any other potentially polluting substances will be stored in a designated storage area on site situated away from any sensitive receptors such as watercourses and will be stored within impervious bunds with 110% capacity to ensure complete spill / leak retention.
c. Machinery and equipment will be routinely inspected to ensure they are in good working order and to detect any leakage at an early stage.
d. Spill kits will be available on site at all times.
e. Where appropriate wheel washing will be used to prevent excess soil being transferred to public roads.
f. Any construction work will be undertaken in accordance with the EMP which will be developed in conjunction with the construction contractor and SEPA.

23.3.8 Fluids used during horizontal directional drilling could potentially cause contamination to local watercourses. The following measures will be taken to minimise any impacts:

a. The drill fluid will comprise of water and non-oil based drilling fluid. Drilling fluids used will be non toxic and biodegradable.
b. A closed loop recycling system will separate drill cuttings from reusable drilling fluids limiting the quantity of any water-based drill fluid and cuttings lost to the environment.

Any excavated drill cuttings will be contained for appropriate disposal by licensed contractors.

Mitigation for drainage and dewatering of peat

23.3.9 Dewatering of peat may occur as a result of its excavation for the construction of foundations for the hydro electric power station. To minimise any adverse impacts to peat, the following measures will be taken

a. Where required excavated peat will be kept wet to avoid oxidising conditions developing in the peat.
b. If surplus peat is used in the construction of the floating road (access track) verges it will be laid in the same layer formation as excavated to reduce the likelihood of the peat drying out.
c. Pre-construction geotechnical analysis will be undertaken to determine the likelihood of compression of peat and if required design adjustments will be made to ensure the peat habitat is protected where practicable.
d. Where any flows have been diverted from the peat during the construction of the floating road (access track) and created any water filled access track site depressions then appropriate mitigation, (for example plastic sheet piling dams) will be used.

Mitigation for peat slips

23.3.10 The access track and onshore development site are on a slight slope and therefore there is the potential that a peat slip could occur at this site due to excavation of foundations adjacent to the slope. The potential for peat slips during construction is thought to be extremely low; however, final design and associated surveys have not yet been completed. A number of mitigation measures are proposed to reduce this potential:

a. A pre-construction geotechnical investigation will be undertaken as part of wider survey of the site pre construction and this will allow informed assessment of the potential risk of peat slip.
b. Relevant guidance will be followed including Guidelines for the risk management of peat slips on the construction of low volume / low cost roads over peat (Forestry Commission Scotland, January 2006) and Construction tracks in the Scottish Uplands (SNH, 2005).
c. During construction of the floating road (access track), peat will be loaded slowly to allow the underlying peat to respond to the increasing load and allow the peat time to consolidate and gain strength and not shear.
d. The floating road (access track) will be subject to regular engineering control and monitoring to ensure construction and consolidation is proceeding as intended.
e. The floating road (access track) will use a geogrid, which will comply with BS EN 13249: 2001.

Mitigation of carbon loss

23.3.11 There is potential for carbon loss to occur during excavation of peat for foundations. Carbon loss will be minimised through the following measures:

a. Minimise the volume of peat to be excavated through use of floating roads.
b. Where possible re-use any surplus excavated peat in the verges adjacent to floating roads.
c. Construct a floating road to reduce the impact on peat.

Mitigation of increased pH of peatland

23.3.12 Import of materials during construction may lead to changes in pH of the peat environment. Mitigation includes:

a. To reduce an increase of pH in the acidic peat environment during construction any building materials to be used on site will be locally won.
b. Alkaline stone such as limestone will not be used on site.

Chapter 9: Benthic ecology

23.3.13 No mitigation is proposed.

23.3.14 Monitoring measures for benthic ecology are discussed in Section 23.4.

Chapter 10: Ornithology

23.3.15 No potential impact on birds has been assessed to be significant and no mitigation is proposed.

23.3.16 It is a legal requirement to undertake a pre-construction survey of the development area, and if an active nest of a Schedule 1 species is discovered, a disturbance risk assessment prepared under a Breeding Bird Protection Plan (BBPP) will be submitted to SNH for approval.

23.3.17 Lewis Wave Power is aware of the following good practice (non mitigation) measures:

a. Good practice for vessels to maintain defined routes and maximum vessel speed of 15 km/hr (approximately 8 knots) is likely to give most seabird species time to move away from an approaching vessel without resorting to flight.
b. Good practice methodology will be adhered to regarding pollution and contamination control (see Chapter 20: Water Quality)
c. At the time of decommissioning, good practice guidance on habitat reinstatement will be followed.

Chapter 11 Marine mammals and basking sharks

23.3.18 No potential impact on marine mammals or basking sharks has been assessed to be significant and no mitigation is proposed.

23.3.19 Lewis Wave Power is aware of the following good practice (non mitigation) measures:

a. During all installation activity vessels will maintain a consistent speed and gradually slow down/accelerate when required to ensure that vessel noise is reduced where possible in line with the Codes of Conduct provided by Dolphin Space Programme (2009). This will allow marine mammals to move away from vessels.

b. Lewis Wave Power will use a low environmental impact, hydraulic fluid in the Oyster devices.

c. Standard good practice, such as the Pollution Prevention Guidelines issued by SEPA (e.g. PPG 5: Works and maintenance in or near water) will be followed to minimise the risk of pollution events.

d. Any chemicals used during construction will be detailed in the EMP and its associated method statements for approval by SEPA and Marine Scotland.

Chapter 12: Fish and shellfish

Mitigation of displacement / loss of nursery and feeding grounds

23.3.20 To mitigate against disturbance to fish and shellfish during construction, vessel movements will be kept to the minimum practical number and will be limited to defined transit corridors.

Mitigation of increased substratum / benthic habitat

23.3.21 During operation, there is opportunity for the design of the gap fillers to be modified to produce suitable benthic habitat for fish and shellfish species. In particular if the eventual design for the gap filler had suitable sized holes for lobsters to use as burrows it could be assumed that the lobster population within the development site would increase.

Chapter 13: Terrestrial and intertidal ecology

Potential impacts during construction

Mitigation of loss or disturbance of important terrestrial habitats and species

23.3.22 The following mitigation measures are proposed:

a. Detailed method statements relating to all activities with the potential to adversely impact on sensitive habitats will be developed and agreed, in consultation with an ecologist and the relevant consultees, in advance of construction works commencing. Site supervision, by a suitably experienced environmental clerk of works, will ensure the successful implementation of proposed mitigation measures, including pollution prevention, monitoring of buffers around construction areas, and adherence to current construction best practice.

b. Vegetated turves and peat removed during compound excavation will be carefully stored and restored in appropriate locations as soon as possible after disturbance.

c. Turves will be bladed and kept moist to avoid drying out

d. Turves will be stored within the compound construction footprint, at least 200m from watercourses and sensitive habitats where practicable.

e. Excavated peat turf will be removed as intact as possible. Disturbance and movement of the turves will be minimised.

f. Best practice measures to encourage rapid stabilisation and re-vegetation of exposed peat will be implemented where required (e.g. using an appropriate nurse seed mix to stabilise the peat).

g. Road surfaces will be inspected regularly during construction, and if dust is seen to be mobilised from the road, road spraying may be undertaken.

h. Following construction, any bare areas will be left to regenerate naturally or where appropriate re-seeded with an appropriate mix of native species of local provenance.

i. All drainage designed within the scheme will be in compliance with The Water Environment (Controlled Activities) (Scotland) Regulations 2011, and all surface water will be managed in agreement with SEPA.

Mitigation of disturbance or loss or disturbance of important intertidal habitats and species

23.3.23 The construction contractor will provide and implement a construction method statement that adopts the relevant good practice guidance set out in CIRIA "*The Coastal and marine environmental site guide*" (C584) and include the following mitigation measures:

a. Intertidal construction footprint on the shore will be kept as small as possible

b. Construction activities, materials, machinery and vehicles will be limited to defined construction areas and routes, minimising the footprint to prevent disturbance of nearby habitat;

c. Where possible surface laid pipework will be attached to rock rather than boulders;

d. Construction material will be removed from site; and

e. If material is removed from the intertidal habitat it will be stored and replaced within the same intertidal zone.

Mitigation of: Impacts on otters at all stages of development

23.3.24 To minimise potential adverse impact to otters during all phases of the development, the following mitigation will be adhered to:

23.3.25 Construction, operation and maintenance activities will maintain a strict footprint of works, and construction vehicles and equipment will not be active on, or stored by, the coastline for longer than is essential. This will minimise disturbance to the shore;

23.3.26 Construction operation and maintenance work will be undertaken during daylight working hours (excluding horizontal directional drilling works). Where artificial light is required, lights will be directed away from otter sensitive areas to allow them to migrate through the area undisturbed. During summer months, construction may continue later into the evening without the need for artificial lighting.

23.3.27 Whilst the location of the development works avoids areas suitable for otter it is important to protect the otter's food resource by avoiding pollution to the watercourses. Construction areas will be left in a safe condition during periods of inactivity, with chemicals and construction materials stored safely with appropriate bunding in accordance with SEPA's Pollution Prevention and Chemical Guidelines (PPG2 - Above ground oil storage tanks, and PPG5 – Works in, near or liable to affect watercourses).

23.3.28 Key measures to further mitigate disturbance to otters on site will include capping all pipes, covering all trenches or providing a means for otter to escape should they enter a trench.

23.3.29 Construction of the access road network will adhere to design Manual of Roads and Bridges (DMRB) Volume 10 Section 1 Part 9 HA 81/99 (Nature conservation advice on relation to otters) and The Scottish Wildlife Series publication 'Otters and Development'

23.3.30 Offshore operation and maintenance procedures manuals will include good practice guidance for boat operators aimed at avoiding disturbance to otters during operation and maintenance activities.

23.3.31 A speed limit of 15 miles per hour (mph) will be implemented on the access road during all phases of development.

23.3.32 Prior to the commencement of operations an otter survey will be undertaken within the proposed footprint of construction plus a 50m buffer zone around it (200m buffer along any watercourse coastal area), to confirm the extent of use at the time of construction (otters may increase their use of the site in the interim period between the current survey and the commencement of construction).

23.3.33 If pipework is surface laid and work in the intertidal area confirmed, the outcomes of the otter survey will be discussed with SNH and otter mitigation measures, where necessary, for the site will be agreed with SNH prior to construction and will be detailed within the EMP for the development;

23.3.34 A sediment management plan and pollution management plan will be developed in consultation with SEPA and SNH in accordance with SEPA's PPG guidelines PPG 5 (Works in, near or liable to affect watercourses) and PPG 6 (working at construction and demolition sites). Both plans will be incorporated within the Construction Method Statement.

23.3.35 Any otter casualties occurring during construction will be retained and SNH will be notified.

23.3.36 Construction will adhere to The Scottish Wildlife Series publication 'Otters and Development'.

Chapter 14: Seascape, landscape and visual assessment

23.3.37 Buildings will be coloured in agreement with the Western Isles Council to help blend in with the surrounding rough grass moorland.

Chapter 15: Shipping and navigation

Mitigation drawn from Navigation Risk Assessment

23.3.38 To minimise the risk of collision of vessels with the development, the Navigation Risk Assessment (NRA) identified a number of mitigation measures, which will be implemented to reduce potential hazards:

a. Emergency response procedures, Emergency Response Cooperation Plan (ERCoP) plan will be developed in liaison with Maritime and Coastguard Agency and Royal National Lifeboat Institution;

b. Outcomes of device design testing and lessons learned from the Oyster Project at Billia Croo, Orkney will be applied before similar devices are deployed in Lewis;

c. Hazard Workshop for operational phase with key project personnel/vessel masters etc. ;

d. Liaison/dialogue with local fishermen during major maintenance operations;

e. Maintenance operations will be planned around weather window;

f. Weather forecasting and monitoring conditions will be undertaken continuously;

g. Vessels on site will be tasked with monitoring shipping/fishing in the area to warn them of the operations;

h. Navigational warnings will be broadcasts e.g., Navtex and information will be marked on UKHO charts;

i. Continued liaison will be maintained with Harbour Masters, local coastguard and fishermen operating in the area.

j. Oyster devices will be marked to meet the requirements of the Northern Lighthouse Board (NLB) prior to installation.

k. Navigational Aids will be installed and maintained as directed by NLB.

l. The site will be marked on hydrographic charts and Kingfisher charts as well as FishSAFE

m. Coordinates of site and devices will be provided to local fishermen and canoe / kayak clubs

n. Operating procedures will be in place, including safety requirements as well as wider site management measures

o. The devices will be monitored through a control and instrumentation system (SCADA system) to ensure early detection of device malfunction, allowing the operators to alert other users and regulators regarding significant changes in operation or status of the site.

p. A safety/exclusion zone will be applied for the operational phase.

q. Lewis Wave Power will develop an ERCoP which will have the provision to alert the Coastguard if there is a risk that a device has broken free from its foundations in order for navigational safety warnings to be issued to shipping in the area.

Mitigation of hazards drawn from Navigation Risk Assessment

23.3.39 Eleven hazards were identified in the NRA with the potential to occur during the operational phase. The following mitigation measures, proposed by the in the NRA, will decrease the risk of these hazards and the impact of increased pressure on search and rescue services:

a. Devices will be clearly marked;

b. Notices to mariners will be issued regularly;

c. Local notices will be posted as appropriate;

d. Hydrographer broadcasts will be made;

e. The site will be designed as a no anchorage zone

f. Ongoing fisheries liaison measures will be put in place;

g. Pilot books will be updated as appropriate;

h. An emergency response plan will be developed and tested;

i. Method statements and risk assessments will be produced for activities;

j. Life jackets will be worn by all offshore personnel during maintenance activities;

k. A clear policy for working in adverse weather will be developed;

l. A marine safety management system will be put in place;

m. Only experienced and trained crews will be used for maintenance activities ; and

n. A voluntary agreement will be sought with local fishermen not to lay and recover their potting gear in and around the devices.

Chapter 16: Commercial fisheries

23.3.40 Lewis Wave Power will develop an agreement with local inshore fishermen to support the planned management of a safety exclusion area around the immediate construction/installation activities, under The Construction (Design and Management) Regulations 2007 (CDM) and discourage the entry of any vessel within the designated construction area.

23.3.41 By working with the local fishermen it may be possible reduce the exclusion zones and temporary displacement in both size and duration.

23.3.42 Gap fillers may be placed under the Oyster WECs, which may become suitable habitat for lobster and crab. It can be assumed that these species will increase in abundance within the proposed development site, with opportunities for overspill. This will have limited effect during the initial stages of the construction but effects will increase with time and as more of the gap fillers are installed.

23.3.43 There are potential new opportunities that will be created for the existing fishing fleet as a source of alternative employment associated with the proposed development, creating a socio-economic stimulus.

23.3.44 Good communication with the local fishing fleet will be maintained via the Inshore Fishing Group (IFG) throughout the pre-construction and construction periods.

Chapter 17: Traffic and Transport

23.3.45 Road disruption will be minimised whilst construction is undertaken along New Road and the access track to the development site by following a suitable methodology.

23.3.46 The contractor will provide a traffic management plan, which will ensure that the increase in traffic on Lewis does not significantly affect to the normal A857 traffic.

23.3.47 Further mitigation measures, if required, will be determined in discussions with the relevant Roads Department (Western Isles Council).

Chapter 18 Archaeology and cultural heritage

23.3.48 The development will include the removal of an area of lazybeds, a post medieval agricultural feature typical in the Western Isles) during construction. The extent and form of the lazybeds will be recorded through rectification of aerial photographs.

23.3.49 To prevent impacts upon previously unrecorded archaeology a programme of archaeological works will be undertaken. In the first instance the construction compound will be subject to evaluation trenching in order to establish the archaeological potential more fully than is possible from non-intrusive studies. Further work will be undertaken as appropriate.

23.3.50 No mitigation is proposed during operation.

Chapter 19: Onshore noise

23.3.51 The control of noise from construction operations will be achieved through the application by the principal Contractor for a Section 61 'prior consent' to the Western Isles Council in accordance with the guidance set out in the Control of Pollution Act 1974.

23.3.52 Construction related traffic is limited to daytime periods only.

23.3.53 Best Practical Means (BPM) measures to reduce noise in construction operations will be implemented and may include:

a. Education and awareness raising of construction operatives with regard to the prevention of local community noise disturbance.

b. Minimising the idling of vehicles in proximity to the residential properties.

c. Avoiding excessive revving of plant equipment engines.

d. Extra care taken in handling and placing materials.

e. Ensuring that as much as possible the most modern plant equipment is used and fitted with appropriate noise attenuation.

f. Ensuring proper maintenance and operation of plant equipment and vessels.

<u>Chapter 20: Water quality</u>

23.3.54 The risk of pollution events will be minimised by following standard good practice, such as the Pollution Prevention Guidelines issued by SEPA. Lewis Wave Power is committed to using environmentally friendly chemicals whilst still maintaining performance. Appropriate EMP will be put in place.

23.3.55 Installation contractors will put in place appropriate Site EMPs and Pollution Control and Spillage Response Plans that will be agreed with the relevant statutory bodies prior to offshore construction activities commencing. Further mitigation includes the following:

a. Lewis Wave Power will develop its own Emergency Response Plan which will address the response to accidental / non-routine events, including pollution related events.

b. All vessels associated with the Lewis development will comply with IMO/MCA codes for prevention of oil pollution and, where appropriate, will have onboard SOPEPs (i.e. vessels over 400GT).

c. All contracted vessels will carry oil and chemical spill mop up kits.

d. As far as possible vessels with an established track record of operating in similar waters where the conditions can become severe over a short period of time will be employed. They will also be familiar with operating conditions in the area and will adhere to all appropriate navigational standards and practices.

e. Installation and major routine (planned) maintenance activities will only take place in instances where Lewis Wave Power are confident that there is no risk of bad weather to avoid incidences leading to an increased risk of accidental/non routine events.

f. Hydraulic and accumulator modules are designed to be isolated if necessary. Any problems will result in the problem module being isolated from the rest of the system before it is recovered; this will prevent the release of large quantities of any hydraulic fluid into the water.

23.3.56 There is potential for the development to lead to introduction of marine non-native species to the Western Isles. The greatest potential for this is through the movement of vessels to the site for construction, operation and maintenance activities. To mitigate this potential impact the following measures are proposed:

a. Once the vessels for construction activities are confirmed, a risk assessment will be conducted taking account of vessel activities, previous locations, and planned routes that could introduce marine non-native species to the area. The assessment and measures indicated by the assessment will be agreed with Marine Scotland.

b. If the risk assessment identifies a concern, further consultation with be undertaken with SNH and SEPA, with the aim of compliance with Water Framework and Marine Strategy Framework Directive objectives.

Chapter 21: Socio economics and local community

23.3.57 No mitigation is proposed.

Chapter 22: Tourism and recreation

23.3.58 The installation will be designed to minimise unnecessary noise.

23.3.59 The development will undertake appropriate traffic management measures (see Chapter 17: Traffic and Transport) and associated mitigation. To minimise displacement of tourism activities during construction activities the following safety procedures will be implemented:

a. Notice of the activities would be promulgated through the UKHO Maritime Safety Information system (i.e. Notices to Mariners (NMs) and Radio Navigational Warnings (NavWarns/WZs)) and will occur just prior to and during the maintenance works

b. Installation vessels will comply with the COLREGS in that they would display the appropriate lights and marks for vessels engaged in such activities

c. Presence on site of manned vessels capable of monitoring and advising the other marine traffic using the area,

23.3.60 During operation, the array will be appropriately buoyed and charted as an underwater obstruction and annotated, to mitigate disruption of water based tourism and recreational activity.

23.4 Additional Monitoring and Good Practice Measures

23.4.1 Lewis Wave Power will develop an appropriate monitoring and reporting programme to be implemented during the construction and operational phases to monitor the reaction of key sensitive receptors, as identified in the relevant ES chapters.

23.4.2 The monitoring programme will give the opportunity to re-assess the effectiveness of the mitigation measures implemented. Pre-installation monitoring and a "Deploy and Monitor" strategy are each considered in turn below.

Pre-installation monitoring

23.4.3 The monitoring strategy prior to installation of the development will be established in consultation with SNH. A number of elements of pre-installation monitoring are already in place, for example, vantage point monitoring of the area of development for marine mammals and birds, as well as incidental basking shark sightings, has been ongoing since October 2010.

Terrestrial ecology

23.4.4 The development has taken account of otter sensitive areas and the footprint for onshore works avoids these. The need for a European Protected Species (EPS) Licence is not currently anticipated; however, as confirmed with SNH, this will need to be reconsidered once the final design of the development and a pre-construction otter survey has been undertaken. Although otters can breed at any time of the year, females of the otter population of the Western Isles usually give birth in late spring (April to May) and cubs tend to stay in the natal den for up to 3 months afterwards.

23.4.5 Prior to the commencement of operations an otter survey will be undertaken, within the proposed footprint of construction plus a 50m buffer zone around it (200m buffer along any watercourse coastal area), to determine current use at the time of construction (otters may increase their use of the site in the interim period between the current survey and the commencement of construction).

23.4.6 The results of the survey will be discussed with SNH prior to construction commencing.

Intertidal ecology

23.4.7 The potential changes to hydrodynamics identified within *Chapter 7: Physical environment and coastal processes* are based upon current best knowledge. The consequential impact on intertidal ecology, although assessed as minor to negligible based on the current ecology and magnitude of effect, are uncertain, given the absence of developments of similar scale or nature. It is proposed, therefore that monitoring of changes to ecology is included in post installation monitoring of the development, as part of Marine Scotland Licencing Operating Team's (MS-LOT's) stated policy to "deploy and monitor". It is suggested that intertidal monitoring is the focus of monitoring of marine ecology, with a similar assessment made for Benthic Ecology (see *Chapter 9: Benthic ecology*). If significant change in the intertidal is observed from the phases 1 and 2 of development (see *Chapter 5: Project description*), it is suggested that it will then be assumed that changes of a similar nature may also be occurring subtidally and an appropriate subtidal monitoring plan then be established to run during phases 3 and 4.

23.4.8 An intertidal survey was completed across the area of potential influence and concluded that no rare or protected species were present, with the exception of the United Kingdom Biodiversity Action Plan (UKBAP) habitat 'under boulder communities' which, at this dynamic and highly exposed site is naturally subject to a range of movement. Similarly, the benthic drop down video surveys have not identified any rare or protected species within the area of potential influence.

23.4.9 It is proposed for re-locatable transects to be set up prior to construction of the development within the intertidal zone prior to installation to provide baseline data for change to be measured against. Transects will be set up according to methodology outlined in Wyn et al., (2000) and Hiscock (1996). It is proposed for two transects to be established: one within the area of potential influence and one on a similar type of shore, exposure and aspect outwith but close to the area of potential influence. A baseline survey will be undertaken in spring, summer and autumn at each site to record the substrate and biotopes present, and heights of zonation down the shore. Videos and photographs will be used to document the shore at each location.

23.4.10 Full details of intertidal monitoring will be agreed with SNH prior to commencing.

Ornithology

23.4.11 None of the development's potential effects on birds are deemed to be significant. Even so, best practice dictates that an appropriately detailed monitoring programme should be agreed and implemented. The value of monitoring the Lewis Wave Array to the wider wave renewables industry is likely to be particularly high given that this would be one of the first wave array projects globally.

23.4.12 Under the Breeding Bird Protection Plan (BBPP) surveys to locate the nests of birds listed in Schedule 1 of the Wildlife and Countryside Act will be undertaken prior to construction (and decommissioning) works during the period March to August. These surveys will be undertaken to inform measures to safeguard any breeding attempts from disturbance. The details of the BBPP would be agreed with SNH first and in light of the most recent survey information. The BBPP is likely to focus on, but not necessarily be limited to, provisions to protect from disturbance the breeding sites of greylag goose, corncrake and dunlin.

Marine mammal and basking shark

23.4.13 The first year's vantage point survey for marine mammals and basking shark has been completed, and the frequency of seal, cetacean and basking shark records is relatively low. At this interim stage, these data suggest no likely significant effect on breeding grey seals, qualifying features of North Rona and Monach Isles SACs. SNH have confirmed they will make full evaluation and advice regarding grey seals on submission of the report at the end of the second year of Vantage Point data collection. SNH recommend that continuation of survey work until September 2012 to capture two years of baseline data, as taking into consideration the above observations, further data collection would be advantageous to provide a better baseline for post-construction monitoring and a more robust and informed decision making process. The second year of baseline monitoring is currently underway.

23.5 Deploy and monitor

23.5.1 Wave Energy Convertor technology is an emerging technology, with limited operational developments upon which to base aspects of assessment. Where devices have been operating and potential environmental interactions have been monitored, the results to date indicate no significant adverse environmental impacts (for example, the Aquamarine Power Oyster development at Billia Croo, Orkney). However, Lewis Wave Power appreciates that the potential interactions of an array of Oyster devices is to some extent unknown, and assessments must be necessarily based on data for single devices from expert judgement based on knowledge of potential receptors and current understanding of the potential effects of single devices extrapolated to encompass an array.

23.5.2 A 'deploy and monitor' strategy for the Lewis array will be established in consultation with Marine Scotland Licensing and Operations Team (MS-LOT) and SNH.

Intertidal ecology

23.5.3 Re-locatable transects will be revisited every spring, summer and autumn over a timeframe to be agreed with MS-LOT and SNH.

23.5.4 Due to the dynamic nature of the coastline, change is likely to occur. A comparison will be made between the two relocatable transects (one within and one outwith the area of potential influence) to ascertain if levels of change are different. If significant change in the intertidal is observed from the phases 1 and 2 of development (see Chapter 5: Project description), it is suggested that it will then be assumed that changes of a similar nature may also be occurring subtidally and an appropriate subtidal monitoring plan will then be established to run during phases 3 and 4.

23.5.5 Further investigations may therefore be required to ascertain the impacts of the development on coastal processes (such as within the offshore benthic region). The outcomes of the surveys and any further work required will be discussed with SNH and MS-LOT.

Ornithology

23.5.6 The results and implications of the second year of bird surveys will be discussed with SNH and MS-LOT.

Marine mammal and basking shark

23.5.7 The results and implications of the second year of marine mammal and basking shark surveys will be discussed with SNH and MS-LOT.

23.6 Management

23.6.1 A number of management protocols will be implemented during the construction, operation and decommissioning of the development to ensure suitable actions are taken in the prevention, reduction and offsetting of any impacts.

23.6.2 A full EMP for the operational phase of the development will be implemented in agreement with Comhairle nan Eilean Siar following submission of this ES. The EMP will consist of a working document which details the environmental actions highlighted in the ES. It will detail all activities to be carried out on site, an identification of all pollution risks and the management protocols to be put in place to control these, identification of the personnel responsible for each element of the EMP, details of any staff training which will be completed to ensure all parties are aware of their responsibilities, details of emergency/spillage response plans, details of inspections and maintenance timeframes and procedures, and details of when the plan will be reviewed for updates and improvements.

23.6.3 A separate Environmental Monitoring and Mitigation Plan (EMMP) will be agreed with MS-LOT and will include details of the post-installation monitoring programme, and detail agreed reporting and decision making protocols.

23.6.4 A detailed Construction Method Statement (CMS) and a Pollution Incident Response Plan (PIRP) will be prepared and agreed with SEPA, SNH and MS-LOT prior to commencement of construction.

23.6.5 At least two months prior to construction commencing, a Construction Environmental Management Document (CEMD) (which forms the basis of the more detailed site specific EMP) will be submitted to SEPA for consultation.

23.6.6 All work will be undertaken to an overarching Health, Safety and Environmental Management System, which will include the CMS, the PIRP and the EMP. The project will be supervised in accordance with the Construction Design and Management Regulations (2007)

23.6.7 All wastes activities will be undertaken in accordance with the Waste Management Licensing Regulations 1994 (as amended for Scotland), the Landfill (Scotland) Regulations 2003 (as amended) and the Special Waste Amendment (Scotland) Regulations 2004 (as amended). In addition, the volume of materials excavated and stored will be minimised. This will include for the management of any material (peat, rock foreshore materials, kelp, water, sewage etc) which may need to be removed during construction and operation of the development;

23.6.8 A Traffic statement will be developed in consultation with Comhairlie nan Eilean Siar (Western Isles Council)); including the following details on the construction vehicles: Size; Weight; Number of axles; Construction Programme; and Swept Path Analysis. The Traffic Statement will consider the route taken from Stornoway Harbour, through the town of Stornoway and onto the A857 to the development site.

23.6.9 An environmental clerk of works will be appointed, to be present on site and oversee the construction phase. The clerk of works will have responsibility for overseeing the implementation of mitigation measures agreed with Marine Scotland during licensing.

23.7 Conclusions

23.7.1 An assessment of the environmental impacts of the development has been carried out in accordance with EU, UK and Scottish regulations, and has extensively consulted statutory and non-statutory bodies and interested parties. The findings have been presented in this Environmental Statement, along with the detailed technical appendices.

23.7.2 Significant impacts, in terms of the EIA regulations, are limited after mitigation to Landscape and Visual Impacts (see Table 4, above). The Western Isles Council has been kept informed of the outcome of the Landscape and Visual Assessment. All other impacts, after mitigation, are not significant in terms of the EIA regulations.

23.7.3 Measures to mitigate negative impacts of the development are proposed. Lewis Wave Power and has also made a number of further commitments to establish overall plans for quality, health, safety and environmental management. This will ensure that the wave array, during construction, operation and decommissioning, will be conducted in a responsible manner.

23.7.4 The 40MW Lewis Wave Array Project offers a strong positive contribution to the UK and Scottish national ambitions to install renewable energy capacity by 2020. There could be some limited negative environmental impacts, but a balanced evaluation based on the Environmental Statement favours construction of the 40MW Lewis Wave Array Project.

24. REFERENCES

ABPmer and HR Wallingford. (2009). Coastal Process Modelling for Offshore Wind Farm Environmental Impact Assessment: Best Practice Guide. Report to COWRIE.

Amoudry, L, Paul S. Bell, P. L., Black, K. S., Gatliff, R. W., Helsby, R, Souza, A.J., Thorne, P.D and Wolf, J. (2009). A Scoping Study on: Research into Changes in Sediment Dynamics Linked to Marine Renewable Energy Installations.

Anatec 2012, Navigation Risk Assessment West Lewis Oyster Wave Array

Angus Jackson, Charlotte Marshall and Cat Wilding 2009. *Palinurus elephas*. European spiny lobster. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 20/11/2011]. Available from: <http://www.marlin.ac.uk/specieshabitats.php?speciesID=4022>

Aquamarine Power (2011) Oyster 2 Wave energy project: European Marine Energy Centre Billia Croo, Orkney

Aquamarine Power Ltd (2010) RESEARCH AND DEVELOPMENT Impact of APL 10 MW Site on Siadar Wave Energy Development, Internal document (APL-RD.RA.04-REP-0013)

Aspect Surveys. (2010). Site Investigation Surveys: Siadar to Bragar, Isle of Lewis Scotland. A report to Aquamarine Power Ltd., 28pp.

Barne, J.H., Robson, C.F., Kaznowska, S.S., Doody, J.P., Davidson, N.C., & Buck, A.L., eds. 1997. Coasts and seas of the United Kingdom. Regions 15 & 16. North-west Scotland: the Western Isles and west Highland. Peterborough, Joint Nature Conservation Committee. (Coastal Directories Series.)

Barnes. M (2008a). *Micromesistius poutassou*. Blue whiting. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 20/11/2011]. Available from: <http://www.marlin.ac.uk/speciesinformation.php?speciesID=3808>

Barnes. M (2008b). *Melanogrammus aeglefinus*. Haddock. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 20/11/2011]. Available from: <http://www.marlin.ac.uk/speciesinformation.php?speciesID=3783>

Barnes. M (2008c). *Merluccius merluccius*. European Hake. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 20/11/2011]. Available from: <http://www.marlin.ac.uk/speciesinformation.php?speciesID=3797>

Barnes. M (2008d). *Microstomus kitt*. Lemon sole. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 20/11/2011]. Available from: <http://www.marlin.ac.uk/speciesinformation.php?speciesID=3810>

Barnes. M (2008e). *Merlangius merlangus*. Whiting. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [on-line]. Plymouth: Marine Biological

Association of the United Kingdom. [cited 25/11/2011]. Available from: <http://www.marlin.ac.uk/speciesinformation.php?speciesID=3794>

Barnes. M (2008f). *Galeorhinus galeus*. Tope shark. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 25/11/2011]. Available from: <http://www.marlin.ac.uk/speciesinformation.php?speciesID=3368>

British Standards Institution (2008), Guide to evaluation of human exposure to vibration in buildings. Part 1: vibration sources other than blasting. BSI, London.

British Standards Institution (2009), 5228-1:2009 Code of Practice For Noise and Vibration Control on Construction and Open Cast Coal Sites – Part 1: Noise. HMSO, London.

Burgess, C and Church M 1997 'Coastal Erosion Assessment for Lewis: A report for Historic Scotland'. Grey Literature report available (http://www.scapetrust.org) accessed on 08/08/2011

CEFAS (2004). Offshore Wind Farms. Guidance note for Environmental Impact Assessment in respect of FEPA and CPA requirements. Version 2. Available from http://www.cefas.co.uk/publications/files/windfarm-guidance.pdf

Cefas (2009). Herring in the North Sea (ICES Division IV, VIId and IIIa) – 2009

Centre for Ecology and Hydrology Hydrometric Register (http://www.ceh.ac.uk/data/nrfa/)

Chanin, P.R.F. (2003a). Ecology of the European otter Lutra lutra. Conserving Natura 2000 Rivers Conservation Ecology Series No. 10, English Nature, Peterborough.

Chanin, P.R.F (2003b). Monitoring the otter *Lutra lutra*. Conserving Natura 2000. Rivers Monitoring Series No. 10, English Nature, Peterborough.

Charlotte Marshall and Emily Wilson 2009. *Pecten maximus*. Great scallop. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 20/11/2011]. Available from: <http://www.marlin.ac.uk/speciesinformation.php?speciesID=4056>

CIRIA C648 (2006), Control of water pollution from linear construction projects

CIRIA Guidance note C692 Environmental Good Practice on Site Guide (3rd edition)

Comhairle nan Eilean Siar (2006) Western Isles Local Plan Strategic Environmental Assessment Scoping Report. Available at: http://www.cne-siar.gov.uk/localplanning/documents/Finalised%20Western%20Isles%20SEA%20Scoping%20Report%2026%2004%2006.pdf

Comhairle nan Eilean Siar (2008) Western Isles Local Plan. Available at: http://www.cne-siar.gov.uk/localplanning/documents/plandocsadopted/localplan.pdf

Comhairle nan Eilean Siar (2011a) Factfile – Population. Available at: http://www.cne-siar.gov.uk/factfile/population/

Comhairle nan Eilean Siar (2011b) Outer Hebrides Local Development Plan Proposed Plan. Available at: http://www.cne-siar.gov.uk/planningservice/documents/ldp/Outer%20Hebrides%20LDP%20Proposed%20Plan%202011%20(English).pdf

Comhairle nan Eilean Siar (CnES) 2010: Large Scale Wind Energy Developments.

Council Directive 67/548/EEC of 27 June 1967 on the approximation of laws, regulations and administrative provisions relating to the classification, packaging and labelling of dangerous substances.

Countryside Council for Wales, Brady Shipman Martin and University College Dublin: Guide to Best Practice in Seascape Assessment, Marine Institute (2001).

DECC (2005), U.K. Government, Methodology for Assessing the Marine Navigational Safety Risks of Offshore Windfarms, Version Date: 7th September 2005.

DECC (2009) Offshore energy SEA 7.

Department for Energy and Climate Change (2009) The UK Low Carbon Transition Plan.

Department for Energy and Climate Change (2011) UK Renewable Energy Roadmap.

Department for Energy and Climate Change (2012) Renewable Obligation (ROCS) Banding Consultation.

Department for Transport’s Design Manual for Roads and Bridges; Available from: http://www.dft.gov.uk/ha/standards/dmrb/index.htm

Department of Trade and Industry (2006). The Energy Challenge Energy Review Report 2006

Department of Transport, Welsh Office (1988) Calculation of Road Traffic Noise London, HMSO

Det Norske Veritas (2011) Offshore standard DNV-OS-C101 Design of offshore steel structures, general (LRFD method)

Directive 1999/45/EC - classification, packaging and labeling of dangerous preparations

DMRB Volume 10 Section 1 Part 9 HA 81/99 (Nature conservation advice on relation to otters) http://www.dft.gov.uk/ha/standards/dmrb/index.htm

Dolphin Space Programme (DSP) (2009). Codes of Conduct. Available at: http://www.dolphinspace.org/index.asp?pageid=10448

DTI in association with Scottish Natural Heritage, Countryside Commission for Wales and The Countryside Agency (2005). Guidance on the Assessment of the Impact of Offshore Windfarms Seascape and Visual Impact Report

Duck, C. (2010). Charting Progress 2 Healthy and Biological Diverse Seas Feeder Report: Section 3.5: Seals. Published by Department for Environment Food and Rural Affairs on behalf of UKMMAS. p506-539. In: UKMMAS (2010) Charting Progress 2 Healthy and Biological Diverse Seas Feeder Report (Eds. Frost, M & Hawkridge, J).

Dunbar MJ, Fowler SL, Fuller I & Irvine, M (1997). Chapter 9.7. Leisure and tourism. In: Coasts and seas of the United Kingdom. Regions 15 and 16. North-west Scotland: The Western Isles and west Highland, ed. By Barne

Ellis, J., Ungaro, N., Serena, F., Dulvy, N., Tinti, F., Bertozzi, M., Pasolini, P., Mancusi, C., Noarbartolo Di Sciara, G. 2007. Raja montagui. In: IUCN 2008. 2008 IUCN Red List of Threatened Species. www.iucnredlist.org.

Ellis, J.R., Milligan, S., Readdy, L., South, A., Taylor, N. & Brown, M. (2010). Mapping the spawning and nursery grounds of selected fish for spatial planning. Report to the Department of Environment, Food and Rural Affairs from Cefas. Defra Contract No. MB5301

EMEC (2005). Environmental Impact Assessment (EIA): Guidance for developers at the European marine energy centre (EMEC).

EMEC (undated). European Marine Energy Centre website available at: www.emec.org.uk. Accessed on 14/12/2011

EMEC and Xodus Group (in draft) Consenting, EIA and HRA Guidance for Marine Renewable Energy Developments in Scotland PART FOUR – WAVE & TIDAL ANNEX EMEC and Xodus AURORA: Report for Marine Scotland

Envision and horner+maclennan, 2006. Visual Representation of Windfarms Good Practice Guide, Scottish Natural Heritage, The Scottish Renewables Forum and the Scottish Society of Directors of Planning.

Envison, (2011) Isle of Lewis Benthic Ecology Drop-down Video Survey

European Commission (EC) (2012). Science for Environment Policy; Can the public support wave power? Available at: http://ec.europa.eu/environment/integration/research/newsalert/pdf/271na4.pdf

European commission fisheries website, 2011 available at: http://ec.europa.eu/fisheries/marine_species/index_en.htm. accessed 19/12/2011

Evans, P.G.H., Anderwald, P. & Baines M.E. (2003). UK Cetacean Status Review. Sea Watch Foundation. Available at: http://www.seawatchfoundation.org.uk/docs/28.%20UK%20cetacean%20status%20review%202003.pdf

Faber Maunsell (2007). Marine renewables SEA environmental report. Section C7 Fish and shellfish.

Faber Maunsell (2007). Scottish Marine Renewables Strategic Environmental Assessment (SEA).

Faber Maunsell and Metoc Plc. (2007). Scottish Marine Renewables SEA, Environmental Report. Report to the Scottish Executive. Environmental Report Section C SEA Assessment: Chapter C4 Seabed Contamination and Water Quality

FCE, SNH (2010) Floating Roads on Peat Available from http://www.roadex.org/index.php/services/partner-knowledge-bank/scotland/floating-roads-on-peat-report

Fisheries Research Services (FRS) (2004) Fact Sheet: Lobsters and Crabs. Available at: http://www.scotland.gov.uk/Uploads/Documents/FM16LobstersCrabs.pdf

Forestry Commission, (2006) Guidelines for the risk management of peat slips on the construction of low volume / low cost roads over peat,

Galparsoro.I, Borja.A, Bald.J, Liria.P,Chust.G.(2009) Predicting suitable habitat for the European lobster (Homarus gammarus), on the Basque continental shelf (Bay of Biscay), using Ecological-Niche Factor Analysis Ecological Modelling. 224(4) 556-567

Geological Survey of Great Britain (Scotland), Lewis and Harris (North), 1:100,000 scale;

Good dives website available at http://www.gooddive.com/uk-diving/isle-of-north-uist-diving.htm. Accessed 14/12/2011

Gordon, J.E. and Sutherland, D.G. (1993) Quaternary of Scotland, Geological Conservation Review Series, No. 6, Chapman and Hall, London, 695 pp.

Grant. A, (2008), Guidance on Landscape/Seascape Capacity for Aquaculture, Natural Heritage Management- Scottish Natural Heritage (2008)

Great Britain (1974) Control of Pollution Act 1974 HMSO, London

Grogan, A, Philcox, C & Macdonald, D (2001) Nature Conservation & Roads: Advice in relation to otters. Wildlife Conservation & Research Unit, Oxford

Halcrow Group Ltd (2009). Economic and Community Benefit Study, Final Report, January 2009. Scottish Government.

Hallaitken (2007) Outer hebrides Migration Study Final Report. Available at: http://www.cne-siar.gov.uk/factfile/population/documents/OHMSStudy.pdf

Hansen, L.P. and Quinn, T.P. (1998) The marine phase of the Atlantic salmon (*Salmo salar*) life cycle, with comparisons to Pacific salmon. Canadian Journal of Fisheries and Aquatic Sciences 55 104-118.

Harrald, M. A. (2010). Further Scottish leasing round (Saltire prize Projects): regional local guidance September 2010. Scottish Marine and Freshwater Science, 1(18).

Harrald. M, and Davies. I (2010) The saltire prize programme: Further Scottish Leasing Round (Saltire Prize projects) Regional Locational Guidance

Hebridean Marine Energy Futures (Unpublished). Waverider buoy report for three months period covering October-December 2011.

Hilti (2011). Safety Data Sheet for Hilti HIT-RE 500 for Adhesive mortar for rebar and anchor fastenings in solid concrete. Available at http://www.hilti.co.uk/fstore/holuk/techlib/docs/Hilti-HIT-RE500-GB.06.2011.pdf accessed on 21/02/2011

Hiscock, K (ed.) (1996). Marine Nature Conservation Review: rational and methods. Coasts and seas of the United Kingdom. MNCR Series. Joint Nature Conservation Committee, Peterborough.

Historic Scotland GIS datasets (http://data.historic-scotland.gov.uk/pls/htmldb/f?p=2100:10:0::NO:::)

HM Government (2004) The UK Renewable Energy Strategy

Holland.G.J, Greenstreet.S.P.R, Gibb.I.M, Fraser. H.M, Robertson.M.R (2005) Identifying sandeel *Ammodytes marinus* sediment habitat preferences in the marine environment. Mar. Ecol. Prog. Ser. 303: 269–282

Houghton Fluid Technology and Service World Wide (2008) Safety data sheet: Antifoaming agent 70.

http://www.aquamarinepower.com/projects/north-west-lewis http://www.decc.gov.uk/en/content/cms/meeting_energy/renewable_ener/renewable_ener.aspx

http://www.sciencedaily.com/releases/2010/01/100118132130.htm

http://www.Scotland.gov.uk

http://www.scotland.gov.uk/News/Releases/2011/05/18093247

http://www.bwea.com/edu/calcs.html

http://www.scotland.gov.uk/Topics/marine/Licensing/marine/LicensingManual

http://www.scotland.gov.uk/Topics/marine/marineenergy

http://www.scotland.gov.uk/Topics/marine/marine-environment/species/fish/shellfish/BrownCrab

http://www.snh.gov.uk/docs/B925810.pdf

http://www.wildernessscotland.com/adventures_itinerary.php?tripID=151 accessed: 14/12/2011

ICES (2011). Celtic Sea and West of Scotland. Whiting in Division VIa (West of Scotland). Advice for 2012.

ICES Fish map (Undated) Thornback Ray

IEMA (2006). Guidelines for Environmental Impact Assessment

Institute of Ecology and Environmental Management (2006) Guidelines for Ecological Impact Assessment in the United Kingdom – Marine and Coastal (Final version 5 Aug 2010). http://www.ieem.net/ecia.asp

Institute of Ecology and Environmental Management (2006) Guidelines for Ecological Impact Assessment in the United Kingdom (version 7 July 2006). http://www.ieem.org.uk/ecia/index.html

Institute of Environmental Management and Assessment, Guidelines for environmental impact assessment, March 2004;

International Standards Organisation (2010) Mechanical vibration and shock — Vibration of fixed structures — Guidelines for the measurement of vibrations and evaluation of their effects on structures. ISO, Geneva, Switzerland

IPIECA (2010) Alien invasive species and the oil and gas industry: Guidance for prevention and management www.ogp.org.uk/pubs/436.pdf.

Jackson, D., Whitfield, P. (2011). Surveying and monitoring of Marine birds in relation to marine Renewables deployments in Scotland (Volume IV) IN Guidance on surveying and monitoring in relation to marine Renewables deployments in Scotland. Scottish Natural Heritage Commissioned Report No. XXX (iBids and Project no).

JNCC (1997). Coasts & Seas of the United Kingom, Region 15 & 16 North-west Scotland: The Western Isles and west Highland

JNCC, (2010), Handbook for Phase 1 habitat survey - a technique for environmental audit, ISBN 0 86139 636 7

JNCC. (2010a). UK Priority Species and Habitats. Retrieved October 2011, from http://jncc.defra.gov.uk/page-5705.

K. MacKenzie. K, Longshaw.M, Begg G.S, and McVicar. H. (1998) Sea lice (Copepoda: Caligidae) on wild sea trout (Salmo trutta L.) in Scotland ICES Journal of Marine Science, 55: 151–162.

Kongsberg (2011a). Measurement of underwater noise during installation of 2.4MW Oyster Array at EMEC wave test site, Billia Croo, Orkney, Kongsberg Technical Report 250121-TR-0001 produced for Aquamarine Power Ltd, September 2011.

Kongsberg (2011b). Measurement of background underwater noise off Isle of Lewis, Kongsberg Technical Report 250121-TR-0002 produced for Aquamarine Power Ltd, December 2011.

Laist. D.W., Knowlton. A.R. Mead. J.G. Collet. A.S. Podesta (2001). Collisions between ships and whales. Marine Mammal Science 17: 35-75

Lewis Wave Power Limited (2011) Environmental Scoping Report: 40 MW Oyster Wave Array: West Coast Lewis

Lewis Wind Power (2011) Stornoway Wind Farm Environmental Statement

Linley E.A.S., Wilding T.A., Black K., Hawkins A.J.S. & Mangi S. (2007). Review of the reef effects of offshore wind farm structures and their potential for enhancement and mitigation. Report from PML Applications Ltd and the Scottish Association for Marine Science to the Department for Business, Enterprise and Regulatory Reform (BERR), Contract No: RFCA/005/0029P

Macleod, K ., Lacey, C., Quick, N., Hastie, G., Wilson J. (2011). Surveying and monitoring of Cetaceans and basking sharks in relation to marine renewables deployments in Scotland (Volume II) IN Guidance on surveying and monitoring in relation to marine renewables deployments in Scotland. Scottish Natural Heritage Commissioned Report No. XXX (iBids and Project no).

MAGIC Interactive environmental GIS tool: Available from http://www.magic.gov.uk

Malcolm. I.A., Godfrey. J, and Youngson. A.F. (2010). Review of migratory routes and behaviour of Atlantic salmon, sea trout and European eel in Scotland's coastal environment: implications for the development of marine renewables.. Scottish Marine and Freshwater Science Vol 1 No 14.

Marine Energy Group (2009) Marine Renewable Potential

Marine Scotland (2010) Mackerel web page accessed at: http://www.scotland.gov.uk/Topics/marine/marine-environment/species/fish/pelagic/mackerel.

Marine Scotland (2011) Lewis Wave Power Oyster Wave Energy Convertor Array, North West Coast Lewis - Scoping Opinion

Marine Scotland (2011) Videos of the seabed available from URL http://www.scotland.gov.uk/Topics/marine/science/MSInteractive/seabedlayer Consulted on 15/12/2011

Marine Scotland (2011a) effort data available from the Scotish Government website available from: http://www.scotland.gov.uk/Topics/Statistics/Browse/Agriculture-Fisheries/RectangleData accessed 10/11/2011

Marine Scotland (2011b) Landings data available from the Scottish Government website available from: http://www.scotland.gov.uk/Topics/Statistics/Browse/Agriculture-Fisheries/RectangleData accessed 10/11/2011

Marine Scotland Licencing (2011) Lewis Wave Power Oyster Wave Energy Convertor Array, North West Coast Lewis. Scoping Opinion

Marine Scotland: Fishing Effort and Quantity and Value Web Page: http://www.scotland.gov.uk/Topics/Statistics/Browse/Agriculture-Fisheries/RectangleData

MarLIN, undated. Website, available at: http://www.marlin.ac.uk/

MarLIN. (2007). http://www.marlin.ac.uk/specieshabitats.php?speciesID=3614. (H. Tyler-Walters, Producer, & Marine Biological Association of the United Kingdom.) Retrieved October 2011, from *Laminaria hyperborea*. Tangle or cuvie. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme.

MCA 2008) Marine Guidance Notice 371, Offshore Renewable Energy Installations (OREIs) - Guidance on UK Navigational Practice, Safety and Emergency Response Issues.

Moore, C. G. and Roberts, J. M. (2011). An assessment of the conservation importance of species and habitats identified during a series of recent research cruises around Scotland. Scottish Natural Heritage Commissioned Report No. 446.

Moore, C. G. and Roberts, J. M. (2011). An assessment of the conservation importance of species and habitats identified during a series of recent research cruises around Scotland. Scottish Natural Heritage Commissioned Report No. 446.

Moore, C. G. and Roberts, J. M. (2011). An assessment of the conservation importance of species and habitats identified during a series of recent research cruises around Scotland. Scottish Natural Heritage Commissioned Report No. 446.

National Biodiversity Network (2012). NBN Gateway website. Available at: http://data.nbn.org.uk/

National Strategy for Climate Change

NBN 2011. National Biodiversity Network interactive species search map for salmon. Available at: http://data.nbn.org.uk/imt/?mode=SPECIES&species=NBNSYS0000188606 Accessed on: 23/11/2011.

NBN gateway source: http://data.nbn.org.uk

Neal, K.J and Wilson, E. 2008. *Cancer pagurus*. Edible crab. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [on-line]. Plymouth: Marine Biological Association of the United Kingdom.

Neal.K, Pizzolla. P and Wilding.C (2008). *Dipturus batis*. Common Skate. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 20/11/2011]. Available from: <http://www.marlin.ac.uk/reproduction.php?speciesID=3183>

Nedwell J.R. & Brooker A.G. (2008). Measurement and assessment of background underwater noise and its comparison with noise from pin pile drilling operations during installation of the SeaGen tidal turbine device, Strangford lough. Available at: http://www.offshorewind.co.uk/Assets/Final%20report_26%2001%2009.pdf

Nedwell J.R., Langworthy J. and Howell D. (2003). Assessment of sub-sea acoustic noise and vibration from offshore wind turbines and its impact on marine wildlife; initial measurements of underwater noise during construction of offshore windfarms, and comparison with background noise. Subacoustech Report ref: 544R0423, published by COWRIE.

Nolet, B.A., Wansink, D.E.H., and Kruuk, H (1993). Diving of otters (*Lutra lutra*) in a marine habitat: use of depths by a single-prey loader. Journal of Animal Ecology 62, 22-32

Northridge, S. P., M. L. Tasker, et al. (1995). "Distribution and relative abundance of harbour porpoises (*Phocoena phocoena* L.), white-beaked dolphins (*Lagenorhynchus albirostris Gray*),and minke whales (*Balaenoptera acutorostrata Lacepede*) around the British Isles." ICES Journal of Marine Biology 52(1): 55-66.

Npower renewables and RWE group (2007) Siadar Wave Energy Project Environmental Statement

OSPAR (2009). Background Document for Basking shark Cetorhinus maximus. Available at: http://qsr2010.ospar.org/media/assessments/Species/P00419_basking_shark.pdf

Perrin, W.F.,. Würsig, B.G., Thewissen, J.G.M (2008) Encyclopedia of Marine Mammals

Policy Advice Note 75 (PAN 75) Planning for Transport

Powell, H.T., Holme, N.A., Knight, S.J.T., Harvey, R., Bishop, G., & Bartrop, J. 1979. Survey of the littoral zone of the coast of Great Britain: 3. Shores of the Outer Hebrides. Nature Conservancy Council, CSD Report, No. 272.

Protection of United Kingdom Waters from Pollution from Ships, Department for Transport, Department for Environment, Food and Rural Affairs, undated Establishment of Marine Environmental High Risk Areas (MEHRAs)

Ramsay, D. L. & Brampton, A. H., (2000). Coastal cells in Scotland: Cells 8 & 9 – The Western Isles. Scottish Natural Heritage Research, Survey and Monitoring Report No 150.

Reid, J.B, Evans, P.G.H and Northridge, S.P. (2003). Atlas of cetacean Distribution in North-west European waters. JNCC, Peterborough

Richards, J. 1998. Western Isles landscape character assessment. Scottish Natural Heritage Review No 92.

Richardson J. (1991). Effects of Noise on Marine Mammals : Executive Summary. LGL Ecological Research Associates Inc. Available at: http://www.gomr.boemre.gov/PI/PDFImages/ESPIS/4/4801.pdf

Ritchie & Mather (1970). Beaches of Lewis and Harris. Department of Geography, University of Aberdeen, for the Countryside Commission for Scotland. Reprinted 2004 by Scottish Natural Heritage as Commissioned Report No. 088.

Rowley. S. (2008). *Molva molva*. Ling. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [on-line]. Plymouth: Marine Biological Association of the

United Kingdom. [cited 20/11/2011]. Available from: <http://www.marlin.ac.uk/speciesinformation.php?speciesID=3826>

Royal Haskoning (2010). SeaGen Environmental Monitoring Programme: Biannual Update, July 2009 – Jan 2010. Available at: http://www.seageneration.co.uk/downloads/SeaGen%20biannual%20report%20April%202010.PDF

Royal Haskoning. (2011). Coastal geomorphology walkover survey.

Royal Haskoning. (2012). Historical Trend Analysis and Expert Geomorphological Assessment. Report to Aquamarine Power Ltd.

RWE (group) Npower renewables and (2007) Siadar Wave Energy Project Environmental Statement

Saunders, G., Bedford, G.S., Trendall, J.R., and Sotheran, I. (2011). Guidance on survey and monitoring in relation to marine renewables deployments in Scotland. Volume 5. Benthic Habitats. Unpublished draft report to Scottish Natural Heritage and Marine Scotland.

SCANS II (2006). Small cetaceans in the European Atlantic and North Sea

SCOS (2010). Scientific Advice on Matters Related to the Management of Seal Populations

Scott, K.E., Anderson,C. and Benson,J.F et.al. (2005). An assessment of the sensitivity and capacity of the Scottish seascape in relation to offshore windfarms. Scottish Natural Heritage Commissioned Report No. 103.

Scott, K.E., Anderson,C. and Benson,J.F. (2005) et.al. Landscape capacity study for onshore wind energy development in the Western Isles Scottish Natural Heritage Commissioned Report No. 042

Scottish Executive (1999) Planning Advice Note (PAN) 56 Planning and Noise, The Scottish Office

Scottish Executive (2000). Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2000.

Scottish Executive (2005) Going for green growth: a green jobs strategy for Scotland Available at: http://www.scotland.gov.uk/Resource/Doc/54357/0013160.pdf

Scottish Executive. 2007. Scottish Marine Renewables SEA. Environmental Report Section C SEA Assessment: Chapter C7 Fish and Shellfish.

Scottish Government (2011a). Scotland's Marine Atlas. Available at: http://www.scotland.gov.uk/Topics/marine/science/atlas

Scottish Government (2011b). Consultation on Seal Haul-out Sites. Available at: http://www.scotland.gov.uk/Resource/Doc/347210/0115571.pdf

Scottish Government (2012). Seal Licensing. Available at: http://www.scotland.gov.uk/Topics/marine/Licensing/SealLicensing

Scottish Government (2008) Scottish Aquaculture: A Fresh Start: A Consultation on a Renewed Strategic Framework for Scottish Aquaculture

Scottish Government 2011. 2020 Routemap for Renewable Energy in Scotland August 2011. Available at http://www.scotland.gov.uk/Publications/2011/08/04110353/0 [Accessed December 2011]

Scottish Government, (Undated). Marine energy policy Statement available at: http://www.scotland.gov.uk/Topics/Business-Industry/Energy/Energy-sources/19185/17853-1/MEPS (2008) accessed on 20/11/2011

Scottish Natural Heritage and Forestry Commission Scotland, (2010) Floating roads on peat. Scottish Natural Heritage Information Service. Available from: http://www.snh.gov.uk/publications-data-and-research/snhi-information-service/

Scottish Natural Heritage Priority Marine Features. Available from: http://www.snh.gov.uk/protecting-scotlands-nature/safeguarding-biodiversity/priority-marine-features/

Scottish Natural Heritage. (2011). Priority Marine Features in Scottish Territorial Waters (Draft List). Retrieved October 2011, from http://www.snh.gov.uk/docs/B874876.pdf.

Seafish (2011) Economic survey of the UK fishing fleet 2009.

Seawatch Foundation (undated a). Risso's Dolphin in UK Waters. Available at: http://www.seawatchfoundation.org.uk/docs/Rissos_Dolphin.pdf

Seawatch Foundation (undated b). The White Beaked Dolphin in UK Waters. Available at: http://www.seawatchfoundation.org.uk/docs/White-beaked_Dolphin.pdf

SEPA (2008) Engineering in the water environment good practice guide: construction of river crossings

SEPA (2008) RBMP Water body information sheet for water body 200476 in West Highland available via: http://apps.sepa.org.uk/rbmp/pdf/200476.pdf Accessed: 7/2/2012

SEPA (2010) Land use planning system SEPA guidance note 4: Planning Guidance on wind farm developments (including guidelines for groundwater unit staff and ecologists when assessing the impacts of wind farms on groundwater and associated receptors)

SEPA (2010a) Land use planning system SEPA guidance note 4: Planning Guidance on wind farm developments (including guidelines for groundwater unit staff and ecologists when assessing the impacts of wind farms on groundwater and associated receptors).

SEPA Pollution Prevention and Chemical Guidelines (PPG 5) Works and maintenance in or near water

SEPA RBMP Interactive Map. Available via: http://gis.sepa.org.uk/rbmp. Accessed: 7/2/2012

SEPA Pollution Prevention and Chemical Guidelines (PPG2) - Above ground oil storage tanks

Shark Trust (2009a) Thornback ray Raja clavata fact sheet. available at: www.sharktrust.org/do_download.asp?did=33247. Accessed : 20/11/2011

Shark trust (2009b) spotted ray Raja montagui fact sheet. available at: www.sharktrust.org/do_download.asp?did=33249. Accessed: 20/11/2011

Shark trust (2009c) Tope shark Galeorhinus galeus fact sheet. Available at: www.sharktrust.org/do_download.asp?did=35275. Accessed: 20/11/2011

Sims, D.W. (1999). Threshold foraging behaviour of basking sharks on zooplankton: life on an energetic knife-edge? Proc. R. Soc. Lond. B (1999) 266, 1437-1443. Available at: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1690094/pdf/UUJHLXT1J6KP8E54_266_1437.pdf

SMRU (2011). Provisional Regional PBR for Scottish seals in 2010. Available at: http://scotland.gov.uk/Topics/marine/Licensing/SealLicensing/PBR

SNH (2006) Constructed tracks in the Scottish Uplands.

SNH (2009) A handbook on environmental impact assessment: Guidance for Competent Authorities, Consultees and others involved in the Environmental Impact Assessment Process in Scotland

SNH Scottish Wildlife Series: Otters and Development. Available at: http://www.snh.org.uk/publications/on-line/wildlife/otters/default.asp.

SNIFFER (2009) WFD95 – A Functional Wetland Typology for Scotland.

Soil Survey of Scotland, Stornoway and North Lewis, Sheet 8, 1:50,000 scale;

Southall, B.L. (2005). Final Report of the National Oceanic and Atmospheric Administration (NOAA) International Symposium: Shipping Noise and Marine Mammals: A Forum for Science, Management, and Technology, 18-19 May 2004. Available at: http://www.nmfs.noaa.gov/pr/pdfs/acoustics/shipping_noise.pdf

Sparling, C., Grellier, K., Philpott, E., Macleod, K., Wilson, J. (2011). Surveying and monitoring of Seals in relation to marine renewables deployments in Scotland (Volume III) IN Guidance on surveying and monitoring in relation to marine renewables deployments in Scotland. Scottish Natural Heritage. http://www.snh.gov.uk/docs/A585080.pdf.

SQW consulting (2009). Socio-economic impact assessment of Aquamarine Power's Oyster Projects. Report to Aquamarine Power, March 2009. http://www.oceanrenewable.com/wp-content/uploads/2011/05/SocioEconomic_Report_SQWConsulting-1.pdf

SR, SNH, SEPA & FCS (2010): Good practice during wind farm construction (version 1);

Strachan, R. 2007. National survey of otter Lutra lutra distribution in Scotland 2003–04. Scottish Natural Heritage Commissioned Report No. 211 (ROAME No. F03AC309).

Surfers against sewage 2009. Guidance on environmental impact assessment of offshore renewable energy development on surfing resources and recreation

The Atlantic Salmon Trust (2011) Multi-Source Sampling - Stable Isotope Variation and the Skinny Salmon Story available at: http://www.atlanticsalmontrust.org/research/multisource-sampling-stable-isotope-variation-and-the-skinny-salmon-story.html accessed on: 24/11/2011

The Climate Change (Scotland) Act 2009

The Conservation (Natural Habitats, etc & C) Regulations 1994

The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2000

The Landscape Institute and the Institute of Environmental Management and Assessment. (2002) Guidelines for Landscape and Visual Assessment (Second Edition. Spon Press).

The Marine (Scotland) Act 2010.

The Marine and Coastal Access Act 2009.

The Scottish Government, (2010). Scottish Marine and Freshwater Science Volume 1 No 18: Further Scottish Leasing Round (Saltire Prize Projects): Regional Locational Guidance. [WWW] The Scottish Government. Available from http://www.scotland.gov.uk/Publications/2010/09/17095123/3 [Accessed 09/08/11]

The Town and Country Planning (Development Management Procedure) (Scotland) Regulations 2008.

The Water Environment (Controlled Activities) (Scotland) Regulations 2005

Thompson. B.M, Lawler. A.R. and Bennett, D.B (1995) Estimation of the spatial distribution of spawning crabs (Cancer pagurus L.) using larval surveys of the English Channel. Location: ICES Marine Science Symposia, 199, 139-150.

Thorstad, E.B. Okland, F. Finstad, B. Silvertsgard, R. Bjorn, P.A. and McKinley, R.S. (2004) Migration speeds and orientation of Atlantic salmon and sea trout post-smolts in a Norwegian fjord system Environmental Biology of Fishes, 71, 305-311.

Tyler-Walters. H (2007). *Modiolus modiolus*. Horse mussel. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 15/04/2011].

UK Biodiversity Action Plan Available from http://ukbars.defra.gov.uk/

UK Highways Agency (2008) The Design Manual for Roads and Bridges. Volume 11, Section 3, Part 7 – Noise and Vibration (HA 213/08). HMSO, London

UK Marine SACs Project, Collision between vessels and marine mammals http://www.ukmarinesac.org.uk/activities/ports/ph3_2_2.htm

Van der Kooij J, Scott BE, Mackinson S (2008) The effects of environmental factors on daytime sandeel distribution and abundance on the Dogger Bank. Journal of Sea Research 60: 201-209.

Visit Scotland (2011) Tourism in Northern Scotland 2010 Highlands & Islands, Aberdeen & Grampian, Orkney & Shetland Factsheet

Visit Scotland website http://walking.visitscotland.com/walks/hebrides/212602

Vogel, A, Christie, D., Lidster, M & Morrison, J. (2011). Wave energy convertors, sediment transport and coastal erosion.

Vogel, A. (Unpublished). Preliminary writings: extreme waves, WECs and coastal erosion.

WDCS (undated). Risso's dolphin conservation plan for waters west of the UK. Available at:: http://www.wdcs.org/submissions_bin/Rissos_Conservation_Plan.pdf

Western Isles Local Biodiversity Plan. Available from http://www.cne-siar.gov.uk/biodiversity/

Western Isles Local Council (2008) Western Isles Local Plan. Available at: http://www.cne-siar.gov.uk/localplanning/localplan.asp

Western Isles Species Priority List. Available from http://www.cne-siar.gov.uk/biodiversity/speciesprioritylist.asp

Western Isles Structure Plan (2003). Available at: http://www.cne-siar.gov.uk/eds/strategicplanning/index.asp

Wilding. C and Snowden. E (2008). Raja clavata. Thornback ray. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 25/11/2011]. Available from: <http://www.marlin.ac.uk/speciesinformation.php?speciesID=4229>

Williams, J.J. & Esteves, L.S. 2005, Predicting shoreline changes: A case study in Rio Grande do Sul, Brazil. Geophysical Research Letters, Vol. 32

Wilson. B., Battty. R.S., Daunt. F., Carter. C. (2007). Collision risks between marine renewable energy devices and mammals, fish and diving birds. Report to the Scottish Executive. Scottish Association for Marine Science, Oban, Scotland, PA37 1QA.

Wright, P.J., Jensen, H., Tuck, I., 2000. The influence of sediment type on the distribution of the lesser sandeel, Ammodytes marinus. J. Sea Res. 44, 243–256.

Wyn, G, Brazier, P and McMath, A J (2000). CCW handbook for marine intertidal Phase 1 survey and mapping. CCW Marine Sciences Report: 00/06/01