MeyGen Ltd

MeyGen Tidal Array
EIA Screening Report

ASSIGNMENT A100835-S00
DOCUMENT A-100835-S00-A-REPT-001

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REV	DATE	DESCRIPTION	ISSUED	CHECKED	APPROVED	CLIENT
A02	22/09/23	Issued for Use	MK	EE	CD	
R02	18/09/23	Issued for review	MK	EE	EE	
A01	09/08/23	Issued for Use	EE	KC	KC	-
R01	05/07/23	Issued for review	EE	KC	KC	-

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EXECUTIVE SUMMARY

MeyGen plc intend to apply to vary the existing MeyGen Phase 1 Section 36 Consent via Section 36c (s36c) of the Electricity Act 1989. This EIA Screening Report constitutes a request for the opinion of Scottish Ministers as to whether this proposed s36c variation requires a statutory Environmental Impact Assessment (EIA), under the Electricity Act (Environmental Impact Assessment) Regulations Scotland 2017 and the Marine Works (Environmental Impact Assessment) Regulations Scotland 2017.

The MeyGen Phase 1, Section 36 Consent was awarded in 2013, for a tidal energy power generating station with:

- A total generating capacity not exceeding 86 MW;
- No more than 61 three-bladed single-rotor turbines, each with a rotor diameter of 16 – 20 metres (m);
- All foundations and scour protection; and
- Inter array cabling and export cables to the shore.

The MeyGen Phase 1 Environmental Statement (2012) supported the s36 consent application. The ES (2012) concluded no significant effects on the from Phase 1 86 MW, 86 turbine array and associated onshore and offshore infrastructure, subject to implementation of proposed mitigation (Appendix B).

MeyGen are seeking to vary certain parameters within the MeyGen Phase 1 Section 36 Consent to enable all future phases of MeyGen to benefit from the latest, most efficient tidal turbine technology. This will help achieve a lower levelised cost of energy (LCoE) from the MeyGen site and thereby contribute to national renewable energy targets.

MeyGen seek to vary the following parameters for all future phases of MeyGen Phase 1, with the following proposed changes:

- Increase turbine rotor diameter from 16 - 20 m to 16 - 24 m;
- Reduce the minimum seabed clearance between the rotor tip and the seabed from 4.5 to 3.0 m;
- Remove the rated power cap for each individual turbine (currently restricted 1.0 MW to 2.4 MW) whilst retaining the permitted generating capacity for MeyGen Phase 1, not exceeding 86 MW;
- Increase blade swept area from 201 - 314 m^2 (based on a 16 - 20 m diameter turbine) to 201 - 452 m^2 (based on a 16 - 24 m diameter turbine);
- Reduce the total number of turbines in Phase from 61 specified in ANNEX 1 Section 36 (2013), to up to 40 turbines;
- Increase of offshore export cables rating from 6.6 kV to a maximum of 33 kV

The proposed changes yield an indicative Phase 1 array of up to 40 turbines, whilst retaining the overall maximum generating capacity of 86 MW, representing less than half of the 86 turbines assessed within MeyGen Phase 1 ES (2012).

This screening report considers the impacts of the proposed changes on each receptor with the MeyGen Phase 1 ES (2012) and concludes that the impacts of the proposed changes would not have any additional significant impacts on any receptor, subject to implementation of mitigation proposed in MeyGen Phase 1 ES (2012) summarised in this report (Appendix B), and therefore would not result in significant environmental impact. As part of engagement with regulators and key stakeholders undertaken to develop this screening report, the need to update collision risk modelling (CRM) to understand impact of proposed changes on key marine species was noted. This exercise has been undertaken using the next phase of the MeyGen project as an example, with CRM confirming no adverse effect upon regional populations of harbour seal, grey seal, harbour porpoise and minke whale, as well as European shag, black guillemot and Atlantic salmon. Following review of the MeyGen Phase 1 Environmental Statement (2012), and

further consideration of environmental effects arising from the proposed changes, no further significant impacts were identified to arise from the proposed changes, and it is considered that an EIA is not required.

This screening request illustrates how the proposed changes to the future stages of the MeyGen project may be represented in a future development scenario and provides the required information to inform this request for an EIA Screening Opinion.

1 INTRODUCTION

1.1 MeyGen Phase 1 Environmental Statement 2012

In 2012, MeyGen Ltd submitted applications for MeyGen Phase I ('the Project')'s offshore works to Marine Directorate Licensing Operations Team (MD-LOT; previously Marine Scotland Licensing Operations Team, MS-LOT), under Section 36 of the Electricity Act 1989 and Part 4 of the Marine (Scotland) Act 2010. As part of these consent applications a comprehensive Environmental Impact Assessment (EIA) was undertaken. An Environmental Statement (ES), MeyGen Phase 1 ES (MeyGen, 2012) was produced, together with a report containing information to support the Habitats Regulations Appraisal (HRA), to assess the potential impacts of the Phase 1 Project, with a maximum aggregated capacity of 86 MW, and up to 86 tidal turbines (and associated infrastructure) on the natural and human environment.

1.2 Section 36 consent 2013

In 2013, the Scottish Ministers granted MeyGen Ltd consent under Section 36 of the Electricity Act 1989, for the construction and operation of the MeyGen Tidal Energy Project electricity generating station in the Inner Sound of the Pentland Firth, approximately 3 km northwest of John O'Groats, Caithness, Scotland. The MeyGen Phase 1 Environmental Statement (2012) supported the section 36 application.

Section 36 consent (2013) was granted for the construction and operation of Phase 1[1], consisting of up to 61 turbines with a permitted total capacity of 86 MW (Figure 1), conditional upon the Project being built out in Stages.

1.3 Section 36 (2013) Annex 1 description of development

The Project, as shown in ANNEX 3 to this consent (replicated as Figure 1 below), shall have a permitted generating capacity not exceeding 86 MW and shall comprise, subject to condition 2 in ANNEX 2 to this consent, a tidal-powered electricity generating station in the Inner Sound of the Pentland Firth, between the north coast of Scotland and the Island of Stroma including:

1. not more than 61 three-bladed single rotor horizontal axis turbines each with a rotor diameter of no less than 16 metres and no more than 20 metres;
2. all foundations and scour protection; and
3. inter array cabling and export cables to the shore; and
4. all as specified in the Application, Environmental Statement and Supplementary Environmental Information Statement. The references in this consent shall be construed accordingly.

[1] https://marine.gov.scot/sites/default/files/section_36_consent_2013.pdf

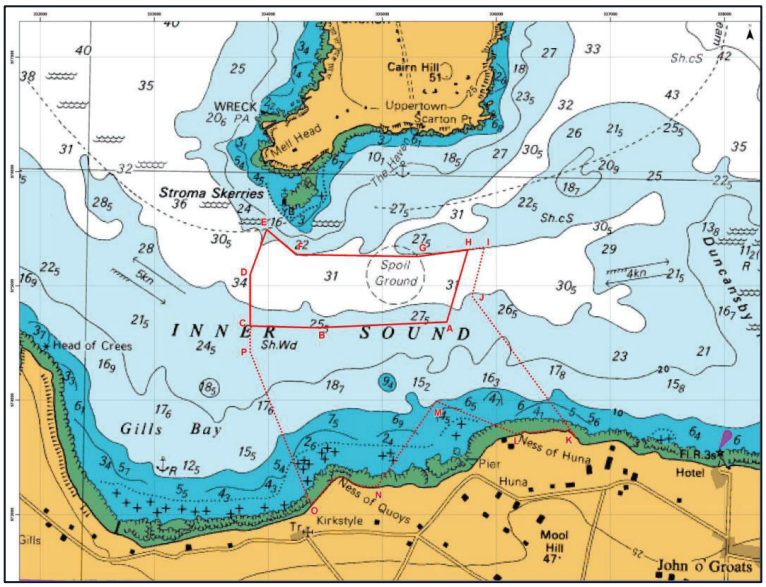

Figure 1 Section 36 (2013) Annex 3 location of MeyGen Phase 1 array location (outlined in solid red line) and bounds of the cable corridor (outlined in dashed red line) within the Inner Sound of the Pentland Firth.

1.4 Section 36 Stage One

The s36 (2013) limited development to an initial Stage of development, referred to as Stage One, that permitted the installation of up to six turbines. The approved stage one six turbine array was informed by Collision Risk Modelling (CRM) conducted by Scottish Natural Heritage (SNH, now NatureScot) that concluded that the potential collisions for harbour seal from a six turbine deployment, based on an avoidance rate of 98%, would avoid an adverse impact on the current harbour seal population within the Orkney and North Coast Management Unit. The harbour seal population was considered by NatureScot to be the receptor at greatest risk of impacts from tidal energy developments in the Pentland Firth and Orkney waters as a result of ongoing declining population of harbour seals status within the Orkney and North Coast Management Unit and wider UK waters.

1.5 Phase 1a

The MeyGen Project is located in the Inner Sound, a body of water in the southern part of the Pentland Firth, between the north coast of Scotland and the island of Stroma. The Inner Sound is approximately 3 km wide at the widest point between Mell Head on Stroma and Gills Bay on the Scottish mainland. The deepest part of the Inner Sound is 48.6 m and the Project is situation in the centre of the main channel where the usable water depths range from 31.5 to 38 m at Lowest Astronomical Tide (LAT). The turbine deployment area is 1.1 km^2 in the centre of the Crown Estate Scotland lease area. A cable corridor to shore has been identified covering an area of 1.3 km^2 (see Figure 1).

In 2017, MeyGen installed the first four turbines (Phase 1a) in the Inner Sound, comprised of:

- 3 x Andritz Hydro Hammerfest HS1500 (1.5 MW, 18 m rotor diameter); and
- 1 x Atlantis Resources AR1500 (1.5 MW, 18 m rotor diameter).

Tidal turbines convert kinetic energy from the flow of water through the Inner Sound (driven by tides) into electrical energy via the generator. The MeyGen turbines are able to extract energy from both the east-going (flood) and west-going (ebb) tidal streams in the Inner Sound. They are supported on the seabed via a turbine support structure (TSS) comprising a gravity-based foundation. Each of the existing four turbines has a dedicated export cable through a horizontally directional drilled (HDD) ducts to shore transporting electricity generated offshore to the onshore 33 kV Ness of Quoys distribution network.

In February 2023, MeyGen Phase 1a became the first tidal stream array in the world to generate 50 GWh of electricity from tidal energy.

1.6 Phase 1b

Phase 1b was the next planned installation at MeyGen, which considered the deployment of a further four turbines in addition to the four Phase 1a turbines. The Phase 1b deployment would have resulted in a total of eight turbines being installed and operated; two more than the six originally permitted within Stage One of the Project.

In 2017, Phase 1b gained approval under Condition 2(b)(ii) of the Section 36 consent, for the additional two turbines, concluding that the deployment of an array of up to eight turbines for Phase 1a and Phase 1b would not result in any impact greater than that previously predicted for the approved Stage One. MeyGen Phase 1b was subsequently not installed.

1.7 Section 36 variation boundary change

In 2019, MeyGen was granted s36c variation to the existing s36 Consent. This amended the Phase 1 area for turbine deployment (as delineated by the solid red line in Annex 3 of the Existing Consent) to include an additional area to the north-west of the Site and to remove a similar sized area from the eastern side of the site (Figure 2).

A Marine Licence (04577/17/1) was granted in 2017 to reflect these updated boundary co-ordinates.

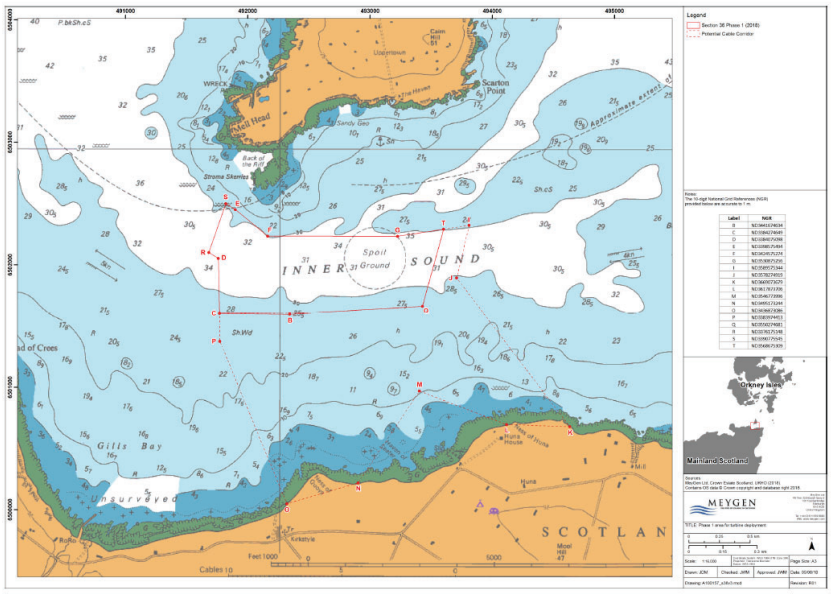

Figure 2 Section 36 (2019) Annex 3 varied location of MeyGen Phase 1 array location (outlined in solid red line) and bounds of the cable corridor (outlined in dashed red line) within the Inner Sound of the Pentland Firth.

1.8 MeyGen 2

In 2022, MeyGen were awarded a Contract for Difference (CfD) from the UK Government Allocation Round (AR) 4. This CfD represents an electricity price guarantee for 28 MW generation. This CfD financially supports the next stage of the MeyGen Tidal Energy Project (referred to hereafter as 'MeyGen 2') which aims to deploy an indicative 10 turbines up to 24 m diameter turbines, circa 3 MW. MeyGen 2 project would be commissioned during 2027.

1.9 Section 36 Condition 2

Condition 2 of the s36 (2013) requires that the development be implemented in a staged manner, to prevent significant adverse impacts to the environment. Specifically, Condition 2 b(ii) of the s36 (2013) stipulates that MeyGen may proceed with the next subsequent stage of development after demonstrating regard to the preservation of the environment and ecology.

Whilst harbour seals have been identified as the receptor at greatest risk from tidal developments, regulators have noted concerns related to collision risk and impact upon other marine mammals species, namely; grey seal, harbour porpoise and minke whale. Recent stakeholder engagement confirmed the requirement for updated collision risk modelling to be conducted to assess the impact of the proposed changes upon these key marine species.

This EIA Screening Report aims to obtain the opinion of Scottish Ministers on whether the s36c consent variation requires statutory EIA. The subsequent s36c consent variation (whether EIA/non-EIA) will seek to vary the parameters described in Chapter 2 and 3. It is intended that all future stages of MeyGen Phase 1 (including MeyGen 2, which consists of 10 additional turbines) would use the varied parameters as described in Chapter 2 and 3.

Additionally, this screening report presents CRM for each of these key marine species to understand the combined impact of deployment of Phase 1a turbines and the proposed changes associated with deployment of MeyGen 2 turbines (next subsequent stage of development).

We anticipate that permission to install the next subsequent phase comprised of ten MeyGen 2 turbines would still require discharge of Condition 2(b)(ii) of the MeyGen Phase 1 consent. The information required to discharge Condition 2(b)(ii) for MeyGen 2 will be provided as a separate document. However, the evidence provided in this EIA Screening Report describes how the proposed MeyGen 2 development has regard to the ecology and environment, with specific reference to marine mammals (harbour and grey seal, harbour porpoise and minke whale), fish (Atlantic salmon) and seabirds (European shag and black guillemot) as required in Condition 2b(ii) and will form the basis of this Condition request.

2 PROPOSED CHANGES TO MEYGEN PHASE 1

MeyGen are seeking to vary certain parameters within s36 (2013) and project description envelope within MeyGen Phase 1 ES (2012) to enable all future phases of MeyGen to install the latest, most efficient tidal turbine technology and achieve a lower levelised cost of energy (LCoE) from the MeyGen site.

MeyGen are seeking to vary the following parameters for all future phases of MeyGen Phase 1. The proposed changes are:

- Increase the rotor diameter of tidal turbines from 16 - 20 m specified in ANNEX 1 Section 36 (2013) to, 16 - 24 m;
- Reduce the minimum clearance between blade tip to the seabed, from 4.5 m specified in Project Description Envelope MeyGen Phase 1 ES (2012) to a minimum of 3 m;
- Remove the rated MW power cap per turbine, currently 1.0 - 2.4 MW, specified in Project Description Envelope MeyGen Phase 1 ES (2012) whilst retaining the permitted generating capacity for MeyGen Phase 1 not exceeding 86 MW, specified in ANNEX 1 Section 36 (2013);
- Increase blade swept area from 201 - 314 m^2 (based on a 16 – 20 m diameter turbine) specified in Project Description Envelope MeyGen Phase 1 ES (2012) to 201 - 452 m^2 (based on a 16 - 24 m diameter turbine);
- Reduce the total number of turbines in Phase from 61 specified in ANNEX 1 Section 36 (2013), to up to 40 turbines;
- Increase of offshore export cables rating from 6.6 kV to a maximum of 33 kV

The s36 (2013) description of development is provided in section 1.3 and MeyGen Phase1 ES (2012) project description envelope is provided in Table 1 below.

2.1 Proposed changes MeyGen Phase 1 ES (2012) project description envelope

Table 1 outlines the difference between the specification of the MeyGen Phase 1 ES (2012) Project Description Envelope and the proposed changes for future phases of MeyGen.

PROJECT PARAMETER	PROJECT DESIGN ENVELOPE ES (2012)	PROPOSED CHANGES
Installed capacity	86 MW	No change
Number of turbines and TSSs	Up to 61 turbines[2]	Total number of Phase 1 turbines is not expected to exceed 40 turbines, this value is dependent upon rated power of each turbine used to build out to 86 MW
TSS design options	Gravity Based System (GBS); Monopile; Pin pile	No change

[2] *Note: up to 86 turbines were considered in the ES (MeyGen, 2012), but the number of turbines was reduced to 61 prior to issue of the Section 36 consent and Marine Licence and consent was ultimately granted for 61 turbines*

PROJECT PARAMETER	PROJECT DESIGN ENVELOPE ES (2012)	PROPOSED CHANGES
Rated power	1.0 – 2.4 MW	This variation seeks to remove restriction on rated power per turbine to future-proof for technical advances
Number of rotors per turbine	1	No change
Number of blades per rotor	2 – 3	No change
Rotor diameter	16 – 20 m	16 – 24 m
Blade swept area	201 – 314 m^2	201 – 452 m^2
Height of structure above seabed (to centre of nacelle)	13.5 – 16 m	No change
Minimum clearance from blade tip to seabed	4.5 m	3.0 m
Minimum clearance from blade tip to sea surface (at LAT)	8 m	No change
Length of turbine nacelle	12 – 23 m	No change
Design options for generation in ebb and flood tides	Mechanical/electrical system to rotate the nacelle into the principal flow direction; Thruster in the nacelle tail to rotate the turbine into principal flow direction; Bidirectional blades that can generate from flows in opposite directions; and Mechanical/electrical system to pitch blades 180° to principal flow direction.	No change
Cut in flow speed	Approximately 1.0 m/s	No change
Cut out flow speed	3.4 – 5.0 m/s [3]	No change
Operating rotational speed	8 – 20 rpm	No change
Turbine separation	Minimum separation distance of 45 m cross-flow and 160 m down-flow	No change
Options for power conditioning equipment	All power conditioning is onshore at the PCC; Power conditioning within turbine nacelle and onshore transformer at the PCC	No change

[3] *Note: 5 m/s was the maximum cut out speed presented in the ES, however modelling to inform the marine mammal collision risk was based on 4.5 m/s. 5 m/s has been used to inform the modelling to inform the collision risk assessment presented in this ER*

PROJECT PARAMETER	PROJECT DESIGN ENVELOPE ES (2012)	PROPOSED CHANGES
Export cables voltage	Export cables rated at a maximum of 6.6kV	Export cables rated at a maximum of 33 kV
Options for transport of turbine to site location	On deck of dynamic positioning (DP) vessel, or Under tow by an installation vessel	No change
Options for turbine installation	Installation vessel lowers nacelle to foundation, or Nacelle is pulled down onto foundation by a cable	No change

All other parameters, as assessed within the Section 36 (2013), Project Description Envelope MeyGen Phase I ES (2012), Environmental Statement, Supplementary Environmental Information Statement, Section 36 variation (2019) amendment to turbine deployment area, (Figure 2) would not be changed, these include:

- Phase 1 area for turbine deployment, amended under Section 36 (2019) variation (see Figure 2);
- Phase 1 would not exceed a generation capacity of up to 86 MW; and
- Minimum clearance of 8 m from blade tip to sea surface at lowest astronomical tide (LAT) would be maintained.

2.2 Pre-application consultation with Scottish Government Marine Directorate

Pre-application engagement with the regulator and key stakeholders is essential to discuss the consenting route to inform the next phase of MeyGen and the proposed changes. Pre-application discussions were held with the Licensing Operations Team of the Marine Directorate of the Scottish Government (MD-LOT), together with NatureScot. MeyGen have consulted with the regulator and key stakeholders on three occasions since December 2022. During these meetings, MeyGen set out the rationale for the proposed changes that they would seek to make. These discussions were held at as early a stage as was practicable.

In December 2022, representatives of the MeyGen development team met with MD-LOT and NatureScot, to update key stakeholders of plans for future developments at the MeyGen site. MeyGen outlined the aspiration to deploy larger turbines, increase swept area, reduce seabed clearance and remove rated power cap.

MD-LOT agreed in principle that changes to Section 36 parameters and those specified within Project Description Envelope could be considered within the section 36C variation application process subject to seeing the detail of what was proposed. NatureScot advised that harbour seal collision risk would require further consideration within the s36c variation application.

In January 2023, MeyGen hosted an Advisory Group, chaired by Dr Ian Davies and attended by MeyGen and their consultants, along with MD-LOT, Marine Directorate scientific advisers, NatureScot and representatives from the Sea Mammal Research Unit (SMRU). During this meeting, the discussion explored with the aid of a draft environmental report the likely environmental effects of future phases of development. This discussion also covered the scope of non-statutory Environmental Report or an EIA (subject to screening opinion) required to support future s36c variation application.

In February 2023, MeyGen held further discussion with NatureScot on the specific issue of harbour seal collision risk, following this meeting MeyGen confirmed the intention to submit a s36c variation application to seek permission for the proposed changes for all future Phase 1 developments at the MeyGen site. NatureScot recommended that harbour seal collision risk modelling should take into account contemporary sources of harbour seal telemetry data and modelling obtained since the site-specific density estimate produced by Band *et al.*, (2016), which had been used to inform the 2017 Condition 2b(ii) application by MeyGen.

MD-LOT recommended that MeyGen request a screening opinion from Scottish Ministers as to whether the proposed changes sought through s36c variation application would be deemed an EIA development.

2.2.1 Section 36C variation application

Section 36C of the Electricity Act 1989 allows a person with the benefit of a s36 consent to apply to Scottish Ministers to have that consent varied.

The Electricity Generating Stations (Applications for Variation of Consent) (Scotland) Regulations 2013 ('the 2013 Regulations') came into force on 1 December 2013; these regulations set out the procedure for a s36C application, including the consultation process to be followed.

The variation to the MeyGen Phase 1 s36 consent that MeyGen seek applies principally to the *construction* of a generating station. MeyGen seek to vary specific parameters within the project envelope to that set out in the existing consent (as opposed to an *operational* variation, for example, varying the consented operational lifetime, or varying time limits on commencement of the development). The proposed changes would not result in development which would be fundamentally or substantially different in terms of scale and/or nature from that authorised by the existing consent.

2.3 Structure of EIA Screening Report

This Environmental Impact Assessment (EIA) Screening Report has been prepared to provide MD-LOT, the marine industries regulator in Scottish waters, the necessary information to provide a screening opinion as to whether the proposed changes would have significant adverse effects on the environment and require a statutory EIA to support a Section 36c (Electricity Act 1989) variation application.

2.3.1 Section 8 Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017

This report is structured in line with Section 8 of the Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017 (as amended) (the EIA Regulations), and with due regard to the selection criteria in Schedule 3 of the EIA Regulations, as follows:

a) a description of the location of the development, including a plan sufficient to identify the area in which the development is proposed to be sited;
b) a description of the proposed development including –

i. a description of the physical characteristics of the proposed development and, where relevant, of decommissioning works;
ii. a description of the location of the proposed development, with particular regard to the environmental sensitivity of geographical areas likely to be affected;

c) a description of the aspects of the environment likely to be significantly affected by the proposed development; and,
d) a description of any likely significant effects, to the extent of the information available on such effects, of the proposed development on the environment resulting from –
    i. the expected residues and emissions and the production of waste, where relevant;
    ii. the use of natural resources, in particular soil, land, water and biodiversity.

2.4 Request for EIA Screening Opinion

MeyGen are seeking the opinion of Scottish Ministers as to whether the proposed s36c variation application requires a statutory Environmental Impact Assessment (an "EIA screening opinion"), under the Electricity Act (Environmental Impact Assessment) Regulations Scotland 2017 and the Marine Works (Environmental Impact Assessment) Regulations Scotland 2017

This report has been prepared, taking into account up to date knowledge and methods of assessment, to allow Scottish Ministers, acting through MD-LOT, to consider this screening request.

The proposed development would not meet the definitions of any development type listed in Schedule 1 of the "Marine Works (Environmental Impact Assessment) Regulations Scotland 2017. The MeyGen Phase 1 development was considered a Schedule 2 development and required an EIA. However the proposed changes to the development are not predicted to have significant environmental effects not already assessed and consented, and therefore the s36c application is not considered to be an EIA development.

This screening request considers the impact of the proposed changes on all the receptors assessed in the ES (2012). This screening report considers the impacts upon on the following receptors from build out of the entire Phase 1 development to 86 MW, and screens out impacts from EIA for all these receptors:

- Physical Environment and Sediment Dynamics;
- Benthic Habitats and Ecology;
- Commercial Fisheries;
- Shipping and Navigation;
- Marine Cultural Heritage;
- Geology Hydrology and Hydrogeology;
- Terrestrial Habitats and Ecology;
- Landscape, Seascape and Visual Impact Assessment;
- Onshore Cultural Heritage;
- Socio-economics Tourism and Recreation;
- Onshore Transportation and Access;
- Onshore Noise and Dust; and
- Accidental Events.

Recent stakeholder engagement confirmed the requirement for updated collision risk modelling to be conducted to assess potential changes to collision risk with tidal turbines arising from the proposed changes upon the following key marine species prior to making a conclusion on whether or not an EIA would be required;

- Marine Mammals (Section 5.3) harbour seal, grey seal, harbour porpoise and minke whale;
- Ornithology (Section 5.4) European shag and black guillemot; and
- Fish Ecology (Section 5.5) Atlantic salmon.

This screening report considers in detail the impact of the proposed changes on these key marine species; marine mammals, birds and fish and the effects of the proposed changes themselves, and the overall or aggregated impact of the changes being sought.

As with previously consented phases of the project there is no predicted population level impact resulting from the combined impact of Phase 1a and the proposed changes within MeyGen 2 (next subsequent stage of development) for these key marine species. CRM is presented herein for the key marine species in the sections outlined above, with further detail provided in Appendix A.

Scottish Government guidance on Section 36C Variation applications[4] (Scottish Government, 2019), stipulates that Section 36C Variation applications would only require an EIA if the proposed change introduces a new significant effect, or if it intensifies an existing significant effect in a substantial way.

This screening request seeks to demonstrate that the proposed changes do not introduce any new significant effects, nor do they intensify any existing significant effects in a substantial way and concludes that an EIA is not required to support s36c variation application. Impacts on the integrity of the protected sites would be avoided subject to appropriate conditions.

[4] https://www.gov.scot/publications/applications-variation-section-36-consents/

3 DESCRIPTION OF PROPOSED DEVELOPMENT

The following describes the physical characteristics of the proposed changes for future Phases of MeyGen Phase 1 development. Note that the changes described in detail below relate only to future developments (MeyGen 2 and onward). Phase 1a project parameters (already deployed and in operation) will not be changed.

3.1 Increase turbine diameter

To enable future phases of MeyGen to install the latest, most efficient tidal turbine technology and achieve a lower levelised cost of energy (LCoE), MeyGen seek to increase the rotor diameter from 16 - 20 m to 16m - 24m.

Bathymetry within the Phase 1 turbine deployment area confirms that the 24 m diameter rotors are the maximum diameter that can be deployed whilst maintaining 8 m sea surface clearance (relative to LAT) and the proposed minimum seabed clearance of 3 m.

Following recent consultation with NatureScot, MeyGen were advised to reassess the potential impact of the proposed changes including the increase in turbine diameter through collision risk modelling (CRM) for the following key marine species:

- Marine mammals (Section 5.3); harbour seal, grey seal, harbour porpoise and minke whale;
- Seabirds (Section 5.4); European shag and black guillemot; and
- Atlantic Salmon (Section 5.5).

The impact of the increase in turbine diameter is compared to the impacts considered in the respective chapters of the ES (2012); Marine Mammals Chapter 11, Ornithology Chapter 12 and Fish Ecology Chapter 13.

Appendix A of this screening report contains the detailed CRM for each of these key marine species.

3.2 Remove rated power cap

MeyGen seek to capitalise on technical advances in tidal turbine engineering and remove the rated power cap for each individual turbine. In general the rated power of an individual turbine increases with increasing diameter.

The existing consent specifies 1.0 – 2.4 MW turbines within the Project Description Envelope of MeyGen Phase 1 ES (2012). It is anticipated that the MeyGen 2 turbines would have a rated power of up to 3 MW per turbine. However future technical advances may develop tidal turbines with rated power in excess of 3 MW. For comparison, the rated power of the installed Phase 1a turbines is 1.5 MW per 18 m diameter turbine. Please note that future phases of MeyGen are likely to deploy turbines with rated power cap exceeding 2 MW however this would be subject to discussion with potential turbine manufacturers and detailed design.

Table 2 demonstrates that the removal of rated power cap would lead to an overall reduction in the number of Phase 1 turbines required to reach 86 MW generating capacity, from the 86 turbines assessed in MeyGen Phase 1 ES (2012) to an indicative 40 turbines deployed within:

- Phase 1a comprises 4 turbines x 1.5 MW (6 MW);
- MeyGen 2 comprise 10 turbines X circa 3 MW up to 24 m diameter (28 MW); and
- Future phases comprise would comprise up to 26 turbines (rated power to be confirmed) up to 24 m diameter (52 MW).

Future phases would require a detailed engineering assessment, accordingly MeyGen presents a range of the number of turbines expected to build out to the maximum (86 MW) generating capacity, with the expected range of turbines for future phases beyond MeyGen2 being between 17 (circa 3 MW) to 26 (circa 2 MW) turbines. Therefore the expected maximum number of Phase 1 turbines with proposed changes required to build out to the maximum (86 MW) generating capacity is 40 turbines.

Table 2 Table summarising consented, installed (Phase 1a) and proposed turbine parameters for future phases MeyGen.

PROJECT STAGE	CONSENTED PHASE 1 DESIGN ENVELOPE	PHASE 1A INSTALLED	MEYGEN 2 NEXT PHASE	FURTHER PHASES OF MEYGEN DEVELOPMENT
Generation capacity	86 MW	6 MW	Ca. 28 MW	Ca. 52 MW
Turbine diameter	16 – 20 m	18 m	Up to 24 m	Up to 24m
Number of turbines	Up to 61 in Phase 1	4 (installed)	10	Range from: 26 turbines at 2 MW to 17 turbines at 3 MW, subject to detailed design
Rated capacity	1 – 2.4 MW	1.5 MW	Seeking to remove rated power cap, such that MeyGen 2 devices would be circa up to 3 MW	Seeking to remove rated power cap, further phases subject to detailed design

The rated power of an individual turbine is an expression of the electrical output of that turbine. It does not describe the physical parameters or operation of the turbine and would not of itself have any environmental impact.

Following on from this it is anticipated that impacts related to the installation, operation and decommissioning of an array of fewer, larger turbines would be of lower significance than the impacts assessed in the MeyGen Phase 1 ES (2012). These impacts are reviewed and discussed further in Section 4.

3.3 Increase rotor swept area

The swept area of a turbine increases proportionally with increased rotor diameter.

It is anticipated that build out of future phases of MeyGen would comprise fewer turbines with larger diameters and higher rated power to achieve the maximum 86 MW Phase 1 generation capacity.

- Phase 1a comprises 4 turbines at 1.5 MW (6 MW);
- MeyGen 2 comprise 10 turbines at circa 3 MW up to 24 m diameter (28 MW); and
- Future phases comprise up to 26 turbines (2MW presented as worse case scenario) up to 24 m diameter (52 MW).

Whilst the proposed changes increase the swept area for an individual turbine, they lead to a comparatively lower total swept area for Phase 1 for build out to 86 MW generation capacity (Tables 3 – 5).

Table 3 Total swept area built out to 86 MW using 20 m diameter turbine – s36 (2013)

PHASE	NUMBER TURBINES	MW PER TURBINE	ROTOR DIAMETER (M)	SWEPT AREA OF ARRAY (M^2)	INSTALLED CAPACITY (MW)
Phase 1 up to 20 m diameter up to 61 turbines	61	1.4	Up to 20 m	19,154	86

Table 4 Total swept area Phase 1a plus build out to 86 MW using 20 m diameter turbines – s36 (2013)

PHASE	NUMBER TURBINES	MW PER TURBINE	ROTOR DIAMETER (M)	SWEPT AREA OF ARRAY (M^2)	INSTALLED CAPACITY (MW)
1a	4	1.5	18 m	1,018	6
Build out to 86 MW using 20 m diameter up to 61 turbines as per s36 (2013)	57	1.4	Up to 20 m	17,898	80
TOTAL	61	--	--	18,916	86

Table 5 Total swept area Phase 1a plus MeyGen 2 and future phases up to 86 MW including proposed changes

PHASE	NUMBER TURBINES	MW PER TURBINE	ROTOR DIAMETER (M)	SWEPT AREA OF ARRAY (M^2)	INSTALLED CAPACITY (MW)
1a	4	1.5	18 m	1,018	6
MeyGen 2	10	Circa 3	Up to 24 m	4,524	28
Future phases	26	TBC 2, presented as worse-case scenario	Up to 24 m	11,761	52
Total	40	--	--	17,303	86

When comparing the total swept area for build out to 86 MW Phase 1 generating capacity:

- Total swept area 61 x 20 m diameter turbine as specified in s36 (2013) =19,154 m^2; and
- Total swept area Phase 1a (4 turbines) plus MeyGen 2 (10 turbines) and future phases (up to 26 turbines) = 17,303m^2.

This represents a 10% reduction in total swept area when compared to MeyGen ES (2012) assessment.

3.4 Reduce minimum seabed clearance

In order to install larger diameter turbines whilst maintaining sea surface clearance, MeyGen seek to reduce seabed clearance. MeyGen does not propose to change the minimum clearance between the blade tip and the sea surface. This will remain at a minimum of 8 m relative to LAT.

The position of the turbine rotor in the water column, is a key parameter in collision risk modelling for key marine species. The reduced minimum clearance between rotor tip and the seabed has been implemented in all revised CRM presented in this report (using the models published by SNH, 2016). CRM results indicate no discernible difference in collision risk for key marine species due to the reduction in minimum clearance between the rotor and the seabed from 4.5 m to 3 m.

Note that the minimum clearance to the seabed specified in the MeyGen Phase I ES (2012) was originally determined for engineering purposes, including fatigue life of blades as opposed to potential environmental impacts. A now greater understanding of bathymetry at the turbine deployment area, array planning for turbine locations and several years of operational engineering data supports reduction in minimum seabed clearance.

3.5 Increase offshore export cables rating to a maximum of 33 kV

Due to the development in offshore technology since the submission of ES (2012), it is now possible to utilise offshore export cables at the MeyGen site at higher than the originally proposed voltage rate (to a maximum of 33 kV in comparison to 6 kV proposed in 2012).

EMFs consist of both electrical (E) and magnetic (B) fields. When electrons, in the form of electrical current, pass through a cable, a B-field is produced. The presence of the B-field can produce a second induced component, a weak electrical field, referred to as induced electrical (iE) field. The strength of E, B and iE fields depends on the magnitude and type of current flowing through the cable and the construction of the cable. Some organisms can detect E- or B-fields (i.e., electro- or magneto-sensitive species) and are presumed to do so by either iE-field detection or magnetite-based detection. Recent scientific evidence has identified some behavioural and physiological impacts in the presence of EMF, but the studies which obtained these findings used simulated levels of EMF in a laboratory environment. These EMF levels would be far greater than any EMF associated with the transmission infrastructure associated with the MeyGen project.

Little evidence exists as to the impacts of B- and iE-fields from *in situ* cables on marine species, but where evidence exists, no study has indicated that EMF levels generated from the infrastructure associated with this Project would be likely to have major or wide-ranging behavioural or physiological impacts upon the marine environment and ecology.

EMF associated with 33 kV cables to be used in the MeyGen development would decay to (or below) background levels (i.e. those associated with natural geomagnetism) beyond the immediate vicinity of the cables themselves. For this reason, it is considered that any EMFs will be of negligible magnitude beyond a few metres from the infrastructure; they will be spatially isolated from any other sources of EMF, and as a result, impacts on any ecological receptor will be highly localised and of insignificant magnitude. For these reasons, the potential impact of EMF associated with this proposed change in cabling has not been considered any further in this report.

3.6 Aggregated effect of proposed changes

The aggregated effect of the proposed changes results in deployment of an indicative 40 turbine array to reach the 86 MW Phase 1 generating capacity comprised of:

- Phase 1a comprises 4 turbines at 1.5 MW (6 MW) which are installed and currently in operation;
- MeyGen 2 comprises 10 turbines at circa 3 MW up to 24 m diameter (28 MW); and
- Future phases comprise up to 26 turbines (rated power TBC) up to 24 m diameter (52 MW) future phases of MeyGen would be subject to approval via Scottish government through condition 2 b(ii).

The indicative 40 Phase 1 turbines required to reach 86 MW generating capacity represents less than half the 86 turbines assessed within ES (2012) and around two thirds of the 61 turbines permitted in the s36 (2013).

Following on from this it is anticipated that impacts related to the installation, operation and decommissioning of an array comprised of fewer, larger turbines would be of lower significance than the impacts assessed in the MeyGen Phase 1 ES (2012). These impacts are reviewed and discussed further in Section 4.

The Project is continuing to look at ways of reducing impacts on the marine environment and ecology, and this is likely to include the use of subsea hubs in subsequent stages of the development. However, this does not comprise part of the changes under the proposed section 36c variation application and will be assessed and consented separately through the marine licensing process.

The proposed changes would lead to a reduction in the number of turbines, turbine support structures and HDD bores and cabling requited to meet the 86 MW Phase 1 generating capacity.

The aggregated effects of the proposed changes leads to:

- Deployment of fewer turbines and fewer turbine support structures;
- Reduction in total number of HDD ducts;
- Reduction in duration of onshore and offshore installation and decommissioning activities;
- Reduction in total swept area for Phase 1 array;
- Reduced amount of materials usage (steel);
- Reduced installation time (visual impacts; carbon emissions; navigational constraints, underwater sound);
- Reduced ambient operating noise due to a reduced number of emitters;
- Reduced seabed footprint from offshore infrastructure; further reduction in the minimal impact on benthic environment;
- Fewer export cables within turbine deployment area and cable corridor; reduction in benthic impacts;
- Reduced duration of maintenance activities (visual impacts; carbon emissions; navigational constraints);

4 DESCRIPTION OF THE ASPECTS OF THE ENVIRONMENT LIKELY TO BE SIGNIFICANTLY AFFECTED BY THE PROPOSED DEVELOPMENT

4.1 Overview of the MeyGen Phase 1 ES (2012)

The MeyGen Phase 1 ES (2012) that supported the original Section 36 consent application, assessed the impact of The MeyGen Tidal Energy Project Phase 1 with a maximum aggregated capacity of 86 MW, with up to 86 tidal turbines and associated infrastructure on the following:

Offshore activities

- The installation and operation of up to 86 tidal stream turbines in the Inner Sound;
- The installation of cable connections between the tidal turbines and onshore infrastructure;
- Horizontal Directional Drilling (HDD) of the cable landfalls; and
- Decommissioning.

Onshore activities

- Construction and operation of the onshore Power Conversation Centre (PCC); and
- Connection of the Project to the grid.

The MeyGen Phase 1 ES (2012) confirmed that the impact pathways for most species/receptors were deemed Not Significant. However, there were some exceptions which were required by consent condition to be mitigated or monitored.

This screening report provides a summary of each receptor considered in MeyGen ES (2012), the significance of the effects of the 86 turbine array and associated infrastructure upon that receptor and then considers any additional significant effects from the proposed changes defined in Chapter 3. This is summarised in Table 6, and then each receptor is considered in detail in Chapter 5.

Table 6 Overview of predicted impacts of proposed changes for each receptor in the MeyGen Phase 1 ES (2012) and any additional impacts from proposed changes

RECEPTOR IN ORIGINAL CONSENTED MEYGEN ES (2012)	SIGNIFICANT EFFECTS IN THE MEYGEN ES (2012)	ANY ADDITIONAL SIGNIFICANT IMPACTS FROM PROPOSED CHANGES	JUSTIFICATION FOR SCREENING REPORT CONCLUSION (2023)
Physical Environment and Sediment Dynamics **Section 9**	No Significant Effects from Phase 1 86 MW, 86 turbine array and associated onshore and offshore infrastructure	No additional impacts, proposed changes reduce impacts assessed in ES (2012)	Refer to Section 5.1 Considered impacts from build out of entire Phase 1 development to 86 MW. Impacts are screened out for EIA.
Benthic Habitats and Ecology **Section 10**	No Significant Effects from Phase 1, 86 MW, 86 turbine array and associated onshore and offshore infrastructure	No additional impacts proposed changes reduce impacts assessed in ES (2012)	Refer to Section 5.2 Considered impacts from build out of entire Phase 1 development to 86 MW. Impacts are screened out for EIA.
Marine Mammals **Section 11**	Potential significant effect: collision risk to harbour seal, grey seal, minke whale, harbour porpoise S36 limited initial phase of development to 6 turbines	As with previously consented phases of the project there is no predicted population level impact resulting from the combined impact of Phase 1a and the proposed changes within MeyGen 2 (next subsequent stage of development).	Refer to Section 5.3 CRM is presented for impact of Phase 1a and MeyGen 2 for harbour seal, grey seal, harbour porpoise and minke whale. Further CRM detail in Appendix A. Impact screened out for EIA.
Ornithology **Section 12**	No Significant Effects from 86 turbine array Impacts on the integrity of the protected sites would be avoided subject to appropriate conditions	As with previously consented phases of the project there is no predicted population level impact resulting from the combined impact of Phase 1a and the proposed changes within MeyGen 2 (next subsequent stage of development).	Refer to Section 5.4 CRM is presented for impact of Phase 1a and MeyGen 2 on European shag and black guillemot Further CRM detail in Appendix A. Impact screened out for EIA.

RECEPTOR IN ORIGINAL CONSENTED MEYGEN ES (2012)	SIGNIFICANT EFFECTS IN THE MEYGEN ES (2012)	ANY ADDITIONAL SIGNIFICANT IMPACTS FROM PROPOSED CHANGES	JUSTIFICATION FOR SCREENING REPORT CONCLUSION (2023)
Fish Ecology **Section 13**	Collision risk to basking shark, Atlantic salmon Barrier effects to basking shark, Atlantic salmon	As with previously consented phases of the project there is no predicted population level impact resulting from the combined impact of Phase 1a and the proposed changes within MeyGen 2 (next subsequent stage of development).	Refer to Section 5.5 CRM is presented for impact of Phase 1a and MeyGen 2 on adult Atlantic Salmon Further CRM detail in Appendix A. Impact screened out for EIA.
Commercial Fisheries **Section 14**	No Significant Effects from Phase 1 86 MW, 86 turbine array and associated offshore infrastructure	No additional impacts, proposed changes reduce impacts assessed in ES (2012)	Refer to Section 5.6 Considered impacts from build out of entire Phase 1 development to 86 MW. Impacts are screened out for EIA.
Shipping and Navigation **Section 15**	Potential Significant Effects Reduced with mitigation. No Significant Effects from Phase 1 86 MW, 86 turbine array and associated offshore infrastructure	No additional impacts, proposed changes reduce impacts assessed in ES (2012)	Refer to Section 5.7 Considered impacts from build out of entire Phase 1 development to 86 MW. Impacts are screened out for EIA.
Marine Cultural Heritage **Section 16**	Significant Effects Reduced with mitigation. No Significant Effects from Phase 1 86 MW, 86 turbine array and associated offshore infrastructure	No additional impacts, proposed changes reduce impacts assessed in ES (2012)	Refer to Section 5.8 Considered impacts from build out of entire Phase 1 development to 86 MW. Impacts are screened out for EIA.
Geology Hydrology and Hydrogeology	Significant Effects Reduced with mitigation.	No additional impacts, proposed changes reduce	Refer to Section 5.9 Considered impacts from build out of entire Phase 1

RECEPTOR IN ORIGINAL CONSENTED MEYGEN ES (2012)	SIGNIFICANT EFFECTS IN THE MEYGEN ES (2012)	ANY ADDITIONAL SIGNIFICANT IMPACTS FROM PROPOSED CHANGES	JUSTIFICATION FOR SCREENING REPORT CONCLUSION (2023)
Section 17	No Significant Effects from Phase 1 86 MW, 86 turbine array and associated offshore infrastructure	impacts assessed in ES (2012)	development to 86 MW. Impacts are screened out for EIA.
Terrestrial habitats and ecology Section 18	Significant Effects Reduced with mitigation. No Significant Effects from Phase 1 86 MW, 86 turbine array and associated offshore infrastructure	No additional impacts, proposed changes reduce impacts assessed in ES (2012)	Refer to Section 5.10 Considered impacts from build out of entire Phase 1 development to 86 MW. Impacts are screened out for EIA.
Landscape, Seascape and Visual Impact Assessment Section 19	Significant Effects Reduced with mitigation. No Significant Effects from Phase 1 86 MW, 86 turbine array and associated onshore and offshore infrastructure	No additional impacts, proposed changes reduce impacts assessed in ES (2012)	Refer to Section 5.11 Considered impacts from build out of entire Phase 1 development to 86 MW. Impacts are screened out for EIA.
Onshore Cultural Heritage Section 20	No Significant Effects from Phase 1 86 MW, 86 turbine array and associated onshore infrastructure	No additional impacts, proposed changes reduce impacts assessed in ES (2012)	Refer to Section 5.12 Considered impacts from build out of entire Phase 1 development to 86 MW. Impacts are screened out for EIA.
Socio-economics Tourism and Recreation Section 21	No Significant Effects from Phase 1 86 MW, 86 turbine array and associated onshore and offshore infrastructure	No additional impacts, proposed changes reduce impacts assessed in ES (2012)	Refer to Section 5.12 Considered impacts from build out of entire Phase 1 development to 86 MW. Impacts are screened out for EIA.

RECEPTOR IN ORIGINAL CONSENTED MEYGEN ES (2012)	SIGNIFICANT EFFECTS IN THE MEYGEN ES (2012)	ANY ADDITIONAL SIGNIFICANT IMPACTS FROM PROPOSED CHANGES	JUSTIFICATION FOR SCREENING REPORT CONCLUSION (2023)
Onshore Transportation and Access **Section 22**	No Significant Effects from Phase 1 86 MW, 86 turbine array and associated onshore infrastructure	No additional impacts, proposed changes reduce impacts assessed in ES (2012)	Refer to Section 5.12 Considered impacts from build out of entire Phase 1 development to 86 MW. Impacts are screened out for EIA.
Onshore Noise and Dust **Section 23**	No Significant Effects from Phase 1 86 MW, 86 turbine array and associated onshore infrastructure	No additional impacts, proposed changes reduce impacts assessed in ES (2012)	Refer to Section 5.12 Considered impacts from build out of entire Phase 1 development to 86 MW. Impacts are screened out for EIA.
Accidental Events **Section 24**	No Significant Effects from Phase 1 86 MW, 86 turbine array and associated onshore and offshore infrastructure	No additional impacts, proposed changes reduce impacts assessed in ES (2012)	Refer to Section 5.12 Considered impacts from build out of entire Phase 1 development to 86 MW. Impacts are screened out for EIA.

4.2 Impacts screened out from EIA

This screening report considers the impact of the proposed changes and the impacts from build out of the entire 86 MW Phase 1 development on the all receptors considered in the MeyGen ES (2012).

For Physical Environment and Sediment Dynamics; Benthic Habitats and Ecology; Commercial Fisheries; Shipping and Navigation; Marine Cultural Heritage; Geology Hydrology and Hydrogeology; Terrestrial Habitats and Ecology; Landscape, Seascape and Visual Impact Assessment; Onshore Cultural Heritage; Socio-economics Tourism and Recreation; Onshore Transportation and Access; Onshore Noise and Dust; and Accidental Events, the impacts for these receptors are screened out from EIA without requiring any additional information. This is discussed in the relevant sections of Chapter 5.

For Marine Mammals, Ornithology and Fish Ecology, additional collision risk information is required, which is discussed in the relevant sections of Chapter 5. Having collated the necessary information, this screening report concludes with a screening out of these receptors for EIA, subject to some existing consent conditions.

4.3 Updated CRM – next phase

As described above, consideration of collision risk with a small number of receptors requires additional information, with recent stakeholder engagement confirming that the most significant risk associated with the proposed changes as outlined in Chapter 3 is the potential of collision risk with key marine species.

In order to seek approval for the next phase of MeyGen development, Condition 2b(ii) s36 (2013) requires that the development be implemented in a staged manner, to avoid significant adverse impacts to the environment. Due to the ongoing declining population of harbour seals status within the Orkney and North Coast Management Unit and wider UK waters, the regional harbour seal population is considered to be the receptor at greatest risk of impacts from tidal energy developments in the Pentland Firth and Orkney waters.

Whilst harbour seals have been identified as the receptor at greatest risk from tidal developments regulators have noted concerns related to collision risk and impact upon of a number of key marine species;

- Marine mammals: harbour seal grey seal, harbour porpoise and minke whale;
- Seabirds: European shag and black guillemot; and
- Fish: Atlantic salmon.

In order to implement the next subsequent phase (MeyGen 2) MeyGen is required to demonstrate regard to the preservation of the environment and ecology to satisfy the terms of s36 Condition 2b(ii). Accordingly this screening report considers CRM for each key marine species to understand the impact of the deployment of Phase 1a turbines together with the proposed changes associated with deployment of MeyGen 2 turbines (next subsequent stage of development).

This screening report presents.

- CRM used to assess impact on marine mammals (Section 5.3); harbour seal, grey seal, harbour porpoise and minke whale;
- Encounter-Time-Probability Model (ETPM) used to assess impacts on seabirds (Chapter 5.4); European shag and black guillemot; and
- Collision Risk Modelling (CRM) used to assess impact on adult Atlantic salmon (Chapter 5.5).

The rationale that supports the CRM for each of these key marine receptors is described in detail within each receptor chapter, and further CRM detail is presented in Appendix A.

4.3.1 Future discharge of Condition 2(b)(ii)

We anticipate that permission to install the next subsequent phase of MeyGen comprised of ten MeyGen 2 turbines would still require discharge of Condition 2(b)(ii) of the MeyGen Phase 1 consent, which is not the aim of this report. The information required to discharge Condition 2(b)(ii) for MeyGen 2 will be provided. However, the evidence provided in this EIA Screening Report describes how the proposed MeyGen 2 development has regard to the ecology and environment, with specific reference to marine mammals (harbour and grey seal, harbour porpoise and minke

whale), fish (Atlantic salmon) and seabirds (European shag and black guillemot) as required in Condition 2b(ii) and will form the basis of this Condition 2(b)(ii) request at a subsequent stage of the process.

4.4 Summary of the consenting and assessment ethos

The approach to the consenting of the subsequent phases of MeyGen, and the approach to the assessment presented herein, is summarised overleaf.

	Phase 1a	MeyGen 2	Future MeyGen Phases
	Installed according to Section 36 (2013) consent envelope	MEYGEN SEEK VARIATION FOR ALL FUTURE PHASES ACCORDING TO THE FOLLOWING PROPOSED CHANGES • Increase turbine rotor diameter from 16 - 20m to 16 – 24 m; • Reduce the minimum seabed clearance between the rotor tip and the seabed from 4.5 to 3.0 m; • Remove the rated power cap for each individual turbine (currently restricted 1.0 MW - 2.4 MW) whilst retaining the permitted generating capacity for MeyGen Phase 1, not exceeding 86 MW; • Increase blade swept area from 201 - 314 m^2 (based on a 16 - 20m diameter turbine) to 201 - 452 m^2 (based on a 16 - 24 m diameter turbine); • Reduce the total number of turbines in Phase from 61 specified in ANNEX 1 Section 36 (2013), to up to 40 turbines; and • Increase in export cables maximum voltage from 6.6 kV to 33 kV	
	Phase 1a (6MW)	MeyGen 2 (28MW)	Future phases 52 (MW)
	-	Condition 2 S36 (2013) development implemented in a staged manner	Condition 2 S36 (2013) development implemented in a staged manner
	4 turbines installed	10 turbines	Up to 26 turbines, dependent upon rated power up to maximum generating capacity of 86 MW.
Receptors considered in consented MeyGen ES (2012):	MeyGen Phase 1 ES (2012) predicts no significant impact from Phase 1 86 MW, 86 turbine array and associated onshore and offshore infrastructure, subject to implementation of mitigation. Screening report (2023) considers impact the of Phase 1 development of up to 40 turbines, from build out of entire Phase 1 development to 86 MW. No additional impacts, proposed changes reduce impacts assessed in ES (2012). Impacts are screened out of further assessment.		
Physical Environment and Sediment Dynamics			
Benthic Habitats and Ecology			
Commercial Fisheries			
Shipping and Navigation			
Marine Cultural Heritage			
Geology Hydrology and Hydrogeology			
Terrestrial habitats and ecology			
Landscape, Seascape and Visual Impact Assessment			
Onshore Cultural Heritage			
Socio-economics Tourism and Recreation			
Onshore Transportation and Access			
Onshore Noise and Dust			
Accidental Events			
Marine Mammals	Potential significant effect: collision risk to harbour seal, grey seal, minke whale, harbour porpoise CRM is presented for impact of Phase 1a and MeyGen 2 for harbour seal, grey seal, harbour porpoise and minke whale. As with previously consented phases of the project there is no predicted population level impact resulting from the combined impact of Phase 1a and the proposed changes within MeyGen 2 (next subsequent stage of development) upon key marine mammal species.	s36 condition 2 b(ii) MeyGen may proceed with the next subsequent stage of development after demonstrating regard to the preservation of the environment and ecology. All future phases of MeyGen will require CRM to understand the collision risk to harbour seal, grey seal, harbour porpoise and minke whale. It is intended that the discharge of Condition 2b (ii) requires the assessment of the impact of the next subsequent phase of MeyGen development within the varied s36 consent, upon key marine mammal species The varied s36 consent permits the proposed changes (subject to approval).	
Ornithology	Potential significant effect: collision risk to European shag and black guillemot ETPM is presented for impact of Phase 1a and MeyGen 2 upon ; European shag and black guillemot. As with previously consented phases of the project there is no predicted population level impact resulting from the combined impact of Phase 1a and the proposed changes within MeyGen 2 (next subsequent stage of development) upon key seabird species.	s36 condition 2 b(ii) MeyGen may proceed with the next subsequent stage of development after demonstrating regard to the preservation of the environment and ecology. All future phases of MeyGen will require ETPM to understand the collision risk to European shag and black guillemot. It is intended that the discharge of Condition 2b (ii) requires the assessment of the impact of the next subsequent phase of MeyGen development within the varied s36 consent, upon key seabird species. The varied s36 consent permits the proposed changes (subject to approval).	
Fish Ecology	Potential significant effect: collision risk to Atlantic salmon CRM is presented for impact of Phase 1a and MeyGen 2 upon adult Atlantic Salmon. As with previously consented phases of the project there is no predicted population level impact resulting from the combined impact of Phase 1a and the proposed changes within MeyGen 2 (next subsequent stage of development) upon Atlantic Salmon.	s36 condition 2 b(ii) MeyGen may proceed with the next subsequent stage of development after demonstrating regard to the preservation of the environment and ecology. All future phases of MeyGen will require CRM to understand the collision risk to Atlantic salmon. It is intended that the discharge of Condition 2b (ii) requires the assessment of the impact of the next subsequent phase of MeyGen development within the varied s36 consent, upon Atlantic Salmon. The varied s36 consent permits the proposed changes (subject to approval).	

Key:	Installed	Impacts assessed in screening report (2023)	Variation sought for all future phases	s36 implemented in stages, with each stage assessed through an environmental report undertaken to satisfy condition 2b(ii)

5 SCREENING OF IMPACT OF THE PROPOSED CHANGES FOR EACH RECEPTOR WITHIN MEYGEN PHASE 1 ES (2012)

The following chapter screens the impact of the proposed changes as outlined in Chapter 3 upon each receptor within the MeyGen Phase 1 Environmental Statement (2012).

5.1 Physical environment and sediment dynamics

The MeyGen Phase 1 ES (2012) Chapter 9 concluded that the installation, operation and decommissioning of up to 86 turbines and associated infrastructure is not expected to alter the hydrodynamics significantly enough to change existing processes.

The MeyGen Phase 1 ES (2012) combined a desk-based assessment with a modelling study to assess physical processes impacts arising from the Project and considered plausible impacts at the construction/installation, operation and decommissioning phases of the project. All impact pathways for physical environment and sediment dynamics were considered Not Significant, although water quality considered some mitigation measures, related to piling and horizontal directional drilled (HDD) ducts. Table 7 presents a comparison with the proposed changes.

Table 7 Summary of impacts on the physical environment and sediment dynamics from MeyGen Phase 1 ES (2012) compared with expected impacts from the proposed changes

IMPACT	SIGNIFICANCE OF IMPACTS ASSESSED IN ES (2012)	CONSEQUENCES OF PROPOSED CHANGES	RESIDUAL SIGNIFICANCE
Change in seabed morphology from drill cuttings discharge	Not significant	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of offshore activities reduces impacts	No additional environmental impacts.
Displacement of sediment resulting in alteration or loss of bedform and geomorphology (installation)	Not significant	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of offshore activities reduces impacts	No additional environmental impacts.
Change in water quality	Not significant – management required and mitigation proposed	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of offshore activities reduces impacts	No additional environmental impacts.

IMPACT	SIGNIFICANCE OF IMPACTS ASSESSED IN ES (2012)	CONSEQUENCES OF PROPOSED CHANGES	RESIDUAL SIGNIFICANCE
Change in hydrodynamics	Not significant	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of offshore activities reduces impacts	No additional environmental impacts.
Change in wave height	Not significant	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of offshore activities reduces impacts	No additional environmental impacts.
Change in sediment dynamics	Not significant	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of offshore activities reduces impacts	No additional environmental impacts.
Erosion of the coastline	Not significant	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of offshore activities reduces impacts	No additional environmental impacts.
Displacement of sediment resulting in alteration or loss of bedforms and geomorphology (decommissioning)	Not significant	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of offshore activities reduces impacts	No additional environmental impacts.

This screening report considers the build out to the entire 86 MW Phase 1 development including the proposed changes as described in Chapter 3 and the impact upon physical environment and sediment dynamics. The indicative 40 turbines required to build out to 86 MW in future phases of MeyGen would be significantly reduced from the 86 turbines considered in ES (2012). The proposed changes reduce the overall number of turbines, turbine support structures, HDD bores and cabling.

It is not anticipated that there would be any additional significant impacts on the physical environment and sediment dynamics. The impact of the proposed changes upon physical environment and sediment dynamics is likely to be reduced from that which was assessed in the ES (2012).

The build out to the entire 86 MW Phase 1 development including the proposed changes as described in Chapter 3 and the impact upon the physical environment and sediment dynamics receptor, subject to implementation of proposed mitigation (Appendix B), can therefore be screened out from EIA.

As such, the physical environment and sediment dynamics receptor will not be considered further in this EIA screening report.

5.2 Benthic habitats and ecology

The MeyGen Phase 1 ES (2012) Chapter 10 concluded that the installation, operation and decommissioning of up to 86 turbines and associated infrastructure is not expected to have a significant impact upon benthic habitats and ecology, subject to the implementation of proposed mitigation (Appendix B).

The impacts of the Project on the benthic habitat and ecology were assessed within the MeyGen Phase 1 ES (2012). The region has a relatively low benthic biodiversity due to the high energy tide-swept nature of the rocky environment. The Phase 1 turbine deployment area is largely comprised of a rocky seabed, with boulders, broken bedrock and bedrock platform. The Phase 1 turbine deployment area is also exposed to a high level of tidal scour and the biotopes in the area reflect this with scour-tolerant fauna (e.g. acorn barnacle *Balanus cretanus* and dahlia anemone *Urticina felina*) being present.

EMF associated with 33 kV cables to be used in the MeyGen development would decay to (or below) background levels (i.e. those associated with natural geomagnetism) beyond the immediate vicinity of the cables themselves. For this reason, it is considered that any EMFs will be of negligible magnitude beyond a few metres from the infrastructure; they will be spatially isolated from any other sources of EMF, and as a result, impacts on any ecological receptor will be highly localised and of insignificant magnitude. For these reasons, the potential impact of EMF associated with this proposed change in cabling has not been considered any further in this report.

For these reasons, it is considered that there is no potential pathway for additional environmental impacts due to EMF emissions resulting from the use 33kV cables.

The ES (2012) concluded that no significant impacts would occur from the Project activities. Table 8 presents a comparison with the proposed changes.

Table 8 Summary of impacts on benthic ecology from MeyGen Phase 1 ES (2012) compared with proposed changes

IMPACT	SIGNIFICANCE OF IMPACTS ASSESSED IN ES (2012)	CONSEQUENCES OF PROPOSED CHANGES	RESIDUAL SIGNIFICANCE
Direct physical impact and loss of habitat (construction and installation)	Not significant – mitigation proposed	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of offshore activities reduces impacts	No additional environmental impacts.

IMPACT	SIGNIFICANCE OF IMPACTS ASSESSED IN ES (2012)	CONSEQUENCES OF PROPOSED CHANGES	RESIDUAL SIGNIFICANCE
Release of drill cuttings and fluid (construction and installation)	Not significant – mitigation proposed	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of offshore activities reduces impacts	No additional environmental impacts.
Release of sediment bound contaminants (construction and installation)	Not significant	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of offshore activities reduces impacts	No additional environmental impacts.
Marine non-native species (construction and installation)	Not significant – mitigation proposed	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of offshore activities reduces impacts	No additional environmental impacts.
Electro-magnetic effects (operation and maintenance)	Not significant – mitigation proposed	Reduction in cabling results in reduced impacts.	No additional environmental impacts.
Hydrodynamic change (operation and maintenance)	Not significant	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts.	No additional environmental impacts.
Sediments – change in suspended sediment levels in the water column (operation and maintenance)	Not significant	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts.	No additional environmental impacts.

IMPACT	SIGNIFICANCE OF IMPACTS ASSESSED IN ES (2012)	CONSEQUENCES OF PROPOSED CHANGES	RESIDUAL SIGNIFICANCE
Introduction of new hard structures (operation and maintenance)	Not significant	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts.	No additional environmental impacts.
Antifouling (application of antifouling treatment) (operation and maintenance)	Not significant	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts.	No additional environmental impacts.

Since the ES (2012) was published, the Marine Directorate has designated a list of Priority Marine Features (PMF) in Scotland's seas. From baseline surveys, it does not appear that any PMFs are present within the Phase 1 turbine deployment area. There are nearshore *Laminaria* (kelp) beds, although the combination of utilising HDD ducts for cable landfall methodology (with emergence ca. 700 m from shore) and the reduced number of export cables would minimise possible impacts on these nearshore habitats.

The ES (2012) concluded that the physical turbine parameters do not directly influence benthic habitats and ecology. The ES (2012) concluded that the maximum cable footprint was considered relevant, and a reduction in number of turbines, turbine support structures and export cables would reduce the seabed footprint impact on benthic habitats and species.

This screening report considers the of build out to the entire 86 MW Phase 1 development including the proposed changes as described in Chapter 3 and the impact upon benthic habitats and ecology. The indicative 40 turbines required to build out to 86 MW in future phases of MeyGen would be significantly reduced from the 86 turbines considered in ES (2012). The proposed changes reduce the overall number of turbines, turbine support structures, HDD bores and cabling.

It is not anticipated that there would be any additional significant impacts on the benthic habitats and ecology. The impact of the proposed changes upon benthic habitats and ecology is likely to be reduced from that which was assessed in the ES (2012).

The build out to the entire 86 MW Phase 1 development including the proposed changes as described in Chapter 3 and the impact upon the benthic habitats and ecology receptor, subject to implementation of proposed mitigation (Appendix B), can therefore be screened out from EIA.

As such, the benthic habitats and ecology receptor will not be considered further in this EIA screening report.

5.3 Marine mammals

The MeyGen Phase 1 ES (2012) Section 11 concluded that the installation, operation and decommissioning of up to 86 turbines and associated infrastructure is not expected to have a significant impact upon marine mammals, subject to the implementation of proposed mitigation (Appendix B). Table 9 presents a comparison with the proposed changes.

Table 9. Summary of impacts on marine mammals from MeyGen Phase 1 ES (2012) compared with proposed changes

IMPACT	SIGNIFICANCE OF IMPACTS ASSESSED IN ES (2012)	CONSEQUENCES OF PROPOSED CHANGES	RESIDUAL SIGNIFICANCE
Noise (TSS pile drilling, construction vessels)	Not significant	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of offshore activities reduces impacts	No additional environmental impacts.
Ship strike (installation vessels) and ducted propellers	Not significant (reduced after proposed mitigation)	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of offshore activities reduces impacts. Contemporary evidence confirms that fatal "corkscrew" injuries are not associated with ducted propellers	No additional environmental impacts.
Disturbance due to physical presence of vessels	Not significant	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of offshore activities reduces impacts	No additional environmental impacts.
Increased turbidity	Not significant	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of offshore activities reduces impacts	No additional environmental impacts.

IMPACT	SIGNIFICANCE OF IMPACTS ASSESSED IN ES (2012)	CONSEQUENCES OF PROPOSED CHANGES	RESIDUAL SIGNIFICANCE
Indirect effects via prey species	Not significant	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of offshore activities reduces impacts	No additional environmental impacts.
Accidental spillage from vessels (Installation, O&M)	Not significant	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of offshore activities reduces impacts.	No additional environmental impacts.
Operational noise	Not significant	Reduced number of turbines, results in reduced impacts. Reduction in duration of offshore activities reduces impacts	No additional environmental impacts.
Maintenance noise	Not significant	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of offshore activities reduces impacts.	No additional environmental impacts.
Ship strike (maintenance vessels) and ducted propellers	Not significant (reduced after proposed mitigation)	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of offshore activities reduces impacts. Contemporary evidence confirms that fatal "corkscrew" injuries are not associated with ducted propellers	No additional environmental impacts.
Turbine collision - harbour porpoise, minke whale and grey seal	Not significant	As with previously consented phases of the project there is no predicted population level impact resulting from the combined impact of Phase	CRM is presented below for impact of Phase 1a and MeyGen 2 (varied parameters) for, grey seal, harbour porpoise and minke whale. Further CRM detail is provided in Appendix A.

IMPACT	SIGNIFICANCE OF IMPACTS ASSESSED IN ES (2012)	CONSEQUENCES OF PROPOSED CHANGES	RESIDUAL SIGNIFICANCE
		1a and the proposed changes within MeyGen 2 (next subsequent stage of development)	
Turbine collision - harbour seal	Not significant (reduced after proposed mitigation)	As with previously consented phases of the project there is no predicted population level impact resulting from the combined impact of Phase 1a and the proposed changes within MeyGen 2 (next subsequent stage of development)	CRM is presented below for impact of Phase 1a and MeyGen 2 (varied parameters) for harbour seal. Further CRM detail is provided in Appendix A.
Physical barrier to movement		Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of offshore activities reduces impacts	No additional environmental impacts.
Indirect effects via prey species		Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of offshore activities reduces impacts	No additional environmental impacts.

The proposed changes would not result in any additional environmental impacts. Further assessment work has been undertaken on potential changes to collision risk with tidal turbines arising from the proposed changes and their implementation in MeyGen 2 to confirm this conclusion. The following section also reflects the existing requirement as per condition 2bII of the Section 36 consent (2013) and therefore provides CRM for harbour seal, grey seal, harbour porpoise and minke whale in order to step into the next subsequent phase of MeyGen development.

5.3.1 Updated marine mammal CRM for next MeyGen phase (MeyGen 2)

The original s36 consent (2013) limited the initial Stage of development referred to as Stage One to six turbines. The approved six turbine stage one was informed by CRM studies conducted by SNH (now NatureScot) that confirmed that potential collisions for harbour seal, based on an avoidance rate of 98%, from a six turbine deployment would avoid an adverse impact on the current harbour seal population within the Orkney and North Coast Management Unit. Due to the ongoing declining population of harbour seals status within the Orkney and North Coast Management Unit and wider UK waters, the regional harbour seal population is considered to be the receptor at greatest risk of impacts from tidal energy developments in the Pentland Firth and Orkney waters.

In order to seek approval for the next subsequent phase of MeyGen development, Condition 2 S36 (2013) requires that the development be implemented in a staged manner, to prevent significant adverse impacts to the environment. Further to this, Condition 2 b(II) stipulates that MeyGen may proceed with the next subsequent stage of development after demonstrating regard to the preservation of the environment and ecology.

Whilst harbour seals have been identified as the receptor at greatest risk from tidal developments regulators have noted concerns related to collision risk and impact upon other marine mammals species namely: grey seal, harbour porpoise and minke whale. Recent stakeholder engagement confirmed the requirement for updated collision risk modelling to be conducted to assess the impact of the proposed changes upon a number of these key marine species; namely harbour seal, grey seal, harbour porpoise and minke whale.

Accordingly, this screening report presents CRM for each of these key marine species to understand the combined impact of deployment of Phase 1a turbines and the proposed changes associated with deployment of MeyGen 2 turbines including variation in parameters described in Chapter 2 and 3 (next subsequent stage of development).

The marine mammal impact assessment presented in the MeyGen Phase 1 ES (2012) described a limited number of data gaps and uncertainties related to the assessment of novel (at the time) tidal energy technology. To date MeyGen has generated over 50 GWh of electricity and acquired five years' operational experience. For those data gaps and uncertainties that are relevant to the impact assessment described herein, a review of changes since the MeyGen Phase 1 ES (2012) has been undertaken, and the extent to which additional information has become available is described.

5.3.2 Impact on harbour seal

With respect to harbour seals for the purpose of an assessment to support this EIA screening report:

- Where the potential impact (i.e., the predicted number of harbour seal collisions) is the same or lower than the most recent PBR* limit for harbour seals in the North Coast and Orkney seal management area, both for the development alone and when combined with other anthropogenic "takes" impacting the same management unit, the impact would be deemed not significant; or
- Where potential impacts are likely to be greater than the most recent PBR limit, the impact would be deemed to be significant.

*Potential Biological Removal (PBR) is the number of individual seals that can be removed from the population without causing a decline in the population, and is a value published on behalf of the Scottish Government.

5.3.3 CRM for harbour seals

Collision risk modelling for harbour seals is explored in more detail in Appendix A; a summary of the findings is presented below.

There have been no recent changes in legislation relevant to potential impacts on seals that influence this impact assessment. However, evidence suggests that the harbour seal population in the North Coast and Orkney seal management area has shown an ongoing decline, the cause(s) of this decline remain largely uncertain. In recent

years the Scottish Government has been funding a programme of research investigating various potential drivers for this decline, including predation by killer whales (*Orcinus orca*), biotoxins, and maternal health.

During the determination for the MeyGen Phase 1 s36 application (2012), NatureScot (then SNH) undertook modelling of marine mammal collision rates using contemporary published data on harbour seal densities. This SNH (2013) modelling underpinned the marine mammal impact assessment for the s36 (2013). Since that time, further studies have taken place to refine density estimates for harbour seal and updated density estimates have become available for use in modelling of collision rates for this species.

Further analysis of harbour seal telemetry data within the Pentland Firth and Inner Sound region was undertaken by Onoufriou *et al*. (2021). This study aimed not to derive absolute density estimates of harbour seals for use in impact assessment, but to investigate the varying usage of the Inner Sound and MeyGen Phase 1 turbine deployment area by harbour seals during different tidal phases, and pre- and post-installation of the four Phase 1a MeyGen turbines. This study found no significant change in at sea distribution between pre- and post-installation of the turbines. However, harbour seals showed clear avoidance responses during turbine operations, with a significant decrease in predicted abundance of 11 – 49% (95% CI) within ~2 km of the array. This avoidance behaviour, at the scale of several kilometres, suggests that harbour seal avoidance may be occurring during the potentially higher risk periods, i.e., during operation, when turbines are rotating at velocities which could lead to injury or mortality. MeyGen have obtained modelled harbour seal density maps for four tidal states, hereafter referred to as the updated MeyGen harbour seal density maps (2023), based upon the analysis presented in Onoufriou *et al.* (2021) but which, unlike the publication, are intended to be utilised in an impact assessment context.

MeyGen have implemented the SNH (2016) collision risk model (CRM) approach to determine the predicted risk of collision to harbour seals from the MeyGen 2 development. The variable seal density depending on tidal state as described by the updated MeyGen harbour seal density maps (2023) was incorporated into a suite of collision risk models. The estimated total North Coast and Orkney regional harbour seal population size is 99, and assuming no behavioural avoidance, the CRM estimated 544.77 harbour seal collisions for a one-year period for the ten turbines of MeyGen 2. Further details on this is presented in Appendix A, with the subsequent sections considering the consequences of this value.

5.3.4 Animal behaviour

The updated MeyGen harbour seal density maps (2023) assume that all 99 individuals are out at sea at any given time, but it has been shown that harbour seals spend on average 32% of their time at rest, either hauled out or resting at the surface at sea (Russell *et al*. 2015). As such, it can be assumed that 32% of the 99 individuals estimated to be resident in the North Coast and Orkney population would not be at risk for collision. Assuming no behavioural avoidance and accounting for the proportion of harbour seal population at rest, the CRM estimates 370.44 seal collisions for a one-year period for the ten turbines of MeyGen 2.

There is limited information relating to marine mammal behaviour around tidal turbines and assumptions have to be made with regard to active avoidance and evasion. There is increasing evidence that marine mammal collisions with tidal turbines are unlikely, as studies show other marine mammals (i.e. harbour porpoise) exhibits significant avoidance of turbines, regardless of whether the turbine is rotating or not, even while frequently being observed to swim in close proximity (Gillespie *et al*. 2021; Palmer *et al*. 2021). For harbour seal, predicted collisions can be multiplied by a

rate of avoidance. According to the SNH (2016) advice to MeyGen, an avoidance rate of 98% is reasonable for harbour seal and grey seal. Accounting for behavioural avoidance and for the proportion of harbour seal population at rest, the CRM estimates 7.41 harbour seal collisions in a one-year period for the ten turbines of MeyGen 2.

MeyGen, the Marine Directorate and their advisers, have recognised the uncertainty related to marine mammal interactions around tidal turbines. The Scottish Government as part of the Marine Mammal Scientific Support has funded Marine Mammal HiCUP: A High Current Underwater Platform for the Long-Term Monitoring of Fine-Scale Marine Mammal Behaviour Around Tidal Turbines was deployed adjacent to the Atlantis turbine in Phase 1a in May 2022. Final reporting to MD-LOT after the acquisition of one year's data is scheduled for Q2 2024.

5.3.5 Sub-lethal interactions

It has been reported that collisions between seals and tidal turbines would not be serious or fatal at impact speeds of less than 5.1 m s^{-1} (Onoufriou *et al.* 2019). Assuming 98% avoidance and after removing the portion of the rotor disc where blade velocity is <5.1 m s^{-1} (for each hourly model simulation), the CRM estimates 5.92 severe or fatal harbour seal collisions for a one-year period for the ten turbines of MeyGen 2.

5.3.6 Summary of harbour seal CRM for MeyGen 2

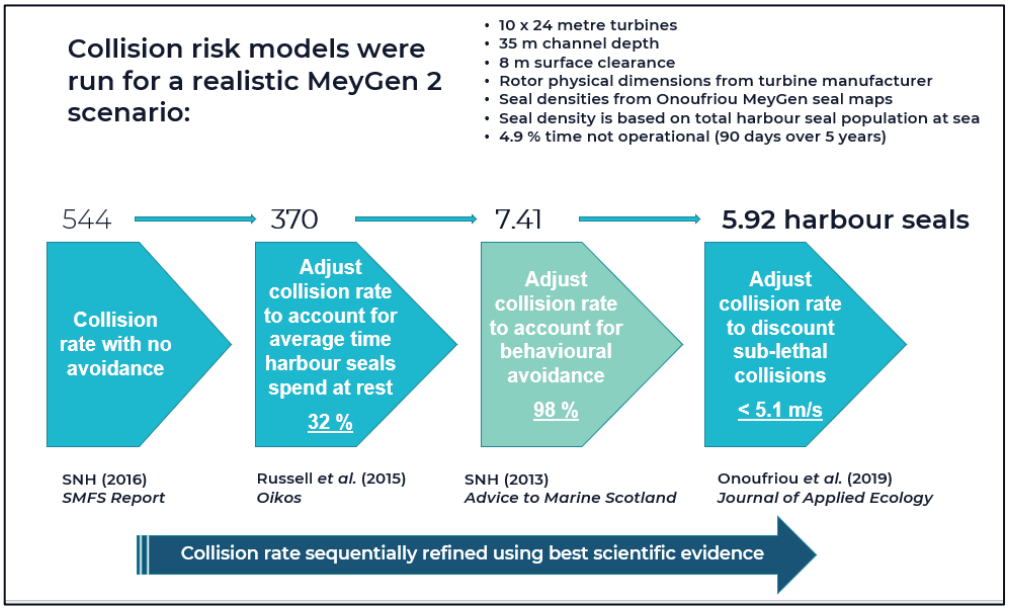

Figure 3 Summary CRM for MeyGen 2

The CRM predicts the annual harbour seal collision for one year period accounting for; animal behaviour, avoidance rate and discount sub lethal at 5.92 severe or fatal harbour seal collisions for a one-year period for the ten turbines of MeyGen 2. The predicted annual harbour seal collision for one year period is below the PBR limit for harbour seals in the North Coast and Orkney seal management area.

5.3.7 Cumulative impacts – tidal

A cumulative impact assessment (CIA) was presented in the MeyGen Phase 1 ES (2012) which included the entire MeyGen Phase 1 Project (86 MW) and a number of projects with the potential to have cumulative impacts alongside the MeyGen Project. Since the Phase 1 assessment was undertaken, the progress of a number of these projects has been halted or delayed, and the number of projects at EIA scoping stage or beyond (i.e., those for which information is available in the public domain) remains very limited. The only tidal energy projects located within the North Coast and Orkney seal management unit area that are known to have progressed to submitting an application since the MeyGen previous CIA in 2012 are Brims Tidal Array and the European Marine Energy Centre (EMEC) Fall of Warness Tidal Test Site. Brims Tidal Array Ltd submitted an initial application in 2016; however, consent was never issued, and the development is currently not progressing. The EMEC Fall of Warness site is consented and in operation and is the only known tidal development within the North Coast and Orkney seal management area.

Table 10 Harbour seal cumulative impacts with other tidal energy projects in North Coast and Orkney seal management area.

TIDAL DEVELOPMENT	PBR (SCOS, 2021)	HARBOUR SEAL TAKE	METHOD AND AVOIDANCE RATE
MeyGen Phase 1a	8	1.16	SNH (2016) CRM; 98% avoidance (from MeyGen, 2017)
MeyGen 2 [this EIA screening report 2023]		5.92	SNH (2016) CRM; 98% avoidance
EMEC Fall of Warness		0.34	SNH/Band (2012) CRM; 98% avoidance
Cumulative impact		7.42	

5.3.8 Cumulative impacts – other developments

There is potential for other developments in the North Coast and Orkney region to disturb and/or displace harbour seals in addition to the collision risk from tidal developments which could result in a cumulative impact on the harbour seal population. In the wider region, the following developments are planned or underway:

- Pentland Floating Offshore Wind Farm;
- West of Orkney Wind Farm;
- The EMEC Billia Croo wave test site;
- A number of subsea power and telecommunications cables under construction and repair; and
- Oil and gas infrastructure and activity concentrated in Scapa Flow.

Given the distance of these developments from the MeyGen Phase 1 project area, the relatively constrained range of harbour seals, and in all cases the negligible impacts predicted to harbour seals from these co-occurring developments, no significant cumulative impacts are anticipated.

5.3.9 Cumulative impacts - licensed seal shooting

The population of harbour seals around the North Coast and Orkney seal management area has declined greatly and remains small, without evident signs of recovery (SCOS, 2021). Given these ongoing conservation concerns, MD-LOT has not licensed any shooting of harbour seals in the North Coast and Orkney seal management area in recent years.

5.3.10 Cumulative impacts summary

Only the EMEC Fall of Warness tidal energy test site is predicted to have anything other than negligible additional impacts on harbour seals within the North Coast and Orkney seal management area. Other developments have either impacts of low or no significance or are too distant from MeyGen Phase 1 turbine deployment area to have any significant impacts on the regional harbour seal population. There is no licensed seal shooting in the North Coast and Orkney seal management area.

The combined predicted collision rate from the deployment of Phase 1a turbines and the proposed changes associated with deployment of MeyGen 2 turbines (next subsequent stage of development and EMEC Fall of Warness constitutes the total predicted anthropogenic 'take' from the North Coast and Orkney seal management unit, and this rate is less than the PBR for harbour seals for the North Coast and Orkney seal management unit.

5.3.11 CRM harbour seal conclusion

By incorporating the best available evidence on harbour seal densities, an updated CRM has been conducted to understand the combined impact of deployment of Phase 1a turbines and the proposed changes associated with deployment of MeyGen 2 turbines (next subsequent stage of development).

The CRM demonstrates that the potential impact (i.e., the predicted number of harbour seal collisions) is lower than the most recent PBR limit for harbour seals in the North Coast and Orkney seal management area, both for the development alone and when combined with other anthropogenic "takes" impacting the same management unit, the impact would be deemed not significant.

In conclusion combined impact of deployment of Phase 1a turbines and the proposed changes associated with deployment of MeyGen 2 turbines (next subsequent stage of development) would not have a significant impact on regional harbour seal population and is screened out for EIA.

5.3.12 Other marine mammal species

During recent consultation with NatureScot (January 2023) MeyGen were advised to also consider the combined impact of deployment of Phase 1a turbines and the proposed changes associated with deployment of MeyGen 2 turbines (next subsequent stage of development) upon; grey seal, harbour porpoise and minke whale.

A revised SNH (2016) CRM has been conducted using the best available density estimate for each of these species. Assuming a 98% avoidance rate for harbour porpoise and grey seal, and 95% avoidance rate for minke whale. Further detail is provided for each species in the text that follows.

Table 11 Summary of impacts on other marine mammal species from deployment of Phase 1a turbines and the proposed changes associated with deployment of MeyGen 2 turbines (next subsequent stage of development)

SPECIES	MANAGEMENT UNIT	POPULATION SIZE	PBR	PREDICTED COLLISION RATE AS % OF MU	RESIDUAL SIGNIFICANCE
Grey seal *Halichoerus grypus*	North Coast and Orkney SMU	32,043	1,923	0.41% *	Not significant
Harbour porpoise *Phocoena phocoena*	UK portion of North Sea Management Unit	159,632	Not available for this species	0.005% *	Not significant
Minke whale *Balaenoptera acutorostrata*	UK portion of Celtic And Greater North Seas Management Unit	10,288	Not available for this species	0.04% **	Not significant

5.3.13 Grey seal

With respect to grey seal for the purpose of an assessment to support this EIA screening report:

- Where the potential impact (i.e., the predicted number of grey seal collisions) is the same or lower than the most recent PBR limit for grey seal in the North Coast and Orkney seal management area, both for the development alone and when combined with other anthropogenic "takes" impacting the same management unit, the impact would be deemed not significant; or
- Where potential impacts are likely to be greater than the most recent PBR limit, the impact would be deemed to be significant.

The CRM predicted a collision rate for grey seals equating to 6.8% of the PBR limit, which, based on the population of the MU, is lower than the most recent PBR limit for grey seal in the North Coast and Orkney seal management area.

In conclusion the combined impact of deployment of Phase 1a turbines and the proposed changes associated with deployment of MeyGen 2 turbines (next subsequent stage of development) would not have a significant impact on the regional grey seal population and is screened out for EIA.

5.3.14 Harbour porpoise

With respect to harbour porpoise for the purpose of an assessment to support this EIA Screening Report. CRM is used to assess the potential impact i.e., the predicted number of harbour porpoise collisions compared to the percentage of the harbour porpoise management unit population and whether the combined impact of deployment of Phase 1a turbines and the proposed changes associated with deployment of MeyGen 2 turbines (next subsequent stage of development) would have a significant impact on the regional population of harbour porpoise.

The CRM predicted a collision rate of <8 harbour porpoises which, given the population size of the management unit, is not likely to have significant impacts on the harbour porpoise regional population.

In conclusion the combined impact of deployment of Phase 1a turbines and the proposed changes associated with deployment of MeyGen 2 turbines (next subsequent stage of development) would not have a significant impact on regional harbour porpoise population and is screened out for EIA.

5.3.15 Minke whale

With respect to minke whale for the purpose of an assessment to support this EIA Screening Report. CRM is used to assess the potential impact i.e., the predicted number of minke whale collisions compared to the percentage of the minke whale management unit population and whether the combined impact of deployment of Phase 1a turbines and the proposed changes associated with deployment of MeyGen 2 turbines (next subsequent stage of development) would have a significant impact on regional population of minke whale.

The CRM predicted a collision rate of <5 minke whales per annum which, given the population size of the management unit. is not likely to have significant impacts on the minke whale regional population.

In conclusion the combined impact of deployment of Phase 1a turbines and the proposed changes associated with deployment of MeyGen 2 turbines (next subsequent stage of development) would not have a significant impact on regional minke whale population and is screened out for EIA.

5.4 Ornithology

The MeyGen Phase 1 ES (2012) concluded that the installation, operation and decommissioning of up to 86 turbines and associated infrastructure is not expected to have a significant impact upon ornithology, subject to the implementation of proposed mitigation. Table 12 presents a comparison with the proposed changes.

Table 12. Summary of impacts on ornithology from MeyGen Phase 1 ES (2012) compared with expected impacts from proposed changes

SPECIES	IMPACT	SIGNIFICANCE OF IMPACTS ASSESSED IN ES (2012)	CONSEQUENCES OF PROPOSED CHANGES	RESIDUAL SIGNIFICANCE
Red-throated diver, Fulmar, Gannet, Cormorant, Shag, Eider, Great skua, Arctic skua, Kittiwake, Common gull, Great black-backed gull, Herring gull, Arctic tern, Guillemot, Razorbill, Black guillemot, Puffin	Disturbance / displacement due to increased boat traffic (construction, installation and decommissioning)	Not significant	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of offshore activities reduces impact.	No additional environmental impacts.
All species	Release of drill cuttings and fluid (construction and installation)	Not significant	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of offshore activities reduces impact.	No additional environmental impacts.
Red-throated diver, Fulmar, Gannet, Cormorant, Shag, Eider, Great skua, Arctic skua, Kittiwake, Common gull, Great black-backed gull, Herring gull, Arctic tern, Guillemot,	Accidental spillage from vessels (during construction, installation, operations, maintenance, and decommissioning)	Not significant (total and partial loss of inventory)	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of offshore activities reduces impact.	No additional environmental impacts.

SPECIES	IMPACT	SIGNIFICANCE OF IMPACTS ASSESSED IN ES (2012)	CONSEQUENCES OF PROPOSED CHANGES	RESIDUAL SIGNIFICANCE
Razorbill, Black guillemot, Puffin				
Red-throated diver, Fulmar, Gannet, Cormorant, Shag, Eider, Great skua, Arctic skua, Kittiwake, Common gull, Great black-backed gull, Herring gull, Arctic tern, Guillemot, Razorbill, Black guillemot, Puffin	Disturbance / displacement due to underwater noise (construction and installation)	Not significant	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of offshore activities reduces impact.	No additional environmental impacts.
Golden plover, Dunlin, Greenshank, Greenland white-fronted goose, Greylag goose (Icelandic breeding population), Whooper swan, Wigeon, Common scoter	Effects of onshore infrastructure construction activities on terrestrial birds (construction and installation)	Not significant	Reduced number HDD bores and cabling results in reduced impacts. Reduction in duration of onshore activities reduces impact. No additional onshore impacts.	No additional environmental impacts.
All species	Disturbance / displacement due to maintenance activity	Not significant	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of onshore and offshore activities reduces impact.	No additional environmental impacts.

SPECIES	IMPACT	SIGNIFICANCE OF IMPACTS ASSESSED IN ES (2012)	CONSEQUENCES OF PROPOSED CHANGES	RESIDUAL SIGNIFICANCE
Red-throated diver, Fulmar, Gannet, Cormorant, Shag, Eider, Great skua, Arctic skua, Kittiwake, Common gull, Great black-backed gull, Herring gull, Arctic tern, Guillemot, Razorbill, Black guillemot, Puffin	Accidental leakage of pollutants from turbines (operations and maintenance)	Not significant	Reduced number of turbines, results in reduced impacts. Reduction in duration of offshore activities reduces impact.	No additional environmental impacts.
Gannet, Cormorant, European shag, Guillemot, Razorbill, Puffin, Black guillemot	Displacement due to the presence of the turbines (operations and maintenance)	Not significant	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of offshore activities reduces impact.	No additional environmental impacts.
Gannet, Cormorant, European shag, Guillemot, Razorbill, Puffin, Black guillemot	Collision risk to diving birds (operations and maintenance)	Not significant	As with previously consented phases of the project there is no predicted population level impact resulting from the combined impact of Phase 1a and the proposed changes within MeyGen 2 (next subsequent stage of development).	CRM is presented below for impact of Phase 1a and MeyGen 2 for; European shag and black guillemot. Further detail on the CRM is provided Appendix A.

SPECIES	IMPACT	SIGNIFICANCE OF IMPACTS ASSESSED IN ES (2012)	CONSEQUENCES OF PROPOSED CHANGES	RESIDUAL SIGNIFICANCE
All species	Indirect effects on birds e.g. local redistribution of prey (operations and maintenance)	Not significant	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of onshore and offshore activities reduces impact.	No additional environmental impacts.
Hen harrier, Merlin, Short-eared owl, Golden plover, Dunlin, Greenshank, Greenland white-fronted goose, Greylag goose, Whooper swan	Effects of operation of onshore infrastructure on terrestrial birds (operations and maintenance)	Not significant	No change	No additional environmental impacts.
All species	Disturbance/displacement due to offshore decommissioning activities	Not significant	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of offshore activities reduces impact.	No additional environmental impacts.

The proposed changes would not result in any additional environmental impacts. Further assessment work has been undertaken on potential changes to collision risk with tidal turbines arising from the proposed changes to confirm this conclusion. The following section also reflects the existing requirement as per condition 2bii of the Section 36 consent (2013) and therefore provides CRM for a number of key bird species in order to step into the next subsequent phase of MeyGen development.

5.4.1 Updated seabird CRM for next MeyGen phase

In order to seek approval for the next subsequent phase of MeyGen development, Condition 2 S36 (2013) requires that the development be implemented in a staged manner, to prevent significant adverse impacts to the environment.

Further to this Condition 2 b(ii) stipulates that MeyGen may proceed with the next subsequent stage of development after demonstrating regard to the preservation of the environment and ecology.

Whilst harbour seals have been identified as the receptor at greatest risk from tidal developments, regulators have also noted concerns related to collision risk and impact upon key seabird species. European shag and black guillemot have been noted as the species of greatest concern for the MeyGen Project. These diving species are known to occur regularly within the Inner Sound, including the MeyGen Phase 1 turbine deployment area.

Recent stakeholder engagement, confirmed the requirement for the reassessment of collision risk to understand the combined impact of deployment of Phase 1a turbines and the proposed changes associated with deployment of MeyGen 2 turbines (next subsequent stage of development) on European shag and black guillemot.

The Encounter-Time-Probability Model (ETPM) developed by SNH (2016) was used to provide a measure of the potential risk to seabird species from collision with tidal turbines. An ETPM scenario was implemented to understand the combined impact of deployment of Phase 1a turbines and the proposed changes associated with deployment of MeyGen 2 turbines (next subsequent stage of development) upon European shag and black guillemot.

ETPM has been undertaken and compared to that presented in the Phase 1 ES (MeyGen, 2012). This ornithology assessment drew on parameters from the Ornithology Technical Report produced in support of the ES (2012).

5.4.2 European shag

ETPM is used to assess the potential impact of the combined impact of deployment of Phase 1a turbines and the proposed changes associated with deployment of MeyGen 2 turbines (next subsequent stage of development) and provide the encounter rate required to cause European shag population level effects. The encounter rate is then used to consider if the combined impact of deployment of Phase 1a and MeyGen 2 turbines have a significant impact on regional population of European shag.

ETPM for European shag predicts that each individual in the local population is at risk of collision for 1.9 seconds per year (annual exposure time). The annual exposure time is used to generate the collision probability required to account for additional mortality. Collision probability is assumed to be equivalent to the collision rate, and therefore at least 0.0187 collisions per second are required for the additional mortality to cause a population decline. This approximates to one collision for every 54 seconds that European shags spend within the rotor swept water volume being required to cause a population decline in this species.

European shag primarily forages on sandeels which are not present in any great number in the turbine deployment area, which is characterised by tide swept bedrock. The encounter rate required to cause population level effects is unlikely to be reached for the 14 turbine combined array of Phase 1a and MeyGen 2. Further to this the encounter rate does not consider any potential avoidance behaviour and the likelihood of sufficient European shag presence to result in a population level impact is further reduced.

In conclusion the combined impact of deployment of Phase 1a turbines and the proposed changes associated with deployment of MeyGen 2 turbines (next subsequent stage of development) would not have a significant impact on the regional population of European shag and is screened out for EIA.

5.4.3 Black guillemot

ETPM is used to assess the potential impact of the combined impact of deployment of Phase 1a turbines and the proposed changes associated with deployment of MeyGen 2 turbines (next subsequent stage of development) and provide the encounter rate required to cause black guillemot population level effects. The encounter rate is then used to consider if the combined impact of deployment of Phase 1a and MeyGen 2 turbines would have a significant impact on regional population of black guillemot.

The ETPM for black guillemot, predicts that each individual in the local population is at risk of collision for 0.9 seconds per year (annual exposure time), and therefore at least 0.0112 collisions per second are required for additional mortality to cause a population decline. This approximates to one collision for every 89 seconds that black guillemot spend within the rotor swept water volume being required to cause a population decline.

Black guillemot generally forage in rocky, vegetated areas associated with lower tidal flows than those found in the turbine deployment area. The encounter rate required to cause population level effects is unlikely to be reached for the 14 turbine combined array of Phase 1a and MeyGen 2. Further to this the encounter rate does not consider any potential avoidance behaviour and the likelihood of sufficient black guillemot presence to result in a population level impact is further reduced.

In conclusion the combined impact of deployment of Phase 1a turbines and the proposed changes associated with deployment of MeyGen 2 turbines (next subsequent stage of development) would not have a significant impact on the regional population of black guillemot and is screened out for EIA.

5.5 Fish ecology

The MeyGen Phase 1 ES (2012) concluded that the installation, operation and decommissioning of up to 86 turbines and associated infrastructure is not expected to have a significant impact upon fish ecology, subject to the implementation of proposed mitigation.

Fish collision risk modelling and barrier effects with respect to marine fish were assessed within the MeyGen Phase 1 ES (2012). The modelling of collision rates determined that the deployment of 86 turbines resulted in the greatest encounter rate and 16 m rotor blades resulted in the highest encounter probability for marine fish. Barrier effects were concluded to be greatest with 20 m turbine blades as they resulted in a larger swept area. It was also determined that migratory species utilising the Pentland Firth were most likely to be impacted by barrier effects and were considered to represent the worst-case scenario. Table 13 presents a comparison with the proposed changes.

Table 13 Summary of impacts on fish ecology from MeyGen Phase 1 ES (2012) compared with expected impacts from proposed changes.

SPECIES	IMPACT	SIGNIFICANCE OF IMPACTS ASSESSED IN ES (2012)	CONSEQUENCES OF PROPOSED CHANGES	RESIDUAL SIGNIFICANCE
Sandeel, Herring, Lemon sole	Loss of spawning grounds	Not significant	No change.	No additional environmental impacts.
Blue whiting, Angler fish, Hake, Mackerel, Ling, Sandeel, Saithe, Herring, Haddock, Lemon sole, Whiting, Cod, Spotted ray, Spur dog, Tope	Loss of nursery grounds	Not significant	No change.	No additional environmental impacts.
Herring	Noise (during construction, installation, operation and maintenance)	Not significant – mitigation proposed	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of offshore activities reduces impact.	No additional environmental impacts.
All	Increased turbidity	Not significant	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of offshore activities reduces impact.	No additional environmental impacts.

SPECIES	IMPACT	SIGNIFICANCE OF IMPACTS ASSESSED IN ES (2012)	CONSEQUENCES OF PROPOSED CHANGES	RESIDUAL SIGNIFICANCE
All	Smothering	Not significant – mitigation proposed	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of offshore activities reduces impact.	No additional environmental impacts.
All	Changes to prey species (construction, installation, operation and maintenance)	Not significant	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of offshore activities reduces impact.	No additional environmental impacts.
All	Release of sediment bound contaminants	Not significant	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of offshore activities reduces impact.	No additional environmental impacts.
All	Accidental spillage from vessels (construction, installation, operation and maintenance)	Not significant – mitigation proposed	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of offshore activities reduces impact.	No additional environmental impacts.

SPECIES	IMPACT	SIGNIFICANCE OF IMPACTS ASSESSED IN ES (2012)	CONSEQUENCES OF PROPOSED CHANGES	RESIDUAL SIGNIFICANCE
All	Release of drill cuttings and fluid	Not significant – mitigation proposed	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of offshore activities reduces impact.	No additional environmental impacts.
Basking sharks	Collisions with installation vessels (installation and construction)	Not significant	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of offshore activities reduces impact.	No additional environmental impacts.
All	Marine non-native species	Not significant	Reduction in duration of offshore activities reduces impact.	No additional environmental impacts.
All	Loss of habitat	Not significant	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of offshore activities reduces impact.	No additional environmental impacts.
All	Increase of available habitat	Not significant	No change	No additional environmental impacts.
Elasmobranchs	Electro-magnetic fields (EMF)	Significant (residual impacts after mitigation – not significant)	Reduced number of turbines reduces cabling	No additional environmental impacts.

SPECIES	IMPACT	SIGNIFICANCE OF IMPACTS ASSESSED IN ES (2012)	CONSEQUENCES OF PROPOSED CHANGES	RESIDUAL SIGNIFICANCE
All	Collision with turbines (operation)	Not significant – mitigation proposed	As with previously consented phases of the project there is no predicted population level impact resulting from the combined impact of Phase 1a and the proposed changes within MeyGen 2 (next subsequent stage of development).	CRM is presented below for impact of Phase 1a and MeyGen 2 for Atlantic salmon. Further detail on the CRM is detailed in Appendix A.
All	Changes in water flow	Not significant	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of offshore activities reduces impact.	No additional environmental impacts.

The proposed changes would not result in any additional environmental impacts. Further assessment work has been undertaken on potential changes to collision risk with tidal turbines and on EMF arising from the proposed changes to confirm this conclusion. The following section also reflects the existing requirement as per condition 2bii of the Section 36 consent (2013) and therefore provides CRM for Atlantic salmon in order to step into the next subsequent phase of MeyGen development.

5.5.1 Updated Atlantic salmon CRM for next MeyGen phase

In order to seek approval for the next subsequent phase of MeyGen development, Condition 2 s36 (2013) requires that the development be implemented in a staged manner, to prevent significant adverse impacts to the environment. Further to this Condition 2 b(ii) stipulates that MeyGen may proceed with the next subsequent stage of development after demonstrating regard to the preservation of the environment and ecology.

Whilst harbour seals have been identified as the receptor at greatest risk from tidal developments, regulators and stakeholders have also noted concerns related to collision risk and impact upon Atlantic salmon. Recent stakeholder engagement confirmed the requirement for the reassessment of collision risk from the combined impact of deployment of Phase 1a turbines and the proposed changes associated with deployment of MeyGen 2 turbines (next subsequent stage of development) upon Atlantic salmon.

5.5.2 Atlantic salmon – EMF

The MeyGen ES (2012) highlighted electromagnetic fields (EMF) as having the potential to significantly impact marine fish. Future phases of MeyGen would comprise an indicative 40 turbines in Phase 1 up to 86MW generating capacity, and require less subsea cabling compared to the 86 individually cabled turbines assessed in the ES (2012), leading to a smaller area of impact on marine fish from EMF.

EMFs consist of both electrical (E) and magnetic (B) fields. When electrons, in the form of electrical current, pass through a cable, a B-field is produced. The presence of the B-field can produce a second induced component, a weak electrical field, referred to as induced electrical (iE) field. The strength of E, B and iE fields depends on the magnitude and type of current flowing through the cable and the construction of the cable. Some organisms can detect E- or B-fields (i.e., electro- or magneto-sensitive species) and are presumed to do so by either iE-field detection or magnetite-based detection. Recent scientific evidence has identified some behavioural and physiological impacts in the presence of EMF, but the studies which obtained these findings used simulated levels of EMF in a laboratory environment. These EMF levels would be far greater than any EMF associated with the transmission infrastructure associated with the MeyGen project.

Little evidence exists as to the impacts of B- and iE-fields from *in situ* cables on marine species, but where evidence exists, no study has indicated that EMF levels generated from the infrastructure associated with this Project would be likely to have major or wide-ranging behavioural or physiological impacts upon the marine environment and ecology.

EMF associated with 33 kV cables to be used in the MeyGen development would decay to (or below) background levels (i.e. those associated with natural geomagnetism) beyond the immediate vicinity of the cables themselves. For this reason, it is considered that any EMFs will be of negligible magnitude beyond a few metres from the infrastructure; they will be spatially isolated from any other sources of EMF, and as a result, impacts on any ecological receptor will be highly localised and of insignificant magnitude. For these reasons, the potential impact of EMF associated with this proposed change in cabling has not been considered any further in this report.

Recent scientific evidence continues to highlight EMF as a relevant area of study with respect to marine organisms; however, there have been no studies that have conclusively demonstrated significant environmental impacts on marine fish species due to the installation of marine electrical infrastructure. For these reasons, it is considered that there is no potential pathway for additional impacts due to EMF emissions from 33kV cables.

5.5.3 Atlantic salmon smolts

Recently published scientific evidence (Newton *et al.*, 2021) indicates that Atlantic salmon smolts swim close to the sea surface (< 2 metres depth). Since a minimum clearance from blade tip to sea surface of 8 m at (lowest astronomical tide) would be maintained, encounters between smolts and the rotor-swept area of MeyGen tidal turbines are unlikely. For this reason, it is proposed that the collision rate for Atlantic salmon smolts will not be modelled, as there is no mechanism for additional significant impact to salmon smolts.

5.5.4 Atlantic salmon adults – ES (2012)

Recent stakeholder engagement confirmed a requirement for reassessment of the combined impact of deployment of Phase 1a turbines and the proposed changes associated with deployment of MeyGen 2 turbines (next subsequent stage of development) for adult Atlantic salmon. Table 14 presents a comparison with the proposed changes, with further detail provided in Appendix A.

Table 14 Summary of impacts on diadromous fish from MeyGen Phase 1 ES (2012) compared with expected impacts from proposed changes

SPECIES	IMPACT	SIGNIFICANCE OF IMPACTS ASSESSED IN ES (2012)	CONSEQUENCES OF PROPOSED CHANGES	RESIDUAL SIGNIFICANCE
Atlantic salmon, European eel, Sea trout	Barriers to movement	Not significant	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of offshore activities reduces impact.	No additional environmental impacts.
Atlantic salmon	Collision risk to Atlantic salmon (operations and maintenance)	Not significant	As with previously consented phases of the project there is no predicted population level impact resulting from the combined impact of Phase 1a and the proposed changes within MeyGen 2 (next subsequent stage of development).	CRM is presented for below for the effect of Phase 1a and MeyGen 2 for adult Atlantic salmon. Further detail on the CRM is provided in Appendix A.

The encounter rate model used in the MeyGen Phase 1 ES (2012) to assess collision risk for diadromous fish was based upon a model developed to support ornithological impact assessments for onshore wind turbines. In consultation with MD-LOT and SNH, this model was recommended as the best available model (at that time) for estimating encounter rate with salmon, since the principles underlying the model for birds travelling through the air are applicable to fish moving through the water column. To facilitate comparison with the collision modelling undertaken in the MeyGen Phase 1 ES (MeyGen, 2012), a CRM (SNH, 2016) has been used to provide a measure of the potential risk to adult salmon from the combined impact of deployment of Phase 1a turbines and the proposed changes associated with deployment of MeyGen 2 turbines (next subsequent stage of development). The CRM considers the number of animals likely to pass through each rotor swept area and the probability of collision for each such passage to generate a prediction of collisions over a specified period of time.

The MeyGen Phase 1 ES (2012) concluded that at the assumed avoidance rate of 95% the proportion of the population of 1SW and MSW adults impacted was less than 0.01% for 86 turbines and was not deemed a significant impact. The adult salmon modelling work presented within ES (2012) considered 86 turbines and estimated that this array could lead to 98 collisions with adult salmon, assuming 95% avoidance (equivalent to 0.5 1SW and 0.6 MSW fish per turbine, per year). Marine Scotland (2012) undertook additional modelling for a six turbine Stage One development, which predicted 8.55 adult salmon collisions per year, assuming 95% avoidance.

5.5.5 Atlantic salmon adults – revised CRM

For adult salmon, a CRM scenario (Appendix A) was implemented to understand the combined impact of deployment of Phase 1a turbines and the proposed changes associated with deployment of MeyGen 2 turbines (next subsequent stage of development). This modelled scenario predicts annual collisions of up to 408 adults per year, assuming no avoidance. This estimate equates to 0.112% of the regional adult Atlantic salmon (one sea winter (1SW) and multiple sea winter (MSW)) population). At a population level, this proportion is unlikely to have any significant effects even if it is assumed that every collision resulted in a physical injury, disorientation or mortality. Application of an assumed avoidance rate of 95% shows that the likelihood of population level effects is further reduced, with only 0.006% of the regional population of adult salmon predicted to collide with the combined 14 turbine array of Phase 1a and MeyGen 2.

Revised CRM of the combined impact of deployment of Phase 1a turbines and the proposed changes associated with deployment of MeyGen 2 turbines (next subsequent stage of development) predicted the number of collisions of adult salmon is of a similar magnitude to that predicted for the six approved Stage One turbines, where a 95% avoidance rate results in an estimated 23 collisions annually.

In conclusion the combined impact of deployment of Phase 1a turbines and the proposed changes associated with deployment of MeyGen 2 turbines (next subsequent stage of development) would not have a significant impact on regional Atlantic salmon population and is screened out for EIA.

5.6 Commercial fisheries

The MeyGen ES (2012) highlighted the concern for potential displacement of fishing effort, and changes in the abundance and distribution of target species; however, it was concluded that there would be no significant impact, upon commercial fisheries, subject to the implementation of proposed mitigation.

The MeyGen Phase 1 ES (2012) considered that exclusion of fishing grounds would occur in the turbine deployment area and may occur intermittently within the offshore Project area during essential maintenance operations (for safety reasons). The Phase 1 turbine deployment area (1.1 km^2) as shown in Figure 2 defined by s36c variation (2019) would not change. Table 15 presents a comparison with the proposed changes.

Table 15 Summary of impacts on commercial fisheries from MeyGen Phase 1 ES (2012) compared with expected impacts from proposed changes

IMPACT	SIGNIFICANCE OF IMPACTS ASSESSED IN ES (2012)	CONSEQUENCES OF PROPOSED CHANGES	RESIDUAL SIGNIFICANCE
Temporary exclusion from fishing grounds	Not significant – mitigation proposed	No change	No additional impacts.
Displacement of fishing effort targeting new or alternative fishing grounds	Not significant – mitigation proposed	No change	No additional impacts.
Change in abundance and distribution of target species (construction and installation)	Not significant	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of offshore activities reduces impacts	No additional impacts.
Risk of contamination (accidental spillage from vessels) (construction, installation, operation, maintenance and decommissioning)	Not significant – mitigation proposed	Reduced number of turbines, turbine support structures, HDD ducts and cabling results in reduced impacts. Reduction in duration offshore activities including O&M and decommissioning.	No additional impacts.
Displacement of fishing effort	Not significant	No change	No additional impacts.
Change in abundance and distribution of target species (operation and maintenance)	Not significant	Reduced number of turbines, turbine support structures, HDD ducts and cabling results in reduced impacts. Reduction in duration offshore activities	No additional impacts.
Loss of fishing gear due to entanglement	Not significant – mitigation proposed	Reduced number of turbines, turbine support structures, HDD ducts and cabling results in reduced impacts. Reduction in duration offshore activities	No additional impacts.
Indirect impacts to recreational fishing	Not significant	No change	No additional impacts.

IMPACT	SIGNIFICANCE OF IMPACTS ASSESSED IN ES (2012)	CONSEQUENCES OF PROPOSED CHANGES	RESIDUAL SIGNIFICANCE
Disturbance of fishing grounds (decommissioning)	Not significant – mitigation proposed	Reduced number of turbines, turbine support structures, HDD ducts and cabling results in reduced impacts. Reduction in duration offshore activities including decommissioning	No additional impacts.
Temporary changes in distribution and abundance of targeted species (decommissioning)	Not significant	Reduced number of turbines, turbine support structures, HDD ducts and cabling results in reduced impacts. Reduction in duration offshore activities including decommissioning	No additional environmental impacts.
Resumption of fishing activities in traditional fishing grounds	Positive	No change	No additional impacts.

This screening report considers the of build out to the entire 86 MW Phase 1 development including the proposed changes as described in Chapter 3 and the impact upon commercial fisheries. The indicative 40 turbines required to build out to 86 MW in future phases of MeyGen would be a significantly reduced number compared to the 86 turbines considered in ES (2012). The proposed changes reduce the overall number of turbines, turbine support structures, HDD bores and cabling.

It is not anticipated that there would therefore be any additional significant impacts on the commercial fisheries. The impact of the proposed changes upon commercial fisheries is likely to be reduced from that which was assessed in the ES (2012). The build out to the entire 86 MW Phase 1 development including the proposed changes as described in Chapter 3 and the impact upon commercial fisheries receptor, subject to implementation of proposed mitigation (Appendix B), can be therefore screened out from EIA.

As such, the commercial fisheries receptor will not be considered further in this EIA screening report.

5.7 Shipping and navigation

The MeyGen Phase 1 ES (2012) concluded that the installation, operation and decommissioning of up to 86 turbines and associated infrastructure is not expected to have a significant impact upon shipping and navigation, subject to the implementation of proposed mitigation.

The impacts of the Project on shipping and navigation were assessed within the MeyGen Phase 1 ES (2012), combining desk-based and field studies. The Pentland Firth has two channels available for transiting vessels: the Outer Sound as the recommended route used by most vessels, and the Inner sound, which contains the MeyGen Project. The ES

(2012) considered possible impacts with transiting traffic and the restriction of sea room during installation activities. Some impact pathways were considered Significant, with residual risks reduced as low as reasonably practicable (ALARP). Table 16 presents a comparison with the proposed changes.

Vessel collision risk with subsea turbines is mitigated by maintaining a minimum of 8 m clearance at LAT between the blade tip and the sea surface, this minimum clearance would not change.

Table 16 Summary of impacts on shipping and navigation from MeyGen Phase 1 ES (2012) compared with expected impacts from proposed changes

IMPACT	SIGNIFICANCE OF IMPACTS ASSESSED IN ES (2012)	CONSEQUENCES OF PROPOSED CHANGES	RESIDUAL SIGNIFICANCE
Collision risk with work vessel	Not significant – mitigation proposed	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of offshore activities reduces impacts	No additional impacts.
Re-routeing due to work vessels and associated safety zones (construction and installation)	Significant (residual risks reduced to ALARP)	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of offshore activities reduces impacts	No additional impacts.
Working vessel gets into difficulty	Significant (residual risks reduced to ALARP)	No change	No additional impacts.
Powered collision with subsea turbine	Not significant – mitigation proposed	No change sea surface clearance.	No additional impacts.
Drifting vessel collision with subsea turbine	Not significant – mitigation proposed	No change sea surface clearance.	No additional impacts.
Increase in vessel-to-vessel collision risk due to re-routeing	Not significant – mitigation proposed	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of offshore activities reduces impacts	No additional impacts.
Loss of station	Significant (residual risks reduced to ALARP)	No change.	No additional impacts.
Anchor interaction	Not significant – mitigation proposed	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in	No additional impacts.

IMPACT	SIGNIFICANCE OF IMPACTS ASSESSED IN ES (2012)	CONSEQUENCES OF PROPOSED CHANGES	RESIDUAL SIGNIFICANCE
		duration of offshore activities reduces impacts.	

This screening report considers the build out to the entire 86 MW Phase 1 development including the proposed changes as described in Chapter 3 and the impact upon shipping and navigation. The indicative 40 turbines required to build out to 86 MW in future phases of MeyGen would be a significantly reduced number compared to the 86 turbines considered in ES (2012). The proposed changes reduce the overall number of turbines, turbine support structures, HDD bores and cabling.

It is not anticipated that there would be any additional significant impacts on shipping and navigation. The impact of the proposed changes upon shipping and navigation is likely to be reduced from that which was assessed in the ES (2012). The build out to the entire 86 MW Phase 1 development including the proposed changes as described in Chapter 3 and the impact upon shipping and navigation receptor, subject to implementation of proposed mitigation, can therefore be screened out from EIA.

As such, the shipping and navigation receptor will not be considered further in this EIA screening report.

5.8 Marine cultural heritage

The MeyGen Phase 1 ES (2012) concluded that the installation, operation and decommissioning of up to 86 turbines and associated infrastructure is not expected to have a significant impact upon marine cultural heritage, subject to the implementation of proposed mitigation.

The impacts of the Project on marine cultural heritage were assessed within the MeyGen Phase 1 ES (2012) through a desk-based assessment, including remote sensing survey data and other benthic surveys which confirmed the Project area had no evidence of and low potential for marine cultural material, as large areas of the seabed have been scoured down to bare rock. Some geophysical anomalies were identified within 100 metres of the turbine and cable deployment areas, where direct and indirect impacts could have uncertain/moderate to major significance. However, with the implementation of the suggested mitigation measures in the MeyGen Phase 1 ES (2012), the impacts were reduced to minor or negligible. Table 17 presents a comparison with the proposed changes.

Table 17 Summary of impacts on marine cultural heritage from MeyGen Phase 1 ES (2012) compared with expected impacts from proposed changes

IMPACT	SIGNIFICANCE OF IMPACTS ASSESSED IN ES (2012)	CONSEQUENCES OF MEYGEN 2	RESIDUAL SIGNIFICANCE
Damage caused by placing turbine and cable over marine cultural material	Uncertain-major (Residual impacts after mitigation – not significant)	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of offshore activities reduces impacts.	No additional environmental impacts.
Damage to discovered marine cultural material Impact	Not significant – mitigation proposed	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of offshore activities reduces impacts.	No additional environmental impacts.
Damage to marine cultural material from scouring caused by alteration of currents from placing turbine and cable on seafloor	Uncertain-major (Residual impacts after mitigation – not significant)	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of offshore activities reduces impacts.	No additional environmental impacts.
Damage caused by removal of turbine and cable to marine cultural material	Not significant – mitigation proposed	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of offshore activities reduces impacts.	No additional environmental impacts.

This screening report considers the of build out to the entire 86 MW Phase 1 development including the proposed changes as described in Chapter 3 and the impact upon marine cultural heritage. The indicative 40 turbines required to build out to 86 MW in future phases of MeyGen would be a significantly reduced number compared to the 86 turbines considered in ES (2012). The proposed changes reduce the overall number of turbines, turbine support structures, HDD bores and cabling.

It is not anticipated that there would be any additional significant impacts on marine cultural heritage. The impact of the proposed changes upon marine cultural heritage is likely to be reduced from that which was assessed in the ES (2012). The build out to the entire 86 MW Phase 1 development including the proposed changes as described in Chapter 3 and the impact upon marine cultural heritage, subject to implementation of proposed mitigation, can therefore be screened out from EIA.

As such, the marine cultural heritage receptor will not be considered further in this EIA screening report.

5.9 Geology, hydrogeology and hydrology

The MeyGen Phase 1 ES (2012) concluded that the installation, operation and decommissioning of up to 86 turbines and associated infrastructure is not expected to have a significant impact upon geology, hydrogeology, and hydrology, subject to the implementation of proposed mitigation.

The MeyGen Phase 1 ES (2012) conducted a desk-based assessment of geology, hydrogeology and hydrology impacts arising from the Project. ES (2012) considered plausible impacts at the construction, installation, operation, maintenance, and decommissioning phases of the project. Some impact pathways were considered Significant; however several layout, design, and construction proposals were identified to mitigate for these effects, and these impacts were considered Not Significant. Table 18 presents a comparison with the proposed changes.

Table 18 Summary of impacts on geology, hydrogeology & hydrology from MeyGen Phase 1 ES (2012) compared with expected impacts from proposed changes

IMPACT	SIGNIFICANCE OF IMPACTS ASSESSED IN ES (2012)	CONSEQUENCES OF PROPOSED CHANGES	RESIDUAL SIGNIFICANCE
Pollution event (construction and installation)	Significant (Residual impacts after mitigation – Not Significant)	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of onshore activities reduces impacts.	No additional environmental impacts.
Erosion and sedimentation	Significant (Residual impacts after mitigation – Not Significant)	No change	No additional environmental impacts.
Soil compaction and loss of quality	Significant (Residual impacts after mitigation – Not Significant)	No change.	No additional environmental impacts.
Increase in surface runoff	Not significant	No change	No additional environmental impacts.
Modification of drainage patterns	Not significant	No change.	No additional environmental impacts.
Impediments to surface flows	Significant (Residual impacts after mitigation – Not Significant)	No change	No additional environmental impacts.
Increase in fluvial flood risk	Significant (Residual impacts after mitigation – Not Significant)	No change	No additional environmental impacts.

IMPACT	SIGNIFICANCE OF IMPACTS ASSESSED IN ES (2012)	CONSEQUENCES OF PROPOSED CHANGES	RESIDUAL SIGNIFICANCE
Modification of groundwater levels and flows (construction and installation)	Significant (Residual impacts after mitigation – Not Significant)	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of onshore activities reduces impacts.	No additional environmental impacts.
Damage to geological or geomorphological features (construction, installation and decommissioning)	Not significant	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of onshore activities and results in reduced impacts.	No additional environmental impacts.
Mobilisation of contaminants (construction, installation and decommissioning)	Not significant	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of onshore activities results in reduced impacts.	No additional environmental impacts.
Pollution event (O&M)	Not significant	No change.	No additional environmental impacts.
Erosion and sedimentation (O&M and decommissioning)	Not significant	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of onshore activities including decommissioning results in reduced impacts.	No additional environmental impacts.
Impediments to surface flows (O&M and decommissioning)	Not significant	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of onshore activities including decommissioning results in reduced impacts.	No additional environmental impacts.
Pollution event (decommissioning)	Significant (Residual impacts after mitigation – Not Significant)	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of onshore activities including decommissioning results in reduced impacts.	No additional environmental impacts.

IMPACT	SIGNIFICANCE OF IMPACTS ASSESSED IN ES (2012)	CONSEQUENCES OF PROPOSED CHANGES	RESIDUAL SIGNIFICANCE
Soil compaction and loss of quality (decommissioning)	Significant (Residual impacts after mitigation – Not Significant)	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of onshore activities including decommissioning results in reduced impacts.	No additional environmental impacts.
Increase in fluvial flood risk (decommissioning)	Not significant	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of onshore activities including decommissioning results in reduced impacts.	No additional environmental impacts.
Modification of groundwater levels and flows (decommissioning)	Not significant	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of onshore activities including decommissioning results in reduced impacts.	No additional environmental impacts.

This screening report considers the of build out to the entire 86 MW Phase 1 development including the proposed changes as described in Chapter 3 and the impact upon geology, hydrogeology, and hydrology. The indicative 40 turbines required to build out to 86 MW in future phases of MeyGen would be a significantly reduced number compared to the 86 turbines considered in ES (2012). The proposed changes reduce the overall number of turbines, turbine support structures, HDD bores and cabling

It is not anticipated that there would be any additional significant impacts on the physical environment and sediment dynamics. The impact of the proposed changes upon geology, hydrogeology, and hydrology is likely to be reduced from that which was assessed in the ES (2012). The build out to the entire 86 MW Phase 1 development including the proposed changes as described in Chapter 3 and the impact upon geology, hydrogeology, and hydrology receptor, subject to implementation of proposed mitigation, can therefore be screened out from EIA.

As such, the geology, hydrogeology, and hydrology receptor will not be considered further in this EIA screening report.

5.10 Terrestrial habitats and ecology

The MeyGen Phase 1 ES (2012), Chapter 18, concluded that the installation, operation and decommissioning of up to 86 turbines and associated infrastructure is not expected to have a significant impact upon terrestrial habitats and ecology, subject to the implementation of proposed mitigation.

The ES (2012) concluded that overall impacts associated with terrestrial habitats were insignificant but noted that otters are present in coastal habitats adjacent to the Project and there is potential for disturbance. Impacts to otters were deemed significant but temporary, and only likely during the construction phase and the proposed mitigation would manage potential impacts.

The ES (2012) assessed impacts of the onshore component of the Project specific to terrestrial ecology receptors, focusing on impacts to terrestrial habitats and protected species. Combining desk-based research and on-site surveys, the assessment considered impacts on a wider Project area, which was further refined to a smaller footprint at both the Ness of Quoys and Ness of Huna Power Conversion Centre (PCC) sites and a single cable corridor. Only the substation site at Ness of Quoys has been developed, and it is anticipated that all future onshore development will be conducted at Ness of Quoys site. The mitigation measures proposed in the ES (2012) are related to a much wider development footprint.

The ES (2012) assessed impacts on terrestrial habitats as insignificant, some of these habitats may be of value to protected species, such as water vole and otter, potentially significant impacts were identified during the construction phase, as well as potential for localised habitat loss, but proposed mitigation would manage these impacts and ensure that they do not affect the viability of the local populations. Table 19 presents a comparison with the proposed changes.

Table 19 Summary of impacts on terrestrial habitats and ecology from MeyGen Phase 1 ES (2012) compared with expected impacts from proposed changes

IMPACT	SIGNIFICANCE OF IMPACTS ASSESSED IN ES (2012)	CONSEQUENCES OF PROPOSED CHANGES	RESIDUAL SIGNIFICANCE
Impact to statutorily protected sites	Not significant	Reduced number HDD bores and cabling results in reduced impacts. Reduction in duration of onshore activities results in reduced impacts.	No additional environmental impacts.
Disturbance to terrestrial habitats	Not significant	Reduced number HDD bores and cabling results in reduced impacts. Reduction in duration of onshore activities results in reduced impacts.	No additional environmental impacts.

IMPACT	SIGNIFICANCE OF IMPACTS ASSESSED IN ES (2012)	CONSEQUENCES OF PROPOSED CHANGES	RESIDUAL SIGNIFICANCE
Terrestrial habitat loss	Not significant	No change to onshore environment.	No additional environmental impacts.
Disturbance to otters	Significant (Residual impacts after mitigation – not significant)	Reduced number HDD bores and cabling results in reduced impacts. Reduction in duration of onshore activities results in reduced impacts.	No additional environmental impacts.
Disturbance to water vole	Significant (Residual impacts after mitigation – not significant)	Reduced number HDD bores and cabling results in reduced impacts. Reduction in duration of onshore activities results in reduced impacts.	No additional environmental impacts.
Temporary disturbance to habitats during decommissioning operations	Not significant	Reduced number HDD bores and cabling results in reduced impacts. Reduction in duration of onshore activities including decommissioning results in reduced impacts.	No additional environmental impacts.
Temporary disturbance to otters during decommissioning operations	Significant (Residual impacts after mitigation – not significant)	Reduced number HDD bores and cabling results in reduced impacts. Reduction in duration of onshore activities including decommissioning results in reduced impacts.	No additional environmental impacts.

This screening report considers the of build out to the entire 86 MW Phase 1 development including the proposed changes as described in Chapter 3 and the impact upon terrestrial habitats and ecology. The indicative 40 turbines required to build out to 86 MW in future phases of MeyGen would be a significantly reduced number compared to the 86 turbines considered in ES (2012). The proposed changes reduce the overall number of turbines, turbine support structures, HDD bores and cabling.

It is not anticipated that there would be any additional significant impacts on terrestrial habitats and ecology receptors. The impact of the proposed changes upon terrestrial habitats and ecology is likely to be reduced from that which was assessed in the ES (2012). The build out to the entire 86 MW Phase 1 development including the proposed changes as described in Chapter 3 and the impact upon terrestrial habitats and ecology receptor, subject to implementation of proposed mitigation, can therefore be screened out from EIA.

As such, the terrestrial habitats and ecology receptors receptor will not be considered further in this EIA screening report.

5.11 Landscape, seascape and visual impact

The MeyGen Phase 1 ES (2012) Chapter 19 concluded that the installation, operation and decommissioning of up to 86 turbines and associated infrastructure is not expected to have a significant impact upon landscape, seascape and visual impact, subject to the implementation of proposed mitigation.

The impacts of the Project on the landscape, seascape, and visual impacts were assessed within the ES (2012) for two potential sites at Ness of Huna and Ness of Quoys . The baseline characteristics of the landscape, seascape, and visual resources of the area were considered inherently compatible with the proposed development, and combined with the substantial embedded mitigation measures in the design of the onshore facilities concluded that only a limited number of impacts are considered Significant. The Ness of Quoys and Ness of Huna sites would both experience Significant impacts due to the large geographical extent of the Zone of Theoretical Visibility (ZTV). However only the substation site at Ness of Quoys has been developed, and it is anticipated that all future onshore development will be conducted at Ness of Quoys site. Table 20 presents a comparison with the proposed changes.

Table 20. Summary of landscape, seascape and visual impact from MeyGen Phase 1 ES (2012) compared with expected impacts from the proposed changes

IMPACT	SIGNIFICANCE OF IMPACTS ASSESSED IN ES (2012)	CONSEQUENCES OF MEYGEN 2	RESIDUAL SIGNIFICANCE
Construction and drilling noise	Not significant	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of onshore and offshore results in reduced impacts.	No additional impacts.
Direct damage, removal or destruction of onshore cultural heritage assets	Significant	No change to onshore environment.	No additional impacts.
Power Conversion Centre (PCC) operational noise	Not significant	No change to onshore environment.	No additional impacts.

IMPACT	SIGNIFICANCE OF IMPACTS ASSESSED IN ES (2012)	CONSEQUENCES OF MEYGEN 2	RESIDUAL SIGNIFICANCE
Setting	Significant (Residual impacts after mitigation – significant for Canisbay Kirk and graveyard; all others Not Significant)	Reduction in duration of onshore activities including decommissioning results in reduced impacts.	No additional impacts.

This screening report considers the of build out to the entire 86 MW Phase 1 development including the proposed changes as described in Chapter 3 and the impact upon landscape, seascape and visual impact. The indicative 40 turbines required to build out to 86 MW in future phases of MeyGen would be a significantly reduced number compared to the 86 turbines considered in ES (2012). The proposed changes reduce the overall number of turbines, turbine support structures, HDD bores and cabling.

It is not anticipated that there would be any additional significant impacts on landscape, seascape and visual impact. The impact of the proposed changes upon landscape, seascape and visual impact is likely to be reduced from that which was assessed in the ES (2012). The build out to the entire 86 MW Phase 1 development including the proposed changes as described in Chapter 3 and the impact upon landscape, seascape and visual impact receptor, subject to implementation of proposed mitigation, can therefore be screened out from EIA.

As such, landscape, seascape and visual impact receptor will not be considered further in this EIA screening report.

5.12 Onshore impacts

The MeyGen Phase 1 ES (2012) Chapters 20 Onshore Cultural Heritage; 21 Socio-economics Tourism and Recreation; 22 Onshore Transportation and Access; 23 Onshore Noise and Dust; 24 Accidental Events concluded that the installation, operation and decommissioning of up to 86 turbines and associated infrastructure is not expected to have a significant impact upon onshore impacts, subject to the implementation of proposed mitigation.

The ES (2012) assessed onshore impacts on multiple offshore receptors, including onshore cultural heritage, socio-economic, tourism and recreation, onshore transport and access, and onshore noise and dust impacts and accidental events. The proposed development area does not contain Scheduled Ancient Monuments, Listed Buildings, or other statutorily designated assets, although such sites are found close by and could be significantly impacted by the Project. However, with appropriate mitigation strategies and careful management, the proposed development is not expected to significantly impact onshore cultural heritage. Table 21 presents a comparison with the proposed changes.

Table 21 Summary of onshore impacts from MeyGen Phase 1 ES (2012) compared with expected impacts from proposed changes

IMPACT	SIGNIFICANCE OF IMPACTS ASSESSED IN ES (2012)	CONSEQUENCES OF MEYGEN 2	RESIDUAL SIGNIFICANCE
Onshore cultural heritage, Chapter 20			

IMPACT	SIGNIFICANCE OF IMPACTS ASSESSED IN ES (2012)	CONSEQUENCES OF MEYGEN 2	RESIDUAL SIGNIFICANCE
Construction and drilling noise	Not significant	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of onshore activities results in reduced impacts.	No additional impacts.
Direct damage, removal or destruction of onshore cultural heritage assets	Significant	No change to onshore environment.	No additional impacts.
PCC operational noise	Not significant	No change to onshore environment.	No additional impacts.
Setting	Significant	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of onshore activities results in reduced impacts.	No additional impacts.
Socio-economics, tourism and recreation, Chapter 21			
Local employment and GVA impacts during construction, O&M, and decommissioning	Positive	Further development will have ongoing positive benefits.	No additional impacts.
Wider qualitative economic benefits during construction, O&M and decommissioning	Positive	Further development will have ongoing positive benefits.	No additional impacts.
Local tourism business impacts during construction and decommissioning	Significant/positive (Residual impacts after mitigation – not significant)	No significant difference expected (positive or negative)	No additional impacts.
Wider tourism impacts during construction and decommissioning	Significant/positive (Residual impacts after mitigation – not significant)	No significant difference expected (positive or negative)	No additional impacts.

IMPACT	SIGNIFICANCE OF IMPACTS ASSESSED IN ES (2012)	CONSEQUENCES OF MEYGEN 2	RESIDUAL SIGNIFICANCE
Recreation impacts during construction and decommissioning	Significant at one site (Residual impacts after mitigation – not significant)	No significant difference expected (positive or negative)	No additional impacts.
Tourism and recreation impact during operations and maintenance	Not significant	No significant difference expected (positive or negative)	No additional impacts.
Onshore transport and access, Chapter 22			
Road traffic congestion associated with PCC site	Not significant – mitigation proposed	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in duration of onshore activities results in reduced impacts. No change ongoing Maintenance requirements.	No additional impacts.
Alteration of Road traffic congestion during cable installation	Not significant – mitigation proposed	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts. Reduction in onshore construction activities reduces impacts	No additional impacts.
Road traffic congestion associated with transport of offshore components to assembly site	Significant (Residual impacts after mitigation – not significant)	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduced impacts Reduction in onshore and offshore construction activities.	No additional impacts.
Traffic congestion during operation and maintenance	Not significant	No change ongoing maintenance requirements.	No additional impacts.
Onshore noise and dust impacts, Chapter 23			
PCC/HDD site and cable route construction noise	Not significant	Reduced number of HDD ducts results in reduction in duration onshore activities	No additional impacts.

IMPACT	SIGNIFICANCE OF IMPACTS ASSESSED IN ES (2012)	CONSEQUENCES OF MEYGEN 2	RESIDUAL SIGNIFICANCE
Construction and drilling traffic noise	Not significant	Reduced number of HDD ducts results in reduction in duration onshore activities	No additional impacts.
Horizontal Directional Drilling noise	Daytime – not significant Night time – Significant (Residual impacts after mitigation – not significant)	Reduced number of HDD ducts results in reduction in duration onshore activities	No additional impacts.
Impacts due to airborne dust during construction	Not significant	Reduced number of HDD ducts results in reduction in duration onshore activities	No additional impacts.
PCC operational noise (operation and maintenance)	Daytime – not significant Night time – Significant (Residual impacts after mitigation – not significant)	No change ongoing operation and maintenance.	No additional impacts.
Accidental events, Chapter 24			
Oil spills from vessels	Not significant	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduction duration offshore activities reduced installation time, fewer vessel operations.	No additional impacts
Leaks/pollution during support structure installation	Significant (Residual impacts after mitigation – not significant)	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduction duration offshore activities reduced installation time, fewer vessel operations.	No additional impacts
Vehicle collision	Not significant	Reduced number of turbines, turbine support structures, HDD bores and cabling results in reduction duration offshore activities reduced installation time, fewer vessel operations.	No additional impacts
Leak of fluid from turbines	Not significant	Reduced number of turbines results in reduced impacts	No additional impacts

IMPACT	SIGNIFICANCE OF IMPACTS ASSESSED IN ES (2012)	CONSEQUENCES OF MEYGEN 2	RESIDUAL SIGNIFICANCE
Fire risk at PCC	Not significant	No change from ES (2012)	No additional impacts

This screening report considers the of build out to the entire 86 MW Phase 1 development including the proposed changes as described in Chapter 3 and the impact upon the following onshore receptors: Onshore Cultural Heritage; Socio-economics Tourism and Recreation; Onshore Transportation and Access; Onshore Noise and Dust; Accidental Events. The socio-economics, tourism and recreation receptors were found to be mostly positively impacted by the Project during all phases. The Project will have positive economic impacts at a local level, within the wider industry supply chain and the tourism business economy. Onshore elements may potentially have a limited number of adverse tourism and recreational impacts, but following mitigation were assessed as Not Significant. Some positive likely impacts on socio-economics could be reduced due to fewer turbines resulting in shorter installation campaigns.

The indicative 40 turbines required to build out to 86 MW in future phases of MeyGen would be a significantly reduced number compared to the 86 turbines considered in ES (2012). From an onshore perspective the proposed changes reduce the overall number of HDD bores required at the Ness of Quoys substation site. It is not anticipated that there would be any additional significant impacts on the onshore receptors. The impact of the proposed changes upon onshore receptors is likely to be reduced from that which was assessed in the ES (2012). The build out to the entire 86 MW Phase 1 development including the proposed changes as described in Chapter 3 and the impact upon onshore receptors, subject to implementation of proposed mitigation, can therefore be screened out from EIA.

As such, the onshore Cultural Heritage; Socio-economics Tourism and Recreation; Onshore Transportation and Access; Onshore Noise and Dust; Accidental Events receptors will not be considered further in this EIA screening report.

5.13 Potential for HRA requirement

Following the MeyGen Phase 1 consent application, it was concluded that the installation, operation and decommissioning of up to 86 turbines and associated infrastructure would not have any adverse effects on the integrity of European sites, such as Special Protection Areas (birds) and Special Areas of Conservation (marine mammals).The Habitats Regulations Appraisal was carried out for:

SPAs: North Caithness Cliffs SPA, Caithness and Sutherland Peatlands SPA, Pentland Firth Islands SPA, Hoy SPA, East Caithness Cliffs SPA, Copinsay SPA , Marwick Head SPA, Rousay SPA, Sule Skerry and Sule Stack SPA, Calf of Eday SPA, West Westray SPA, Fair Isle SPA, North Rona and Sula Sgeir SPA, Noss SPA , Hermaness, Saxa Vord and Valla Field SPA, Fetlar SPA, Foula SPA, Handa SPA, Auskerry SPA,

SACs for Marine Mammals : North Rona SAC , Berwickshire and North Northumberland Coast SAC , Faray and Holm of Faray SAC, Isle of May SAC, Dornoch Firth and Morrich More SAC, Sanday SAC, Moray Firth SAC

SACs for Migratory Fish and Freshwater Pearl Mussels: River Thurso SAC, Berriedale and Langwell Waters SAC, River Borgie SAC, River Naver SAC, River Evelix SAC, River Oykel SAC, River Moriston SAC, River Spey SAC, Little Gruinard

River SAC, Abhainn Clais an Eas and Allt a' Mhuilinn SAC, River Bladnoch SAC, Endrick Water SAC, North Harris SAC, Langavat SAC, River Dee SAC, River South Esk SAC, River Tay SA, River Teith SAC, River Tweed SAC

The Appropriate Assessment was carried out in 2013, since then new SPA's and SACs were classified including Seas Off Foula SPA, Moray Firth SPA, Bluemull & Colgrave Sounds SPA, Scapa FLow SPA, North Orkney SPA, East Mainland Coast Shetland SPA and Southern North Sea SAC that should be taken into consideration while assessing any Likely Significant Effects (LSEs) on the protected features.Following review of the potential impact pathways associated with the proposed changes, it is not anticipated that the proposed changes would result in any additional Likely Significant Effects on the features of any European site.

However, as part of any subsequent application, MeyGen would undertake an HRA screening, to assess whether future phases of MeyGen would have any Likely Significant Effects on protected sites, including SPAs, SACs or Ramsar sites in the form of a screening report, likely included as a chapter within a broader environmental report.

6 SUMMARY OF ANY SIGNIFICANT IMPACT ON THE ENVIRONMENT RESULTING FROM THE PROPOSED CHANGES

6.1 Proposed changes

This section summarises the content presented in this screening report.

MeyGen seek to vary the following parameters for all future Phase 1 developments at the MeyGen site:

- Increase the diameter of tidal turbines from the 16 - 20m specified in ANNEX 1 Section 36 (2013) to 16 - 24m;
- Reduce the minimum clearance between blade tip to the seabed, from the 4.5 m specified in Project Description Envelope MeyGen Phase 1 ES (2012) to a minimum of 3 m;
- Remove rated MW capacity per turbine, currently 1.0 to 2.4 MW, specified in Project Description Envelope MeyGen Phase 1 ES (2012) whilst retaining the permitted generating capacity MeyGen Phase 1 not exceeding 86 MW, specified in ANNEX 1 Section 36 (2013);
- Increase blade swept area from 201 - 314 m^2 (16 – 20 m diameter turbine) specified in Project Description Envelope MeyGen Phase 1 ES (2012) to 201 - 452 m^2 (16 - 24 m diameter turbine);
- Reduce the total number of turbines in Phase from 61 specified in ANNEX 1 Section 36 (2013), to up to 40 turbines;
- Increase of export cables maximum voltage from 6.6 kV to 33 kV

The aggregated effect of the proposed changes yields an indicative 40 turbine array required to reach 86 MW Phase 1 generating capacity, representing less than half of the 86 turbines and associated infrastructure assessed within MeyGen Phase 1 ES (2012). This indicative 40 turbine array comprises:

- The already installed Phase 1a comprising 4 turbines at 1.5 MW (6 MW);
- The in-development MeyGen 2 comprising 10 turbines at circa 3 MW up to 24 m diameter (28 MW); and
- Future phases comprise up to 26 turbines (rated power to be confirmed) up to 24 m diameter (52 MW). Subject to approval via Scottish government through condition 2 b(ii).

The MeyGen Phase 1 ES (2012) concluded that the installation, operation and decommissioning of up to 86 turbines and associated infrastructure was not expected to result in any significant impacts (subject to the implementation of proposed mitigation). Following on from this it is anticipated that impacts related to the installation, operation and decommissioning of an array comprised of fewer, larger turbines would be of lower significance than the impacts assessed in the MeyGen Phase 1 ES (2012).

6.2 Screening Report Conclusions

This screening report concludes that the impact of build out to the entire 86 MW Phase 1 development including the proposed changes upon the following receptors with the MeyGen Phase1 ES (2012) would not have any additional significant impacts subject to implementation of proposed mitigation:

- Physical Environment and Sediment Dynamics;
- Benthic Habitats and Ecology;

- Commercial Fisheries;
- Shipping and Navigation;
- Marine Cultural Heritage;
- Geology Hydrology and Hydrogeology;
- Terrestrial Habitats and Ecology;
- Landscape, Seascape and Visual Impact Assessment;
- Onshore Cultural Heritage, Socio-economics, Tourism and Recreation, Transportation and Access, Noise and Dust; and
- Accidental Events.

The impacts for these receptors were therefore screened out from EIA. In addition, impacts upon marine mammals, ornithology and fish ecology from the build out to the entire 86 MW Phase 1 development including the proposed changes were also screened out from EIA. However, recent stakeholder engagement confirmed that the most significant risk associated with the proposed changes was related to the potential of collision risk with key marine species and requested that collision risk modelling was undertaken to support the screening assessment conclusions; collision modelling, including its wider context, is discussed as follows.

6.3 Collision Risk Modelling

The original s36 consent (2013) limited the initial Stage of development referred to as Stage One to six turbines to avoid adverse impacts upon harbour seal population within the Orkney and North Coast Management Unit. Whilst harbour seals have been identified as the receptor at greatest risk from tidal developments, regulators have noted concerns related to collision risk and impact upon other key marine species namely: grey seal, harbour porpoise, minke whale; European shag, black guillemot and Atlantic salmon. Condition 2 of the s36 (2013) also requires that the development be implemented in a staged manner, to prevent significant adverse impacts to the environment. Future phases of MeyGen would be subject to approval via Scottish government through condition 2 b(ii).

This screening report presents CRM for each of the key marine species to understand the potential impact of the proposed changes to the Project, and to understand the combined impact of deployment of Phase 1a turbines and the proposed changes associated with deployment of MeyGen 2 turbines (next subsequent stage of development):

- CRM for harbour seal, grey seal, harbour porpoise and minke whale confirmed no adverse effect upon the respective regional populations and screened out for EIA;
- ETPM for European shag and black guillemot confirmed no adverse effect upon the respective regional populations and screened out for EIA; and
- CRM for adult Atlantic salmon confirmed no adverse effect on the regional population and screened out for EIA.

As with previously consented phases of the project there is no predicted population level impact resulting from the combined impact of Phase 1a and the proposed changes within MeyGen 2 (next subsequent stage of development) upon key marine species.

6.4 Conclusions

MeyGen considers that the proposed changes to the project design envelope will not introduce any new significant effects, nor will they intensify any existing significant effect which are subject to the implementation of proposed

mitigation. Where specific concern was raised around how collision risk might be affected by the proposed changes, assessment has been presented using the next phase of MeyGen project as an example of how the proposed design envelope changes would not result in a significant environmental impact.

For all future MeyGen phases including MeyGen 2the Environmental Report required to support discharge of Condition 2b(ii) of the s36 (2013) will also assess the impact of the proposed changes within the varied s36 (2023) consent, subject to its approval, such that any potential impacts on receptors are identified, assessed and mitigated where appropriate in light of any new information available at that time.

This screening report seeks the opinion of Scottish Ministers on whether making the proposed changes to certain parameters listed in Chapter 3, should require a statutory EIA. The assessments presented here seek to present Scottish Ministers and their advisors sufficient information required to be able to provide such a screening opinion. Any subsequent s36c variation application would be accompanied by an environmental report, whether EIA or non-EIA, informed by appropriate stakeholder engagement.

7 REFERENCES

Band, B., Sparling, C., Thompson, D., Onoufriou, J., San Martin, E. and West, N., 2016. Refining estimates of collision risk for harbour seals and tidal turbines (pp. 1-133). Edinburgh, UK: Marine Scotland Science.

Gillespie, D., Palmer, L., Macaulay, J., Sparling, C. and Hastie, G., 2021. Harbour porpoises exhibit localized evasion of a tidal turbine. Aquatic Conservation: Marine and Freshwater Ecosystems, 31(9), pp.2459-2468.Godfrey et al. (2014).

Marine Scotland, 2012. Marine Renewables: Consideration of Atlantic Salmon Collision Modelling – Meygen – Inner Sound; Pentland Firth. https://marine.gov.scot/datafiles/lot/Meygen/June_2013_MSS_SNH_report-Consideration_of_Atlantic_Salmon_Collision_Modelling/20130607_Meygen_Salmon_review-Final_PDF_Version_A951792.pdf.

MeyGen, 2017. MeyGen Project - Environmental Report April 2017. Document Number: A-100157-S02-EIAS-002.

MeyGen (2012). Environmental Statement (ES), MeyGen Phase 1. https://marine.gov.scot/data/environmental-statement-meygen-tidal-energy-project.

Newton, M., Barry, J., Lothian, A., Main, R., Honkanen, H., Mckelvey, S., Thompson, P., Davies, I., Brockie, N., Stephen, A., Murray, R. O., Gardiner, R., Campbell, L., Stainer, P., and Adams, C., 2021. Counterintuitive active directional swimming behaviour by Atlantic salmon during seaward migration in the coastal zone. – ICES Journal of Marine Science, 78, 1730 – 1743.

Onoufriou, J., Russell, D.J., Thompson, D., Moss, S.E. and Hastie, G.D., 2021. Quantifying the effects of tidal turbine array operations on the distribution of marine mammals: Implications for collision risk. Renewable Energy, 180, pp.157-165.

Onoufriou, J., Brownlow, A., Moss, S., Hastie, G. and Thompson, D., 2019. Empirical determination of severe trauma in seals from collisions with tidal turbine blades. Journal of Applied Ecology, 56(7), pp.1712-1724.

Palmer, L., Gillespie, D., MacAulay, J.D., Sparling, C.E., Russell, D.J. and Hastie, G.D., 2021. Harbour porpoise (Phocoena phocoena) presence is reduced during tidal turbine operation. Aquatic Conservation: Marine and Freshwater Ecosystems, 31(12), pp.3543-3553.

Russell, D.J., McClintock, B.T., Matthiopoulos, J., Thompson, P.M., Thompson, D., Hammond, P.S., Jones, E.L., MacKenzie, M.L., Moss, S. and McConnell, B.J., 2015. Intrinsic and extrinsic drivers of activity budgets in sympatric grey and harbour seals. Oikos, 124(11), pp.1462-1472.

Scottish Natural Heritage, 2016. Assessing collision risk between underwater turbines and marine wildlife. SNH guidance note.

Scottish Natural Heritage, 2013. Inner Sound tidal energy proposal by MeyGen Ltd. SNH marine mammal advice summary note. Sent by SNH to MS-LOT, 5 April 2013.

Special Committee on Seals, 2021. Scientific Advice on Matters Related to the Management of Seal Populations: 2021. Natural Environment Research Council.

APPENDIX A APPENDIX A COLLISION RISK

INVESTIGATIONS INTO HARBOUR SEAL COLLISION RISK

During consultation over the Section 36 (2013) consent application for MeyGen Phase 1, NatureScot expressed concerns over potential adverse impacts on the regional harbour and grey seal population. NatureScot undertook further work to refine the approach and assessment of collision risk and considered that the potential collisions for harbour seals for a first stage of the MeyGen Project of six turbines would avoid an adverse impact on the current harbour seal population within the North Coast and Orkney seal management area. In awarding s36 consent (2013), MD-LOT included condition 2b(ii), which stated that any development beyond an initial six turbine stage would have to demonstrate *regard to the preservation of the environment and ecology*.

MeyGen are seeking to vary certain parameters within s36 (2013) and project description envelope within MeyGen Phase 1 ES (2012) to enable all future phases of MeyGen to install the latest, most efficient tidal turbine technology and achieve a lower levelised cost of energy (LCoE) from the MeyGen site.

MeyGen are seeking to vary the following parameters for all future phases of MeyGen Phase 1, the proposed changes are:

- Increase the diameter of tidal turbines from 16 – 20 m specified in ANNEX 1 Section 36 (2013) to 16 – 24 m;
- A reduction in the minimum clearance between blade tip to the seabed, from 4.5 m specified in Project Description Envelope MeyGen Phase 1 ES (2012) to a minimum of 3 m;
- Remove rated MW power cap per turbine, currently 1.0 to 2.4 MW, specified in Project Description Envelope MeyGen Phase 1 ES (2012) whilst retaining the permitted generating capacity MeyGen Phase 1 not exceeding 86 MW, specified in ANNEX 1 Section 36 (2013);
- Increase blade swept area from 201 - 314m^2 (16 – 20 m diameter turbine) specified in Project Description Envelope MeyGen Phase 1 ES (2012) to 201 - 452 m^2 (16 - 24 m diameter turbine);
- Reduce the total number of turbines in Phase from 61 specified in ANNEX 1 Section 36 (2013), to up to 40 turbines;
- Increase of export cables maximum voltage from 6.6 kV to 33 kV

MeyGen intend to submit a s36 c variation application to seek permission for the proposed changes for all future Phase 1 developments at the MeyGen site.

The Environmental Impact Assessment (EIA) screening report that this appendix accompanies has been prepared to provide MD-LOT, the marine industries regulator in Scottish waters, the necessary information to provide a screening opinion as to whether the proposed changes would require a statutory EIA to support a Section 36c (Electricity Act 1989) variation application.

In order to inform this Environmental Impact Assessment (EIA) Screening Report, MeyGen have undertaken a comprehensive update to the collision risk modelling approach, incorporating updated information these include:

- An update to harbour seal at-sea densities (based on the method in Onoufriou *et al.*, 2021);
- Utilising accurate data on current flow speeds derived directly from the MeyGen Phase 1 turbine deployment area, based on a validated hydrodynamic model (MeyGen data);
- Utilising turbine parameters which reflect the refined current flow speeds, rather than a single average value for a year (MeyGen / turbine manufacturer proprietary data);

- Incorporation of an estimate of proportion of the harbour seal population at rest (per Russell *et al.*, 2015); and
- Refinement based on the likelihood of serious or fatal injury, based on collision velocity (per Onoufriou *et al.*, 2019).

In addition, MeyGen have used the refined hydrodynamic and turbine parameters to re-model the collision risk for grey seal, harbour porpoise and minke whale.

Calculating harbour seal density MeyGen Phase 1 turbine deployment area

Onoufriou *et al.*, (2021) presented a modelled distribution of harbour seals at sea, within the Inner Sound, as part of a study which explored whether the presence and/or the operational status of the four MeyGen Phase 1a tidal turbines (deployed in 2017) influenced the distribution of harbour seals. This study used GPS location data from harbour seals with telemetry tags on haul-outs on the north coast of Scotland to model the relationship between probability of occurrence in the Inner Sound and a suite of environmental and engineering parameters, including tidal state and operational status of the turbines. In the paper, Onoufriou *et al.* (2021) presented a predicted distribution of harbour seals for four states of the tide (peak of the flood tide, peak of the ebb tide, high water, and low water), represented by the proportion of the regional population present within each 500 x 500 m square of a regular grid.

Onoufriou *et al.*, (2021) used only a subset of available harbour seal data from the North Coast region to examine the impact of the presence/operational status of the turbines. As a result, location data from harbour seal trips outside of the immediate vicinity of the Inner Sound were excluded. One outcome of this is that the distributions presented by Onoufriou *et al.*, (2021) do not represent the total distribution of the population of harbour seals from the North Coast population. The updated MeyGen harbour seal modelling sought to (1) fit the model to all the location data from all seals tagged at North Coast haul-outs, and (2) use the resulting model to predict the distribution of harbour seals across a larger spatial domain than the published Onoufriou *et al.*, (2021) study had presented.

Updated MeyGen harbour seal density maps (2023)

The outcome of this revised modelling (hereafter referred to as the "updated MeyGen harbour seal density maps (2023)") was a predicted distribution of harbour seals for each of four tidal states, across a domain which represents the maximum spatial extent of harbour seals tracked from North Coast haul-outs using telemetry tags (Figure 4). These predicted distributions use the same modelling method determined through extensive model selection, according to the details in Onoufriou *et al.*, (2021). The updated MeyGen harbour seal density maps (2023) maps estimate the proportion of the local population of harbour seals within 500 x 500 m grid cells, for each of four tidal states, across a domain covering the whole Pentland Firth, southern Scapa Flow, Thurso Bay, and Duncansby Head, and including the islands of southern Orkney, Stroma, and the Pentland Skerries. The predictions cover an area approx. 60 km east to west and 40 km north to south.

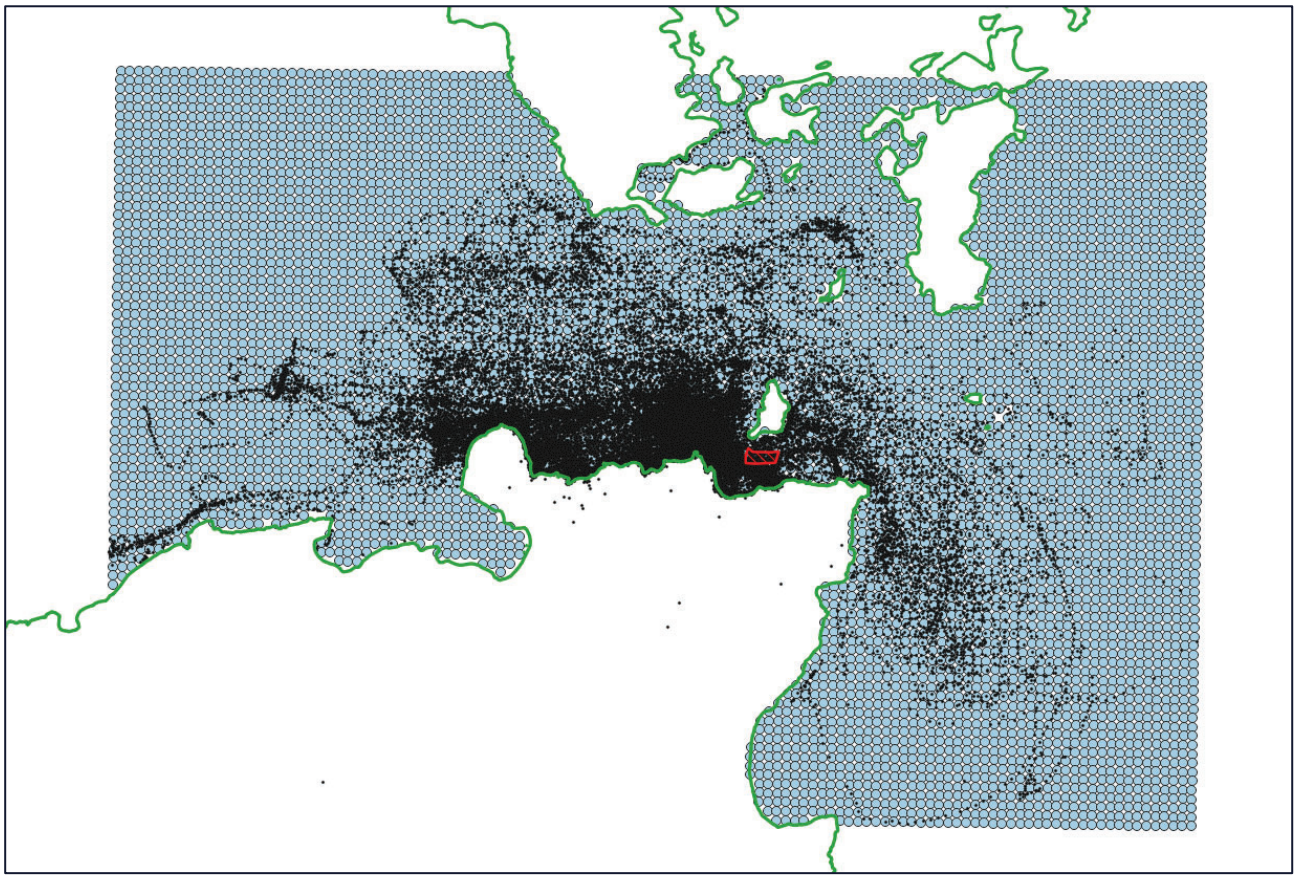

Figure 4 Map illustrating the extent of the seal density prediction grid (pale blue grid), together with raw harbour seal telemetry locations overlaid (black dots) and MeyGen phase 1 turbine deployment area (red outline). Mainland Scotland lies to the south, and the islands of Orkney lie to the north.

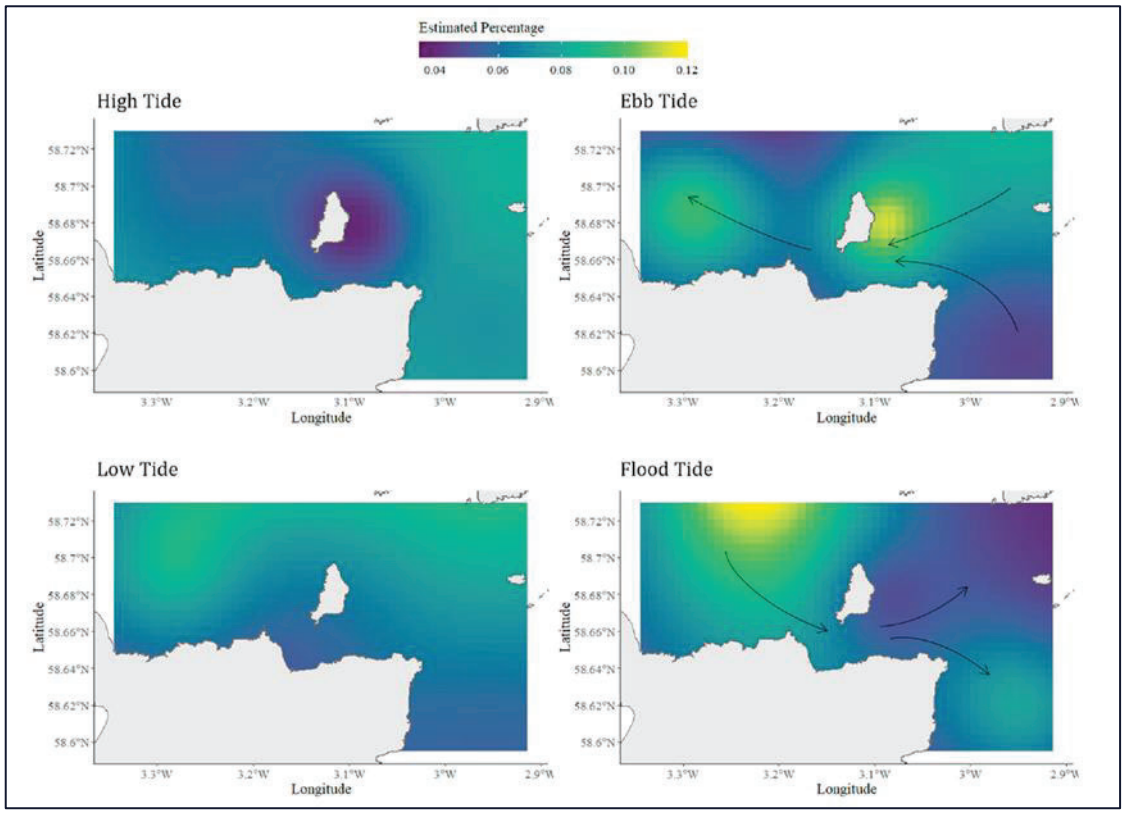

Figure 5 Map illustrating harbour seal density at four states of the tide.

To obtain an absolute harbour seal density from the proportion of population per grid cell, the proportion was multiplied by the local regional population. Harbour seals are counted from aerial surveys during the August moulting period. At the last count (in 2016), 71 harbour seals were counted at haul-outs within 10 km of the MeyGen array area. This raw count can be scaled by the probability of seals hauled out during this time of year (0.72), to estimate the total number of seals in the North Coast regional population. The estimated total North Coast regional harbour seal population size is 99 (95% confidence interval 81 – 131).

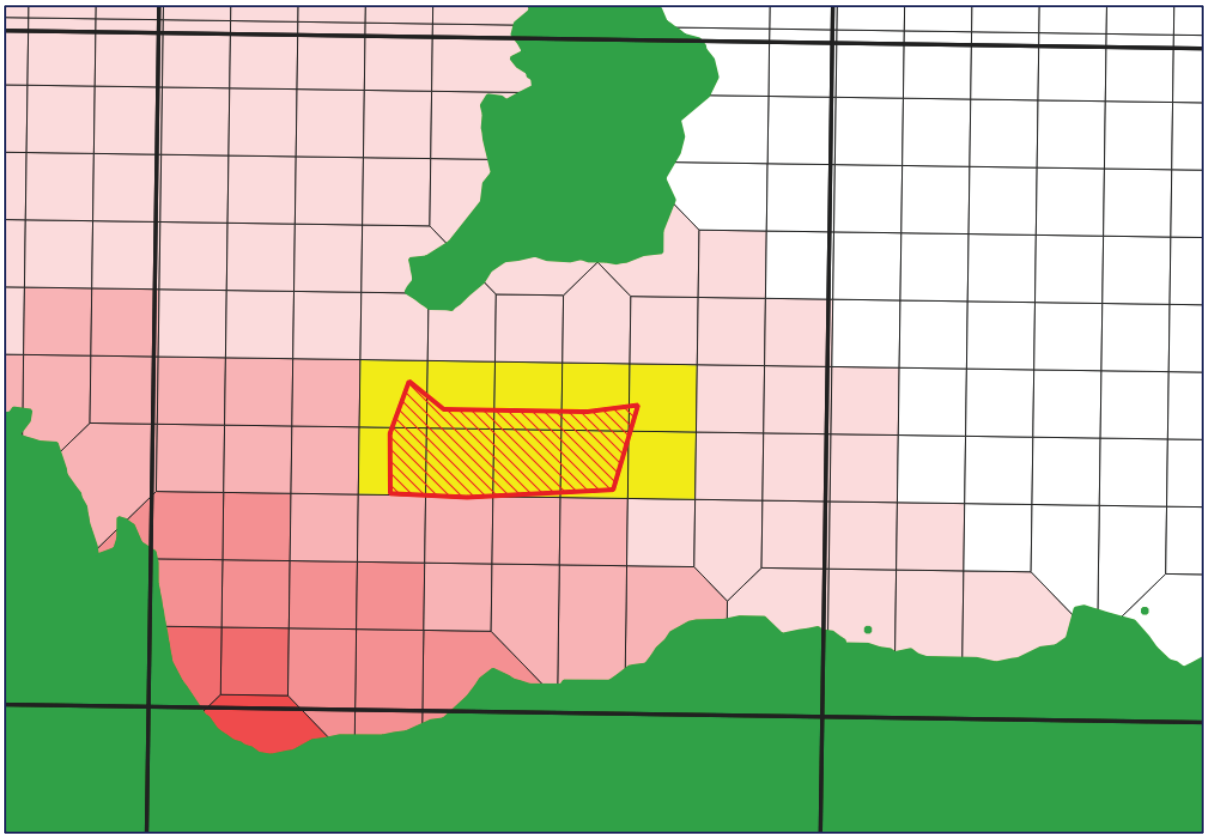

Figure 6 The MeyGen phase 1 turbine deployment area overlaid on the grid used to generate the Updated MeyGen harbour seal density maps (2023). The ten grid cells which overlapped with the MeyGen phase 1 turbine deployment area are highlighted in yellow.

For each harbour seal density prediction, the 500 x 500 m grid cells from the Updated MeyGen harbour seal density maps (2023) which overlapped with the MeyGen phase 1 turbine deployment area were selected (Figure 1), and the total proportion of the local seal population present in these cells was calculated. This encompassed 10 grid cells, and the total area covered by these cells was 2.5 km^2. After scaling the proportion of the population by the total number of harbour seals in the population to calculate an absolute density of harbour seals for the area covered by these 10 grid cells. This was then normalised to state the average harbour seal density for the 10 grid cells on a per km^2 basis (Table 22).

Calculating flow for four states of the tide

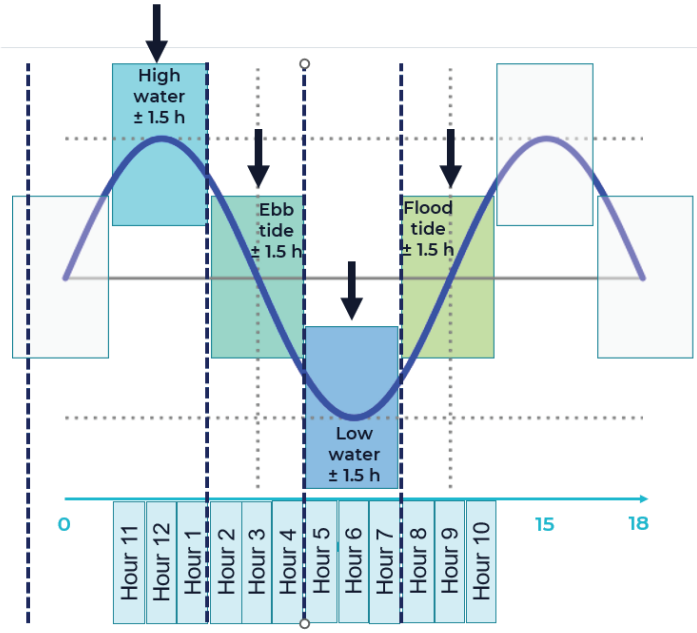

Figure 7 Calculating harbour seal density for each of the four states of the tide.

Table 22 Calculating the harbour seal density for four tidal states to be used in collision risk modelling.

TIDAL STATE	HIGH WATER	LOW WATER	PEAK FLOOD	PEAK EBB
Area of overlapping cells	2.5 km^2	2.5 km^2	2.5 km^2	2.5 km^2
Summed % harbour seal population in overlapping cells	0.6192	0.2699	0.6546	0.6206
Number of harbour seals in regional population	99	99	99	99
Number of harbour seals in 2.5 km^2 area	0.61301	0.2672	0.6481	0.6144
Density of harbour seals per km^2	0.245	0.107	0.259	0.246

Comparison with other seal density estimates

Onoufriou et al., (2021)

The maps produced by Onoufriou *et al.*, (2021) did not aim to derive absolute density estimates of harbour seals for use in impact assessment, but to investigate the varying usage of the Inner Sound and MeyGen phase 1 turbine deployment area by harbour seals during different tidal phases, and pre- and post-installation of the Phase 1a turbines. This study found no significant change in at sea distribution between pre- and post-installation of the turbines. However, harbour seals showed clear avoidance responses during turbine operations, with a significant decrease in predicted abundance of 11 – 49% (95% CI) within ~2 km of the array. This avoidance behaviour, at the scale of several kilometres, suggests that avoidance of the vicinity of the array by harbour seals may be occurring during turbine operation, when interactions with rotating turbines could lead to injury or mortality.

Onoufriou *et al.*, (2021) used a sub-sample of the data set used to generate the updated MeyGen harbour seal density maps (2023), but also identified the operational/non-operational periods of the MeyGen Phase 1a turbines as a covariate within the modelling approach. In producing the Updated MeyGen harbour seal density maps (2023) all North Coast harbour seal telemetry data collected between 2010-2019 were included (including pre/post-installation of Phase 1a as well as turbine operational/non-operational periods) when fitting the model, without distinguishing between operational periods. This approach diverges from the method implemented in Onoufriou *et al.*, (2021), which could mask the avoidance behaviour evident when the operational status of the turbine was included as a term in the model.

Band et al. (2016)

The harbour seal density estimates for each tidal state, derived from the updated MeyGen harbour seal density maps (2023) for the MeyGen Phase 1 turbine deployment area, are (except in the case of the Low Water prediction) significantly higher than the estimated density derived from raw telemetry data presented by Band *et al.* (2016). Band *et al.* (2016) estimated a density of 0.097 harbour seals km^{-2} for the MeyGen Phase 1 turbine deployment area, based on the proportion of time that tagged harbour seals spent within the MeyGen Phase 1 turbine deployment area, scaled to the regional population size. The Band *et al.* (2016) estimate was based on the 2013 count data which indicated that the Pentland Firth region hosted a population of 75 harbour seals. This local estimate increased to 99 seals during the most recent complete counts of the Pentland Firth region in 2016, which represents a 32% increase on the 2013 estimate. However, this increase belies the continuing decline in the harbour seal population observed in the whole North Coast and Orkney seal management area, where counts at haul-out sites fell by 28% between the periods 2011 - 2015 and 2016 - 2021, at an average rate of 8.5% *per annum* (SCOS, 2021).

Carter et al. (2022)

The density estimates for each tidal state, derived from the updated MeyGen harbour seal density maps (2023) for the MeyGen Phase 1 turbine deployment area, are in all cases lower than the Carter *et al.*, (2022) density estimates (0.437 harbour seals km^{-2}), estimated using a similar habitat preference modelling approach to Onoufriou *et al.*, (2021) but fitted using a larger regional data set, a maximum foraging range of 273 km for harbour seals, and predicting on a 5 x 5 km grid. The coarser resolution of the Carter *et al.*, (2022) predictions means that the finer-scale variability observed within the Pentland Firth region is lost, as the grid square overlapping the MeyGen phase 1 turbine

deployment area covers the whole Inner Sound, including the Gills Bay coast and much of the Isle of Stroma. When visualising the updated MeyGen harbour seal density maps (2023), it can be noted that the harbour seal density is highest closer to the coast, and in areas outwith the Inner Sound, to the west, which is not observed at the coarser scale of the Carter *et al.* maps. The Carter *et al.*, (2022) estimate also uses the entire UK population (estimated as 42,303 harbour seals; SCOS, 2021) as its reference, rather than the local population that is known to haul out on the North Coast and use the Inner Sound, which may lead to some inflation of at-sea density estimates by assuming that other harbour seals (e.g., from Orkney) occur in the Inner Sound, for which there is no evidence.

Assumptions - updated MeyGen harbour seal density maps (2023)

Proportion of seals at sea (100%)

One of the principal assumptions in the density metrics derived from the updated MeyGen harbour seal density maps (2023) is that 100% of the North Coast harbour seal population (99 individuals) are at sea, all the time. Harbour seals divide their time into various activities, some of which do occur at sea (e.g., travelling, foraging) and some take place on or very close to land (e.g., mating, giving birth, provisioning of young, moulting). Harbour seals tend to make short foraging trips and remain generally close to land, as can be observed in the telemetry data for harbour seals tracked from the North Coast. Scientific studies have identified a range of factors that influence the time spent hauled out by harbour seals, such as age and sex, weather, time of day and time in the tidal cycle. Russell *et al.* (2015) used behavioural and location data from harbour seals fitted with telemetry tags in the UK (n = 126) in a state-space model to determine periods spent in different behavioural states during the non-breeding period, including *resting*, which included time spent on land and time spent at sea but not diving. The study reported that the median time that individual harbour seals spent resting was 32% (15 – 53%). This could be further broken down to 20% (10 – 36%) of time hauled out on land and 11% (1 – 30%) resting (i.e., not diving) at sea. These activity budgets do not cover the moult period (around the month of August) as harbour seals moulted off the tags which had been affixed to their fur. However, it is known from a study of harbour seals during the moult that during this period, approx. 72% (54 – 88%) of animals are hauled out at any time (Lonergan *et al.*, 2013), so the 32% resting as reported by Russell *et al.* (2015) is likely an underestimate of harbour seals in a resting state over the course of a whole year.

Even when acknowledging that a portion of the 32% of their time spent resting is spent at sea (median = 11%; Russell *et al.*, 2015), during these periods of rest harbour seals are not diving, and thus would not have the potential to encounter the swept area of the tidal turbines, which will be a minimum of 8 metres at LAT below the sea surface. Thus, it is reasonable to consider that 32% of the time, harbour seals are not at risk of collision.

Inclusion of pre- and post-MeyGen Phase 1a telemetry data in modelling

One of the key findings of Onoufriou *et al.* (2021) was that while there was no discernible difference between the occurrence of harbour seals in the wider Inner Sound pre- and post-installation of the MeyGen Phase 1a turbines in 2017, there was a decrease in the predicted abundance of harbour seals of 27.6% (11 – 49%) within 2 km of the MeyGen array during operational (versus non-operational) periods. This apparent avoidance behaviour, at the scale of several kilometres, suggests that harbour seal avoidance may be occurring during operational periods, when interactions with rotating turbines could cause injury or mortality. However, the data set used to fit the model used to generate the updated MeyGen harbour seal density maps (2023) included all harbour seal tracking data from the North Coast region, including data collected pre- and post-installation of MeyGen.

Because the model fitting data set includes pre- and post-installation telemetry data, the model will to an extent have captured this reduction in abundance during periods when the turbines were operating. By including the whole tracking data set from 2010 – 2019 together when fitting the model, and not explicitly modelling the impact of operational/non-operational periods (as it was in the published study, where this was modelled as a binary "operational"/"not operational" covariate), it is possible that the effect of seal avoidance of operational turbines may be masked and the reduction in abundance in proximity to the array be less pronounced than could be expected based on the findings of Onoufriou *et al.*, (2021). While quantifying this avoidance effect would not be possible without additional analysis, it is plausible that the effect of the operational turbines would lead to further reductions in the density of harbour seals within 2 km of the array, and thus a lower risk of collision with tidal turbines.

Maximum foraging range of North Coast harbour seals

In generating the updated MeyGen harbour seal density maps (2023), the model domain was constrained to the maximum foraging range observed from the sample of harbour seals tagged on the North Coast (a domain of approx. 60 km x 40 km). This is assumed to represent the maximum foraging range of harbour seals from the North Coast population, i.e., that the local population is constrained within this domain. The predictive maps estimate the proportion of that local population in each 500 x 500 m grid square within this domain. Although not observed in the sample of tracking data used to model the distribution of harbour seals in this study, it is plausible that this population ranges further at certain times of the year to exploit foraging opportunities beyond the Pentland Firth. If the predictive model domain was correspondingly larger, the local population of 99 harbour seals estimated to reside in this region might be smeared across a larger domain, which could result in smaller proportions of the population predicted to occur in each grid cell, and thus a lower predicted density of harbour seals within the Inner Sound. In comparison to the radius of approx. 30 km used as the maximum range in producing the Updated MeyGen harbour seal density maps (2023) (2023), Carter *et al.*, (2022), in a similar habitat preference modelling study, constrained harbour seals to within 273 km of their haul-out, based on the maximum foraging range of any harbour seal tagged in that study.

Estimating harbour seal collision risk for MeyGen 2

MeyGen have implemented the SNH (2016) collision risk model (CRM) approach to determine risk of collision to harbour seals from the proposed changes associated with deployment of MeyGen 2 turbines (next subsequent stage of development). Fixed parameters used within the CRM are presented in Table 23.

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Table 23 Collision Risk Modelling parameters.

PARAMETER	INPUT	PROVENANCE OF PARAMETER
Rotor diameter (m)	24	Data provided by turbine manufacturer
Rotor minimum depth (m)	8	Minimum depth at LAT
Water depth (m)	35	Channel depth at LAT
Clearance to seabed (m)	3	Fixed parameter in CRM scenarios reflecting proposed change to consented design
Channel width (m)	7,000	Approx. width of Pentland Firth at narrowest point
Time over which the number of encounters should be calculated	One year	Collision rate *per annum*
Number of rotors (equal to the number of turbines)	10	Number of additional turbines being proposed for MeyGen 2 phase
Number of blades per turbine	3	Data provided by turbine manufacturer
Rotation speed (rpm)	Variable with flow speed	Data provided by turbine manufacturer
Time not operational (%)	4.9%	Based on planned maintenance cycle
Mean current speed (m/s)	Variable with tidal state	Data provided by MeyGen Ltd
Mean rotor width front to back (m)*	0.276	Data provided by turbine manufacturer
Maximum blade width (m)	2.25	Data provided by turbine manufacturer
Blade pitch at blade tip (degrees)	Variable with flow speed	Data provided by turbine manufacturer
Blade profile**	See modelling spreadsheets	Data provided by turbine manufacturer
Harbour seal density (animals km^{-2})	Variable with tidal state	Data from updated MeyGen harbour seal density maps (2023)

The variable density depending on tidal state as described by the updated MeyGen harbour seal density maps (2023) was incorporated into a suite of collision risk models, each one representing a one-hour period of the tidal cycle. The ebb and flood tidal cycle lasts approximately 12 hours and is therefore divided into 12 sections for each hourly bin. The current data from the MIKE21 model at an indicative turbine location (TTG2) within the MeyGen Phase 1 turbine deployment area were analysed for the year 2020 to obtain an average flow speed (in m s^{-1}) for each hourly bin (Figure 8).

Altogether, 12 CRM scenarios were run, each representing 1/12th (8.33%) of a year, i.e., the proportion of a year associated with each one-hour period of the tidal cycle. The collision risk estimate for the whole year was the sum of the predicted rates of collision for each of these 12 model scenarios.

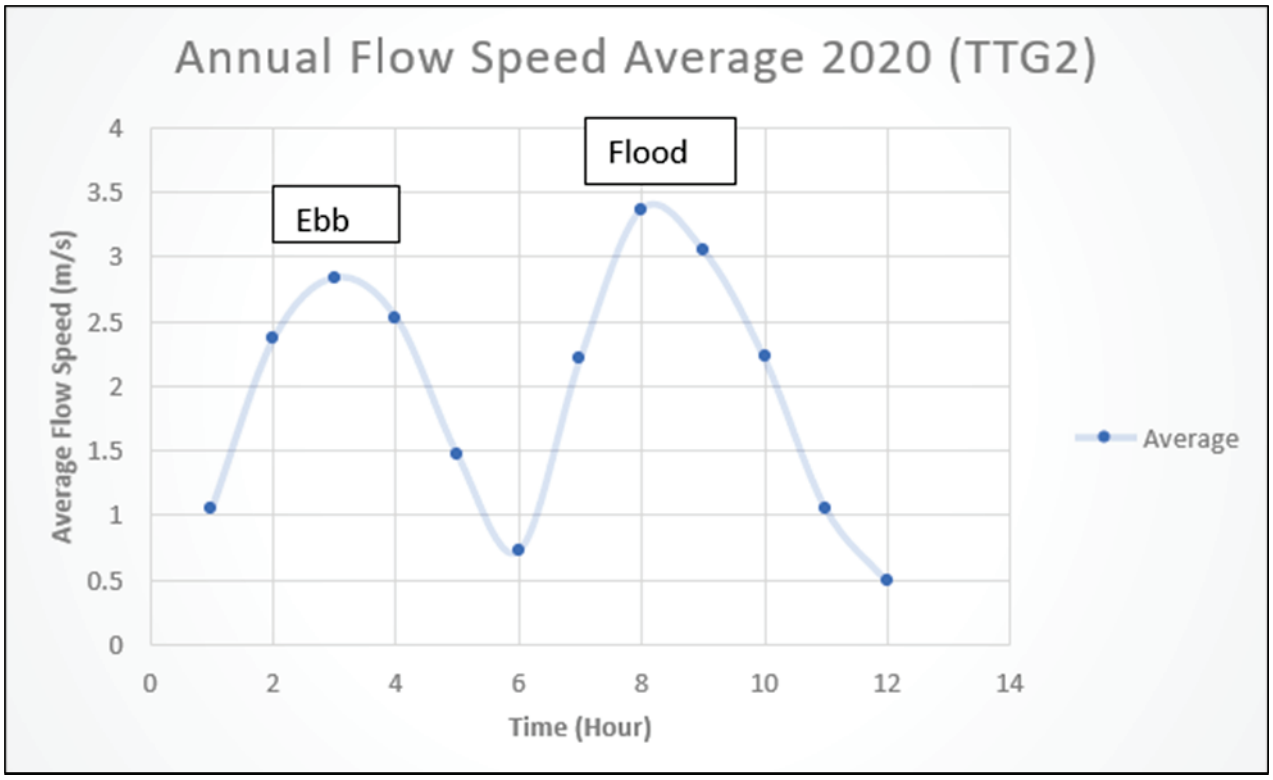

Figure 8 Graph illustrating how annual average flow speed varies across the tidal cycle in the MeyGen Phase 1 turbine deployment area. The average (mean) modelled flow speeds were used in the collision risk modelling.

Tidal turbine parameters used within the CRM simulations were provided by potential turbine suppliers for MeyGen 2. These parameters included rotations per minute (RPM) at each of the average flow speeds for each one-hour period, and blade pitch at each flow speed. Other physical turbine parameters (e.g., blade dimensions and profile) were also provided by potential turbine suppliers.

Other parameters that influence the predicted rate of collisions were retained (where appropriate) between model scenarios. These included minimum clearance to the sea surface and channel depth. Each model scenario was run for an array of 10 x 24 metre diameter three-bladed horizontal axis turbines (Table 24). These turbines are expected to operate on a planned maintenance cycle of 90 days every five years, which equates to 4.9% downtime. This was implemented in the CRM through the "% time not operational" parameter.

Table 24 Collision risk model outputs for 12 model scenarios representing one year of operation of a ten-turbine MeyGen 2 array. Collision risk is presented without any behavioural avoidance.

HOUR OF TIDAL CYCLE	PERIOD OF TIDAL CYCLE	HARBOUR SEAL DENSITY (PER KM2)	TURBINE RPM	CURRENT FLOW SPEED (m/s)	HARBOUR SEAL COLLISION RATE
Hour 1	High	0.245	4.52	1.06	27.97
Hour 2	Ebb	0.246	10.25	2.36	63.42
Hour 3	Ebb	0.246	12.34	2.84	76.35
Hour 4	Ebb	0.246	10.98	2.53	67.95
Hour 5	Low	0.107	6.34	1.47	17.09
Hour 6	Low	0.107	0	0.73	0.63
Hour 7	Low	0.107	9.58	2.21	25.8
Hour 8	Flood	0.259	14.3	3.37	82.83
Hour 9	Flood	0.259	14.19	3.06	91.09
Hour 10	Flood	0.259	9.62	2.22	62.7
Hour 11	High	0.245	4.52	1.06	27.97
Hour 12	High	0.245	0	0.49	0.97
Sum					**544.77**

For a one-year period, assuming no behavioural avoidance, the CRM estimates there will be **544.77 harbour seal collisions.**

Accounting for resting proportion of harbour seal population

As discussed in Section 2.1.2, Russell *et al.* (2015) analysed harbour seal telemetry data from 121 tracked harbour seals from the non-breeding period to reveal that UK harbour seals spend on average 32% of their time at rest, either hauled out or resting (i.e., not diving) at sea. This analysis considered data from the months of October – June, thus excluding the moult period. While the harbour seal densities derived from the Updated MeyGen harbour seal density maps (2023) assume that the entire local harbour seal population (99 animals) is at sea, it can be assumed that a minimum of 32% of these animals will not be at risk of collision while at rest. Revising the collision rates in *Table 24* (Section 0) to remove this resting population results in a reduced collision rate (Table 25).

Table 25 Scaling CRM collision rates to remove the proportion of the harbour seal population that is resting.

Hourly period	CRM rate (0 % avoidance)	Proportion of harbour seal population resting (hauled out or resting at sea)	CRM rate (0% avoidance) scaled to remove resting proportion of harbour seal population
Hour 1	27.97	0.32	**19.02**
Hour 2	63.42		**43.13**
Hour 3	76.35		**51.92**
Hour 4	67.95		**46.21**
Hour 5	17.09		**11.62**
Hour 6	0.63		**0.43**
Hour 7	25.8		**17.54**
Hour 8	82.83		**56.32**
Hour 9	91.09		**61.94**
Hour 10	62.7		**42.64**
Hour 11	27.97		**19.02**
Hour 12	0.97		**0.66**
Sum	544.77		**370.44**

For a one-year period, assuming no behavioural avoidance and accounting for the proportion of the harbour seal population at rest, the CRM estimates 370.44 harbour seal collisions.

Accounting for behavioural avoidance

In their advice to other tidal developers (including MeyGen) in the past, NatureScot (previously Scottish Natural Heritage) advised that an avoidance rate of 98%, derived through expert judgment in the absence of empirical evidence, could be considered reasonably precautionary (SNH, 2013). There is increasing evidence that marine mammal collisions with the installed Phase 1a tidal turbines are improbable (Palmer *et al.*, (2021), Gillespie *et al.*, (2021),

Hastie et al., (2018), Sparling *et al.*, (2018), Nova Innovation (2021), SMRU (2023)). For consistency with earlier assessments, a range of avoidance rates are presented here (Table 26).

Table 26 Harbour seal collision rate with a range of associated avoidance rates.

Hourly period	CRM rate 0% avoidance (Accounting for 32% of harbour seal population at rest)	CRM rate 95% avoidance	CRM rate 98% avoidance	CRM rate 99% avoidance	CRM rate 99.5% avoidance
Hour 1	19.02	9.51	**0.38**	0.19	0.10
Hour 2	43.13	21.56	**0.86**	0.43	0.22
Hour 3	51.92	25.96	**1.04**	0.52	0.26
Hour 4	46.21	23.10	**0.92**	0.46	0.23
Hour 5	11.62	5.81	**0.23**	0.12	0.06
Hour 6	0.43	0.21	**0.01**	0.00	0.00
Hour 7	17.54	8.77	**0.35**	0.18	0.09
Hour 8	56.32	28.16	**1.13**	0.56	0.28
Hour 9	61.94	30.97	**1.24**	0.62	0.31
Hour 10	42.64	21.32	**0.85**	0.43	0.21
Hour 11	19.02	9.51	**0.38**	0.19	0.10
Hour 12	0.66	0.33	**0.01**	0.01	0.00
Sum	**370.44**	**185.22**	**7.41**	**3.70**	**1.85**

For a one-year period, assuming 98% avoidance and assuming that 32% of the regional harbour seal population will be resting, the CRM estimates 7.41 harbour seal collisions.

Accounting for sub-lethal collisions

A study by Onoufriou *et al.* (2019) reported that collisions between seals and tidal turbines would likely only cause severe trauma/death above a certain rotational velocity threshold. Following analysis of data on simulated collisions between seals and turbine blades (using seal carcases and a simulated turbine rotor blade attached to a motor boat), the study predicted that >50% of collisions would be serious or fatal at impact speeds of 5.1 m s^{-1} (3.2 – 6.6 m s^{-1}). Onoufriou *et al.* (2019) indicate that seal collisions with areas of the rotor disc where the impact velocity is below 5.1 m s^{-1} would not be severe or fatal.

Using the rotation speed (RPM) associated with each average flow speed, the area of the rotor disc where the rotor velocity would be <5.1 m s^{-1} was calculated. The proportion of the rotor disc associated with this area could be calculated, which could be used to scale the collision rate to account for this *safe* area of the rotor disc moving <5.1 m s^{-1} (Table 27).

Table 27 Removing non-lethal collisions from the CRM estimates.

Hourly period	CRM rate 98% avoidance (accounting for 32% of harbour seal population at rest)	Total area of rotor disc (m^2)	Area of rotor disc where rotor blade velocity <5.1 m/s (m^2)	Proportion of rotor disc where rotor blade velocity <5.1 m/s	CRM rate (98% avoidance) with sub-lethal proportion removed
Hour 1	**0.38**	452.4	359.68	0.80	**0.08**
Hour 2	**0.86**		69.40	0.15	**0.73**
Hour 3	**1.04**		47.78	0.11	**0.93**
Hour 4	**0.92**		60.82	0.13	**0.80**
Hour 5	**0.23**		181.46	0.40	**0.14**
Hour 6	**0.01**		452.39	1.00	**0.00**
Hour 7	**0.35**		78.54	0.17	**0.29**
Hour 8	**1.13**		36.32	0.08	**1.04**
Hour 9	**1.24**		36.32	0.08	**1.14**
Hour 10	**0.85**		78.54	0.17	**0.70**
Hour 11	**0.38**		359.68	0.80	**0.08**
Hour 12	**0.01**		452.39	1.00	**0.00**
Sum	**7.41**				5.92

For a one-year period, assuming 98% avoidance and after removing the portion of the rotor disc where blade velocity is <5.1 m s^{-1} (for each hourly model simulation), the CRM estimates 5.92 severe or fatal harbour seal collisions.

Residual precaution in collision risk modelling predictions

Although a number of steps have been taken to refine the assessment, there remains multiple precautionary aspects to this assessment:

- The Russell *et al.* (2015) resting activity budget of 0.32 was calculated from data spanning the period from October – June. This does not include the period of the moult (centred around the month of August; Morris *et al.*, 2021), when typically, 0.72 of harbour seals are hauled out (Lonergan *et al.*, 2013; SCOS, 2021). Therefore, the true average number of harbour seals hauled out (across a period of one year) will likely be higher than the 0.32 value presented by Russell *et al.*, (2015) which has been incorporated into this assessment of collision risk.
- The Updated MeyGen harbour seal density maps (2023) use the total available pre/post-installation harbour seal telemetry data set, which could mask the signal of reduction in abundance during operational periods (discussed above), reported as 27.6% (11 – 49%) up to 200 metres from the array. A reaction of this strength at up to 200

metres is likely to be more acute close to the turbines, assuming that animals are responding to the sound of operational turbines (Hastie *et al.* 2018).

- The CRM assumes that all harbour seals occurring in the MeyGen phase 1 turbine deployment area are undertaking U-shaped foraging dives. Harbour seals are known to haul out on coastlines around the Inner Sound, therefore seal movements in this area are likely to encompass both foraging behaviour (diving) and travelling to and from foraging grounds outwith the Inner Sound. Therefore, the assumption within the CRM that harbour seals undertake U-shaped dives to the seabed, which is known not to be accurate in the Inner Sound (Band *et al.*, 2016). This assumption means that a significant proportion of harbour seal dives are predicted to be at depths where collision with turbine rotors could occur, which may not be reflected in reality.
- 98% avoidance remains a precautionary assumption, as noted by NatureScot (SNH, 2013). This assumes that out of every 100 harbour seal encounters with the rotor disc, two would lead to collision. While severity of injury has been accounted for in this modelling exercise (also in a precautionary way), fine-scale behavioural avoidance has not been incorporated further, despite the increasing evidence that marine mammals exhibit behavioural avoidance to the area around operational tidal turbines.
- Unplanned downtime has not been accounted for in collision risk estimates. On the understanding that the 4.9% planned downtime will be a *minimum* non-operational time.

Summary MeyGen 2 CRM refinement

By incorporating contemporary pieces of evidence to support the refinement of collision risk estimates for harbour seals, the proposed changes associated with deployment of MeyGen 2 turbines (next subsequent stage of development) would not have adverse effects on the regional harbour seal population, in spite of a reduction in the PBR limit for this harbour seal population since the original application in 2012.

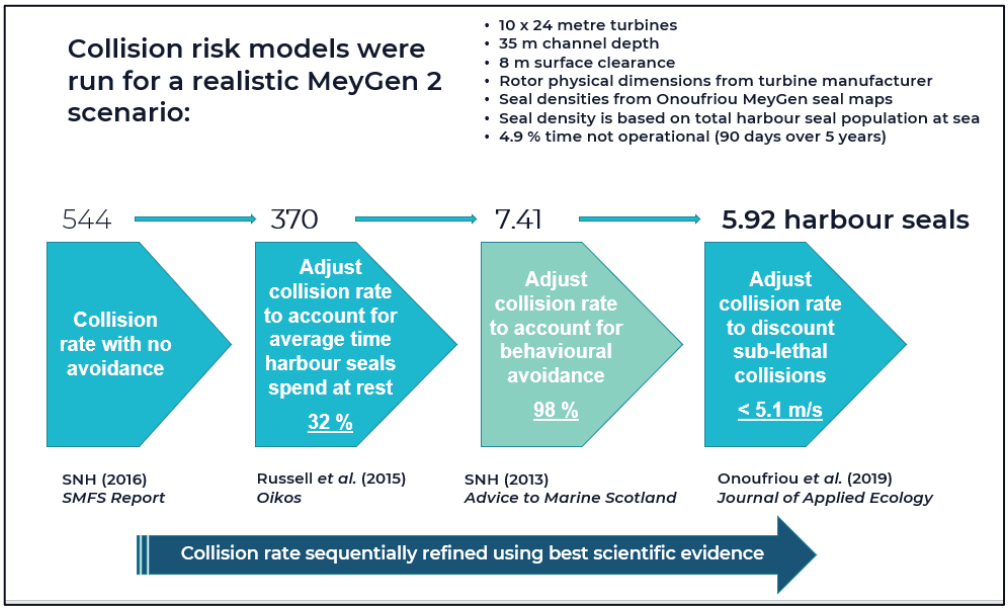

Figure 9 Summary of CRM refinement.

The predicted number of harbour seal collisions *per annum* from the installation of 10 x 24 metre turbines is 5.92. The current PBR limit, issued on behalf of the Scottish Government, for the North Coast and Orkney harbour seal management area is eight individuals.

The collision risk modelling approach outlined here uses the SNH (2016) CRM tool, parameterised with the best available evidence on current speeds, turbine design and incorporating flexibility around harbour seal density predicted for four tidal periods. Collision rates have then been scaled using information drawn from relevant scientific literature with respect to harbour seal behaviour (i.e., activity budgets, turbine avoidance) and the consequences of collision. While these scalars have reduced the estimated collision rate, MeyGen consider the approach taken to model the risk of collision to be robust and defendable and note that multiple layers of precaution remain throughout the parameters used in the assessment.

Summary Phase 1a and MeyGen 2 CRM

The CRM demonstrates collision risk associated with the combined impact of the deployment of Phase 1a turbines and the proposed changes associated with deployment of MeyGen 2 turbines (next subsequent stage of development), (i.e., the predicted number of harbour seal collisions) is lower than the most recent PBR limit for harbour seals in the North Coast and Orkney seal management area, based on PBR limit of eight harbour seals; SCOS, 2021; Table 28).

Table 28 Collision rates for harbour seal from the combined Phase 1a / MeyGen 2 array

PHASE 1A (MEYGEN, 2017; 98% AVOIDANCE)	MEYGEN 2 (98% AVOIDANCE)	COMBINED PHASE 1A + MEYGEN 2 (98% AVOIDANCE)
1.16	5.92	7.08

Cumulative impacts – tidal

A cumulative impact assessment (CIA) was presented in the MeyGen Phase 1 ES (2012) which included the entire MeyGen Phase 1 Project (86 MW) and a number of projects with the potential to have cumulative impacts alongside the MeyGen Project. Since the Phase 1 assessment was undertaken, the progress of a number of these projects has been halted or delayed, and the number of projects at EIA scoping stage or beyond (i.e., those for which information is available in the public domain) remains very limited. The only tidal energy projects located within the North Coast and Orkney seal management unit area that are known to have progressed to submitting an application since the MeyGen previous CIA in 2012 are Brims Tidal Array and the European Marine Energy Centre (EMEC) Fall of Warness Tidal Test Site. Brims Tidal Array Ltd submitted an initial application in 2016; however, consent was never issued, and the development is currently not progressing. The EMEC Fall of Warness site is consented and in operation and is the only known tidal development within the North Coast and Orkney seal management area. An updated assessment of cumulative collisions is presented in Table 29.

Table 29. Harbour seal cumulative impacts with other tidal energy projects in North Coast and Orkney seal management area.

TIDAL DEVELOPMENT	PBR (SCOS, 2021)	HARBOUR SEAL TAKE	METHOD AND AVOIDANCE RATE
MeyGen Phase 1a	8	1.16	SNH (2016) CRM; 98% avoidance (from MeyGen, 2017)
MeyGen 2 [this EIA screening report 2023]		5.92	SNH (2016) CRM; 98% avoidance
EMEC Fall of Warness		0.34	SNH/Band (2012) CRM; 98% avoidance
Cumulative impact	7.42		

Cumulative impacts summary

Only the EMEC Fall of Warness tidal energy test site is predicted to have anything other than negligible additional impacts on harbour seals within the North Coast and Orkney seal management area. Other developments have either impacts of low or no significance or are too distant from MeyGen Phase 1 area to have any significant impacts on the regional harbour seal population. There is no licensed seal shooting in the North Coast and Orkney seal management area.

The combined predicted collision rate from the deployment of Phase 1a turbines and the proposed changes associated with deployment of MeyGen 2 turbines (next subsequent stage of development and EMEC Fall of Warness constitutes the total predicted anthropogenic 'take' from the North Coast and Orkney seal management unit, and this rate is less than the PBR for harbour seals for the North Coast and Orkney seal management unit.

CRM harbour seal conclusion

By incorporating the best available evidence on harbour seal densities an updated CRM has been conducted to understand the combined impact of deployment of Phase 1a turbines and the proposed changes associated with deployment of MeyGen 2 turbines (next subsequent stage of development).

The CRM demonstrates that the potential impact (i.e., the predicted number of harbour seal collisions) is lower than the most recent PBR limit for harbour seals in the North Coast and Orkney seal management area, both for the development alone and when combined with other anthropogenic "takes" impacting the same management unit, the impact would be deemed not significant.

In conclusion combined impact of deployment of Phase 1a turbines and the proposed changes associated with deployment of MeyGen 2 turbines (next subsequent stage of development). would not have a significant impact on regional harbour seal population.

OTHER MARINE MAMMAL SPECIES

During recent consultation with NatureScot (January 2023) MeyGen were advised to also consider the combined impact of deployment of Phase 1a turbines and the proposed changes associated with deployment of MeyGen 2 turbines (next subsequent stage of development) upon;

- Grey seal Halichoerus *grypus*;
- Harbour porpoise *Phocoena phocoena*; and
- Minke whale *Balaenoptera acutorostrata*.

The SNH (2016) CRM was run, using the best available density estimate for each of these species and collision rates for grey seal, harbour porpoise (assuming 98% avoidance) and minke whale (assuming 95% avoidance) (Table 30) and set in a regional context in Table 31.

Table 30 Collision rates for grey seal, harbour porpoise and minke whale from proposed changes associated with deployment of MeyGen 2 turbines (next subsequent stage of development)

Hour of tidal cycle	Period of tidal cycle	Turbine RPM	Flow speed m/s	GREY SEAL CRM collision rate 98% avoidance	HARBOUR PORPOISE CRM collision rate 98% avoidance	MINKE WHALE CRM collision rate 95% avoidance
Density (individuals/km^2) (Data source)				3.06 (Carter *et al.*, 2022)	0.152 (SCANS III)	0.0095 (SCANS III)
Hour 1	High	4.52	1.06	6.23	0.37	0.20
Hour 2	Ebb	10.25	2.36	14.08	0.85	0.43
Hour 3	Ebb	12.34	2.84	16.95	1.02	0.53
Hour 4	Ebb	10.98	2.53	15.084	0.91	0.48
Hour 5	Low	6.34	1.47	8.72	0.52	0.28
Hour 6	Low	0	0.73	0.312	0.02	0.04
Hour 7	Low	9.58	2.21	13.164	0.79	0.40
Hour 8	Flood	14.3	3.37	17.902	1.05	0.63
Hour 9	Flood	14.19	3.06	19.264	1.15	0.55
Hour 10	Flood	9.62	2.22	13.22	0.79	0.40
Hour 11	High	4.52	1.06	6.23	0.37	0.20
Hour 12	High	0	0.49	0.21	0.01	0.03
Sum (i.e., collisions per year)				131.37	7.87	4.10
PBR (SCOS, 2021)				1,923	-	-
Management Unit (MU) population (MU reference)				32,043 (SCOS, 2021)	159,632 (IAMMWG, 2022)	10,288 (IAMMWG, 2022)
Predicted collisions as percentage of MU				0.41%	0.005%	0.04%

Table 31 Predicted collision rates for grey seal, harbour porpoise and minke whale from the combined deployment of Phase 1a turbines and the proposed changes associated with deployment of MeyGen 2 turbines (next subsequent stage of development)

SPECIES	PHASE 1A OR STAGE ONE CRM (DATA SOURCE)	MEYGEN 2	COMBINED PHASE 1A + MEYGEN 2	PROPORTION OF MANAGEMENT UNIT SIZE (MANAGEMENT UNIT POPULATION)
Grey seal (98% avoidance)	72.60 (MeyGen, 2017)	131.37	203.97	0.64% (32,043; SCOS, 2021)
Harbour porpoise (98% avoidance)	2.016 (SNH, 2013)	7.87	9.886	0.006% (159,632; IAMMWG, 2022))
Minke whale (95% avoidance)	4.23 (SNH, 2013)	4.10	8.33	0.08% (10,288; IAMMWG, 2022)

Grey seal

With respect to grey seal for the purpose of an assessment to support this EIA screening report:

- Where the potential impact (i.e., the predicted number of grey seal collisions) is the same or lower than the most recent PBR limit for grey seal in the North Coast and Orkney seal management area, both for the development alone and when combined with other anthropogenic "takes" impacting the same management unit, the impact would be deemed not significant.
- Where potential impacts are likely to be greater than the most recent PBR limit, the impact would be deemed to be significant.

The grey seal collision risk modelling associated with the combined impact of deployment of Phase 1a turbines and the proposed changes associated with deployment of MeyGen 2 turbines (next subsequent stage of development) predicts that collision rates would impact <1% of the respective grey seal Management Unit population which equates to 10.6% of the PBR limit for grey seals for the North Coast and Orkney seal management unit (SCOS, 2021).

In conclusion the combined impact of deployment of Phase 1a turbines and the proposed changes associated with deployment of MeyGen 2 turbines (next subsequent stage of development) would not have a significant impact on the regional grey seal population.

Harbour porpoise

With respect to harbour porpoise for the purpose of an assessment to support this EIA screening report.

CRM is used to assess the potential impact i.e., the predicted number of harbour porpoise collisions compared to the percentage of the harbour porpoise management unit population and whether the combined impact of deployment of Phase 1a turbines and the proposed changes associated with deployment of MeyGen 2 turbines (next subsequent stage of development) would have a significant impact on the regional population of harbour porpoise.

The CRM predicted a collision rate of <10 harbour porpoises which is not likely to have significant impacts on the harbour porpoise regional population.

In conclusion the combined impact of deployment of Phase 1a turbines and the proposed changes associated with deployment of MeyGen 2 turbines (next subsequent stage of development) would not have a significant impact on regional harbour porpoise population.

Minke whale

With respect to minke whale for the purpose of an assessment to support this EIA screening report.

CRM is used to assess the potential impact i.e., the predicted number of minke whale collisions compared to the percentage of the minke whale management unit population and whether the combined impact of deployment of Phase 1a turbines and the proposed changes associated with deployment of MeyGen 2 turbines (next subsequent stage of development) would have a significant impact on regional population of minke whale.

The CRM predicted a collision rate of <9 minke whales per annum which is not likely to have significant impacts on the minke whale regional population.

In conclusion the combined impact of deployment of Phase 1a turbines and the proposed changes associated with deployment of MeyGen 2 turbines (next subsequent stage of development) would not have a significant impact on regional minke whale population.

SEABIRDS

Recent stakeholder engagement confirmed the requirement for the reassessment of collision risk to understand the combined impact of deployment of Phase 1a turbines and the proposed changes associated with deployment of MeyGen 2 turbines (next subsequent stage of development) on European shag and black guillemot.

European shag and black guillemot have been noted as the seabird species of greatest concern for the MeyGen Project. These diving species are known to occur regularly within the Inner Sound, including the MeyGen phase 1 turbine deployment area (MeyGen, 2012). Collision modelling has been undertaken and compared to that presented in the Phase 1 ES (MeyGen, 2012).

Encounter-Time-Probability Model

The model used in the Phase 1 ES (2012) was an Encounter-Time-Probability Model (ETPM) commissioned by NatureScot in 2010. The model development was overseen by SNH and the Marine Environment Spatial Planning Group, a group which was led by MD-LOT and included representatives from NatureScot, the Joint Nature Conservation Committee (JNCC), and the renewables industry.

In order to enable comparison with the ETPM implemented in the MeyGen Phase 1 ornithology technical report (RPS, 2012) an updated ETPM developed by SNH (2016) was used to provide a measure of the potential risk.

The ETPM calculates the time for which each bird in the population is exposed to the cylindrical volume of water swept by the rotor of a turbine (i.e., the volume of water within which the bird is at risk of colliding with a turbine) based on the species' population and the proportion of time each bird spends within the Project area.

Alongside the ETPM, a population model is run to assess the predicted critical additional mortality due to collisions which would cause an adverse effect to a seabird population. The output of this population model is an estimate of the minimum number of birds of a certain species that would have to be removed from a population by an activity (e.g., operating tidal turbines) for the population level effects to occur.

The ETPM then combines the number of birds that would have to be removed from the population to cause a significant population level effect, with the time each bird in the population is likely to be exposed to the turbines, in order to estimate the collision rate for each bird within the rotor-swept volume, which would be sufficient to cause an adverse effect on the identified population.

Once that theoretical collision rate has been defined, the next stage of the assessment process is to consider how that species is using the Project area to determine whether such a collision rate would be likely to occur (i.e., a qualitative judgement is made on whether such a collision rate is likely).

It should be noted that the ETPM works in the opposite way to the marine mammal and fish CRM presented in this report. Modelling. Marine mammal and fish CRM predicts the number of collisions per year and asks the question of whether that will cause a significant impact at the population level. ETPM, bird modelling works out how many collisions would cause a population level effect and asks whether or not that number of collisions is likely to occur at the site.

The ETPM developed by SNH (2016) was used to provide a measure of the potential risk to seabird species from collision with tidal turbines. An ETPM scenario was implemented to understand the combined impact of deployment of Phase 1a turbines and the proposed changes associated with deployment of MeyGen 2 turbines (next subsequent stage of development) upon European shag and black guillemot.

ETPM has been undertaken and compared to that presented in the Phase 1 ES (MeyGen, 2012). This ornithology assessment drew on parameters from the Ornithology Technical Report produced in support of the ES (2012).

Model input data

The tidal turbine parameters used in the model input for the ETPM are the same as those in the collision risk assessment parameters used for the marine mammal collision risk assessment. The parameters specific to seabirds only are highlighted in Table 32 below.

Table 32 Parameters used in the ETPM for seabirds.

PARAMETER	EUROPEAN SHAG	BLACK GUILLEMOT	SOURCE
Area of site (m^2)	183,330	183,330	MeyGen Phase 1 turbine deployment area approx. 1.1 km^2, divided by 61 consented turbines, multiplied by 10 to reflect the area occupied by 10 MeyGen 2 turbines
Target population	922 (non-breeding) 307 (breeding)	800 (year-round)	Colony size (termed in the model as 'N') derived from Table 4.12 (European shag) and 4.20 (black guillemot) in the RPS (2012) ornithological technical report for the MeyGen Project
Number on site	Variable, depending on the month being considered. The model calculates risk for each month separately.	Variable, depending on the month being considered. The model calculates risk for each month separately.	Number on site derived from the density estimates presented in Table 4.11 (European shag) and 4.19 (black guillemot) of the RPS (2012) ornithological technical report for the MeyGen Project
Proportion of population foraging on site	Calculated in model	Calculated in model	-
Critical added mortality (number of individuals)	30	8	Termed 'D' and presented in Table 4.12 (European shag) and 4.20 (black guillemot) of

PARAMETER	EUROPEAN SHAG	BLACK GUILLEMOT	SOURCE
			the RPS (2012) ornithological technical report for the MeyGen Project. These are the additional mortality values to effect a ~ 0.3% *per annum* decline in the population, based on a population model (RPS, 2012).
Length of bird (m)	0.72	0.31	BTO Birdfacts, in line with the SNH (2016a) guidance on collision modelling

Modelling results

The number of seabird collisions per second predicted by the ETPM to be necessary to cause a decline in the regional population of European shag and black guillemot is presented in Table 34 below.

Table 33 Results of the ETPM for European shag and black guillemot.

SPECIES	COLONY SIZE (N)	EXPOSURE TIME (T)		MORTALITY	COLLISION PROBABILITY (PER BIRD EXPOSED, PER SECOND)	
		MEYGEN 2	PHASE 1A + MEYGEN 2 COMBINED		MEYGEN 2	PHASE 1A + MEYGEN 2 COMBINED
EUROPEAN SHAG	922	1.2	1.9	30	0.0262	0.0187
BLACK GUILLEMOT	800	0.6	0.9	8	0.0157	0.0112

European shag summary

ETPM is used to assess the potential impact of the combined impact of deployment of Phase 1a turbines and the proposed changes associated with deployment of MeyGen 2 turbines (next subsequent stage of development) and provide the encounter rate required to cause European shag population level effects.

The encounter rate is then used to consider if the combined impact of deployment of Phase 1a turbines and the proposed changes associated with deployment of MeyGen 2 turbines (next subsequent stage of development) would have a significant impact on regional population of European shag.

ETPM for European shag, predicts that each individual in the local population is at risk of collision for 1.9 s per year (annual exposure time). The annual exposure time is used to generate the collision probability required to account for additional mortality.

Collision probability is assumed to be equivalent to the collision rate, and therefore at least 0.0187 collisions per second are required for the additional mortality to cause a population decline. This approximates to one collision for every 54 seconds that European shags spend within the rotor swept water volume being required to cause a population decline in this species.

European shag primarily forages on sandeels which are not present in any great number in the turbine deployment area, which is characterised by tide swept bedrock. The encounter rate required to cause population level effects is unlikely to be reached for the 14 turbine combined array. Further to this the encounter rate does not consider any potential avoidance behaviour.

In conclusion the combined impact of deployment of Phase 1a turbines and the proposed changes associated with deployment of MeyGen 2 turbines (next subsequent stage of development) would not have a significant impact on the regional population of European shag.

Black guillemot summary

ETPM is used to assess the potential impact of the combined impact of deployment of Phase 1a turbines and the proposed changes associated with deployment of MeyGen 2 turbines (next subsequent stage of development) and provide the encounter rate required to cause black guillemot population level effects. The encounter rate is then used to consider if the combined impact of deployment of Phase 1a turbines and the proposed changes associated with deployment of MeyGen 2 turbines (next subsequent stage of development) would have a significant impact on regional population of black guillemot.

The ETPM for black guillemot, predicts that each individual in the local population is at risk of collision for 0.9 s per year (annual exposure time), and therefore at least 0.0112 collisions per second are required for additional mortality to cause a population decline. This approximates to one collision for every 89 seconds that black guillemot spend within the rotor swept water volume being required to cause a population decline.

ack guillemot generally forage in rocky, vegetated areas associated with lower tidal flows than those found in the turbine deployment area. The encounter rate required to cause population level effects is unlikely to be reached for the 14 turbine combined array. Further to this the encounter rate does not consider any potential avoidance behaviour.

In conclusion the combined impact of deployment of Phase 1a turbines and the proposed changes associated with deployment of MeyGen 2 turbines (next subsequent stage of development) would not have a significant impact on the regional population of black guillemot.

ATLANTIC SALMON

Atlantic salmon smolts

Recent evidence from Atlantic salmon smolt tracking (acoustic telemetry studies) has emerged in a recent publication, which illustrated that in the weeks after entering the marine environment, post-smolts from Scottish rivers almost exclusively swim within the top two metres of the water column (Newton *et al.*, 2021).

Given that smolts passing through the Inner Sound have likely only entered the marine environment a number of days or weeks previously, it is likely that this surface-swimming behaviour persists in salmon smolts that could occur within the MeyGen Phase 1 turbine deployment area. In light of this stark evidence that salmon smolts spend the vast majority of their time very close to the surface, and the fact that there would be a minimum of 8 metres clearance between the rotor-swept area and the sea surface, relative to LAT it is unlikely that salmon smolts will encounter the swept area Phase 1 and/or MeyGen 2 turbines.

For this reason, the collision rate for Atlantic salmon smolts has not been modelled here, and impact to salmon smolts is assessed to be not significant.

Impacts upon adult Atlantic salmon are presented below.

Atlantic salmon adults

Recent stakeholder engagement confirmed a requirement for reassessment of the combined impact of deployment of Phase 1a turbines and the proposed changes associated with deployment of MeyGen 2 turbines (next subsequent stage of development) for adult Atlantic salmon.

The tidal turbine parameters used in the CRM for Atlantic Salmon are the same as those used for the marine mammal collision risk assessment. The population parameters specific to modelling Atlantic salmon collision risk are highlighted in Table 34.

Table 34 Parameters used in the CRM for adult Atlantic salmon.

ASSUMPTIONS		OUTPUTS (1SW)	OUTPUTS (MSW)	COMMENT
Returning salmon Population (1SW)	249,506	-	-	ICES (2021), 10-year average
Returning salmon Population (MSW)	252,409	-	-	ICES (2021), 10-year average
Proportion from/to east coast	88%	219,565	222,120	Xodus (2012)
East coast proportion	90%	**197,609**	**199,908**	% of east coast returning population assumed to go through Pentland Firth.

ASSUMPTIONS		OUTPUTS (1SW)	OUTPUTS (MSW)	COMMENT
returning via Pentland Firth				
East coast proportion returning via Orkney waters	10%	21,957	22,212	% of east coast returning population assumed to go through Pentland Firth.

For Atlantic salmon, a migratory species, the exact routes that they would take on their movements to and from feeding and spawning grounds are not known and assumptions have been made to allow the assessment of potential impact to occur. Similarly, population estimates have a degree of uncertainty inherent within them. Despite this, the information currently available is considered sufficiently robust to undertake a 'degree of magnitude' assessment of collision risk.

The most up to date source on Atlantic salmon migration patterns around Scotland is Malcolm *et al*. (2010), this study details the likelihood of Atlantic salmon from rivers on the east coast of Scotland migrating north and east towards the Faroe Islands and west Greenland. Fish returning to Scotland are most likely to come from a north westerly direction. The lack of historic Atlantic salmon fisheries in Orkney and Shetland suggest the Pentland Firth as the most likely migration route.

The use of the Pentland Firth as a key migratory route is supported by a recent Atlantic salmon tagging study undertaken by Godfrey *et al*. (2014). This study focusses on depth ranges of migrating salmon but does additionally highlight the difficulty in predicting the proportion of Atlantic salmon passing though the Pentland Firth. As a result, the assumptions relevant to salmon populations that were adopted for the original MeyGen Phase 1 ES (2012) CRM are considered relevant here as they have been reviewed and accepted for use in EIA by MD-LOT (Marine Scotland, 2013). The key assumptions which have been made for this CRM modelling are:

- Total returning salmon population numbers have been taken from ICES (2021) with the 10-year average figure being selected;
- 88% of the total returning population is assumed to head towards east coast waters (Marine Scotland, 2013);
- 90% of the east coast returning population is assumed to pass through the Pentland Firth, of which 10% return via Orkney waters (Marine Scotland, 2013); and
- Returning adult Atlantic salmon can be categorized as *grilse*, fish that spend one winter foraging at sea (one sea-winter; 1SW) before returning to spawn, or fish that spend multiple (typically two or three) winters foraging at sea (multi sea-winter; MSW) before returning to spawn. MSW fish tend to be larger than 1SW returners.

The number of adult Atlantic salmon collisions predicted by the CRM is shown in Table 35.

Table 35 Results of the CRM for adult Atlantic salmon (values given to zero decimal places, unless below 1 in which case one decimal place is given)

AVOIDANCE RATE (%)	PHASE 1A		MEYGEN 2		COMBINED PHASE 1A + MEYGEN 2	
	1SW	MSW	1SW	MSW	1SW	MSW
0	41	36	174	196	215	232
50	21	18	87	98	108	116
75	10	9	44	49	54	58
80	8	7	35	39	43	46
90	4	4	17	20	21	24
95	2	2	9	10	11	12
96	2	1	7	8	9	9
98	0.8	0.7	3	4	4	5
99	0.4	0.4	2	2	3	3
99.5	0.2	0.2	0.9	1	2	2

A comparison of 'per turbine rate' associated with the Phase 1a 18 m dimeter turbine and proposed MeyGen2 24m diameter turbine is presented in Table 36.

Table 36 Comparison between the modelling undertaken to inform this assessment (2023) and that undertaken for the MeyGen Phase 1 ES (2012) in terms of absolute number of adult Atlantic salmon in the population that could collide with a single turbine.

TURBINE	0% AVOIDANCE		95% AVOIDANCE	
	1SW	MSW	1SW	MSW
Single Phase 1a 18 m turbine, ES modelling (Xodus, 2012)	12.1	10.6	0.61	0.53
Single MeyGen2, 24 m turbine	17.4	19.6	0.87	0.96

In terms of the proportion of Atlantic Salmon population that could be affected, a comparison between that previously calculated for 86 turbines considered in ES (2012)and that calculated for the combined impact of deployment of Phase 1a turbines and the proposed changes associated with deployment of MeyGen 2 turbines (next subsequent stage of development), is provided in Table 37.

Table 37 Comparison between the modelling undertaken to inform this assessment (2023) and that undertaken for the MeyGen Phase 1 ES (2012) in terms of percentage of each age group in the population predicted to collide with the turbine array.

TURBINE	PERCENTAGE OF AGE GROUP PREDICTED TO COLLIDE WITH OPERATIONAL TURBINES			
	0% avoidance		95% avoidance	
	1SW	MSW	1SW	MSW
86 turbines – Phase 1 ES (2012)	0.38%	0.45%	0.0190%	0.022%
14 turbines – Phase 1a and the proposed changes MeyGen 2 turbines	**0.109%**	**0.116%**	**0.00544%**	**0.00580%**

A comparison can be made between the results obtained for the combined impact of deployment of Phase 1a turbines and the proposed changes associated with deployment of MeyGen 2 turbines (next subsequent stage of development) with a simulation for the stage one, six-turbine array that Marine Scotland had modelled during determination of the s36 (2013; Table 38).

Table 38 Results of the CRM for adult Atlantic salmon for Marine Scotland Stage One model (2013) and combined Phase 1a / MeyGen 2 model.

FEATURE	PREDICTED NUMBER OF COLLISIONS PER YEAR	
	0% avoidance	95% avoidance
Array		
Stage One, six turbine arrays modelled by Marine Scotland during review of ES (2012)	171	8.55
14 turbines Phase 1a and the proposed changes MeyGen 2 turbines	447	22.35

The predicted number of collisions of adult salmon from the combined impact of deployment of Phase 1a turbines and the proposed changes associated with deployment of MeyGen 2 turbines (next subsequent stage of development) for adult Atlantic salmon, is therefore of a similar magnitude to that predicted for the six consented Stage One turbines,

Atlantic Salmon summary and conclusions

The following key CRM findings have been made for the combined impact of deployment of Phase 1a turbines and the proposed changes associated with deployment of MeyGen 2 turbines (next subsequent stage of development).

- The CRM predicts annual collisions of up to 447 adults per year, assuming no avoidance. This estimate equates to 0.112% of the regional adult Atlantic salmon (1SW and MSW) population. At a population level, this proportion is unlikely to have any significant effects even if it is assumed that every collision resulted in a physical injury, disorientation or mortality. Application of an assumed avoidance rate of 95% shows that the likelihood of population level effects is further reduced, with only 0.006% of the regional population of adult salmon predicted to collide with the combined 14 turbine array.
- Recently published scientific evidence (Newton *et al.*, 2021) indicates that Atlantic salmon smolts swim close to the sea surface (< 2 metres depth), which leads to the conclusion that encounters with the rotor-swept area of MeyGen tidal turbines, given the minimum clearance of 8m form blade tip to sea surface relative to LAT, is unlikely.

In conclusion the combined impact of deployment of Phase 1a turbines and the proposed changes associated with deployment of MeyGen 2 turbines (next subsequent stage of development) would not have a significant impact on regional Atlantic salmon population.

References

Band, B., Sparling, C., Thompson, D., Onoufriou, J., San Martin, E. and West, N., 2016. Refining estimates of collision risk for harbour seals and tidal turbines (pp. 1-133). Edinburgh, UK: Marine Scotland Science.

British Trust for Ornithology, 2023. Birdfacts, 2023. https://www.bto.org/understanding-birds/welcome-birdfacts.

Carter, M.I.D., Boehme, L., Cronin, M.A., Duck, C.D. Grecian, W.D., Hastie, G.D., Jessopp M., Matthiopoulos, J., McConnell, B.J. Miller, D.L., Morris, C.D., Moss, S.E.W., Thompson, D. Thompson, P.M., Russell, D.J.F., 2022. Sympatric Seals, Satellite Tracking and Protected Areas: Habitat-Based Distribution Estimates for Conservation and Management. Frontiers in Marine Science. Volume 9 – 2022.

Gillespie, D., Palmer, L., Macaulay, J., Sparling, C. and Hastie, G., 2021. Harbour porpoises exhibit localized evasion of a tidal turbine. Aquatic Conservation: Marine and Freshwater Ecosystems, 31(9), pp.2459-2468.

Godfrey, J.D., Stewart, D.C., Middlemas, S.J. and Armstrong, J.D., 2014. Depth use and movements of homing Atlantic salmon (Salmo salar) in Scottish coastal waters in relation to marine renewable energy development. Scottish Marine and Freshwater Science Volume 5 Number 18.

Hastie, G.D., Russell, D.J., Lepper, P., Elliott, J., Wilson, B., Benjamins, S. and Thompson, D., 2018. Harbour seals avoid tidal turbine noise: Implications for collision risk. Journal of Applied Ecology, 55(2), pp.684-693.

IAMMWG, 2022. Updated abundance estimates for cetacean Management Units in UK waters (Revised 2022). JNCC Report No. 680, JNCC Peterborough, ISSN 0963-8091.Morris, C.D., Duck, C.D., and Thompson, D. 2021. Aerial surveys of seals in Scotland during the harbour seal moult, 2016-2019. NatureScot Research Report 1256.

ICES, 2021. Working Group on North Atlantic Salmon (WGNAS). Volume 3, Issue 29. ICES Scientific Reports.

Lonergan, M., Duck, C., Moss, S., Morris, C. and Thompson, D. 2013. Rescaling of aerial survey data with information from small numbers of telemetry tags to estimate the size of a declining harbour seal population. Aquatic Conservation: Marine and Freshwater Ecosystems, 23, 135-144.

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. Edinburgh: Scottish Government, 72 pages. doi: 10.7489/1459-1.

Marine Scotland, 2013. Marine Renewables: Consideration of Atlantic Salmon Collision Modelling – Meygen – Inner Sound; Pentland Firth. https://marine.gov.scot/datafiles/lot/Meygen/June_2013_MSS_SNH_report-Consideration_of_Atlantic_Salmon_Collision_Modelling/20130607_Meygen_Salmon_review-Final_PDF_Version_A951792.pdf

MeyGen, 2012. Environmental Statement (ES), MeyGen Phase 1. https://marine.gov.scot/data/environmental-statement-meygen-tidal-energy-project.

MeyGen, 2017. MeyGen Project - Environmental Report April 2017. Document Number: A-100157-S02-EIAS-002.

Morris, C.D., Duck, C.D.,and Thompson, D. 2021. Aerial surveys of seals in Scotland during the harbour seal moult, 2016-2019. NatureScot Research Report 1256.

Newton, M., Barry, J., Lothian, A., Main, R., Honkanen, H., Mckelvey, S., Thompson, P., Davies, I., Brockie, N., Stephen, A., Murray, R. O., Gardiner, R., Campbell, L., Stainer, P., and Adams, C., 2021. Counterintuitive active directional swimming behaviour by Atlantic salmon during seaward migration in the coastal zone. – ICES Journal of Marine Science, 78, 1730 – 1743.

Nova Innovation, 2021. Shetland Tidal Array Monitoring Report: Subsea Video Monitoring. https://marine.gov.scot/sites/default/files/enfait-0364_subsea_video_monitoring_report_v4.0_final.pdf.

Onoufriou, J., Russell, D.J., Thompson, D., Moss, S.E. and Hastie, G.D., 2021. Quantifying the effects of tidal turbine array operations on the distribution of marine mammals: Implications for collision risk. Renewable Energy, 180, pp.157-165.

Onoufriou, J., Brownlow, A., Moss, S., Hastie, G. and Thompson, D., 2019. Empirical determination of severe trauma in seals from collisions with tidal turbine blades. Journal of Applied Ecology, 56(7), pp.1712-1724.

Palmer, L., Gillespie, D., MacAulay, J.D., Sparling, C.E., Russell, D.J. and Hastie, G.D., 2021. Harbour porpoise (Phocoena phocoena) presence is reduced during tidal turbine operation. Aquatic Conservation: Marine and Freshwater Ecosystems, 31(12), pp.3543-3553.

RPS, 2012. MeyGen Tidal Energy Project Inner Sound, Pentland Firth. Ornithological Technical Report. Version 1.2. Project Number: SGP 6356.

Russell, D.J., McClintock, B.T., Matthiopoulos, J., Thompson, P.M., Thompson, D., Hammond, P.S., Jones, E.L., MacKenzie, M.L., Moss, S. and McConnell, B.J., 2015. Intrinsic and extrinsic drivers of activity budgets in sympatric grey and harbour seals. Oikos, 124(11), pp.1462-1472.

Sparling, C., Lonergan, M. and McConnell, B., 2018. Harbour seals (Phoca vitulina) around an operational tidal turbine in Strangford Narrows: No barrier effect but small changes in transit behaviour. Aquatic Conservation: Marine and Freshwater Ecosystems, 28(1), pp.194-204.

Special Committee on Seals, 2021. Scientific Advice on Matters Related to the Management of Seal Populations: 2021. Natural Environment Research Council.

SMRU, 2023. Report to Scottish Government - Marine Mammal Scientific Support Research Programme MMSS/003: Interactions of Marine Mammals with Marine Industries. Interim progress report, 31 January 2023.

Scottish Natural Heritage, 2013. Inner Sound tidal energy proposal by MeyGen Ltd. SNH marine mammal advice summary note. Sent by SNH to MS-LOT, 5 April 2013.

Scottish Natural Heritage, 2016. Assessing collision risk between underwater turbines and marine wildlife'. SNH guidance note.

Xodus (2012). Estimating encounter rate for Atlantic salmon for the MeyGen Tidal Energy Project, Phase 1 and potential population effects. Document number A-30596-S00-TECH-013.

Xodus Group, 2012. Estimating the encounter rate for Atlantic salmon for the MeyGen Tidal Energy Project, Phase 1 and potential population effects.

APPENDIX B PROPOSED MITIGATION

Table 39 Proposed mitigation measures for impacts assessed within EIAR in MeyGen Phase 1 ES (2012)

IMPACT	DEVELOPMENT STAGE	PROPOSED MITIGATION
		Physical Environment and Sediment Dynamics
Impact 9.3: Change in water quality	Construction	· Minimise as far as practicable the depth and diameter of the turbine foundation piles (without compromising technical performance); · Minimise as far as practicable the volume of drill cuttings released into the marine environment during breakthrough of HDD bores, by implementing a closed loop recycling system to return drill cuttings and fluid from the HDD to shore.
		Benthic Habitats and Ecology
Impact 10.1: Direct physical impact and loss of habitat	Construction	· The area of kelp that may need cleared will be restricted to as small as practicable around the cable and only larger plants will be removed if possible. · Installation layout will be clearly defined and communicated to any personnel involved in kelp clearance.
Impact 10.2: Release of drill cuttings and fluid	Construction	· Minimise as far as practicable the depth and diameter of the turbine foundation piles (without compromising technical performance).
Impact 10.4: Marine non-native species	Construction	· All vessels involved in all stages of the Project will adhere to all relevant guidance (including the IMO guidelines) regarding ballast water and transfer on non-native marine species.
Impact 10.5: Electro-magnetic effects	Operation	· Where cables are not within boreholes attempts will be made to lay cables within natural crevices and cracks in the seabed to reduce cable wear. This will ensure that the majority of the cable is not exposed. · The length of the drilled boreholes for the cable will be maximised (as far as technically and commercially practicable) to increase the length of cable under the seabed. · Ongoing research by Marine Scotland and their advisors will be monitored for potentially successful mitigation strategies.
		Marine Mammals

IMPACT	DEVELOPMENT STAGE	PROPOSED MITIGATION
Impact 11.1: Noise (TSS pile drilling, construction vessels)	Construction	· No injury impact is expected due to the low levels of noise emissions and no marine mammal observer (the general role of which is to assist in mitigation of the injury impact) is therefore required. Note, however, that the principles of the JNCC guidance on protection of marine European protected species from injury and disturbance (JNCC, 2010) and of relevant guidelines on minimising the risk of injury to marine mammals will be adopted as necessary (for example, reducing the duration of noise emitting activities).
Impact 11.2: Ship strike (installation vessels) and ducted propellers	Construction	· MeyGen has provided the following update, the ES 2012 read: ~~It is understood that investigation is ongoing on the potential link between spiral injuries in seals and ducted propellers and that mitigation measures relevant to minimising the risk of seal spiral injuries and fatalities are currently being developed at an industry and regulator level~~. Contemporary evidence confirms that fatal "corkscrew" injuries are not associated with ducted propellers. MeyGen commit to undertaking frequent reviews of the literature regarding this topic and to regularly discuss advances in understanding of this topic with relevant regulatory and advisory bodies. MeyGen will apply appropriate mitigation, as deemed necessary in consultation with Marine Scotland and SNH, ~~should vessels with ducted propellers be found to be responsible for seal mortalities.~~
Impact 11.6: Accidental spillage from vessels	Construction	· All vessels associated with Project operations will comply with IMO/MCA codes for prevention of oil pollution and any vessels over 400 GT will have onboard SOPEPs. · All vessels associated with Project operations will carry onboard oil and chemical spill mop up kits. · Where possible vessels with a proven track record for operating in similar conditions will be employed. · Vessel activities associated with installation, operation, routine maintenance and decommissioning will occur in suitable conditions to reduce the chance of an oil spill resulting from the influence of unfavourable weather conditions
Impact 11.7: Operational noise	Operation	· Although no specific mitigation measures are proposed. Operational monitoring will be implemented in order to confirm the impact predications made here (see Section 11.12).
Impact 11.9: Ship strike (maintenance vessels) and ducted propellers	Operation	· MeyGen has provided the following update, the ES 2012 read: ~~It is understood that investigation is ongoing on the potential link between spiral injuries in seals and ducted propellers and that mitigation measures relevant to minimising the risk of seal spiral injuries and fatalities are currently being developed at an industry and regulator level~~. Contemporary evidence confirms that fatal "corkscrew" injuries are not associated with ducted propellers. MeyGen commit to undertaking frequent reviews

IMPACT	DEVELOPMENT STAGE	PROPOSED MITIGATION
		of the literature regarding this topic and to regularly discuss advances in understanding of this topic with relevant regulatory and advisory bodies. MeyGen will apply appropriate mitigation, as deemed necessary in consultation with Marine Scotland and SNH, ~~should vessels with ducted propellers be used, to avoid any significant impact~~.
Impact 11.10: Turbine collision	Operation	· MeyGen has provided the following wording the ES (2012) read;. The proposed changes yield an indicative Phase 1 array of up to 40 turbines, whilst retaining the overall maximum generating capacity of 86 MW, representing less than half of the 86 turbines assessed within MeyGen Phase 1 ES (2012). Whilst harbour seals have been identified as the receptor at greatest risk from tidal developments regulators have noted concerns related to collision risk and impact upon of a number of key marine species; · Marine mammals: harbour seal grey seal, harbour porpoise and minke whale; · Seabirds: European shag and black guillemot; and · Fish: Atlantic salmon. MeyGen therefore propose in line with the Scottish Government Survey, Deploy and Monitor Policy that the monitoring of the deployments ~~in years one and two~~ will allow for a better definition of avoidance rates and to better understand the possible impact associated with build out to ~~full~~ 86 MW ~~turbine~~ array. It will also inform the potential requirement for future mitigation and ensure no significant impacts on marine mammals. .
Impact 11.11: Physical barrier to movement	Operation	· No specific mitigation measures are proposed as no significant impact predicted. Operational monitoring will be implemented in order to confirm the impact predications made in the report

IMPACT	DEVELOPMENT STAGE	PROPOSED MITIGATION
		Ornithology
Impact 12.1: Disturbance / displacement due to increased boat traffic	Construction	· No specific mitigation measures are proposed as no significant impact predicted. monitoring will be implemented in order to confirm the impact predications made in the report
Impact 12.2: Release of drill cuttings and fluid	Construction	· No specific mitigation measures are proposed as no significant impact predicted. monitoring will be implemented in order to confirm the impact predications made in the report
Impact 12.3: Accidental spillage from vessels	Construction	· All vessels associated with Project operations will comply with IMO/MCA codes for prevention of oil pollution and any vessels over 400 GT will have onboard SOPEP's. · All vessels associated with Project operations will carry onboard oil and chemical spill mop up kits. · Where possible vessels with a proven track record for operating in similar conditions will be employed. ·Vessel activities associated with installation, operation, routine maintenance and decommissioning will occur in suitable conditions to reduce the chance of an oil spill resulting from the influence of unfavourable weather conditions.
Impact 12.4: Disturbance / displacement due to underwater noise	Construction	· No specific mitigation measures are proposed as no significant impact predicted. monitoring will be implemented in order to confirm the impact predications made in the report
Impact 12.5: Effects of onshore infrastructure construction activities on terrestrial birds	Construction	· Although no significant impacts are predicted, once specific onshore Project areas are known, further, targeted investigation will be undertaken to ascertain the status, distribution and habitat use of birds within the Project footprint and surrounding environment.
Impact 12.6 Disturbance / displacement due to maintenance activity	Operation	· No specific mitigation measures are proposed as no significant impact predicted. Operational monitoring will be implemented in order to confirm the impact predications made in the report

IMPACT	DEVELOPMENT STAGE	PROPOSED MITIGATION
Impact 12.8: Accidental leakage of pollutants from turbines	Operation	· Only recognised marine standard fluids and substances will be used in the turbine hydraulic systems. · Hydraulic fluids will be mostly water based, biodegradable and be of low aquatic toxicity. · Project specific emergency response procedures will be implemented and include contingency arrangements in the unlikely event of a pollution incident.
Impact 12.9: Displacement due to the presence of the turbines	Operation	· No specific mitigation measures are proposed as no significant impact predicted. Operational monitoring will be implemented in order to confirm the impact predications made in the report
Impact 12.10: Collision risk to diving birds	Operation	· No specific mitigation measures are proposed as no significant impact predicted. Operational monitoring will be implemented in order to confirm the impact predications made in the report
Impact 12.11: Indirect effects on birds	Operation	· No specific mitigation measures are proposed as no significant impact predicted. Operational monitoring will be implemented in order to confirm the impact predications made in the report
Impact 12.12: Effects of operation of onshore infrastructure on terrestrial birds	Operation	· Once specific onshore Project areas are known, further, targeted investigation will be undertaken to ascertain the status, distribution and habitat use of birds within the Project footprint and surrounding environment. The results of the survey will be used to confirm the impact assessment.
		Fish Ecology
Impact 13.3: Noise	Construction	·Where possible the use of soft start (gradual ramping up) of operations that will emit noise into the Project area will be used. · MeyGen accepts that there is some uncertainty over the noise generated during drilling and turbine operation and as a result commits to conducting noise monitoring for the initial turbines installed and candidate turbine technology to validate the noise modelling.
Impact 13.5: Smothering	Construction	· Minimise as far as practicable the depth and diameter of the turbine foundation piles (without compromising technical performance).

IMPACT	DEVELOPMENT STAGE	PROPOSED MITIGATION
		· Minimise as far as practicable the volume of drill cuttings released into the marine environment during breakthrough of HDD bores, by implementing a closed loop recycling system to return drill cuttings and fluid from the HDD to shore.
Impact 13.8: Accidental spillage from vessels	Construction	· All vessels associated with Project operations will comply with IMO/MCA codes for prevention of oil pollution and any vessels over 400 GT will have onboard Ship Oil Prevention Emergency Plans (SOPEPs). · All vessels associated with Project operations will carry onboard oil and chemical spill mop up kits. · Where possible vessels with a proven track record for operating in similar conditions will be used. · Vessel activities associated with installation, operation, routine maintenance and decommissioning will occur in suitable conditions to reduce the chance of an oil spill resulting from the influence of unfavourable weather conditions.
Impact 13.9: Release of drill cuttings and fluid	Construction	·Minimise as far as practicable the depth and diameter of the turbine foundation piles (without compromising technical performance). · Lubricant used in the compressor to drive air into the drilled piles will be non-toxic and seawater will be used as a drilling fluid, negating the need for any additional chemical input. · Minimise as far as practicable the volume of drill cuttings released into the marine environment during breakthrough of HDD bores, by implementing a closed loop recycling system to return drill cuttings and fluid from the HDD to shore.
Impact 13.11: Marine non-native species	Construction	· All vessels involved in all stages of the Project will adhere to all relevant guidance and legislation (including the IMO guidelines and the International Convention for the Prevention of Pollution from Ships (MARPOL)) regarding ballast water and transfer on non-native marine species
Impact 13.14: Noise	Operation	· Where possible the use of soft start (gradual ramping up) of operations that will emit noise into the Project area will be used. · MeyGen accepts that there is some uncertainty over the noise generated during drilling and turbine operation and as a result commits to conducting noise monitoring for the initial turbines installed and candidate turbine technology to validate the noise modelling.

IMPACT	DEVELOPMENT STAGE	PROPOSED MITIGATION
Impact 13.15: Electromagnetic fields (EMF)	Operation	· Where cables are not within boreholes they will be laid where possible within natural crevices and cracks within the seabed ensuring that the majority of the cable is below the seabed. · The length of the drilled boreholes for the cable will be (as far as technically and commercially possible) to increase the length of cable under the seabed. · Cables will be bundled into groups of 3 minimising the magnetic field by placing the cables close together, allowing the field vectors to cancel each other out. · In addition ongoing research by Marine Scotland and their advisors which will be monitored for further indications of successful mitigation strategies.
Impact 13.17: Collision with turbines	Operation	· MeyGen accepts that there is uncertainty about some potential impacts from the Project and is committed to undertaking a post installation monitoring programme in order to determine the nature of those impacts. Appropriate monitoring will be agreed with Marine Scotland. · To the extent further mitigation is required over and above the first mitigation proposed for Impact 13.15, MeyGen is committed to working with the regulator to identify reasonable measures to mitigated against this impact. As a result no specific mitigation measures for this impact have been identified but ongoing research by Marine Scotland and their advisors which will be monitored for further indications of successful mitigation strategies.
		Commercial Fishing
Impact 14.1: Temporary exclusion from fishing grounds	Construction	· Ensure consultation with fishermen, which may involve the appointment of a Fisheries Liaison Officer to ensure fishermen are informed in advance of installation plans and to promptly answer any queries from fishermen. · Details of the Project will be included in updated Kingfisher fishermen's awareness charts and FishSAFE.
Impact 14.2: Displacement of fishing effort targeting new or alternative fishing grounds	Construction	· Ensure consultation with fishermen, which may involve the appointment of a Fisheries Liaison Officer to ensure fishermen are informed in advance of installation plans, and to promptly answer any queries from fishermen. · Details of the Project will be included in updated Kingfisher fishermen's awareness charts and FishSAFE.
Impacts 14.4: Risk of contamination (accidental spillage from vessels)	Construction	· All vessels associated with Project operations will comply with IMO/MCA codes for prevention of oil pollution and any vessels over 400 GT will have onboard SOPEPs. · All vessels associated with Project operations will carry onboard oil and chemical spill mop up kits.

IMPACT	DEVELOPMENT STAGE	PROPOSED MITIGATION
		· Where possible vessels with a proven track record for operating in similar conditions will be used. · Vessel activities associated with installation, operation, routine maintenance and decommissioning will occur in suitable conditions to reduce the chance of an oil spill resulting from the influence of unfavourable weather conditions.
Impact 14.7: Loss of fishing gear due to entanglement	Operation	· Further consultation with the local fishing fleet to ensure the safe continuation of fishing effort in the cable deployment area once cables are installed. · Consultation with the local fishing fleet, to ensure fishermen are aware of turbine locations. · Provision of offshore Project area location data to local fishermen and Kingfisher Information Services (marine safety authority), to enable incorporation of offshore Project area location data into plotters · Project area will be depicted on charts. Turbines and cables will be depicted on appropriate scale charts. · Cable route coordinates will be circulated to kingfisher and local skippers. · Cables will be grouped (where feasible) to minimise overall footprint on the seabed. · HDD bores will provide protection for at least part of the cable length from shore. · Natural crevices will be used to avoid exposed cables being on the seabed surface as far as practicable. · Additional material weighting will be used where necessary to ensure cable stability on the seabed.
Impact 14.10: Disturbance of fishing grounds	Decommissioning	· Ensure fishermen are aware of decommissioning activities and schedule. · Details of the Project will be included in updated Kingfisher fishermen's awareness charts and FishSAFE
		Shipping and navigation
Impact 15.1: Collision risk with work vessel	Construction	· Experience and lessons learned from other marine renewables projects will be taken into account. · Workshops will be held before the activity takes place involving the Construction company and maritime stakeholders to review the hazards and plan how the work can be safely conducted. · Marine Safety Information broadcasts will be issued by HM Coastguard to inform mariners of the activity at the Project area (8 broadcasts per day covering Fair Isle, Cromarty and Hebrides Areas). · The Project area will be depicted on Admiralty Charts produced by the UKHO. · Navtex and Notices to Mariners will be issued including details of the MeyGen work. · Information on the work activity at the site will be circulated directly to local ports, ferry operators (e.g., Pentland Ferries), fishermen and recreational clubs.

IMPACT	DEVELOPMENT STAGE	PROPOSED MITIGATION
		· Details of the Project will be included in updated Kingfisher fishermen's awareness charts and FishSAFE. · Details of the Project will be included in updated Sailing Directions. · There will be liaison with local Harbour Masters to ensure they are aware of the activity and can notify visitors to their port. · A working VHF channel will be provided to local users. · Safety zone of appropriate dimensions will be applied for to protect working vessels on the site when restricted in manoeuvrability. · Operating procedures will be established to ensure work vessels do not block the channel when they are not actively working on the site. If it is not practicable for the work vessel to depart from the site they will use AIS and marks to indicate that any safety zone is not operational if they are not restricted in manoeuvrability. · Collision risk management procedures will be developed to be used by working vessels specifying traffic monitoring and emergency response procedures. · An Emergency Response Cooperation Plan (ERCoP) will be prepared for the Project following the template provided by the MCA in MGN 371. This will be submitted to the MCA for comment and approval. · There will be a dedicated watchkeeper onboard working vessel(s) or onshore. · Local knowledge will be used during the work whenever possible. · Local harbours will be used for the work where practicable. · Radio broadcasts will be given as necessary to warn approaching vessels about the work activity.
Impact 15.2: Traffic re-routeing due to work vessels and associated safety zones	Construction	· Further consultation will be carried out on the safety zone dimensions with Marine Scotland, the MCA, DECC, the appointed contractor and local stakeholders prior to the application being made to DECC. · Safety zones will be established on a 'rolling' basis, covering only the area of the site in which activity is taking place at a given time. Once that activity has been completed in that specific location, the safety zone will then 'roll on' to cover the next specific location (not the whole Project area). · Work vessels will indicate their status on AIS and using appropriate marks/lights, e.g., if restricted in manoeuvrability. This will signify to passing traffic whether a Safety Zones is in place or not.
Impact 15.3: Working vessel gets into difficulty	Construction	· Working vessels are selected and audited based on suitability for the job and the conditions in the Pentland Firth. · Marine operating procedures are developed specifying allowable wave, tide and weather criteria.

IMPACT	DEVELOPMENT STAGE	PROPOSED MITIGATION
		· Procedures specify that work vessels should seek shelter (or return to base) when not working at the site. · Working personnel are trained in offshore survival and have suitable Personal Protective Equipment (PPE). · The Construction company operates a Safety Management System. · Passage plans are developed for vessels routeing between the Project area and the onshore base. · Work vessel movements are monitored from an onshore control centre, e.g., on AIS and VHF. · An Emergency Response Cooperation Plan (ERCoP) will be prepared for the Project following the template provided by the MCA in MGN 371. This will be submitted to the MCA for comment and approval.
Impact 15.4: Powered collision with subsea turbine	Operation	· The turbines will have a minimum underwater clearance of 8m relative to LAT. · The Project area will be depicted on Admiralty Charts produced by UKHO with an associated note on the available underwater clearance. · Details of the Project will be included in updated fishermen's awareness charts and on FishSAFE. · Details of the Project will be included in updated Sailing Directions. · There will be liaison with local Harbour Masters to ensure they are aware of the activity and can notify visitors to their port. · Marking and lighting of the site will be decided by NLB once they have reviewed the NRA and consulted as appropriate. Discussions to date have indicated that they consider the Project area is effectively marked by the southern part of the island of Stroma and the whole coastline is conspicuous on radar. Therefore, they do not foresee a need for additional marking and lighting. Floating aids to navigation are not considered suitable given the strong tides. · Survey, Deploy and Monitor strategy, i.e., turbines will be installed over a number of years which allows the effect on vessel navigation to be monitored. · An Emergency Response Cooperation Plan (ERCoP) will be prepared for the Project following the template provided by the MCA in MGN 371. This will be submitted to the MCA for comment and approval.
Impact 15.5: Drifting vessel collision with subsea turbine	Operation	· The turbines will have a minimum underwater clearance of 8m relative to LAT. · The Project area will be depicted on Admiralty Charts produced by UKHO with an associated note on the available underwater clearance. · Marking and lighting is being discussed with NLB (refer to mitigation for Impact 15.4). · Turbines could be stopped to maximise underwater clearance.

IMPACT	DEVELOPMENT STAGE	PROPOSED MITIGATION
		· An Emergency Response Cooperation Plan (ERCoP) will be prepared for the Project following the template provided by the MCA in MGN 371. This will be submitted to the MCA for comment and approval. This will include information on tug availability for potentially recovering a drifting vessel.
Impact 15.6: Increase in vessel-to-vessel collision risk due to re-routeing	Operation	· Vessels will have increased awareness of the Project area due to the notification measures carried out before and during Installation (described under the mitigation of Impact 15.1). · The turbines will have a minimum under water clearance of 8m relative to LAT which means a proportion of vessels will not need to re-route as they will have safe under keel clearances when passing over the turbines. · The Project area will be depicted on Admiralty Charts produced by UKHO with an associated note on the available underwater clearance. This will allow vessels to revise their passage in advance, taking into account information on the Project, before setting off from Port. · Details of the Project will be included in updated Sailing Directions. · There will be liaison with local Harbour Masters to ensure they are aware of the Project and can notify visitors to their port.
Impact 15.7: Loss of station	Operation	· The turbines have been subjected to engineering design and third-party verification to ensure they are suitable for deployment in the Inner Sound. · The Project will be using tried and tested equipment and techniques to minimise the risks associated with the high tidal flow environment. · Most parts will be negatively buoyant. · Turbine nacelle designs that use buoyancy as part of the installation and maintenance strategy have failsafe locking systems for the connection between the nacelle and the TSS to prevent accidental release. · On-site monitoring via SCADA will alert the 24-hour control room operations team of turbine failure or an object hitting the turbine. · Emergency Response Cooperation Plan (ERCoP) to be prepared and agreed with the MCA. Emergency response would include informing HM Coastguard, RNLI, Harbours and local users (e.g., Pentland Ferries) so that vessels in the area are alerted to the potential hazard.
Impact 15.8: Anchor interaction	Operation	· Project area will be depicted on charts. Turbine and cables areas will be depicted on appropriate scale charts. · Cables will be grouped (where feasible) to minimise the overall footprint area on the seabed.

IMPACT	DEVELOPMENT STAGE	PROPOSED MITIGATION
		· HDD bores will provide protection for at least part of the cable length from shore. · Natural crevices will be used to avoid exposed cables being on the seabed surface as far as practicable. · Additional material weighting will be used where necessary to ensure cable stability on the seabed
		Marine Cultural Heritage
Impact 16.1: Damage caused by placing turbine and cable over marine cultural material	Construction	The following mitigations are proposed if practicable for sites of moderate and major impact significance within 100m of the development. · Avoidance. · ROV survey of the geophysical anomalies by Remote Operated Vehicle (ROV) in an appropriate manner by specialists in marine archaeology so they can be positively identified. · Detailed wreck survey and salvage. If the ROV survey reveals cultural heritage, plans/elevations will be made with a full photographic record prior to impact. Wrecks should be recorded in an appropriate manner by specialists in marine archaeology. Attempts will be made to retrieve and conserve representative examples of the fabric. If the feature is of high archaeological potential the strategies below may be implemented. · Intrusive archaeological assessment. This response will be implemented for all sites and wrecks with high archaeological potential and where there will be intrusive works. Intrusive assessments would ground truth geophysical survey results and assess the nature, extent and preservation of identified remains. · Full archaeological excavation. This level of mitigation may be deemed necessary as a result of evidence gathered by other levels and should be conducted by specialists in marine archaeology. Provision should be made for the examination and possible conservation of any artefacts recovered. Provision should be made for post-excavation work bringing the results together in a report of publication standard. · Further documentary research and archiving. This response includes further detailed examination of unusual archival sources that would not routinely be consulted. · No recommendations are made for anomalies of low potential. This is due to them being interpreted as natural features.
Impact 16.2: Damage to discovered marine cultural material Impact	Construction	· A reporting protocol will be instigated for the accidental discovery of marine cultural material during development, maintenance and monitoring. · Avoidance. Should cultural material be accidentally discovered, it is proposed that the site be avoided.

IMPACT	DEVELOPMENT STAGE	PROPOSED MITIGATION
		· If it is not practicable to avoid the material a detailed wreck survey will be undertaken. If the ROV survey reveals cultural heritage, plans/elevations will be made with a full photographic record prior to impact. Wrecks will be recorded in an appropriate manner by specialists in marine archaeology. Attempts will be made to retrieve and conserve representative examples of the fabric. If the feature is of high archaeological potential the strategies below may be implemented. · Intrusive archaeological assessment. This response will be implemented for all sites and wrecks with high archaeological potential and where there will be intrusive works. Intrusive assessments would ground truth geophysical survey results and assess the nature, extent and preservation of identified remains. · Full archaeological excavation. This level of mitigation may be deemed necessary as a result of evidence gathered by other levels and should be conducted by specialists in marine archaeology. Provision should be made for the examination and possible conservation of any artefacts recovered. Provision should be made for post-excavation work bringing the results together in a report of publication standard. · Further documentary research and archiving. This response includes further detailed examination of unusual archival sources that would not routinely be consulted. · No recommendations are made for anomalies of low potential. This is due to them being interpreted as natural features.
Impact 16.3: Damage to marine cultural material from scouring caused by alteration of currents from placing turbine and cable on seafloor	Operation	· Avoid placing the turbines on the sandy substrate on the northeast corner of the proposed turbine deployment area.
		Geology, Hydrogeology and Hydrology
Impact 17.1: Pollution event	Construction	· All infrastructure will be located 50m or more from surface watercourses or waterbodies where possible. · Concrete will not be batched on site. · Use of wet concrete near watercourses will be minimised and carefully controlled.

IMPACT	DEVELOPMENT STAGE	PROPOSED MITIGATION
		· Water-based lubricants and drill fluid will be used where possible and drill fluid will be recycled throughout the drilling process to minimise total volume required. Any surplus drill fluid will be disposed of as controlled waste at the end of construction. · Waste water and sewage will be disposed of in accordance with PPG4. Where ground conditions permit, disposal to ground will be considered as the preferred option. Locations of existing private septic tanks and associated pipework will be identified prior to undertaking any ground moving activity and will be avoided as far as possible to minimise the risk of damaging this infrastructure. · Waste materials including drill cuttings generated during HDD (apart from the final 5-10m which will be discharged to sea), will be reused or recycled, and where this is not possible will be disposed of appropriately. A Construction Waste Management Plan will be produced by the appointed principal contractors and will follow guidelines similar to the ones set out in SEPA (2006). · All equipment, materials and chemicals will be stored well away from watercourses, with at least a 50m separation. Chemical, fuel and oil stores will be stored safely in accordance with PPG2. · Machinery standing for several days or longer will have drip trays placed underneath to prevent oil and fuel leaks causing pollution. · Where practicable, refuelling of vehicles and machinery will be carried out in a designated area, on an impermeable surface and well away from any watercourse. · Only emergency maintenance will be carried out within the Project area, on an impermeable surface and well away from watercourses. If vehicles have broken down, necessitating maintenance at the point of breakdown, special precautions will be taken. · Construction traffic movements will be limited as far as practicable, to reduce the risk of accidental spillage. · Washing-out of vehicles used to transport concrete, grout or drilling fluid will not be undertaken on site. · Contingency plans will be in place to ensure that emergency equipment, such as spill kits and absorbent materials, is available on site and will include advice on actions to be taken and personnel to be informed in the event of a pollution incident. · All relevant staff and site personnel will be trained in normal operating and emergency procedures and will be made aware of highly sensitive areas on site.

IMPACT	DEVELOPMENT STAGE	PROPOSED MITIGATION
		· All activity occurring within the Burn of Horsegrow catchment will be undertaken with particular care to minimise pollution risk to the Loch of Mey SSSI/Ramsar site and its tributary watercourses. Additional protection measures will be installed if necessary to ensure the site is adequately safeguarded. · A suitably qualified Environmental Clerk of Works will be appointed who will have responsibility for ensuring mitigation measures are in place and are operating effectively.
Impact 17.2: Erosion and sedimentation	Construction	· All earth-moving operations will be undertaken in compliance with BSI Code of Practice for Earthworks, BS 6031:2009. This will include halting of all earthworks during and immediately after heavy rainfall events. · All heavily sediment-laden discharges will be routed through balancing tanks and one or more suitable filters or silt-busters in series as necessary, to reduce the sediment load. · Water with light sediment load and supernatant water following treatment to remove heavy sediment load will be discharged onto vegetated surfaces and directed away from surface watercourses and ditches to avoid direct entry into the surface water system. · In areas where it is necessary to run cable trenches and working width parallel to and within 20m of roadside or field drainage ditches, additional sediment control measures may be required to ensure the existing drainage network continues to operate at its current level. Additional control measures may take the form of silt fences, bunds, straw bales or other suitable barrier as appropriate to local conditions. · Measures to control surface water runoff will be instigated prior to topsoil stripping. These may include retention of vegetation cover on watercourse banks, installation of straw bales or alternative barrier to intercept runoff or the installation of new land drains. · Sediment control measures and temporary drainage will remain in place until vegetation cover has been re-established on the working width, to prevent reinstated soils being carried into nearby watercourses. · Where open-cut cable crossings of watercourses are proposed, preference will be given to isolated open-cut techniques to minimise any potential release of sediment to the watercourse. Watercourse bed and bank material will be fully reinstated prior to the restoration of flow in the channel. · All activity occurring within the Burn of Horsegrow catchment will be undertaken with particular care to minimise the risk of sediment release to the Loch of Mey SSSI/Ramsar site and its tributary watercourses. Additional protection measures will be installed if necessary to ensure the site is adequately safeguarded.

IMPACT	DEVELOPMENT STAGE	PROPOSED MITIGATION
		· A suitably qualified Environmental Clerk of Works will be appointed who will have responsibility for ensuring mitigation measures are in place and are operating effectively.
Impact 17.3: Soil compaction and loss of quality	Construction	· Vehicle movements on site will be restricted as far as practicable, especially on temporary tracks and within the working width, to restrict soil compaction. · Specialist low ground pressure vehicles will be considered for construction work, to minimise the requirement for temporary tracks. · For the working width and cable trenches, topsoil will be stripped on a field-by-field basis and stored in a mound running alongside the working width on unstripped land. Where possible, topsoil will be stripped in reasonably dry conditions and stored in a mound no more than 2m high. · Stored topsoil will be kept free from the passage of vehicles and will be prevented from intermixing with other materials. Erosion protection will be placed around stockpiles if required to minimise soil loss to surface runoff. · Subsoils removed from the cable trenches will be stored on the opposite side of the working width from stored topsoil and will be laid on undisturbed subsoil. · Topsoil reinstatement will be carried out under suitably dry conditions in order to limit compaction. Soil loosening may be required in areas where compaction is a problem, such as under the running track or under temporary track routes. · A suitably qualified Environmental Clerk of Works will be appointed who will have responsibility for ensuring mitigation measures are in place and are operating effectively.
Impact 17.4: Increase in surface runoff	Construction	· All temporary tracks and hardstanding areas will be removed and fully reinstated upon completion of the construction work.
Impact 17.5: Modification of drainage patterns	Construction	· All temporary excavations associated with excavations will be fully reinstated upon completion of the construction work once vegetation has been re-established on previously stripped ground. · Where permanent modifications to land drainage are required, such as around the PCC site, alternative drainage will be installed prior to construction to provide continuity of flow capacity in the affected area.
Impact 17.6: Impediments to surface flows	Construction	· All crossings will be constructed taking account of guidance and good practice detailed in SEPA's Engineering in the Water Environment Good Practice Guide: River Crossings (2010) and Scottish Executive's River crossings & migratory fish: Design guidance (2000).

IMPACT	DEVELOPMENT STAGE	PROPOSED MITIGATION
Impact 17.7: Increase in fluvial flood risk	Construction	· Ground levels around temporary and permanent watercourse crossings and along the line of the cable trench will not be raised and care will be taken to ensure that bed reinstatement above cable trench crossings does not impede water flow within the channel. · Permanent infrastructure will be located outwith the 1-in-200 year flood risk area and at least 5 m AOD to minimise risk from coastal flooding. · Where possible, siting of the PCC and associated infrastructure will avoid the existing field drainage network. If this is not possible, alternative field drainage will be installed prior to construction work to provide continuity of flow capacity in the affected area. · Track crossings of watercourses, including field and roadside drainage ditches, will be sized appropriately to ensure flow is not restricted. A programme of inspection and maintenance will be put in place to ensure their continued effective operation throughout the lifetime of the project. · Should excess spoil arise from engineering works, this will be disposed of outwith the floodplain area to avoid loss of flood storage capacity.
Impact 17.8: Modification of groundwater levels and flows	Construction	· Cable trench backfill will be compacted to an appropriate degree to minimise along-trench groundwater flow without compromising the required technical performance. · Where the cables are required to be seated on sand, use of cement-bound sand or appropriate alternative impermeable barrier will be considered to divert groundwater from the trench. · If groundwater discharges are identified during construction, cable trenches and infrastructure will be microsited where possible to avoid the identified discharge location. · In the event that the cable route running from Upper Gills to the Hill of Rigifa' is selected as the preferred option, cables will be located as close to the road as possible in order to minimise disruption to the identified groundwater dependent terrestrial ecosystem in this corridor. Consideration will be given to locating the cable trenches across the road from the identified habitat area to avoid further disruption to groundwater flow.
Impact 17.10: Mobilisation of contaminants	Construction	· Excavated material from road surface and sub-base may need appropriate disposal as hazardous waste. Testing will be required to determine if this is required. Disposal would be subject to agreement and licensing by The Highland Council and SEPA. · Water ingress to the excavation may contain contaminants and would require collection and appropriate treatment to remove contaminant prior to discharge. This may be subject to agreement and licensing by SEPA.

IMPACT	DEVELOPMENT STAGE	PROPOSED MITIGATION
Impact 17.11: Pollution event	Operation	· It has been assumed that all operations and maintenance activity will be undertaken in accordance with the good practice and mitigation measures set out above with relation to Impact 17.1.
Impact 17.12: Erosion and sedimentation	Operation	· A programme of regular inspection and maintenance for all permanent drainage features will be put in place and carried out regularly.
Impact 17.13: Impediments to surface flows	Operation	· A programme of regular inspection and maintenance will be implemented to prevent constriction of drainage channels and to ensure continued efficient operation of the drainage network.
Impact 17.14: Pollution event	Decommissioning	· Mitigation relating to Pollution Events is set out above, with relation to Impact 17.1. These good practice and mitigation measures will be implemented during decommissioning. No additional mitigation specific to decommissioning is required.
Impact 17.15: Erosion and sedimentation	Decommissioning	· Mitigation relating to Erosion and Sedimentation is set out above, with relation to Impact 17.2. These good practice and mitigation measures will be implemented during decommissioning. · Excavation and ground-disturbing work will be kept to a minimum as far as practicable, to minimise the potential for mobilising sediment.
Impact 17.16: Soil compaction and loss of quality	Decommissioning	· It has been assumed that all decommissioning activity will be undertaken in accordance with the good practice and mitigation measures set out above with relation to Impact 17.3.
Impact 17.17: Impediments to surface flows	Decommissioning	· It has been assumed that all decommissioning activity will be undertaken in accordance with the good practice and mitigation measures set out above with relation to Impact 17.6.
Impact 17.18: Increase in fluvial flood risk	Decommissioning	· It has been assumed that all repowering/decommissioning activity in the area of the PCC and associated above ground infrastructure will be undertaken in accordance with the good practice and mitigation measures set out above with relation to Impact 17.7.
Impact 17.19: Modification of groundwater levels and flows	Decommissioning	· It has been assumed that all decommissioning activity will be undertaken in accordance with the good practice and mitigation measures set out above with relation to Impact 17.8.
Impact 17.20: Damage to geological or geomorphological features	Decommissioning	· It has been assumed that all repowering/decommissioning activity will be undertaken in accordance with the good practice and mitigation measures set out above with relation to Impact 17.9.

IMPACT	DEVELOPMENT STAGE	PROPOSED MITIGATION
		Terrestrial Habitats and Ecology
Impact 18.2: Disturbance to terrestrial habitats	Construction	· Employment of best working practices during construction works, including restoration of affected habitats to an original condition, where conditions allow. · Submission of Construction Environmental Management Plan (CEMP), including details of measures to reduce construction disturbance to terrestrial habitats and species where possible. · Further ecological investigation in relation to otter and water vole status (once onshore Project specifics are confirmed), to ascertain protected species licensing requirements. · Application for a EPS licence in relation to disturbance of otter habitat and application for a water vole habitat disturbance licence, if either licensing requirement is deemed necessary.
Impact 18.3: Terrestrial habitat loss	Construction	· Where ecologically sensitive habitat loss does occur, compensatory measures (such as replanting of lost tress) will be considered as part of completion of construction and restoration of habitats to an original condition (where project operations allow). · Where otter habitat is disturbed (particularly in the vicinity of the PCC location where long term disturbance may occur), application for a European Protected Species Licence will be undertaken and a programme of relevant mitigation will be implemented where necessary.
Impact 18.4: Disturbance to otters	Construction	· Once specific Project details are known, further targeted investigation will be undertaken to ascertain the status, distribution and habitat use of otters within the Project footprint and surrounding environment. · Where it is ascertained that disturbance to otters will be likely, application for a European Protected Species licence will be made. · As part of the licence, implementation of on otter management plan may be necessary; this will outline best industry practices to minimise disturbance to otters where possible. · Where increased otter road fatality risk is identified, specific mitigation measures will be put in place; this may include otter culverts (for new access tracks), steering fences and wildlife reflectors. It is recognised that installation of such measures may comprise a condition of (European Protected Species) licence, if deemed necessary and should be implemented as part of the Construction Environmental Management Plan (CEMP).
Impact 18.5: Disturbance to water vole	Construction	· Once specific Project details are known, further ecological investigation will be undertaken to ascertain the status of water vole within the onshore Project footprint and surrounding environment.

IMPACT	DEVELOPMENT STAGE	PROPOSED MITIGATION
		· Should water vole be present within the Project footprint, application for a relevant licence will be necessary and habitat protection measures will be implemented during the construction phase to prevent causing disturbance to water voles and water vole habitat. This will likely be included as part of a water vole mitigation plan and / or CEMP. · Should water vole habitat be impacted by construction, affected areas will be restored to an original condition to minimise long term impacts on the local water vole population.
Impact 18.6: Temporary disturbance to otters during maintenance operations	Operation	· Once specific onshore Project details are known, further, targeted investigation will be undertaken to ascertain the status, distribution and habitat use of otters within the Project footprint and surrounding environment. · Should sensitive habitats (i.e. otter holts and resting sites) be located in close proximity to where onshore maintenance and operational activities are taking place (including near shore vessel activities), best industry practices and relevant mitigation measures will be implemented, to avoid causing unnecessary disturbance. · Where disturbance impacts from small scale construction activities involved in the operations and maintenance of the PCC cannot be avoided, acquisition of a European Protected Species licence will be undertaken to ensure potentially disturbing works are legally permitted. · Long term mitigation against increased risk of otter road fatality will be put in place from the construction phase onwards; it is anticipated that mitigation measures such as otter culverts (for new access tracks) and wildlife reflectors will remain effective at deterring otters from crossing roads throughout the duration of the Project.
Impact 18.7: Temporary disturbance to habitats during decommissioning operations	Decommissioning	· Employment of industry best practise during decommissioning works, including restoration of affected terrestrial habitats to an original condition. · Adherence to the Environmental Management Plan (and where relevant, working method statements) throughout the decommissioning phase, aiming to reduce disturbance to terrestrial habitats where possible.
Impact 18.8: Temporary disturbance to otters during decommissioning operations	Decommissioning	· Should sensitive habitats (i.e. otter holts and resting sites) be located in close proximity to where onshore and inshore decommissioning activities are taking place, best working practices and relevant mitigation measures will be implemented to avoid causing unnecessary disturbance to otters where practicably possible. · Where disturbance impacts to otters from decommissioning activities cannot be avoided, acquisition of a EPS licence will be undertaken, to ensure potentially disturbing works are legally permitted.

IMPACT	DEVELOPMENT STAGE	PROPOSED MITIGATION
		· Long term mitigation against increased risk of otter road fatality will likely be in place from the construction phase onwards; it is anticipated that mitigation measures such as otter culverts (for new access tracks), steering fences and wildlife reflectors will remain effective at deterring otters from crossing roads, throughout the duration of the Project and beyond.
		Landscape, Seascape and Visual Impact Assessment
		· Reduction of overall site footprint to minimise loss of physical landscape and seascape elements; · Limiting PCUB height and lowering the buildings by taking away superficial soil layers; · Siting of main PCUBs, control building, and other physical infrastructure within the PCC use natural topographic screening to minimise visibility – in terms of both overall visual envelope (ZTV) and actual visibility from key viewpoints; · Building orientation designed to minimise impact in key viewpoints: e.g. orientation of the main PCUBs has been harmonised with the open vistas when viewed from both the Canisbay Kirk and from the ferry route between Gills Bay and Orkney; · Siting, non-alignment and spacing of PCUBs to minimise additional visual confusion and avoid conflict with existing adjacent historic features and buildings; · Building scale designed to be compatible with scale of landscape and seascape character of site and wider context; · Distinctive building form creates strong identity and clear rationale relating to renewable marine energy source; · A curved roof to reflect the surrounding landscape; · Building form and finishes, include use of natural materials, designed to reflect aesthetic qualities associated with landscape and seascape character of site and wider context; and · Use of local stone walling in harmony with existing uses to help screen control building.
		Onshore Cultural Heritage
Impact 20.2: Direct damage, removal or destruction of onshore cultural heritage assets	Construction	· Avoidance. All sites of major significance will be avoided and the cable route will be designed to avoid most cultural heritage assets. Assets in the Ness of Quoys and Ness of Huna will be avoided where possible by the design and layout of the development.

IMPACT	DEVELOPMENT STAGE	PROPOSED MITIGATION
		· Targetted geophysical survey has already been conducted to identify the presence / absence and extent of archaeological remains at the Ness of Quoys and Ness of Huna in order to manage potential impact. The design will avoid these where possible and intrusive evaluations will be conducted as the next step where it is not. Further survey is recommended at the east end of the Gills to Kirkstyle cable route to identify whether remains extend into it from the prehistoric mound (54) below Canisbay Kirk. · Survey. A detailed topographic / photographic and / or standing building survey of an appropriate level will be conducted for earthworks or vernacular buildings if they cannot be avoided. · Intrusive archaeological evaluation will be conducted if appropriate on remains that cannot be avoided, including those identified by geophysical survey, or to assess the nature and significance of sites that may be of archaeological importance so that appropriate action can be taken. · Archaeological Watching Brief. This will be conducted during ground-breaking construction works if there is a significant potential for but no conclusive proof of archaeological remains, or as a precautionary measure if a site has been identified nearby. The works will allow opportunity for salvage excavation on remains that cannot be avoided. · Archaeological Excavation may be necessary as a result of evidence gathered by other mitigation strategies if archaeological remains cannot be avoided and if required by HC HET. Agreement should be made with HC HET on the standards and extent of excavation and the provisions for post-excavation work and reporting. · A Reporting Protocol for the accidental discovery of archaeological remains will be instated, the nature of which will be agreed with HC HET. · MeyGen will ensure that construction contractors have cultural heritage site maps and lists so that they know what is to be avoided; that the construction teams have a cultural heritage induction, especially if reporting protocols are to be used; and that the construction works manager or Environmental Clerk of Works marks off all sites within or close to edge of the development areas to ensure that they are avoided and not accidentally run over or otherwise impacted.
Impact 20.4: Setting	Operation	· Reduction of overall site footprint to minimise loss of setting of cultural heritage assets. · Siting of main PCUBs, Control Building, and other physical infrastructure within the PCC use natural topographic screening to minimise visibility – in terms of both overall visual envelope (ZTV) and actual visibility from key heritage assets.

IMPACT	DEVELOPMENT STAGE	PROPOSED MITIGATION
		· Building orientation designed to minimise impact in key view: e.g. orientation of the main PCUBs has been harmonised with the open vistas when viewed from both the Canisbay Kirk and from Stroma. · Siting, non-alignment and spacing of PCUBs to minimise additional visual confusion and avoid conflict with existing adjacent historic features and buildings. · Building scale designed to be compatible with scale of landscape and seascape character of site and wider landscape setting. · Distinctive building form creates strong identity and clear rationale relating to renewable marine energy source. · Building form and finishes, include use of natural materials, designed to reflect aesthetic qualities associated with landscape and seascape character of site and wider landscape setting. · Use of local stone walling in harmony with existing uses to help screen buildings. · Design ensures that the prominence of Canisbay Kirk and its dominance of the local landscape is not challenged by the size and height of the buildings and ensuring that the buildings do not break the horizon when looking to them from the sea. · Design ensures that the key view between the kirk and the manse is not interrupted.
		Socio-Economics, Tourism and Recreation
Impact 21.1 Local employment and GVA impacts during construction	Construction	· There are a number of national, regional and local initiatives involving the Scottish Government, regional and local development agencies and the Caithness and North Sutherland Regeneration Partnership with the aim to work towards enhanced skills training, supply chain enhancement, and support for business improvement working in the marine renewables industry, including Caithness. These will assist in realising and maximising the opportunities in the local and wider areas and where appropriate MeyGen will support these initiatives.
Impact 21.2: Wider qualitative economic benefits during construction	Construction	· There are a number of national, regional and local initiatives involving the Scottish Government, regional and local development agencies and the Caithness and North Sutherland Regeneration Partnership with the aim to work towards enhanced skills training, supply chain enhancement, and support for business improvement working in the marine renewables industry, including Caithness. These will assist in realising and maximising the opportunities in the local and wider areas and where appropriate MeyGen will support these initiatives.

IMPACT	DEVELOPMENT STAGE	PROPOSED MITIGATION
Impact 21.3: Local tourism business impacts during construction	Construction	· Consultation with local businesses to manage traffic flows during major events. · During the temporary HDD activities, screening measures may be implemented to reduce impacts on passing visitors. · For the potential positive construction impacts there are a number of national, regional and local initiatives involving the Scottish Government, regional and local development agencies and the Caithness and North Sutherland Regeneration Partnership with the aim to work towards enhanced skills training, supply chain enhancement, and support for business improvement working in the marine renewables industry, including Caithness. These will assist in realising and maximising the opportunities in the local and wider areas and where appropriate MeyGen will support these initiatives.
Impact 21.4: Wider tourism impacts during construction	Construction	· Consultation with local businesses to manage traffic flows during major events. · During the temporary HDD activities, screening measures may be implemented to reduce impacts on passing visitors. · For the potential positive construction impacts there are a number of national, regional and local initiatives involving the Scottish Government, regional and local development agencies and the Caithness and North Sutherland Regeneration Partnership with the aim to work towards enhanced skills training, supply chain enhancement, and support for business improvement working in the marine renewables industry, including Caithness. These will assist in realising and maximising the opportunities in the local and wider areas and where appropriate MeyGen will support these initiatives.
Impact 21.5: Recreation impacts during construction	Construction	· Consultation with local businesses to manage traffic flows during major events. · Temporary interruption of recreation routes during construction will be carefully managed and any diversions clearly sign-posted; information on construction works circulated to recreational businesses and public notices distributed. · During the temporary HDD activities, screening measures may be implemented to reduce impacts on passing recreational users or from recreational focal points. · Marine Safety Information broadcasts will be issued by HM Coastguard to inform mariners of the activity at the MeyGen site. · The Project will be depicted on Admiralty Charts produced by UKHO. · Navtex and Notice to Mariners will be issued including details of MeyGen works.

IMPACT	DEVELOPMENT STAGE	PROPOSED MITIGATION
		· Information on the work activity at the site will be circulated directly to local ports, ferry operators and recreational clubs and businesses
Impact 21.6: Local employment and GVA impacts during O&M	Operation	· There are a number of national, regional and local initiatives involving the Scottish Government, regional and local development agencies and the Caithness and North Sutherland Regeneration Partnership with the aim to work towards enhanced skills training, supply chain enhancement, and support for business improvement working in the marine renewables industry, including Caithness. These will assist in realising and maximising the opportunities in the local and wider areas and where appropriate MeyGen will support these initiatives.
Impact 21.7: Wider qualitative economic benefits during operation and maintenance	Operation	· There are a number of national, regional and local initiatives involving the Scottish Government, regional and local development agencies and the Caithness and North Sutherland Regeneration Partnership with the aim to work towards enhanced skills training, supply chain enhancement, and support for business improvement working in the marine renewables industry, including Caithness. These will assist in realising and maximising the opportunities in the local and wider areas and where appropriate MeyGen will support these initiatives.
Impact 21.9: Local employment and GVA impacts during decommissioning	Decommissioning	· There are a number of national, regional and local initiatives involving the Scottish Government, regional and local development agencies and the Caithness and North Sutherland Regeneration Partnership with the aim to work towards enhanced skills training, supply chain enhancement, and support for business improvement working in the marine renewables industry, including Caithness. These will assist in realising and maximising the opportunities in the local and wider areas and where appropriate MeyGen will support these initiatives.
Impact 21.10: Wider qualitative economic benefits during decommissioning	Decommissioning	· There are a number of national, regional and local initiatives involving the Scottish Government, regional and local development agencies and the Caithness and North Sutherland Regeneration Partnership with the aim to work towards enhanced skills training, supply chain enhancement, and support for business improvement working in the marine renewables industry, including Caithness. These will assist in realising and maximising the opportunities in the local and wider areas and where appropriate MeyGen will support these initiatives. These initiatives will contribute to enhancing the likelihood of these construction employment and output impacts occurring.

IMPACT	DEVELOPMENT STAGE	PROPOSED MITIGATION
Impact 21.11: Local tourism business impacts during decommissioning	Decommissioning	· Consultation with local businesses to manage traffic flows during major events. · For the potential positive decommissioning impacts there are a number of national, regional and local initiatives involving the Scottish Government, regional and local development agencies and the Caithness and North Sutherland Regeneration Partnership with the aim to work towards enhanced skills training, supply chain enhancement, and support for business improvement working in the marine renewables industry, including Caithness. These will assist in realising and maximising the opportunities in the local and wider areas and where appropriate MeyGen will support these initiatives.
Impact 21.12: Wider tourism impacts during decommissioning	Decommissioning	· Consultation with local businesses to manage traffic flows during major events. · For the potential positive decommissioning impacts mitigation as above for economic impacts will increase the likelihood of occurrence.
Impact 21.13: Recreation impacts during decommissioning	Decommissioning	· Consultation with local businesses to manage traffic flows during major events. · Temporary interruption of recreation routes during construction will be carefully managed and any diversions clearly sign-posted; information on construction works circulated to recreational businesses. · During the temporary HDD activities, screening measures may be implemented to reduce impacts on passing recreational users or from recreational focal points. · Marine Safety Information broadcasts will be issued by HM Coastguard to inform mariners of the activity at the MeyGen site. · The Project will be depicted on Admiralty Charts produced by UKHO. · Navtex and Notice to Mariners will be issued including details of MeyGen works. · Information on the work activity at the site will be circulated directly to local ports, ferry operators and recreational clubs and businesses.
		Onshore Transport and Access
Impact 22.1: Road traffic congestion associated with PCC site	Construction	· During the onshore construction phase Project contractors will preferentially use the A836. · Liaison with the local community and users of the area regarding overall construction activities such as details of types, levels, timing and routing of traffic will help to reduce the sensitivity of the receptors to change. · The layout of the site has a large pull in area for large vehicles to avoid blocking the road.

IMPACT	DEVELOPMENT STAGE	PROPOSED MITIGATION
		· The large deliveries will be planned and marshalled so they so not coincide with each other and to avoid the peak traffic times on the local roads infrastructure. · A member of the construction management team will liaise and co-ordinate with the local community to ensure that deliveries do not coincide with significant local events. · The construction team will publicise when deliveries using large or slow moving equipment is planned to inform local road users.
Impact 22.2: Alteration of Road traffic congestion during cable installation	Construction	· The local community will be kept informed of when and where restrictions in traffic flow during cable installation and construction of the permanent access road to the PCC will occur, and identify measures to limit restrictions
Impact 22.3: Road traffic congestion associated with transport of offshore components to assembly site	Construction	· A range of traffic management mitigation measures will be adopted: · If turbine components are to be transported to the Caithness area by road, a traffic management plan should be developed in discussion with Transport Scotland and Transerv who is responsible for the management of the north west Scotland trunk road network as well as the local communities along the proposed route. The traffic management plan will include provision for: · Deliveries using large or slow moving equipment will be planned to avoid peak traffic times · Deliveries using large or slow moving equipment will be planned so they do not coincide with each other. · The operations team will publicise when deliveries using large or slow moving equipment is planned to inform local road users and communities along the route.
		Onshore Noise and Dust Impacts
Impact 23.3 - Horizontal Directional Drilling noise	Construction	· Submission of CEMP detailing predicted HDD noise levels and mitigation measures to be used. · Installation of noise control engineering measures to rig and ancillary equipment. · Use of enclosures, barriers and baffle mounds. · Noise limit of 45 dB LAeq and 60 dB LAFmax for night-time drilling operations at the nearest noise sensitive receptor.

IMPACT	DEVELOPMENT STAGE	PROPOSED MITIGATION
Impact 23.4 – Impacts due to airborne dust during construction	Construction	· Submission of CEMP detailing measures to ensure dust emissions are kept to a minimum.
Impact 23.4 – PCC operational noise	Operation	· Use of acoustic materials to clad the PCC buildings. · Acoustically absorbent lining on inner façade of building. · Installation of acoustic louvers for building ventilation. · Orientation of PCC buildings so that any vent extracts point away from noise sensitive properties.
		Accidental Events
Impact 24.1: Oil spills from vessels	Construction	· Despite no significant impact being identified, mitigation measures are still proposed due to the potential consequence of events. · Vessels associated with all Project operations will comply with IMO/MCA codes for prevention of oil pollution and any vessels over 400GT will have onboard SOPEP's. · Vessels associated with all Project operations will carry onboard oil and chemical spill mop up kits. · Where possible vessels with a proven track record for operating in similar conditions will be employed. · Vessel activities associated with installation, operation, routine maintenance and decommissioning will occur in suitable conditions to reduce the chance of an oil spill resulting from the influence of unfavourable weather conditions.
Impact 24.2: Leaks/pollution during support structure installation	Construction	· Operations will only take place during suitable weather windows. · Vessels over 400GT will have onboard SOPEP's that will be activated in the event of any pollution incident. · Only recognised marine standard fluids and substances will be used in the drilling equipment. · Consideration will be given to CIRIA guidance on the use of concrete in maritime engineering – a good practice guide. · A fibre optic cable will be used to monitor the level of cement, when the cement reaches seabed level pumping of cement will cease immediately. · During cementing operations the cement will be separated from the open sea conductor casing which is only removed once the cement has reached sufficient strength to withstand current forces.

IMPACT	DEVELOPMENT STAGE	PROPOSED MITIGATION
		· Dry cement will be stored in strong bags made of appropriate material to avoid loss of any kind; empty bags will be stored in an appropriate container and disposed of accordingly onshore.
Impact 24.3: Vehicles associated with onshore construction	Construction	· All vehicles used will have up to date MOTs and will be operated by suitably qualified personnel. · Due attention will be given to weather conditions and appropriate action will be taken i.e. vehicles will not be used when the weather is deemed to present dangerous conditions e.g. severe ice and snow. · The plan for the construction phase will take into the account the capacity of the local road network.
Impact 24.4: Total loss of inventory from Horizontal Direction Drill boreholes	Construction	· In the event of any unplanned discharge to sea during HDD activities, the drilling contractor would activate its emergency response plan to ensure discharges were minimised.
Impact 24.5: Leak of fluid from turbines	Operation	· Only recognised marine standard fluids and substances will be used in the turbine hydraulic systems. · Hydraulic fluids will be mostly water based, biodegradable and be of low aquatic toxicity. · Turbine sensors will detect loss of fluid pressure and leaks; enabling maintenance operatives to reduce the risk of further leaks.
Impact 24.6: Fire risk at PCC	Operation	· The design of the building which be such to allow good ventilation. · Due regard will be given to the Fire Safety Scotland (Regulations) 2006 and Part 3 of the Fire Scotland Act 2005 which details the provision for fire safety in non domestic premises. · Alarms and fire detection measures will be included in the design of the PCC. · A fire risk assessment should be carried out for the PCC. · In regard to the storage of fuel, SEPA PP2 'above ground storage tanks' will be followed. In particular the fuel tank will be chosen and positioned with fire risk in mind and will be located with sufficient space around it or a physical fire barrier. The base will also be suitably designed as to minimise fire risk. · The power conversion equipment will be water or air cooled to avoid overheating and will contain very little combustible material. The equipment will be self-extinguishing and a fire/smoke alarm system will be installed in each power conversion container. · Industry standard switches will be used to turn off source of energy in the event of fire detection and there will be a container provided fire and smoke containment.

IMPACT	DEVELOPMENT STAGE	PROPOSED MITIGATION
		· The transformer is F1 certified and meets standard IEC 60076-11. A vacuum cast dry type transformer (significantly lower risk of fire compared to oil filled transformers) will be used. The transformers will be self-extinguishing. · The gas insulated switch gear (virtually no fire risk) meets requirements of standard IEC 60694.