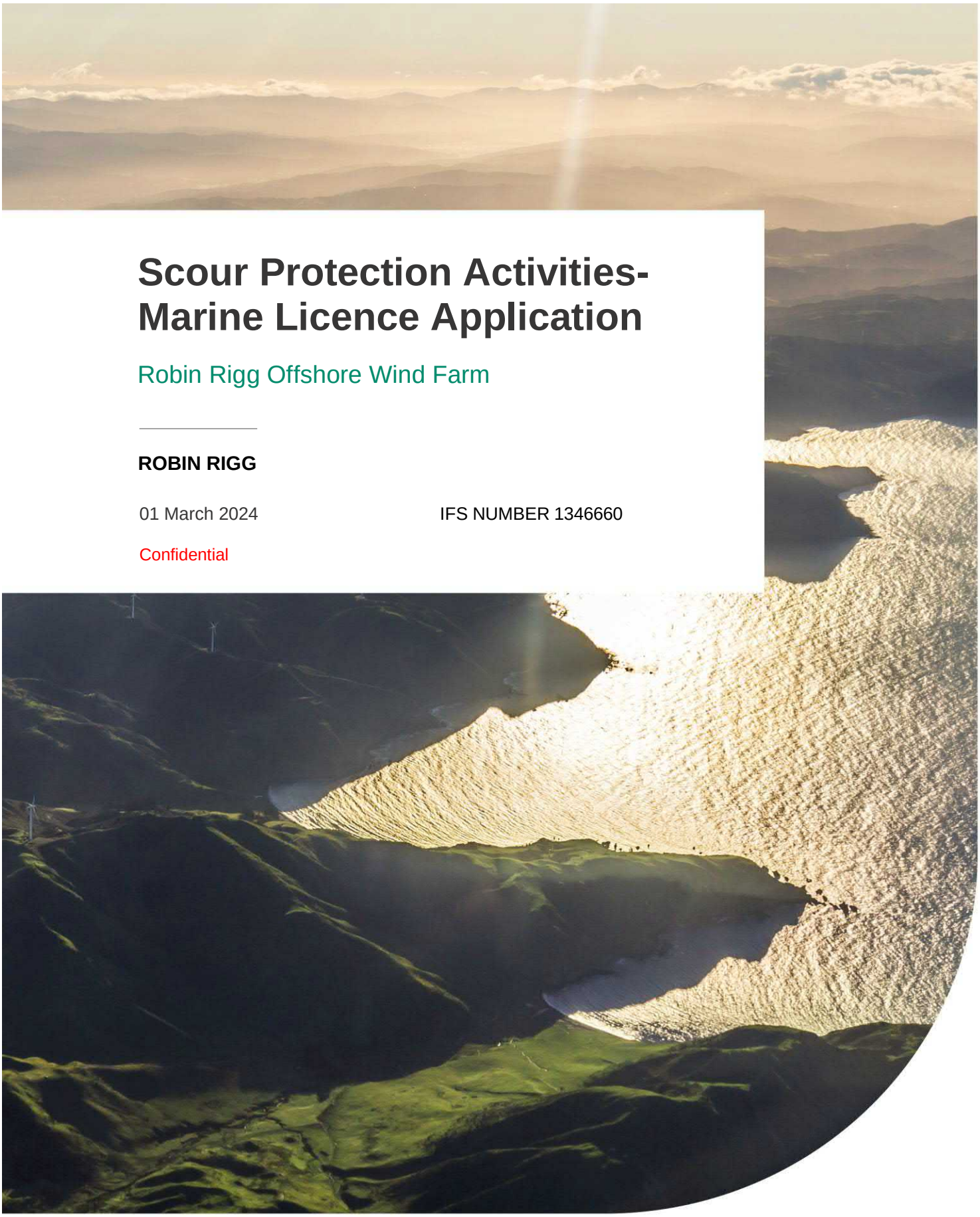

Scour Protection Activities- Marine Licence Application

Robin Rigg Offshore Wind Farm

ROBIN RIGG

01 March 2024

IFS NUMBER 1346660

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Document history

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Issue	Date	Revision Details
A	22/01/2024	Issue to Client
B	01/03/2024	Addressing Client Comments

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Contents

Acronyms and Abbreviations

Acronym	Term
AA	Appropriate Assessment
BS	British Standard
CD	Chart datum
EIA	Environmental Impact Assessment
EMS	European Marine Site
EPS	European Protected Species
ERP	Emergency Response Plan
ES	Environmental Statement
GFT	Galloway Fishery Trust
HRA	Habitat Regulations Appraisal
JNCC	Joint Nature Conservation Committee
LSE	Likely Significant Effect
MBES	Multi-beam echo sounder
MCZ	Marine Conservation Zone
MEMP	Marine Environment Monitoring Programme
MP	Monopile
MSS	Marine Scotland Science
MWS	Marine Warranty Surveyor
NNR	National Nature Reserve
OWF	Offshore Wind Farm
PTS	Permanent Threshold Shift
RRMG	Robin Rigg Management Group
RWE	RWE Renewables UK
SAC	Special Area of Conservation
SCM	Site Condition Monitoring
SNH	Scottish Natural Heritage (Now NatureScot)
SPA	Special Protection Area
SPL	Sound pressure level
SSC	Suspended sediment concentration
SSDV	Side stone dumping installation vessel
SSSI	Sites of Special Scientific Interest
ULS	Ultimate limit state
WFD	Water Framework Directive
WTG	Wind Turbine Generator

1. Introduction

RWE Renewables UK (RWE) is applying for a Marine Licence to install scour protection at two Wind Turbine Generators (WTGs); B4 and C4, at the Robin Rigg Offshore Wind Farm (OWF).

Robin Rigg OWF consists of 58 MHI-Vestas V90 3MW WTGs and two offshore substations. The wind farm was constructed on the Robin Rigg sandbank in the Solway Firth. The seabed sediment conditions in the majority of the wind farm comprise a thick layer of sand on top of varying layers of clay and sand. The Robin Rigg sandbank is in a tidal channel with strong currents resulting in a highly mobile seabed.

Due to the mobile nature of the sediment that supports the foundations of turbines, the northern region of the site has been subject to a global lowering of the seabed. Consequently, extensive scouring has occurred around some of the turbines which has required remedial action. In 2015, a successful Marine Licence application was acquired to decommission two turbines (A1 and B1) that had been destabilised from lowering of the seabed and scouring. Further Marine Licence applications were granted for scour protection work at five turbines (A2, B1, B2, C1 and D1) in 2016 and four turbines in 2018 (B3, C2, C3 and remedial work at A2) as well as adding rock filled nets/bags to provide cable support at the offshore substation locations.

RWE has now identified scour protection requirements at two additional turbine locations (B4 and C4). This Marine Licence application considers a worst case scenario for the requirement of substantial scour protection (using maximum rock placement figures from previous scour protection undertaken at Robin Rigg in 2016 and 2018) at both turbines. As rock placement has thus far proved the most effective mitigation for scour at this site, the scour protection methods for both turbine locations will be rock placement.

It is imperative that this work is completed as soon as possible in 2024 and the foundation structures are not exposed to ongoing tidal action and subsequent scour mechanisms. Annual bathymetric surveys have indicated scouring on the effected turbines might be up to -21 m. If scour levels deteriorate further, WTGs are at risk from falling below safe operational level.

1.1. Scope of this Document

This document provides a summary on the baseline conditions in the Solway Firth regarding key ecological receptors, a summary on the Environmental Impact Assessment (EIA) predictions taken from the Environmental Statement (ES), along with the results of monitoring to validate predictions made in the ES. In addition, information is provided to contextualise the potential impacts of the scour protection proposed at each of the WTGs.

The report is structured to provide the following information:

Section 2 – Proposed works: information on the Project and the proposed works for which approval is sought i.e. installation of scour protection.

Section 3 – Environmental Appraisal: marine receptors taken forward for appraisal based on the potential for an interaction pathway with the proposed works. It draws upon the relevant assessments and mitigations presented in the previous two Scour Protection Impact Assessment (Natural Power 2018, Natural Power 2016) with reference to the original Environmental Statement (Natural Power, 2002).

Section 4 – Habitat Regulations Appraisal (HRA) providing detail on European Designated sites in relation to the predicted impacts.

Section 5 – Water Framework Directive (WFD) Assessment

Section 6 – Summary and Conclusions

2. Project Description

2.1. Overview

The Robin Rigg OWF in the Solway Firth is operated by RWE and was the first commercial OWF in Scottish waters. The site is made up of two Round 1 OWFs, Robin Rigg OWF East and Robin Rigg OWF West, comprised originally of 60 three megawatt Vestas turbines and two offshore sub-stations. There are 62 monopile (MP) foundations, each typically extending 30 m or 40 m into the seabed. Construction of the Robin Rigg OWF and associated cabling began in December 2007 and the site became fully operational in April 2010. The landfall of the 14 km export cable is located in Siddick on the Cumbrian coast.

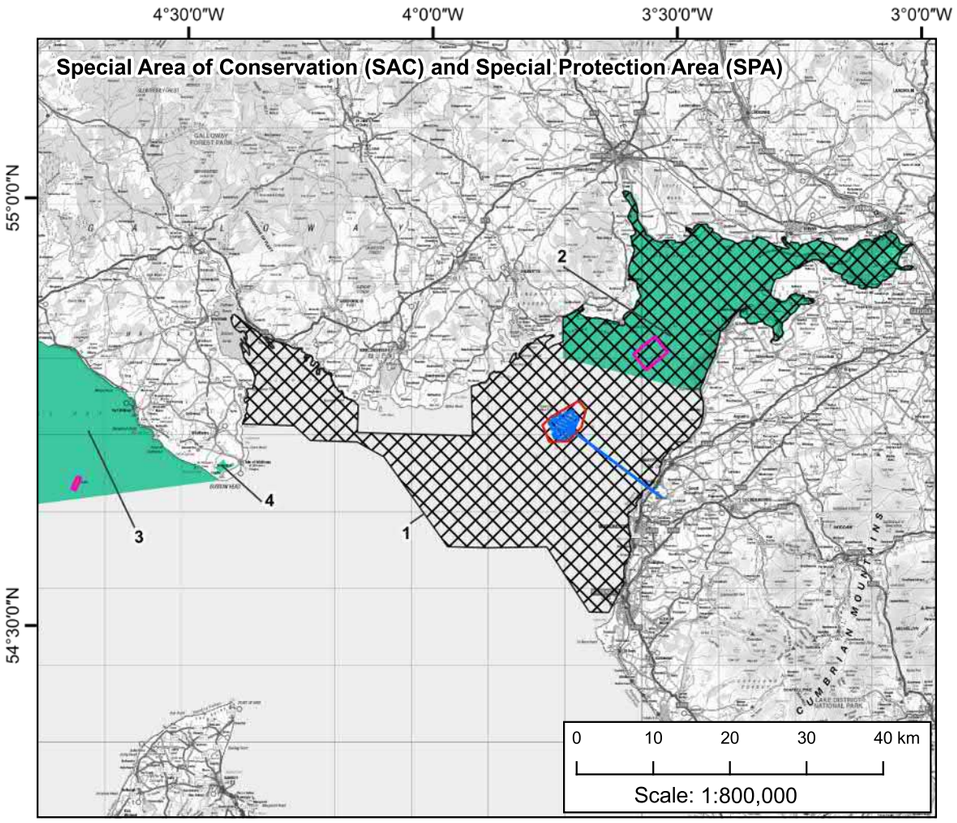
2.2. Background to the Solway Firth

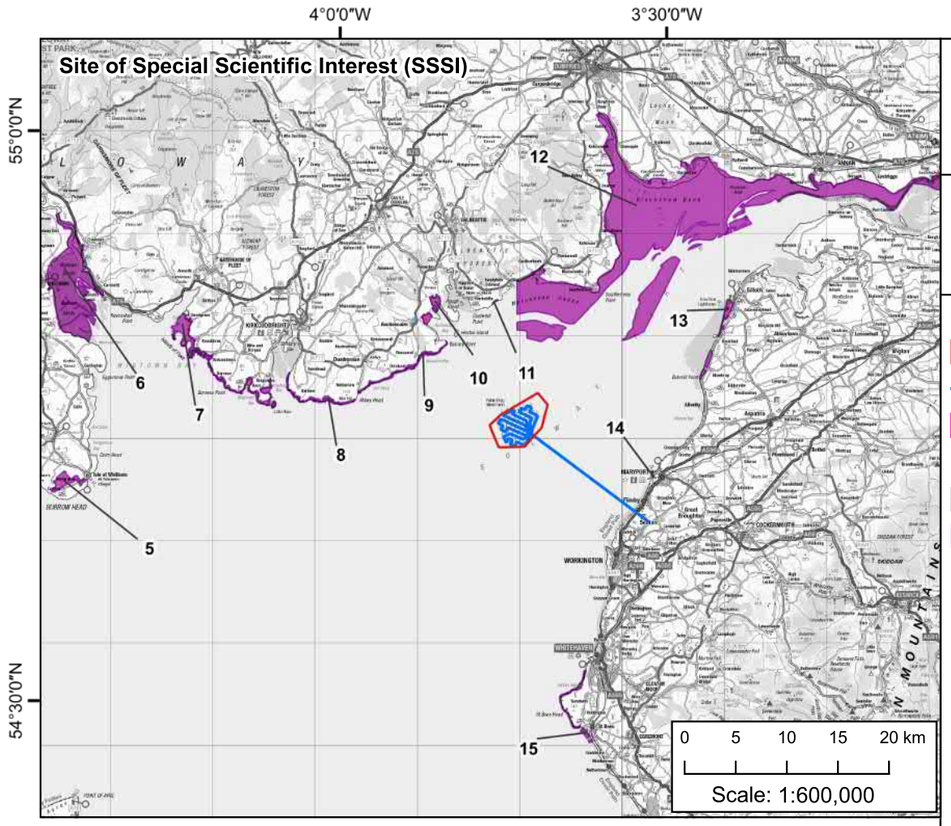
The Solway Firth in the north-eastern Irish Sea, extends from the Mull of Galloway in Scotland across to St. Bees Head on the Cumbrian coast of north-west England forming the third largest continuous area of sedimentary habitat in the country. The Solway Firth is often referred to as an estuary but actually contains six separate estuaries, namely the Inner Solway, Rough Firth and Auchencairn Bay, Dee Estuary, Water of Fleet, Cree Estuary, and Luce Bay. For the purpose of this report 'The Solway Firth' is defined as the area north of a line drawn from Workington to the Abbey Head as this is the area relevant to the location of the Robin Rigg OWF.

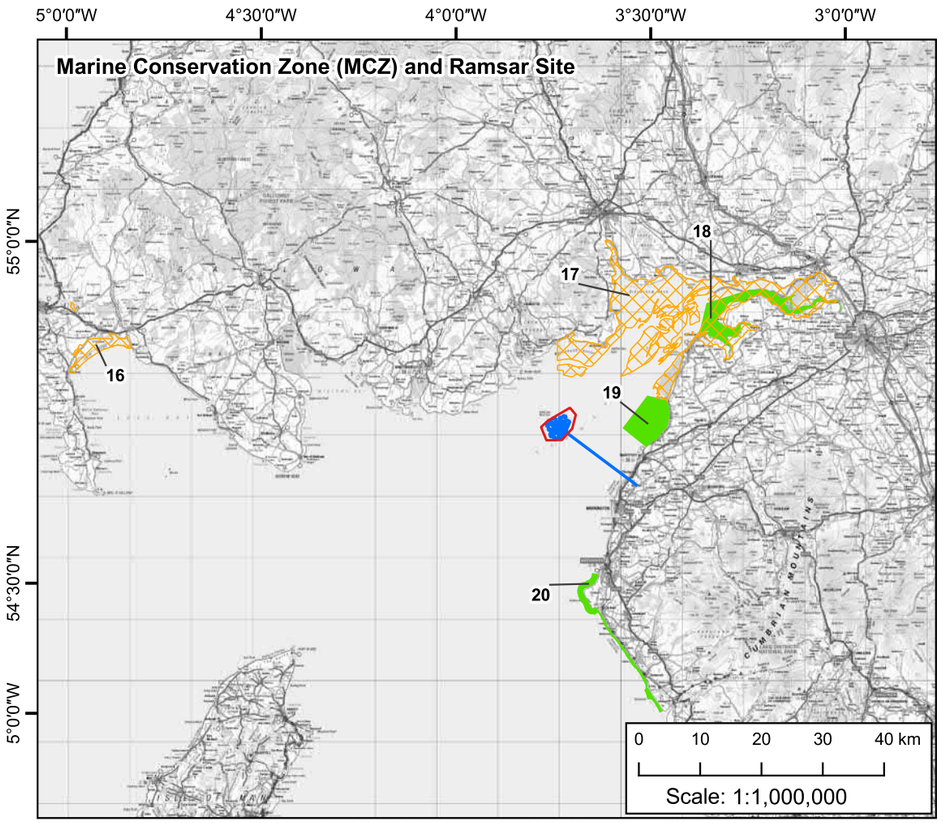
The Solway Firth is a shallow estuary and at low water much of the area of the Inner Solway dries out exposing extensive fringing beaches and sand banks. These shifting sediments of fine, muddy sand dominate both the intertidal and sublittoral zones. The subtidal area within the Solway Firth has been described as being dominated by mobile sediments brought into the area from the Irish Sea, with sedimentary movements resulting in a change of depth and sediment type.

The wind farm is located on a submerged sand bank, known as Robin Rigg. This area of the Solway is characterised by high wave exposure and moderate tidal currents (Anon, 2000), resulting in a highly dynamic environment.

The Solway Firth has long been recognised as having great environmental importance and many areas are protected by a wide variety of national and international designations (Figure 2.1). Most notably the Inner Solway Firth, to the north-east of the Robin Rigg, is designated as the Solway European Marine Site (EMS) made up of the Solway Firth Special Area of Conservation (SAC), Upper Solway Flats & Marshes Special Protection Area (SPA) and Upper Solway Flats & Marshes Ramsar site. This 44,000 ha area supports extensive intertidal mudflats and sand flats and extensive mobile subtidal sandbanks. These habitats form one of the largest continuous areas of sedimentary habitats in the UK and are of international importance. The mudflats and sand flats of the site provide important nursery and feeding grounds for commercial and recreational fish species, as well as providing a significant food source for birds (Anon, 2000). The Robin Rigg OWF also sits within the Solway Firth SPA (renamed, incorporating a marine extension of the Upper Solway Flats & Marshes Special Protection Area (SPA)), designated in December 2020 to protect internationally important bird populations including non-breeding red-throated diver (*Gavia stellata*), common scoter (*Melanitta nigra*) and goosander (*Mergus merganser*). There are also a number of coastal Sites of Special Scientific Interest (SSSI) and Marine Conservation Zones (MCZ) in the Solway Firth in the vicinity of the Robin Rigg OWF.







Designated Sites:

1 - Solway Firth (SPA)
2 - Solway Firth (SAC)
3 - Luce Bay and Sands (SAC)
4 - Burrow Head (SAC)
5 - Burrow Head (SSSI)
6 - Cree Estuary (SSSI)
7 - Borgue Coast (SSSI)
8 - Torrs to Mason's Walk (SSSI)
9 - Abbey Burn Foot to Balcary Point (SSSI)
10 - Auchencairn and Orchardton Bays (SSSI)
11 - Port O'Warren (SSSI)
12 - Upper Solway Flats and Marshes (SSSI)
13 - Silloth Dunes and Mawbray Bank (SSSI)
14 - Maryport Harbour (SSSI)
15 - St. Bees Head (SSSI)
16 - Loch of Inch and Torrs Warren (Ramsar Site)
17 - Upper Solway Flats and Marshes (Ramsar Site)
18 - Solway Firth (MCZ)
19 - Allonby Bay (MCZ)
20 - Cumbria Coast (MCZ)

Project:

Robin Rigg Offshore Wind Farm

Title:

Figure 2.1: Designated Sites in the Solway Firth

Key

- Site boundary
- Array cabling and export cable route
- Designated seal haul-out site
- Special Area of Conservation (SAC)
- Special Protection Area (SPA)
- Site of Special Scientific Interest (SSSI)
- Marine Conservation Zone (MCZ)
- Ramsar

Map projection: British National Grid
Graticules: WGS 84

N

Date: 15-02-24	Prepared by: LH	Checked by: CW
Ref: GB200112_M_444_A		

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2.3. Proposed Works

2.3.1. Need for Scour Protection Works

The northern part of Robin Rigg OWF has suffered extensive seabed lowering, due to the sandbank moving in a southerly direction. Following work regarding the seabed movements within the wind farm, together with structural analysis of wind turbine foundation structures under existing environmental conditions, turbines A1 and B1 were decommissioned in 2015. After decommissioning, the transition piece at B1 remains as a cable joint platform, whilst the whole structure including the monopile was removed at A1 within licencing parameters. In 2016, five turbine locations A2, B1, B2, C1 and D1 were identified as requiring scour protection to prevent further lowering of the seabed leading to potential drops in natural frequency of the turbines that would fall below the WTG manufacturers operational limits. In 2018, three turbine locations B3, C2 and C3 were identified as requiring scour protection and some remedial works were undertaken at turbine A2 where some secondary scour had occurred around the previous rock bag installation.

Routine bathymetric studies undertaken on site have now identified that further scouring has taken place at a further two turbine locations; B4 (54º45.867' N, 3º41.394 W) and C4 (54º45.733'N, 3º41.928'W). The lowering of the seabed at these turbines has resulted in the monopile embedment depth reducing significantly (up to -21 m). This means the remaining embedment is significantly below design limits and an engineering risk assessment is currently in place to ensure the continued operation of the turbines and specifically B4. The extent of the scouring is monitored through regular bathymetric surveying, and this monitoring alongside the measurement of the structures natural frequency, deems this work as urgent. As such, these scour protection works are considered to be critical for the continued safe operation of these turbines.

Figure 2.2 illustrates the location of the Robin Rigg OWF in the Solway Firth and highlights where the scour protection activities will occur.

Similar to the scour protection work undertaken in 2018, it has been determined that loose rock scour protection is best utilised during this campaign. Taking a precautionary approach, it is assumed that the largest quantity of rock used for scour protection in the 2018 scour protection works (13,350 tonnes, 5,000 m^3)[1] will be required for each turbine in the proposed works. However, the installation methodology to undertake this work is currently unknown. Consequently, two potential installation methodologies are provided here which are then used to identify the worst-case scenario for the scour protection works:

- **Installation Method Option 1:** The same methodology used the 2018 scour protection works which involves the use of two bulk carriers and single side stone dumping installation vessel (SSDV).
- **Installation Method Option 2:** Using a single large installation vessel with an excavator on board to load and unload rock, avoiding the need for bulk carriers.

It is believed that these two installation methodologies are representative for the scour protection works, although there is the potential that alternative methodology options may be used. The major difference between installation methods is the number, type and size of the vessels used to undertake the works. Consequently, the vessels and vessel movements of the two installation methods outlined (Option 1 and Option 2) are compared in section 2.3.1.1 of this report where the worst-case scenario out of the two options is identified. This worst-case scenario will then be taken forward as the representative example of the works in assessments as part of this Marine Licence Application.

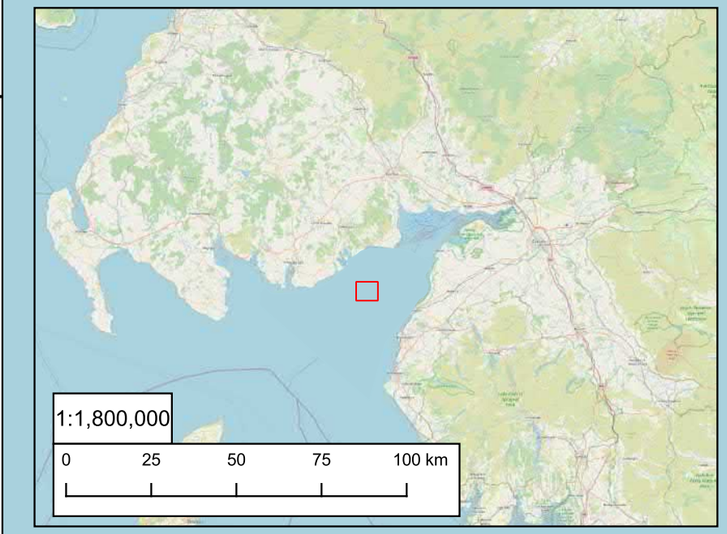
[1] Volumes and weights presented are inclusive of a 5% contingency.

3°45'W

3°42'W

54°47'N

54°45'N



B4

C4

Project:

Robin Rigg Offshore Wind Farm

Title:

Figure 2.2: Extent of Scour Protection Installation Activities

Key

- Site boundary
- Turbines requiring scour protection
- Extent of scour protection (30m)
- Interarray cabling

Scale @ A3: 1:21,000

Coordinate System: WGS84 UTM Zone 30N
Graticules: WGS84

0 300 600 900 1,200 m

N

Date: 01-03-24	Prepared by: JO	Checked by: VR
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2.3.1.1. Vessels and Vessel Movements

Installation Method Option 1

If the same methodology for rock placement as the 2018 scour protection works is chosen then the works are anticipated to require a modified SSDV, with a hold capacity of 1,820 tonnes, and two bulk carriers, with a maximum hold capacity of 5,490 m^3, to complete. Note, the smallest vessel hold capacity specification for the bulk carrier vessels is 4,650 m^3 which is considered as a worst-case. Therefore, the number of trips required by the vessel will not be limited to hold size and carrying materials but will be dictated by the speed of installation at each WTG, as well as weather and tidal conditions.

Vessels will mobilise from their home ports to meet at the Robin Rigg site where the SSDV will undertake the actual rock placement installation activity, travelling to and from the bulk carriers in order to resupply with rock. The bulk carriers (worst case length overall is that each vessel is 95 m) will anchor (five anchor spread as worst case) at an agreed location on the periphery of the northwestern end of Robin Rigg OWF.

The vessel-to-vessel material transfer will take place at these locations in close proximity to the Robin Rigg OWF in order to minimise the SSDV transit times. The material will be transferred from a bulk carrier vessel directly onto the main SSDV (worst case length overall 95 m) in this operation. For loading, the SSDV will position alongside and hold that position using dynamic positioning for the duration it takes for the loading of one bay. When one bay is completed, the SSDV turns around and presents the two empty bays opposite of the first one for loading. This specific sequence for loading of the bays should be followed to avoid having too much list.

As one bulk carrier vessel is depleted by the SSDV, it will be replaced by the other bulk carrier which will arrive with a full load at site. As such, it is anticipated that as a worst-case scenario for assessment purposes, three vessels may be on site at any one time. However, it is more likely that only one bulk carrier and the SSDV will be present at any one time.

Vessel Movements

Vessels are not expected to travel at speeds greater than 13.5 knots. Based on the conservative estimate of rock required for both of the turbines combined of 26,700 tonnes / 10,000 m^3, and the bulk vessel hold capacity of 4,650m^3, the maximum worst case number of vessel movements (including arrivals and departures) used for assessments is six bulk carrier movements (the hold capacity volume should accommodate enough rock for both turbines in three trips to and from site) and 32 SSDV movements on site resupplying and undertaking rock placement (the hold capacity of 1,820 tonnes of the SSDV can accommodate the 26,700 tonnes of rock for both turbines in 15 trips to and from the bulk carriers and the two trips during arrival and departure from site as a worst case).

As such, the scour protection installation works are to be completed with a worst-case maximum of 38 vessel movements using this methodology.

Installation Method Option 2

An alternative installation methodology would involve using a single installation vessel with a hold capacity of 4,200 tonnes. This installation vessel will have an excavator mounted in the middle of the hopper. This is used to load the vessel with rock at the quarry as well as to feed the fall pipe feeder system with rock at the site. There is therefore no requirement for bulk vessels with this methodology.

Vessel Movements

The installation vessel is not expected to travel at speeds greater than 13.5 knots. Based on the conservative estimate of rock required for both of the turbines combined of 26,700 tonnes / 10,000 m^3, and the installation vessel hold capacity of 4,200 tonnes, the maximum worst case number of vessel movements (including arrivals and departures) used for assessments is 14 vessel movements (the hold capacity volume should accommodate enough rock for both turbines in seven trips to and from the site).

Considering the vessel movements required from these two installation methods **Installation Method Option 1** is identified as the **worst-case scenario** for the scour protection works. Therefore, this installation method has been taken forward as the representative example of the works in the environmental assessments as part of this Marine Licence Application.

2.3.1.2. Installation Methods (indicative)

Placing of scour material will be undertaken at low tide and high tide slack water. The rock size used will be based on methods developed for protection of monopiles against erosion. All rock will meet BS Standards and will be suitable for use as a cover layer and will be of density and shape to be as resistant to wear, breakage and water absorption as possible.

The Installation vessel will maintain position next to the turbine monopole by dynamic positioning in drift off/drift by conditions when the combined effect of prevailing wind/tidal flows push the vessel away from the foundation without risk of contact. The installation method and circular design around the monopiles will result in overlap in dumping areas. Rock will be placed in the existing scour hole (and in some cases, where required, on the surrounding bed to provide a falling apron for potential edge scour and seabed degradation), therefore there will be no need to carry out further excavation work to the scour hole. Where used, the excavator has a grab-positioning system by which it can take rock from the deck of the SSDV and install it on the seabed. The grab of the excavator can reach approximately 12 meters underwater. Subsequently the rocks would be dropped from a vertical distance. The distance depends on the height of the tide.

The rock will be placed at least 1.25 m thick out to a radius of up to 30 m. As such, a worst case of 30 m radius from the monopile is being used within the impact assessments presented in Section 0 of this document.

No scour protection material will be placed above the surrounding seabed level. The top level of the scour protection shall not extend above -2.0m chart datum (CD).

2.3.2. Positioning and Anchoring

The Marine Warranty Surveyor (MWS) requirements at Robin Rigg dictate that use of a Class 2 dynamic positioning system be used. Class 1 dynamic positioning is acceptable under drift off conditions. For the worst-case scenario of Installation Method Option 1 the SSDV will likely only use dynamic positioning with no anchor requirements within the OWF boundary. The bulk carriers will not be allowed with the OWF boundary and will instead be anchored outside the Robin Rigg site with a five-anchor spread.

2.3.3. Out-survey Works

For the worst-case scenario of Installation Method Option 1 the process of unloading and installation is monitored using multibeam hardware and software, the use of which enables the accurate charting of the volumes of material placed at each location. The multibeam and vessel positioning system will log the required volume to be unloaded at each location, and after side dumping is complete, the crane-driver will unload each excavator grab level with the surrounding seabed making sure that the material has a fall through the water allowing it to settle in a homogenous way. This will avoid piles of stone and instead ensure the material will create a relatively flat surface. After rock placement, a bathymetric out-survey will be undertaken:

- to document the final level and the extent of the scour protection; and
- to be able to adjust the quantities and unloading techniques to create the best possible result.

The specifications of the multibeam sonar are as shown in Table 2.1.

Table 2.1: Multibeam sonar specifications

Equipment	Purpose	Frequency	Source Pressure Level @ 1m	Sound Exposure Level @ 1 m	Pulse Rate Repetition
Multi Beam Echo Sounder	Bathymetric mapping	200kHz – 400 kHz	218dB re 1μPa	194dB re 1μPa^{2}s (400kHz)	Max. 40 Hz

2.3.4. Monitoring and Maintenance

Scour protection is expected to be hydraulically stable during the Ultimate Limit State (ULS), which is the process associated whereby consideration of large or severe rare events are modelled[2]. In 2016, scour protection monitors were installed to ensure that once installed, and throughout the life of the installation, they do remain stable. No such scour monitor installation was undertaken as part of the 2018 scour protection campaign, and it is unlikely they will be for this work.

Given the mobile nature of sediment and the seabed within the Solway Firth it is difficult to predict how scour protection at each location will perform *in-situ*. The design for scour protection has been based on considerable research, modelling, and previous experience of installation at this site, however, *in-situ* conditions can vary considerably. As such, the current monitoring of scour protection on site will inform the requirement of any potential maintenance requirements.

Subject to the results of ongoing monitoring, it is anticipated that there may be a requirement for a maintenance work to be undertaken during the 12 months post installation, until the scour protection is fully embedded into the scour hole. Due to the highly mobile seabed, and potential for some small-scale movements of scour protection material within the areas where scour protection is required, some minor repositioning of material may be required during this initial 12 months following installation. Durations of any such remedial work are not predicted to exceed the duration of the initial planned work and are unlikely to occur more than twice in the defined maintenance period (i.e. 12 months following installation).

2.3.5. Decommissioning Works

These works will be decommissioned along with the Robin Rigg OWF (Section 36 consent currently expires on 15th June 2032), and this will be documented in the decommissioning methodology that will be written ahead of the decommissioning of the wind farm. The impacts of decommissioning the scour protection are predicted to result in fewer significant effects on receptor groups than the installation of the material.

2.3.6. Programme and Timing

The main installation works are planned to take place in 2024, with exact dates and timelines unknown. The Project requires flexibility in the timings, however, it is likely to be during Q2 or Q3, with periodic validation of *in-situ* performance over a subsequent 12-month period, although this cannot be confirmed at the time of application.

For the worst-case scenario of Installation Method Option 1, considering installation time and weather/tidal down time, the onsite works are expected to take up to five working days at each monopile location as a worst case (based of the 2018 scour protection works). As such, for the purposes of assessment, the duration of the installation works is assumed to be up to two weeks as a worst-case scenario, compensating for reasonable weather downtime.

[2] Designed to withstand rare tidal and storm induced water flow rates.

2.4. Approach to Assessment

The approach to assessment is to consider the potential impacts resulting from installing scour protection at two WTGs at the Robin Rigg OWF to support a new Marine Licence application.

If a route to impact exists, then impacts will be screened in, and additional assessment will be undertaken. The effects and any additional mitigation will be considered and identified.

2.4.1. Activities Requiring Further Assessment

The following Worst Case Scenario information based upon Installation Method Option 1 (Table 2.2) has been identified for each of the different work activities. The information contained within this table provides the detail to inform the impact assessment.

Table 2.2: Summary of worst case scenario information from Installation Method Option 1 that the impact assessment has been carried out on.

Activity	Detail	Where assessed
Vessel movements	Estimated 38 vessels movements to deliver material to site via two bulk carriers and one installation (SSDV) vessel	Statements on Marine Mammals and Birds
Installation of scour protection	The installation of rock scour protection has potential for impacts, therefore assessments have been considered	Statements on Benthos, Fish and Shellfish, Migratory fish, Marine Mammals and Birds
Out-survey	Use of a multibeam echo sounder	EPS Risk Assessment
Maintenance	Use of a multibeam echo sounder and potential maintenance of protection material	Statements on Benthos, Fish and Shellfish, Migratory fish, Marine Mammals, Birds, and EPS Risk Assessment

3. Environmental Appraisal

3.1. Overview

This section presents the environmental topics taken forward for appraisal based on the potential for an impact pathway with the scour protection installation at up to two turbines at the Robin Rigg OWF based upon the worst-case scenario of Installation Method Option 1. It draws upon the relevant assessments and mitigations presented in the Environmental Statement (ES) (Natural Power, 2002) and the conclusions made from the previous scour protection works in 2016 (Natural Power, 2016), and 2018 (Natural Power, 2018).

Each receptor has been screened 'in' or 'out' of the Environmental Summary Report in section 3.2 based on the potential for the scour protection works to impact it. Each receptor 'screened in' is assessed further in the environmental appraisal (sections 3.3-3.7) where the potential effects are deemed to be either **significant** or **not significant.** A significant effect is defined here as one that alters the functional processes / services of the receptor out with the normal variation expected for that receptor over the timeframe of the proposed work (2 weeks, weather dependant).

3.2. Screening of Receptors and Potential Impacts

Table 3.1 screens each of the possible marine receptor topics to be considered as part of the Environmental Summary Report to support the Marine Licence Application in respect of the installation of scour protection at two turbines at the Robin Rigg OWF.

Table 3.1: Screening of Receptors for Proposed Works

Receptor	Installation of scour protection
Physical Processes	The current conditions of the two wind turbines, with significant scouring, has the potential to lead to changes in hydrodynamics due to changes in the topography of the seabed. Scour protection work will likely reverse this impact. There is the potential for very localised impacts from the scour protection works on physical processes (wave action, tidal action and sediment transport) through the introduction of a hard substrate (rock) into a soft sediment habitat (sand). However, this will likely be on a very small scale and would not exceed the impacts expected during average sea conditions experienced regularly on Robin Rigg. Therefore, there is no potential for additional impacts on physical processes and this receptor is **screened out** for further assessment.
Benthic Ecology	The installation of rock scour protection has the potential to result in changes in benthic habitats. There is also the potential for an increase in sediment disturbance in the wind farm area. The introduction of a new substrate has the potential to change the overall functionality of the seabed through: • Temporary increase in suspended sediment concentrations (SSC); • Loss of and/or disturbance to subtidal benthic habitats due to placement of hard substrates on a predominantly sandy substrate. Therefore, there is the potential (albeit negligible) for impacts on benthic ecology and it is **screened in** for further assessment.

Receptor	Installation of scour protection
Fish and Shellfish	The installation of rock scour protection has the potential to result in direct disturbance of species in UK territorial waters, and changes to the sediment and therefore habitat which can influence availability of specific sediment important to key life history stages. The introduction of a new substrate has the potential to change the overall functionality of the seabed through: • Physical disturbance to and/or loss of fish and shellfish habitats due to placement of hard substrates on a predominantly sandy substrate; • Temporary increase in suspended sediment concentrations (SSC). There is also likely to be noise effects on fish and shellfish from the scour installation works. Therefore, there is the potential (albeit negligible) for impacts on fish and shellfish and it is **screened in** for further assessment.
Migratory Fish	The installation of rock scour protection has the potential to result in direct disturbance of migratory fish species in UK territorial waters, and changes to the sediment and therefore habitat in the wind farm area. The introduction of a new substrate has the potential to change the overall functionality of the seabed through: • Physical disturbance to and/or loss of migratory fish habitat due to placement of hard substrates on a predominantly sandy substrate; • Temporary increase in suspended sediment concentrations (SSC). There is also likely to be physiological and behavioural effects of underwater noise and vibration on migratory fish from the scour installation works. Therefore, there is the potential (albeit negligible) for impacts on migratory fish and it is **screened in** for further assessment.
Marine Mammals	The installation of rock scour protection has the potential to result in auditory injury or disturbance to marine mammals in the vicinity of the wind farm area. Potentially harmful anthropogenic noise may come from: – Geophysical survey systems (multi-beam echosounder (MBES)) used during the scour protection installation; – Rock placement; – Vessels. There is also the possibility of collision risk with vessels as part of the scour protection works. Therefore, there is the potential for impacts on marine mammals and it is **screened in** for further assessment.
Birds	The installation of rock scour protection has the potential to result in increased levels of disturbance causing some displacement of birds in the vicinity of the wind farm area. The Solway Firth area is home to several nationally and internationally important bird populations. The level of disturbance on these bird populations will be dependant on the length of the planned work (2 weeks, weather dependant), the sensitivity of the species to disturbance and the timing of the

Receptor	Installation of scour protection
	planned work (Q2 or Q3, 2024). It is likely that some bird species will have a higher level of disturbance than others and it will be necessary to assess them individually. Therefore, there is the potential for impacts on birds and it is **screened in** for further assessment.
Human Uses	The scour protection work has the potential to impact commercial fishery operations, commercial shipping and recreational sailing in the Solway Firth area. The likely impacts for the proposed work will come from: - Potential disturbance impacts during the installation of scour protection; - Potential disturbance of additional vessel movements within the area. However, due to the short timeframe of the work (2 weeks, weather dependant) and the low number of predicted vessel movements (38) it is predicted that there will be negligible impacts of the works on commercial fishing, commercial shipping and recreational sailing. In addition, the effects of the proposed installation works will be considerably less than those that were predicted and experienced during the construction phase of the wind farm which predicted no significant effects on human uses. Therefore, there is no potential for significant impacts on human uses and this receptor is **screened out** for further assessment.

3.3. Benthic Ecology

Due to the status of the Inner Solway as an SAC there have been a number of studies describing the benthic ecology of the qualifying interest features. However, prior to 2001, areas outside the SAC were less well studied (Table 3.2). An extensive benthic survey was carried out from 2001 to 2002 to characterise the site in support of the Robin Rigg OWF EIA and since consent, further surveys have conducted to monitor construction and operational impacts of the site on the benthos.

Table 3.2: Summary of the available data of the benthic environment around the Robin Rigg OWF

Study	Details	Summary
Perkins and Williams (1966)	Report on the distribution and sediment in Solway Firth	UKEA Group Report. Dominant fauna found in central Solway (around the Robin Rigg sand bank) was *Nephtys cirrosa* in clean sands.

Study	Details	Summary
Cutts and Hemingway (1996)	Broad scale habitat mapping of Solway proofed by Van Veen grabs	Report to Scottish Natural Heritage (SNH). Habitat mapping revealed low species diversity and abundance in subtidal areas to the north east of Robin Rigg dominated by *Nephtys cirrosa*, *Magelona mirabilis*, and *Bathyporeia elegans*, in a habitat predominantly made up of fine to medium sands.
Axelsson *et al*., (2006)	Grab sampling at 85 locations within the EMS in 2004	SNH site condition monitoring survey for the SAC found low species diversity and abundance throughout the site.
Robin Rigg OWF ES characterisation (Natural Power Consultants Ltd, 2002)	Grab sampling at 113 sampling stations throughout 2001	Baseline EIA survey to characterise benthic environment. Robin Rigg area represented by low number of species and individuals (*Nephtys cirrosa* and *Bathyporeia elegans*) typical of mobile estuarine environments present within mobile sandbanks.
Robin Rigg OWF Pre-construction and Construction Monitoring (Entec, 2011)	Grab sampling at 17 sampling stations bi/annually 2007 – 2011	Marine Environment Monitoring Programme (MEMP) benthic survey and data analysis. Predominant biotope found to be *Nephtys cirrosa* and *Bathyporeia* spp. *in infralittoral sand* (SS.SSa.IFiSa.NcirBat) throughout.
Robin Rigg OWF Post construction monitoring (Walls *et al*., 2013)		
Robin Rigg Decommissioning Turbine Colonisation (Natural Power Consultants Ltd, 2015)	Turbine colonisation survey of two WTGs (A1 and B1) prior to decommissioning.	Turbines A1 and B1 had been colonised by a dense aggregation of marine organisms, both in the intertidal and subtidal. Dominant species included unicellular green algae, barnacles, grazing limpets and common mussels.

The benthic surveys undertaken at the Robin Rigg OWF during the baseline, pre-construction, construction, and operational periods resulted in the collection of a total of 3796 individuals from 126 taxa (Table 3.3). The results of these surveys are consistent with other studies which have taken place in the central Solway Firth over the past 60 years (e.g. Perkins and Williams, 1966) and those which have taken place slightly further north on the subtidal sand banks of the Upper Solway SAC (Cutts and Hemingway, 1996; Axelsson *et al*., 2006), whereby grab sampling has revealed a habitat of fine to medium sands characterised by sparse communities of short lived benthic species, such as the amphipod *Bathyporeia elegans* and the polychaete *Nephtys cirrosa*, which are tolerant to sediment disturbance and adapted to living in highly mobile environments.

Table 3.3: Top 20 most abundant species samples during the benthic surveys carried out at the Robin Rigg OWF (17 sites only, 2001-2011)

Higher Taxonomic Classification	Species	Number of Individuals
Amphipod	*Bathyporeia elegans*	1123
Polychaete	*Nephtys cirrosa*	540
Polychaete	*Scalibregma inflatum*	265
Bivalve	*Angulus fabula*	169
Bivalve	*Kurtiella bidentata*	159
Polychaete	*Magelona johnstoni*	145
Cumacea	*Pseudocuma longicorne*	144
Polychaete	*Scolelepis mesnili*	107
Bivalve	*Nucula nitidosa*	91
Polychaete	*Spirobranchus lamarckii*	76
Amphipod	*Bathyporeia nana*	72
Bivalve	*Abra alba*	64
Mysid	*Gastrosaccus spinifer*	60
Bivalve	*Donax vittatus*	55
Echinoid	*Echinocardium cordatum*	51
Polychaete	*Nephtys caeca*	49
Polychaete	*Ophelia borealis*	36
Amphipod	*Bathyporeia sarsi*	28
Polychaete	*Nephtys hombergii*	26
Polychaete	*Glycera convoluta*	25

Results of the monitoring provide consistent findings in terms of biotope and species composition at the site with biotopes remaining largely similar over time (Table 3.4). The predominant biotope identified during the baseline in the area of the Robin Rigg OWF was *Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand (SS.SSa.IFiSa.NcirBat). Over the construction years there appears to have been a spatial shift in biotopes, with the biotope *Abra prismatica, Bathyporeia elegans* and polychaetes in circalittoral fine sand (SS.SSa.CFiSa.ApriBatPo) emerging, with a return to SS.SSa.IFiSa.NcirBat during the operational years.

Table 3.4: Biotopes identified at the Robin Rigg OWF 2001-2011

Baseline 2001-2002	Pre-Construction 2007	Construction Year One 2008	Construction Year Two 2009	Operational Year One 2010	Operational Year Two 2011
SS.SSa.IFiSa.NcirBat	SS.SSa.IFiSa.NcirBat	SS.SSa.IFiSa.NcirBat	SS.SSa.IFiSa.NcirBat	SS.SSa.IFiSa.NcirBat	SS.SSa.IFiSa.NcirBat
SS.SSa.IFiSa.IMoSa	SS.SSa.IFiSa.IMoSa		SS.SSa.IFiSa.IMoSa	SS.SSa.IFiSa.IMoSa	SS.SSa.IFiSa.IMoSa
SS.SSa.IMuSa					SS.SSa.IMuSa
		SS.SSa.CFiSa.ApriBatPo	SS.SSa.CFiSa.ApriBatPo		

3.3.1. ES Predictions and Validation

The following predictions (of relevance to the proposed scour protection works) were made within the ES, with respect to benthic ecology (Table 3.5).

Table 3.5: Predictions made during the ES on benthos during the construction period

Impact during construction	ES prediction of significance
Sediment disturbance in the wind farm area	**Not Significant** It was predicted that the construction phase would not significantly increase the amount of sediment that is available for re-distribution by hydrographic processes. The transport and settlement of re-suspended finer sediments by wave and tidal action and residual current movements, to other areas should therefore be insignificant and would not exceed that expected during average rough sea conditions experienced regularly on Robin Rigg. The impact to the .NcirBat biotope and surrounding biotopes within the Solway Firth from increased suspended sediments would therefore not be significant.
Loss or change of habitat in wind farm area	**Not Significant** The biotope is considered to have a low sensitivity and the direct loss of substrate is considered to be of negligible magnitude giving a negligible impact. The impact to the main .NcirBat biotope in the wind farm area from loss of available habitat is therefore not significant.
Noise and vibration	**Not Significant** Reactions to noise and vibration should not interfere with the ecological functioning of identified biotopes.

Extensive data analysis was performed on the results of the Marine Ecology Monitoring Programme (MEMP) benthic surveying undertaken during the baseline, pre-construction, construction and post construction phases of the Robin Rigg OWF (Walls *et al*., 2013a). This report was submitted to Marine Scotland and conclusions accepted by the Robin Rigg Management Group (RRMG) in 2013. This statement provides a summary of the overall conclusions, however the report (Walls *et al*., 2013a) with full details of the surveys undertaken, analysis method, results and conclusion can be found on the Marine Scotland website[3].

The analysis revealed that the benthic infaunal community had changed over time for the whole of the Robin Rigg OWF survey area (including reference areas). The greatest changes in communities occurred between the collection of baseline data and pre-construction (i.e. in the absence of any OWF construction activity), and pre-construction and operation. Changes in the benthic assemblages between pre-construction and operational periods were also observed at reference sites outside the OWF. No significant differences were found between the pre-construction and construction years. Any significant changes in communities were due to shifts in the relative abundance of a few dominant species, which is common in naturally highly dynamic sedimentary environments. Communities inhabiting soft sediments in exposed coastal areas, such as the Solway, are prone to periodic storm-induced disturbance.

The results suggest that changes in benthic community were due to the dynamic nature of the Solway Firth and cyclical patterns in benthic fauna, rather than the impact of construction and operation. The ES predicted any impacts on the benthos as a result of construction activity would not be significant and where any may occur, they would be of a short duration. On the basis of this analysis the ES predictions remain valid.

[3]http://77.68.107.10/Renewables%20Licensing/Robin_Rigg/Monitoring/Robin%20Rigg%20Memp%20Ops%20Yr%202%20-%20Chp%203%20-%20Benthic%20Ecology.pdf

3.3.2. Assessment of Potential Effects

A number of impacts may arise as a result of the scour protection works which could affect the benthic ecology. These include sediment disturbance (and associated increases in suspended sediment concentration (SSC)) and habitat loss.

Increase in Suspended Sediment Concentrations

Surveys confirmed that the area in and around the Robin Rigg OWF is made up of mobile sediments and impoverished fauna consisting of opportunistic species which are well adapted to cope with disturbance, and extensive monitoring studies has found no evidence of any effect on the benthos as a result of the construction or operation of the Robin Rigg OWF works. Therefore, as no adverse effects of increased sediment concentrations due to the wind farm have been seen, it is considered that any impacts that are less than those experienced during the construction or operation phases will not have an observable adverse effect on the benthic environment. It is therefore concluded that any impacts on benthic ecology from an increase in SSC from the scour protection works are deemed to be **not significant.**

Loss of Habitat in Wind Farm Area

The placement of hard substrate on predominantly sandy substrate will lead to a loss of habitat surrounding each of the two turbines. It is proposed that rock scour protection is to be used at both turbines. The worst case for rock placement at the two turbine monopiles is up to 30 m radius (from the edge of each monopile).

The maximum combined area of habitat loss (scour protection for two turbines) is expected to be 0.0065 km^2 as a worst-case scenario, which constitutes 0.06% of the wind farm area[4].

The most recent assessment of the benthic community in and around the Robin Rigg OWF identified the following biotopes – SS.Ssa.IfiSa.NcirBat, SS.Ssa.IfiSa.ImoSa and SS.Ssa.ImuSa (Table 3.4). These biotopes are indicative of impoverished faunal communities and are widely recorded both within the Solway Firth and around the UK (JNCC, 2015). They are not considered to be rare on either a local, regional, or national scale.

When considered in the context of the geographical region (i.e. the Solway Firth), the very small area of habitat affected (up to a maximum of 0.0065 km^2, i.e., 0.06 % of the wind farm area) is such that it will not adversely affect the benthic ecology of the wider area (i.e. beyond the footprint of the scour protection), and will have no detectable effect on the functioning of the system at a local or regional scale. Therefore, any impacts on benthic ecology from a loss of habitat in the wind farm area from the scour protection works are deemed to be **not significant.**

3.4. Fish and Shellfish

The Solway Firth is an important spawning and nursery ground for many species of commercially important fish and shellfish (Ridley *et al*., 1979) and is also important for migratory fish as they pass through the estuary into natal rivers (Anon, 2000) (See Section 3.5 of this document). The fisheries sector is therefore considered to be a very important part of the rural economy for the surrounding communities in Dumfries and Galloway, and Cumbria (Solway Firth Partnership, 2009). Whitefish are the target catch in areas to the south and west of the site, whilst a brown shrimp (*Crangon crangon*) fishery exists to the northeast of the site in the Inner Solway, as well as sporadic cockle (*Cerastoderma edule*) and mussel (*Mytilus edulis*) fisheries on the intertidal sand banks.

A number of studies on fish and shellfish populations in the Solway Firth have been undertaken over the past 30 years, including specific surveys to characterise the area around the Robin Rigg OWF and to monitor the potential impacts of construction and operational impacts on fish and shellfish (Table 3.6).

4 Wind farm area is 10.3 km^2 as reported within the Environmental Statement (Natural Power Consultants, 2002)

Table 3.6: Summary of the available data of the fish and shellfish communities around the Robin Rigg OWF

Study	Details	Purpose
Lancaster & Frid, 2002	Discard study on Solway brown shrimp vessel to North of Robin Rigg OWF. 1995-1997	Scientific Literature. Fish communities were found to be dominated brown shrimps (*Crangon crangon*), plaice (*Pleuronectes platessa*), dab (*Limanda limanda*) and whiting (*Merlangius merlangus*).
ES Characterisation (Natural Power Consultants Ltd, 2002)	Extensive beam trawl survey carried out in the Solway Firth over 12 months at 31 sampling stations. 2001-2002	Baseline EIA surveys to characterise fish and shellfish populations around Robin Rigg OWF. Common species were typical of the area (brown shrimp plaice, dab, and whiting).
Construction monitoring (Entec, 2011)	Quarterly beam trawl survey was carried out at 31 sampling stations. 2008-2010	MEMP Non-migratory fish survey. Data analysis on post consent monitoring the non-migratory fish and shellfish populations around Robin Rigg OWF. Species assemblages found to be similar to baseline and no significant differences attributed to wind farm.
Post construction monitoring (Walls *et al.,* 2013a)	Quarterly beam trawl survey was carried out at 28 sampling stations. 2010-2012	

From previous studies undertaken it is possible to characterise fish communities as being dominated by juvenile flatfish such as plaice (*Pleuronectes platessa*), dab (*Limanda limanda*), sole (*Solea solea*), solenette (*Buglossidium luteum),* and round fish such as juvenile whiting (*Merlangius merlangus*). Lesser weever fish (*Echiichthys vipera*), gobies (*Pomatoschistus* sp.), gurnards (*Eutrigla gurnardus*) and dragonets (*Callionymus lyra*) are also associated with this fish community (Lancaster & Frid, 2002).

During the EIA an extensive beam trawl survey was carried out in the Solway Firth over 12 months which revealed that the most common fish and epibenthic species of commercial and ecological importance to be brown shrimp (*Crangon crangon*), plaice, dab, and whiting (Table 3.7). Two electro-sensitive species, thornback ray (*Raja clavata*) and lesser spotted dogfish (*Scyliorhinus canicula*), were also captured during these surveys. The number of species increases towards the outer estuary as conditions become less extreme and sediment types become more varied, (out with the Robin Rigg OWF), with large numbers of brittlestars (*Ophiuroidea* sp.) occurring. Similar species assemblages were found during construction and post construction surveys undertaken as part of the MEMP requirements (where they were termed 'non-migratory fish' surveys) between 2008 and 2012 (Table 3.7).

The most abundant species captured, the brown shrimp, is of particular commercial importance within the Solway Firth and is also of importance as a source of food for a wide variety of fish, birds and sea mammals, as well as supporting a fishery north of the Robin Rigg OWF. The fish species assemblage found during these surveys corresponds with the demersal fish assemblages as categorised by Ellis *et al.* (2000), whereby the communities recorded at Robin Rigg OWF are typical of general communities within the Solway Firth and throughout much of the shallow eastern Irish Sea (the *Pleuronectes-Limanda* (plaice – dab) assemblage). It is also worth noting that the majority of commercial species captured in and around the Robin Rigg OWF were juvenile (predominantly 0 group) and therefore under minimum landing size, confirming the status of the Solway as a nursery ground for these species.

Table 3.7: Top 20 most abundant species of fish and invertebrates caught during baseline, construction and post construction beam trawl surveys

Common Name	Latin Name	Number of Individuals
Brown shrimp	*Crangon crangon*	98,197
Brittlestar	*Ophiura ophiura*	31,908
Plaice	*Pleuronectes platessa*	21,399
Dab	*Limanda limanda*	20,681
Whiting	*Merlangius merlangus*	10,975
Serpent's table brittlestar	*Ophiura albida*	9,872
Lesser weever	*Echiichthys vipera*	4623
Solenette	*Buglossidium luteum*	3255
Pogge	*Agonus cataphractus*	2,718
Hermit crab	*Pagurus bernhardus*	2,567
Swimming crab	*Liocarcinus spp.*	2,023
Sprat	*Sprattus sprattus*	1,661
Sand goby	*Pomatoschistus minutus*	1,342
Sole	*Solea solea*	980
Common starfish	*Asterias rubens*	837
Scald fish	*Arnoglossus laterna*	822
Pink shrimp	*Pandalus montagui*	406
Masked crab	*Corystes cassivelaunus*	365
Baltic prawn	*Palaemon adspersus*	293
Plumose anemone	*Metridium senile*	281

Source: Walls et al., 2013

3.4.1. ES Predictions and Validation

The following predictions were made within the ES, with respect to fish and shellfish ecology, and construction activities (Table 3.8).

Table 3.8: Predictions made during the ES on benthos and fish and shellfish

Impact during construction	ES prediction of significance
Reduction in populations due to noise and vibration impacts	**Not Significant** Noise and vibration associated with wind farm construction were considered insignificant as a potential source of impact on fish species. Impacts on commercially important flat fish species (plaice and sole) were considered to be negligible due to the lack of a swim bladder, and demersal species such as whiting have the ability to avoid areas of high disturbance. As a result, no significant impacts would occur to fish populations as a result of noise and vibration.
Reduction in populations due to sedimentation	**Not Significant** No significant impacts would occur to fish populations as a result of sedimentation as sedimentation associated with construction activities was not

Impact during construction	ES prediction of significance
	considered to be potentially damaging to fish in the area of the Robin Rigg OWF. As the area is naturally turbid with high levels of suspended sediments in the water column, species in the area will be adapted to these conditions.
Reduction in populations due to potentially polluting substances	**Not Significant** For monopile foundations it was possible that cementitious grout could be used to form the connection between the piles and the main structure. For a single foundation the quantity required would be 12 m^3. Grouting operations may lead to a localised increase in pH but as operations are accurately controlled and there is a high volume of water passing through the development area with each tidal cycle, dilution effects would be such that impacts on fish will not be significant.
Habitat modification	**Not Significant** There is the possibility that fish may be attracted to the proposed wind farm, although the actual size of the total fish populations may not necessarily increase. It is much more likely that the congregations of fish around the proposed wind farm would represent a small redistribution of the existing populations in the area. The overall magnitude of such an impact would therefore be low to negligible.

Extensive data analysis was performed on the results of the beam trawl surveys undertaken during the baseline, construction and post construction phases of the Robin Rigg OWF (Walls *et al*., 2013b). This report was submitted to Marine Scotland and conclusions accepted by the RRMG in 2013. This statement provides a summary of the overall conclusions, however report (Walls *et al*., 2013a) with full details of the surveys undertaken, analysis method, results and conclusion can be found on the Marine Scotland website.[5]

The results of the construction and post construction monitoring revealed that over time there were significant differences in the fish and shellfish assemblages captured in the beam trawls between construction periods. These changes however could not be attributed to the wind farm as they occurred on the scale of the Solway Firth (in reference stations as well as those near the site). In addition, the greatest changes occurred in the absence of any construction activity. Differences in fish and shellfish populations were non-significant between baseline and construction, but were significantly different between baseline and operation, and construction and operation.

The results provide evidence that broad scale changes in fish and invertebrate communities are unlikely to occur at a magnitude beyond natural spatial and temporal variation. In the marine environment, particularly in highly dynamic and turbid estuarine environments such as the Solway Firth, a number of abiotic and biotic factors will result in variation to a population. It is therefore inherently difficult to disentangle natural drivers from anthropogenic pressures such as the construction and operation of an OWF. As a result of this, following three years of operational monitoring it was concluded the predictions made in the ES relating to the potential impacts of the construction and operation of the Robin Rigg OWF were supported by the data collected, and therefore validated.

3.4.2. Assessment of Potential Effects

The construction and operation of an OWF has the potential to affect fish and shellfish present in the vicinity of the works, however the post construction monitoring permitted the predictions of the ES to be validated and no significant effects were found in the fish and shellfish populations, attributable to the existing wind farm infrastructure. Therefore, it is considered that any impacts from the scour protection works that are less than those experienced during the

5 http://www.gov.scot/Topics/marine/Licensing/marine/scoping/Robin-Rigg/memp-yr-3

construction or operation of the wind farm will not have an observable adverse effect on the local fish or shellfish populations.

Increase in Suspended Sediment Concentrations

The waters in the Robin Rigg OWF area are naturally turbid with high levels of suspended sediments in the water column. Therefore, species in the area will be adapted to these conditions. The ES found that no significant impacts would occur to fish populations as a result of an increase in SSC. Due to the impacts of the proposed works being less than those experienced during the construction or operation of the wind farm it is concluded that any impacts from an increase in SSC are deemed to be **not significant**.

Change in Seabed Type within the Footprint of the Scour Protection

Habitat modification as a result of the scour protection works will result in a loss of original habitat (up to a maximum of 0.0065 km^2, i.e., 0.06 % of the wind farm area), potentially affecting food resources for some fish or shellfish species. It is considered however, that due to the change in habitat type from predominantly sandy substrate (with an impoverished faunal community – see Section 3.3) to a homogenous rocky substrate, resultant colonisation may increase the productivity of the area, thus increasing availability of food and/or habitat (e.g. refugia) for some juvenile fish and shellfish species.

Due to the spatial extent of the habitat modification on a regional scale (i.e. the Solway Firth) and the relatively high mobility of the receptor group in general, it is considered that this change will be of minimal consequence to fish and shellfish populations, with no adverse effects on populations. On a local scale (i.e. within the OWF) some fish and shellfish receptors may benefit through increased food provision and habitat availability. As a result, any impacts of the scour protection works on fish and shellfish through changing the seabed type are deemed **not significant.**

3.5. Migratory Fish

A number of migratory fish species are known to be present in rivers around the Solway Firth and therefore pass through the Solway Firth on their way to or from their spawning grounds (Table 3.9). Migratory species known to occur include Atlantic salmon (*Salmo salar*), sea trout (*Salmo trutta*), allis shad (*Alosa alosa*), twaite shad (*Alosa fallax*), sparling/smelt (*Osmerus eperlanus*), sea lamprey (*Petromyzon marinus*), river lamprey (*Lampetra fluviatilis*) and European eel (*Anguilla anguilla*). Many of these species are important for economic reasons and most have high conservation value being protected by both natural and international legislation. A number of rivers and waters are designated as SACs with migratory fish as qualifying features.

Table 3.9: Rivers in the Solway Firth (St. Bees Head to Mull of Galloway) with known populations of migratory fish species

River	Migratory species present	Conservation status – qualifying features
Big Water of Fleet	Atlantic salmon, sea and river lamprey	No designation
Border Esk	Atlantic salmon, sea and river lamprey, sea trout	No designation
Cree	Sparling, allis shad**	SSSI – sparling
Dee (Kirkcudbrightshire)	Atlantic salmon	No designation
Inner Solway	Sea lamprey	SAC – designated feature – sea lamprey
Leven	Atlantic salmon	No designation
Lower River Cree	Atlantic salmon, sea trout, sparling	SSSI – sparling

River	Migratory species present	Conservation status – qualifying features
River Annan	Atlantic salmon, sea and river lamprey, sea trout	No designation
River Bladnoch	Atlantic salmon	SAC – Salmon
River Derwent	Atlantic salmon, sea and river lamprey, sea trout	Part of the River Derwent and Bassenthwaite Lake SAC – Atlantic salmon, sea and river lamprey
River Eden	Atlantic salmon, sea and river lamprey, sea trout	SAC – Atlantic salmon, sea and river lamprey
River Ehen*	Atlantic salmon	SAC – Atlantic salmon
River Ellen	Atlantic salmon	No designation
River Nith	Atlantic salmon, sea and river lamprey, sea trout	No designation
River Sark	Atlantic salmon	No designation
Piltanton Burn	Atlantic salmon	No designation
Urr Water	Atlantic salmon, sea and river lamprey	No designation
Water of Luce	Atlantic salmon, sea and river lamprey	No designation

**The River Ehen enters the Irish Sea to the south of St Bees Head. It has however been included within some reports regarding salmon and Robin Rigg OWF and is therefore included for completeness.*

*** Evidence suggests one or more of the rivers draining into the Solway Firth, possibly the River Cree, may support a spawning population of allis shad.*

Information presented within this section on the status of migratory fish populations in the Solway Firth has been collated from a number of different sources (Table 3.10).

Table 3.10: Summary of previous studies on migratory fish in the Solway Firth

Study	Details	Summary
Robin Rigg OWF ES characterisation (Natural Power Consultants Ltd, 2002)	Section 9.7 – Effects on Fish	Presents the findings of the EIA carried out in relation to the then proposed Robin Rigg OWF development and migratory fish.
Robin Rigg OWF site condition Monitoring - Sparling (2010)	Study commissioned in relation to sparling populations post construction	Presents results of Site Condition Monitoring (SCM) for sparling on the River Cree in 2010
Galloway Fishery Trust (GFT) Reports (2004 – 2013)	Robin Rigg OWF Migratory Fish Reports	Results of monitoring surveys & data collation regarding migratory fish populations in rivers around the Solway Firth.
Salmonid & Freshwater Fisheries	Environment Agency annual reports	Reports presenting findings of routine monitoring and data collection from English rivers in and near the Solway Firth.

Study	Details	Summary
Statistics for England & Wales		
Thorley (2013)	The Potential Influence of the Robin Rigg OWF on the Abundance of Adult and Juvenile Atlantic Salmon	Detailed analysis of the potential influence of the construction & operation of the wind farm on salmon carried out on behalf of Marine Scotland Science (MSS). Assessment of data from 13 rivers (control and treatment) in the Solway Firth area. Findings within the report justified the reduction of monitoring effort in relation to the Robin Rigg OWF.

3.5.1. ES Predictions and Validation

The following predictions (of relevance to the scour protection installation works) were made within the original ES, with respect to impacts on migratory fish (Table 3.11).

Table 3.11: Predictions made within the ES on migratory fish during the construction/decommissioning activities

Impact during construction	ES prediction of significance
Physiological and behavioural effects of underwater noise and vibration	**Not significant** Atlantic salmon – The swim bladder plays no part in the hearing and salmon migrate in deep water channels that are several kilometres to the north and south of the wind farm area. Migration of either juveniles or adults would not be restricted due to noise. Lamprey species - No swim bladder and thus are only susceptible to noise and vibration in the near-field and this is a small area relative to the width of the estuary at the wind farm site.
Direct effects on fish of water quality changes through suspension of sediment in the water column disturbed	**Not significant** Migratory species in the Solway Firth are tolerant of naturally varying levels of suspended sediments. Only limited amounts of fine material (which would be easily transported in suspension) are present and so only local and relatively minor increases in suspended sediment would occur during construction.
Indirect effects of water quality changes through effects on benthic food sources	**Not significant** Assessment of effects on benthic invertebrate communities shows rapid recolonisation and natural tolerance of sediment movements. No effects on food sources for fish species would therefore occur.
Habitat modification	**Not Significant** There is the possibility that fish may be attracted to the proposed wind farm, although the actual size of the total fish populations may not necessarily increase. It is much more likely that the congregations of fish around the proposed wind farm would represent a small redistribution of the existing populations in the area. The overall magnitude of such an impact would therefore be low to negligible.

Monitoring reports detailing the migratory fish populations in the Solway Firth area were produced by the Galloway Fisheries Trust (GFT) throughout the pre-construction, construction and operational phases of the Robin Rigg OWF

as per the requirements of the MEMP. These are summarised in the previous scour protection impact assessments (Natural Power, 2016 & Natural Power, 2018).

Based on the data available after three years of post-construction monitoring, thorough analysis was conducted on salmon populations. This analysis failed to detect an effect of the construction (or operation) of the wind farm on the rod catches of adults or on the densities of juveniles (fry or parr) (Thorley, 2013). The Thorley (2013) study concluded that, given the available data and assumptions of the models, no significant effect of wind farm construction was detected. Because fluctuations in catch and electrofishing survey results were for example observed across both control and test rivers, it cannot be concluded that construction activities were the driver of this change. The predictions made in the ES relating to the potential impacts of the construction of the Robin Rigg OWF on salmon were therefore supported by the data collected and surveys conducted, and predictions have been validated.

Fluctuations in catch numbers of other migratory fish species (sea trout, lamprey, shad, and sparling) have been observed and reported within the GFT monitoring reports. Due to the historical fluctuation in migratory fish populations (Solway Firth Review, 1996), the limitations of using catch data as a proxy for population size, and the inherent difficulties in establishing an effective monitoring protocol on species with scarce populations, it is difficult to draw firm conclusions regarding the potential impact construction works at Robin Rigg OWF may have had. Variation in catch numbers was reported within the ES however, i.e. prior to any construction works, indicating variation has been occurring over a longer timeframe than that of the Robin Rigg OWF construction/operation phases. Furthermore, a decline in catch numbers (particularly in sea trout, lamprey and shad) has occurred on a wider geographical scale than the Solway Firth and therefore an effect of the Robin Rigg OWF construction is considered highly unlikely to have caused fluctuations.

3.5.2. Assessment of Potential Effects

The construction and operation of an OWF has the potential to affect migratory fish present in the vicinity of the works, however the post construction monitoring permitted the predictions of the ES to be validated as the catch data and surveys of migratory fish have failed to detect a change in populations attributable to the existing wind farm infrastructure. Therefore, it is considered that any impacts that are less than those experienced during the construction or operation of the wind farm will not have an observable adverse effect on migratory fish populations.

Increase in Suspended Sediment Concentrations

The waters in the Robin Rigg OWF area are naturally turbid with high levels of suspended sediments in the water column. Therefore, migratory fish in the area will be adapted to these conditions. The ES found that no significant impacts would occur to migratory fish populations as a result of an increase in SSC. Due to the impacts of the proposed works being less than those experienced during the construction or operation of the wind farm it is concluded that any impacts from an increase in SSC on migratory fish are deemed to be **not significant**.

Change in Seabed Type within the Footprint of the Scour Protection

Habitat modification from the scour protection works will result in a loss of some sedimentary habitat. The loss of habitat will have a very limited impact on migratory fish, as species such as salmon and lamprey are not thought to rely on the specific habitats within the Robin Rigg OWF for any particular ecological function, such as spawning or feeding, and sea and river lamprey do not feed on the benthos (they can be parasitic, attaching to migrating fish such as salmon). Furthermore, it is considered that due to the change in habitat type from predominantly sandy substrate (with an impoverished faunal community – see Section 3.3) to a homogenous rocky substrate, resultant colonisation may increase the productivity of the area, thus increasing availability of food for some species.

Due to the very small spatial extent of the habitat modification on a regional scale (i.e. the Solway Firth) from the scour protection works and the high mobility of the receptor group in general, it is considered that this change will be **not significant** for migratory fish with no adverse effects to populations.

3.6. Marine Mammals

The information below provides detail on marine mammal populations in the Solway Firth and summarises the potential impacts during the scour protection installation and any maintenance requirements. The information has been split into consideration of cetaceans (Section 3.6.1) and seals (Section 3.6.3). The Marine Licence application requires an accompany European Protected Species (EPS) risk assessment (all species of cetacean in waters around the UK are considered EPS under Annex IV of the Habitats Directive (Council Directive 92/43/EEC)). An EPS risk assessment was previously produced for the Marine Licence applications for scour protection works in 2016 and 2018 at Robin Rigg OWF. These concluded that there was no potential for auditory injury, and negligible potential for disturbance to any cetacean from any of the activities associated with the scour protection work. Considering these previous findings, a pro-forma EPS risk assessment is presented within this document as Appendix A.

While all cetaceans are EPS, seals are not. Therefore, the impact assessment for the two marine mammal groups has been presented separately for ease of reference to the accompanying appendix. This impact statement draws from and should be read in conjunction with the EPS risk assessment presented in Appendix A of this document.

3.6.1. Description of Cetacean Populations at Robin Rigg

The Solway Firth lies within SCANS-IV block CS-E. In this block a density is available for harbour porpoise (0.5153 animals/km^2), bottlenose dolphins (0.0104 animals/km^2) and minke whale (0.0088 animals/km^2) (Gilles *et al*. 2023).

Natural Power has undertaken marine mammal surveys in the Solway Firth during the pre-construction (February 2004 – January 2005), construction (January 2008 to February 2010) and operational (March 2010 to February 2012) phases of the Robin Rigg Offshore Wind Farm (Natural Power, 2011; Natural Power, 2012; Natural Power, 2013). The only EPS encountered in all years was harbour porpoise (*Phocoena phocoena*). There was a significant reduction in relative harbour porpoise abundance within the Robin Rigg Offshore Wind Farm during construction, but numbers returned to pre-construction levels during operation (Vallejo *et al*., 2017).

3.6.2. Summary of EPS Risk Assessment

To determine potential impacts of the proposed scour protection works upon cetaceans, the activities associated with the work that possess a potential route to impact have been identified. These are considered to be:

- Increased anthropogenic noise from:
  - Geophysical survey systems (multi-beam echosounder (MBES)) used during the scour protection installation;
  - Rock placement; and
  - Vessel noise.
- Vessels:
  - Collision risk

Anthropogenic noise is sound that is produced as a consequence of human activity. It has the potential to cause death or injury to the animals in the vicinity of the noise source if the noise is of sufficient intensity or disturb EPS if the frequencies generated lie within their auditory range. Sound travels much further underwater compared to airborne noise, therefore resulting effects on marine mammals may be at distance from the sound source.

Increase in suspended sediment and associated impacts on prey species from scour protection installation were assessed in Section 3.4 of this document. These impacts have been determined to be less than those seen during the wind farm construction, which in turn have been shown to be not significant. Consequently, the associated impact upon marine mammals is also considered not to be significant and was not assessed further.

Within the EPS risk assessment (Appendix A), details of each potential route to impact were assessed individually against the potential to cause auditory injury or disturb cetaceans. In the case of noise related impacts, the power source levels and audibility ranges were considered. Due to the marine mammal species likely to be encountered during the scour protection works and the short timeframe of the works collision risk was deemed to be negligible with appropriate mitigation for fast travelling vessels (≥ 14 knots).

The EPS risk assessment concludes that there is no potential for auditory injury to EPS from any of the activities associated with the scour protection work at Robin Rigg. In addition, there is negligible potential for disturbance to cetaceans; less than one harbour porpoise is likely to be disturbed by the installation of the scour protection (harbour porpoise being the most responsive to anthropogenic activity).

3.6.3. Description of Seal Populations at Robin Rigg

Both UK seal species are present in the Solway Firth (harbour seal, *Phoca vitulina*, and grey seal, *Halichoerus grypus*) although neither species is particularly numerous compared to other areas around Scotland. The number of seals counted in southwest Scotland (from the English border to the Mull of Kintyre) represents <4% of the Scotland total for harbour seals and <2% of the Scotland total for grey seals (Duck *et al*., 2015). The at-sea distribution (relative density) of grey seals (<0.005% At-Sea Pop. Per 25 km^2) and harbour seals (>=0% At-Sea Pop. Per 25 km^2) in the Solway Firth is equally low (Carter *et al*. 2022).

Seals are not required to be considered as part of EPS risk assessments because they are not classified as such. However, seals have been considered here in relation to the Marine (Scotland) Act 2010 - Part 6 and disturbance at designated breeding and haul-out sites (under the Protection of Seals (Designation of Haul-Out Sites) (Scotland) Order 2014).

There are two designated (by Scottish Ministers to provide additional protection for seals from intentional or reckless harassment) seal haul-out sites in the Solway Firth (see Figure 2.1, Map A). One (Little Scares in Luce Bay i.e. between the Mull of Galloway and Burrow Head) is approximately 65 km to the west of Robin Rigg Offshore Wind Farm. The other (Solway Firth Outer Bank) is approximately 15 km to the east of Robin Rigg Offshore Wind Farm between Southerness Point and Dubmill Point.

3.6.4. Assessment of Potential Effects

Increased anthropogenic noise

While the potential exists for there to be some, limited, disturbance to cetaceans from anthropogenic noise produced from the activities associated with the installation and maintenance of the scour protection (geophysical survey equipment, rock placement and vessel noise), the results of the EPS risk assessment (Appendix A) show that this disturbance will be negligible and not discernible over the low levels of existing disturbance caused by human activity within the Solway Firth. There is no potential for auditory injury to EPS from any of the activities associated with the scour protection work at Robin Rigg.

The two designated seal haul out sites in the Solway Firth are in vicinity to the route that the vessels will take to Robin Rigg OWF. Seals using this area, including the designated haul-out sites, will be accustomed to wind farm-associated vessel traffic (as well as other vessel traffic) and are unlikely to be disturbed by the presence of a SSDV installation vessel on site and transiting between the site and the bulk carriers. Therefore, seals are unlikely to be disturbed by vessel noise associated with the scour protection work.

Therefore, the impacts of anthropogenic noise created as a result of the scour protection work on marine mammals is deemed **not significant.**

Vessel collision risk

As detailed in EPS risk assessment (Appendix A) it is considered that with appropriate mitigation for fast moving vessels (≥ 14 knots) the potential for vessel collisions with marine mammals during the proposed works will be negligible. Therefore, the impacts of vessel collisions on marine mammals as a result of the scour protection work is deemed **not significant.**

3.7. Birds

The Solway Firth area has several site designations for nationally and internationally important bird populations including the Solway Firth SPA (designated in December 2020) and the Upper Solway Flats and Marshes Ramsar site. These sites provide legal protection for 29 features including bar-tailed godwit, black-headed gull, common gull, common scoter, cormorant, curlew, dunlin, golden plover, goldeneye, goosander, grey plover, herring gull, knot, lapwing, oystercatcher, pink-footed goose, pintail, red-throated diver, redshank, ringed plover, sanderling, scaup, shelduck, shoveler, Svalbard barnacle goose, teal, turnstone and whooper swan. The area around the wind farm is also used by several seabird species, particularly, guillemot, razorbill, gannet, Manx shearwater, cormorant, kittiwake, herring gull, and great black-backed gull.

3.7.1. ES Predictions and Validation

The impact assessment presented within the ES predicted that there would be no significant impacts on any bird receptors (Table 3.12).

Table 3.12: Predictions made within the ES on local bird populations

Species	Sensitivity of local population	Magnitude of effect	Significance	Significant impact?
Common scoter	High	Low	Low	No
Red-throated diver	High	Low	Low	No
Manx shearwater	Medium	Negligible	Very low	No
Gannet	Medium	Negligible	Very low	No
Cormorant	Medium	Low	Low	No
Scaup	Medium	Low	Low	No
Kittiwake	Medium	Low	Low	No
Guillemot	Medium	Low	Low	No
Razorbill	Medium	Low	Low	No
“Other seabirds”	Medium	Low	Low	No

Under the MEMP (MEMP, 2004), post-construction ornithological monitoring was undertaken for 11 key bird species between March 2010 and February 2015 inclusive. As part of this programme, extensive data analysis has been undertaken to determine the effects of Robin Rigg OWF construction and operation on these receptors. Reports detailing results from all five years of operational monitoring have been accepted by the RRMG and published on the Marine Scotland website (Walls *et al*., 2013a; Walls *et al*., 2013b; Walls *et al*., 2013c; Nelson *et al*., 2014; Nelson *et al*., 2015). These reports provide full details of the surveys, statistical analyses, results and conclusions of the MEMP monitoring undertaken for birds.

For three species (scaup, common scoter and Manx shearwater) densities were too low during all development phases to undertake statistical examination of potential wind farm effects on their local populations. However, since densities were relatively low, any effects of the wind farm would be on very few birds compared with the local

population size. As a result, it was possible for the post-construction monitoring to validate the finding of no significant impact on these species in the ES. For the other eight species (red-throated diver, cormorant, gannet, razorbill, guillemot, kittiwake, great black-backed gull and herring gull) statistical examination was possible, and it was also concluded that the prediction of no significant effects in the ES was validated.

3.7.2. Assessment of Potential Effects

For all species considered here, scour protection installation works will only result in short term, temporary and reversible impacts through disturbance causing some displacement. The effects of displacement will depend on the abundance of birds present during the works and behavioural response of birds to the works themselves. In general, post-construction monitoring found little effect of construction activities on the bird species studied. This could be because the birds present did not react strongly enough to be detected by the monitoring methods used, or because there was insufficient power to detect a change in the data, or that behavioural responses were too short term to be detected by the monitoring methods. Regardless of which of these was the reason, it is possible to confidently state that there was no large scale, long term change in species abundance and distribution that could be attributed to the construction or presence of the wind farm.

Given that scaup, common scoter and Manx shearwater densities were too low during all development phases to undertake statistical examination of potential wind farm effects on their local populations, it is considered that the relatively small scale of the works would not result in any significant displacement impacts on these species. These species are therefore not considered further in this assessment and the impacts of disturbance on these species from the proposed work is deemed to be **not significant.**

3.7.2.1. Red-throated diver

Red-throated divers are considered one of the most sensitive species in the UK to disturbance in the marine environment. Furness *et al*. (2013) ranked the relative sensitivity of seabird species in the UK to the impacts from OWFs. This ranking included assessment of the relative sensitivity to disturbance and/or displacement from habitat. This process combined a relative score of species sensitivity to disturbance from boat and helicopter traffic, their flexibility in habitat use and their conservation importance. Of the 38 species that were ranked, red-throated and black-throated divers were ranked the highest (i.e. most sensitive).

Since there is no suitable empirical evidence to demonstrate the likely flushing distance of red-throated divers to the type of works planned i.e. scour protection installation works, a range of disturbance distances were assessed based on empirical evidence of the displacement of birds from operational OWFs. There was some indication that displacement of red-throated divers occurred up to 800 m from Robin Rigg OWF during construction Walls *et al*. (2013a), though it is important to note that densities were lower here than at other sites where displacement has been found. Petersen *et al*. (2006) reported reductions in densities of red-throated divers in buffer zones at 2 km and 4 km around wind farms in Denmark. For wind farms in the Belgian sector of the North Sea, Vanermen *et al.* (2012) reported displacement in a 3 km buffer zone. In a review of studies of displacement effects on red-throated divers, Dierschke *et al.* (2012) reported that 2 km was the likely limit in most cases. It is therefore concluded that disturbance beyond 4 km is very unlikely for the type of works described here. It is more likely that the proposed works would cause disturbance within 2 km, but potentially beyond 800 m. Therefore, the number of birds potentially affected by the works was based upon various radii at 800 m, 1 km, 2 km and 4 km around the vessels.

The baseline conditions against which potential impacts have been estimated were based upon five years of post-construction surveys undertaken across the Robin Rigg OWF and surrounding buffer (covering a total area of 360km^2). Estimates were made from data collected using standardised boat-based surveys and model-based analysis techniques. Further details regarding the surveys and modelling methods are provided in the MEMP operational monitoring reports (Walls *et al*., 2013a, 2013b, 2013c; Nelson *et al.,* 2014; Nelson *et al.,* 2015).

Densities of red-throated divers on the sea were estimated for each of the five years following construction both within the Robin Rigg OWF and across the surrounding buffer (Table 3.13).

Table 3.13: Abundance and density of red-throated divers on the sea during the five operational years. Values in parentheses represent upper and lower 95% confidence intervals.

Operational year	Density (birds/km^2)		
	RROWF	Buffer	Total
1	0.01 (0-0.19)	0.11 (0.01-1.60)	0.11 (0.01-1.60)
2	0.04 (0.01-0.19)	0.08 (0.01-0.49)	0.08 (0.01-0.48)
3	0.04 (0-0.28)	0.14 (0.02-0.89)	0.13 (0.02-0.87)
4	0.01 (0-0.08)	0.01 (0-0.08)	0.04 (0-0.24)
5	0.01 (0-0.08)	0.04 (0-0.24)	0.04 (0-0.24)

Source: Nelson et al. 2014; Nelson et al. 2015.

Densities were lower within the Robin Rigg OWF than in the buffer, varying from 0.01 to 0.04 birds/km^2 across the five years of monitoring. Based on a peak density of 0.04 birds/km^2 within the Robin Rigg OWF, the number of birds predicted to be impacted at each displacement distance is shown in Table 3.14.

Table 3.14: Predicted number of red-throated divers disturbed by planned scour protection scheme works at various radii around the works.

Disturbance distance:	800 m	1 km	2 km	4 km
Number of birds disturbed:	0.08	0.13	0.5	2.0

The abundance of red-throated divers around the entire UK was assessed by Join Nature Conservation Committee (JNCC) (O'Brien *et al*. 2008). The population size within the Solway Firth (aerial survey block NW1 in O'Brien *et al*. 2008) was estimated to be 157.3 birds (an average across four surveys) and was used to define the local population for this assessment. O'Brien *et al.* (2008) also provided broader scale population estimates and two of the areas defined by JNCC are relevant here (see Figure 2 in O'Brien *et al.* 2008). These areas are the coastal waters from the Rhins of Galloway in south-west Scotland to the south-western tip of Anglesey in Wales. The total estimated population size in these waters was 1,487 birds, which was defined as the regional population for this assessment.

In order to contextualise the predicted number of birds disturbed by the proposed installation works, the maximum number estimated to be disturbed is compared with the local and regional population scales (Table 3.15).

Table 3.15: Disturbance of scour protection scheme works to red-throated divers at the local, regional and SPA scale.

Disturbance distance (number birds):	800 m	1 km	2 km	4 km
As % of local population (157)	0.05%	0.08%	0.32%	1.28%
As % of regional population (1,487)	0.003%	0.01%	0.02%	0.08%
As % of Solway Firth SPA (527)	0.015%	0.02%	0.09%	0.38%

The number of birds predicted to be displaced out to a highly precautionary 4 km was less than 2% of the local population and less than 0.1% of the regional population. At a more realistic 1 km displacement only 0.08% of the local population and 0.01% of the regional population could be affected. It is also important to consider the consequences of this disturbance to the affected birds. The proposed works are predicted to displace birds to an unknown radius around the works but with a very high confidence that this will be within 4km. The birds disturbed are not predicted to suffer mortality effects, but to move to other waters. Thus, the disturbance may result in increased intra-specific competition for resources (mainly prey) within the remaining waters, however, Dierschke *et al*. (2017) conclude that "*red-throated divers appear to be willing to take a range of prey species and to utilise a range of habitats. Additionally, it is difficult to envisage how inter- or intraspecific competition could reduce prey acquisition through interference or depletion*". In addition, the worst-case scenario for the duration of disturbance is for 14 days of works in Q2 or Q3 of 2024, weather dependant. Since red-throated divers begin to leave the Solway Firth during late Spring and early Summer on migration (Nelson *et al.* 2014), this assessment is precautionary in assuming equal densities of red-throated divers occurring within the Robin Rigg OWF throughout the 14 days of work. Given the short term, temporary and reversible nature of the disturbance it is highly unlikely that it will result in permanent or long-term effects on either the fitness of the individuals involved or to the population they are part of.

The presence of scour protection installation vessels and associated activities may lead to increased flushing of birds through both visual disturbance and unpredictable noise events. Red-throated divers are also known to be sensitive to vessel movements (Schwemmer *et al*. 2011), so there is potential for effects from movement of the vessels expected to be used in the proposed works. For the worst-case scenario of Installation Method Option 1 two bulk carrier vessels will anchor at an agreed location on the north-western edge of the Robin Rigg OWF for the duration of the works, minimising vessel movements. A single installation vessel will be used to complete the installation works. Each installation will take up to five days to complete at each location. Therefore, there will be a worst case of 38 vessel movements during the proposed works, over a two-week period in Q2 or Q3 of 2024. The bulk carrier vessels will be stationary for the duration of the works, and installation vessel movements will be slow and short. Thus, vessel movements during cable removal are unlikely to cause a high degree of disturbance (Schwemmer *et al*. 2011). Potential impacts from unpredictable noise events during rock transfer and installation are expected to be highly localised, short-term and temporary. Therefore, impacts of disturbance from the proposed works on red-throated divers are deemed to be **not significant.**

3.7.2.2. Cormorant

Post-construction ornithological monitoring showed that numbers peak in July and August with a sharp decline in September. It is likely that roosting cormorants (where present) will be disturbed from the turbines at which installation works are taking place. While this species frequently uses noisy human environments (e.g. harbours), Furness *et al*. (2013) scored this species as having a relatively high disturbance score (4 of 5) to ship and helicopter traffic. It is therefore possible that birds will be displaced from a wider area than just the turbines at which works are taking place. If disturbance caused displacement to 1 km, it is predicted that approximately two birds would be displaced (based on the mean density in the wind farm during the first five years of operation), at 2 km it would be

approximately eight birds, and at 4 km it would be approximately 33 birds. Since cormorants are less sensitive to disturbance than red-throated diver (Furness *et al*. 2013) it is unlikely that displacement out to 4 km would occur. It is considered more likely that disturbance would be less than 2 km, so it is predicted that between two and eight birds would be displaced. Given that the abundance in the whole study area during the first five years of operations is between 200 and 500 birds, displacement of two to eight birds would be insignificant. Therefore, impacts of disturbance from the proposed works on cormorants are deemed to be **not significant.**

3.7.2.3. Gannet

Post-construction ornithological monitoring showed that gannet abundance peaked in July but declined quickly through August and September. While some birds will be present during the proposed works, even if disturbance caused displacement to a large distance (e.g., 4 km would be considered a long distance as this is the maximum disturbance distance estimated for the far more sensitive red-throated diver) only a few birds would be affected. In addition, gannets have very long foraging ranges (maximum of 709 km; Woodward *et al*. 2019) so displacement of an area of sea with a 4 km radius would be insignificant in relation to their total foraging range. Therefore, impacts of disturbance from the proposed works on gannets are deemed to be **not significant.**

3.7.2.4. Razorbill

Post-construction ornithological monitoring showed that numbers of razorbills recorded on the sea across the entire study area have distinct spring (April) and autumn (October to November) peaks. Whilst there was an indication that razorbill numbers have decreased slightly within the Robin Rigg OWF during operation compared to pre-construction, this was not statistically significant and it is likely that any effects of the Robin Rigg OWF would be on very few individuals compared to the regional population. Therefore, impacts of disturbance from the proposed works on razorbills are deemed to be **not significant.**

3.7.2.5. Guillemot

Post-construction ornithological monitoring showed that guillemot abundance showed both a spring (April) and a late summer (July) into early autumn (September) peak in abundance across the entire survey area. Guillemots were present within the wind farm footprint throughout construction and operation (Walls *et al*., 2013a, 2013b and 2013c; Nelson *et al*., 2014; Nelson *et al*., 2015; Vallejo *et al*., 2017). As such, it appears that guillemots were not sufficiently affected by the construction of the Robin Rigg OWF for this to be detected by the surveys. Therefore, any impacts of the smaller spatial and temporal scales of the works would be expected to have relatively smaller effects than construction of the whole Robin Rigg OWF. Therefore, impacts of disturbance from the proposed works on guillemots are deemed to be **not significant.**

3.7.2.6. Kittiwake

Post-construction ornithological monitoring showed that kittiwake numbers peaked in April and declined through the summer to a minimum in October. Whilst there was an indication that kittiwake numbers decreased during construction of the Robin Rigg OWF, this reduction was not significant indicating any effect of displacement was minimal. Post-construction monitoring of kittiwakes recorded evidence of an increase in kittiwakes on the sea within the Robin Rigg OWF during operation (Walls *et al*., 2013c; Nelson *et al*., 2014; Nelson *et al*., 2015), providing evidence that any effect of wind farm construction was short-term and temporary. Given that the scale of proposed works is relatively small in comparison to wind farm construction, the impacts of disturbance on kittiwakes are deemed to be **not significant.**

3.7.2.7. Large gull species

Post-construction ornithological monitoring showed that while great black-backed gull abundance varied through the year with little clear pattern, low densities of birds present meant that patterns were unlikely to be detected. However, these low densities strongly suggest that there will be no significant effect on great black-backed gulls from the proposed works. Since densities were higher for herring gull it was possible to be clearer about seasonal abundance. Numbers peaked in the late winter to early spring (January to March) with lowest abundance occurring in August. Due to the lower abundance during the period of the work (April to June) and the high habitat flexibility shown by this species (Furness *et al*., 2013) the works will not have a significant effect on the local herring gull population. Therefore, impacts of disturbance from the proposed works on great-black backed gulls and herring gulls are deemed to be **not significant.**

3.7.2.8. Other Species

It is recognised that other species may also be present within the wider area, including those species listed as features of the Solway Firth SPA. This includes a number of duck and geese species. It is concluded that potential for interaction with these species in negligibly low, and as such any potential effects are similarly negligible. Therefore, impacts of disturbance from the proposed works on all other ornithology receptors in the region are deemed to be **not significant.**

3.8. Consideration of Cumulative Effects

It is considered that based upon the highly localised nature and short timeframe of this work, the only additional work that may act cumulatively is routine operational maintenance at the Robin Rigg OWF site. Based upon this, it is concluded that the scour protection work, which will last a maximum of two weeks with a footprint of 0.0065 km^2, will not lead to a significant cumulative impact.

3.9. Designated Sites

A number of designated sites are present in the Solway Firth region. European Designated habitats (SAC and SPA's (including RAMSARS)) are considered further in Section 4: Habitat Regulations Apprasial.

The following non-Natura designated sites are present in the vicinity of the Robin Rigg OWF (estimated distance from the OWF given in brackets):

- Upper Solway Flats and Marshes Site of Special Scientific Interest (SSSI) (within the Solway Firth SPA) (>13km);
- Caerlaverock National Nature Reserve (NNR) (>13km);
- Solway Firth Marine Conservation Zone (MCZ) (>18km);
- Allonby Bay MCZ (and HPMCZ) (>7km); and
- Cumbria Coast MCZ (>20km).

As these sites are all at considerable distance from the works, it is concluded that there is no potential for any effect to arise on any site from the scour protection works which will be small scale, localised, and short in duration.

4. Habitat Regulations Appraisal (HRA)

Requirements of the Habitats Directive state that any plan or project not directly connected with, or necessary to the management of a Natura 2000 site which is likely to have a significant effect on the interests of that site shall be subject to assessment in respect of the conservation objectives of the Natura 2000 site. The process is known as Appropriate Assessment (AA) and is undertaken by a Competent Authority. It is the responsibility of the applicant to provide the information which the Competent Authority may reasonably require to undertake such an assessment. This process is known as a Habitat Regulation Appraisal (HRA).

The first step in a HRA is to undertake a screening exercise to establish if an impact from the activities described can result in a route to impact upon the designated features of the Natura 2000 sites, and whether this route to impact has the potential to exert a Likely Significant Effect (LSE). This document aims to ensure that sufficient information is provided to the Competent Authority to screen out sites where no LSE is demonstrated, and enable an AA where no LSE cannot be demonstrated.

The European sites in proximity to the Robin Rigg OWF are (estimated distance from the OWF given in brackets):

- Solway Firth SPA (an extension of the Upper Solway Flats & Marshes Special Protection Area (SPA)) (0km);
- Solway Firth SAC (>5km); and
- Luce Bay and Sands SAC (>45km).

The features and conservation objectives relevant to each European site are described in Appendix B.

As the works will be at considerable distance from both the Luce Bay and Solway Firth SAC's it is considered that the small-scale nature of the work and complete lack of direct interaction will ensure that there is no LSE on either site.

The potential for Likely Significant Effects (LSE) cannot be ruled out for the Solway Firth SPA. An assessment of potential impacts on ornithological receptors is presented in Section 3.7.2. The conclusion of this assessment is that no significant impacts will arise on any feature of the Solway Firth SPA, and as such no adverse effects on integrity will occur.

It is considered that based upon the highly localised nature and short timeframe of this work, the only additional work that may act in-combination is routine operational maintenance at the Robin Rigg OWF site. Based upon this, it is concluded that the scour protection work, which will last a maximum of two weeks, will not lead to a significant in-combination impact and it can be concluded that there will be no adverse effect on site integrity in-combination with other plans and projects.

5. Water Framework Directive Assessment

The remedial scour protection works will be implemented in a naturally highly-dynamic environment where there are daily fluctuations in SSC levels within tidal cycles. The addition of rock for scour protection measures, into the existing environment will not affect water quality. Rock will be sourced appropriately and any risk from transportation (including pollution) will be addressed through project specific measures such as the Emergency Response Plan (ERP) (Robin Rigg ERP - ROB-HSSE-ERP-904 v16) which will be submitted alongside this application.

Where applicable, water quality was assessed within the ES within individual receptor topic chapters, and has been presented in relevant tables in the 'ES Predictions and Validation' sections (Section 0). No effects are predicted on water quality.

6. Summary and Conclusions

Turbines at the Robin Rigg OWF are experiencing scour in places where the northern region of the site has been subject to a global lowering of the seabed.

In order to mitigate the effects of the scour experienced, remedial scour protection works are required imminently to prevent any further scour from affecting the function of the turbines. This assessment focussed on the addition of rock at the two locations (B4 and C4) on a number of receptors, namely; benthic ecology, fish and shellfish ecology, migratory fish, marine mammals and birds. Other topics were considered but screened out following initial assessment (Section 3.2, Table 3.1).

The effects of the addition of scour protection material have been determined to be non-significant, and there are no adverse effects on the integrity of any designated sites. In addition, assessments against other relevant legislation (i.e. WFD, and the Habitats Regulations) have found no impact on water quality, and no requirement for a derogation licence under the habitats regulations for EPS.

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Appendices

A. EPS Risk Assessment

The EPS risk assessment in based upon the worst-case scenario of Installation Method Option 1 for the scour protection works (section 2.3).

The main potential routes to impact from the proposed scour protection work will be:

- Increased anthropogenic noise from:
  - Geophysical survey systems (multi-beam echosounder (MBES)) used during the scour protection installation;
  - Rock placement; and
  - Vessel noise.
- Vessels:
  - Collision risk

Increased anthropogenic noise from the scour protection work has the potential to result in auditory injury and disturbance to marine mammals in the vicinity of the wind farm area. As a result, it has been assessed further in Table A.1 below.

The species likely to be present during the proposed work (e.g., harbour porpoise) are small, agile, and not typically susceptible to collisions. Due to the limited time frame of the works (two weeks, weather dependant) and the low maximum number of vessel movements (38), collision risk with marine mammals is considered to be very unlikely. In addition, the vessels associated with the scour protection installation works are not considered to significantly increase the amount of vessel traffic in the Solway Firth. Nonetheless, mitigation, in the form of transit watches, will be undertaken for fast traveling work vessels (≥ 14 knots). Any sightings will be communicated to the Master of the vessel who will adhere to the Scottish Marine Wildlife Watching Code (see http://www.marinecode.org/). With the implementation of this mitigation it is considered that the potential for vessel collisions with marine mammals during the proposed works will be negligible and therefore it is not assessed further in Table A.1 below.

Table A.1: EPS Risk Assessment: Increased Anthropogenic Noise from Scour Protection Activities

Item	Project Information
Project	Robin Rigg OWF
Proposed work	Scour protection (rock placement) at two WTGs.
Location (coordinates)	Solway Firth (54°45.840'N, 003°42.342'W)
Water depth	<10m
Anticipated vessels, timing and duration	One side stone dumping installation vessel (SSDV) and two bulk carriers making a combined total of 38 vessel movements. Work to commence in Q2 or Q3 and last a maximum of 2 weeks (14 days).
Key European Protected Species (EPS) in the area	Harbour porpoise (*Phocoena phocoena*)
Any relevant designated sites in the vicinity of the proposed work	No designated sites in vicinity of proposed work.
Source levels and impact ranges	See Table A2

Item	Project Information
Potential for auditory injury?	MBES: No potential for auditory injury because sound emitted by the MBES is out with the hearing range for all species (Table A.2 & A.3). Rock placement: No potential for auditory injury (source level is less than PTS threshold for all species; Table A.2 & A.3). Vessel noise: No potential for auditory injury (source level is less than PTS threshold for all species; Table A.2 & A.3).
Potential for disturbance?	MBES: No potential for disturbance because sound emitted by the MBES is out with the hearing range for all species (Table A.2 & A.3). Rock placement: There is potential for disturbance as a result of noise from the placement of rock (Table A.2). Vessel noise: There is potential for disturbance from vessel noise associated with the scour protection works (Table A.2).
If yes, how many individuals have the potential to be disturbed?	For both rock placement and vessel noise it is expected that <1 harbour porpoise will be disturbed as a result of the scour protection works. The greatest of the potential impact ranges presented in Table A.2 was used to estimate the number of individuals that have the potential to be disturbed using the following formula: Area = πr^2 where r = impact range (km). Area of the zone of potential impact 0.95 km^2. Local porpoise density is 0.5153 animals/km^2 (SCANS-IV Block CS-E; Gilles *et al*., 2023). Number of porpoises with potential to occur in the zone of potential impact (and therefore be disturbed) = 0.49.
Any mitigation proposed?	No, due to no potential for auditory injury and negligible potential for disturbance of EPS.
Any offence under the Habitats Regulations which transpose the Habitats Directive into UK law?	No.
Is an EPS licence required?	No EPS licence required.

Table A.2: Proposed activities, source levels and impact ranges for harbour porpoise (*Phocoena phocoena*)

Activity	Frequency within auditory bandwidth?	Estimated source level (dB re 1 µPa at 1 m)	Impact range for auditory injury (m)	Impact range for a behavioural response (m; harbour porpoise)
Multi-Beam Echo Sounder (MBES)	Outwith hearing range (200 – 400 kHz)*	N/A	N/A	N/A
Rock placement	Audible	172	<1	550
Vessel noise	Audible	Medium vessels: 161	<1	110

Activity	Frequency within auditory bandwidth?	Estimated source level (dB re 1 µPa at 1 m)	Impact range for auditory injury (m)	Impact range for a behavioural response (m; harbour porpoise)
		Large vessels: 168	<1	200

Source: Sweeney (2018).

**See Table 2.1*

Table A.3: Estimated auditory bandwidth and instantaneous permanent threshold shift (PTS) thresholds (peak SPL; dB re 1 µPa) for the different functional hearing groups.

Functional hearing group	Example species	Estimated auditory bandwidth (kHz)	Peak SPL (dB re 1 µPa at 1 m)
Low frequency cetaceans	Minke whale	0.007 – 35	219
High frequency cetaceans	Bottlenose dolphin	0.15 – 160	230
Very high frequency cetaceans	Harbour porpoise	0.2 – 180	202
Phocid carnivores in water	Grey seal Harbour seal	0.5 – 86	218

Source: NOAA (2018); Southall et al. (2019).

B. European Site Features and Conservation Objectives

Table B.1: European Sites: Features and Conservation Objectives

Site	Feature	Conservation Objectives
Solway Firth SPA	Red-throated diver (*Gavia stellata*); Whooper swan (*Cygnus cygnus*); Barnacle goose (*Branta leucopsis*); Golden plover (*Pluvialis apricaria*); Bar-tailed godwit (*Limosa lapponica*); Pink footed goose (*Anser brachyrhynchus*); Common shelduck (*Tadorna tadorna*)*; Common teal (*Anas crecca*)*; Northern pintail (*Anas acuta*); Northern shoveler (*Anas clypeata*)*; Greater scaup (*Aythya marila*); Common scoter (*Melanitta nigra*)*; Common goldeneye (*Bucephala clangula*)*; Goosander (*Mergus merganser*)*; Eurasian oystercatcher (*Haematopus ostralegus*); Red knot (*Calidris canutus*); Ringed plover (*Charadrius hiaticula*); Grey plover (*Pluvialis squatarola*)*; Northern lapwing (*Vanellus vanellus*)*; Dunlin (*Calidris alpina*)*; Sanderling (*Calidris alba*)*; Common redshank (*Tringa totanus*); Ruddy turnstone (*Arenaria interpres*)*; Eurasian curlew (*Numenius arquata*); Great cormorant (*Phalacrocorax carbo*)*; Black-headed gull (*Larus ridibundus*)*; Common gull (*Larus canus*)*; and Herring gull (*Larus argentatus*). The Solway Firth SPA also supports Waterfowl assemblage, non-breeding (* denotes a named qualifier of the water bird assemblage).	1. To ensure that the qualifying features of the Solway Firth SPA are in favourable condition and make an appropriate contribution to achieving Favourable Conservation Status. 2. To ensure that the integrity of the Solway Firth SPA is maintained or restored as appropriate, in the context of environmental changes by meeting objectives 2a, 2b and 2c for each qualifying feature: - 2a. The populations of the qualifying features are viable components of the site. - 2b. The distributions of the qualifying features throughout the site are maintained, or where appropriate, restored by avoiding significant disturbance of the species. - 2c. The supporting habitats and processes relevant to the qualifying features and their prey/food resources are maintained or where appropriate, restored.
Solway Firth SAC	<u>Habitats</u> - Atlantic salt meadows; - Coastal shingle vegetation outside the reach of waves; - Dune grassland (Priority habitat);	To avoid deterioration of the qualifying habitats (listed below) thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for each of the qualifying

Site	Feature	Conservation Objectives
	- Estuaries; - Glasswort and other annuals colonising mud and sand; - Intertidal mudflats and sandflats; - Reefs; and - Subtidal sandbanks.	features; and To ensure for the qualifying habitats that the following are maintained in the long term: - Extent of the habitat on site; - Distribution of the habitat within site; - Structure and function of the habitat; - Processes supporting the habitat; - Distribution of typical species of the habitat; - Viability of typical species as components of the habitat; and - No significant disturbance of typical species of the habitat
	<u>Species</u> - River lamprey (*Lampetra fluviatilis*); and - Sea lamprey (*Petromyzon marinus*)	To avoid deterioration of the habitats of the qualifying species (listed below) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for each of the qualifying features; and To ensure for the qualifying species that the following are maintained in the long term: - Population of the species as a viable component of the site; - Distribution of the species within site; - Distribution and extent of habitats supporting the species; - Structure, function and supporting processes of habitats supporting the species; and - No significant disturbance of the species.
Luce Bay and Sands SAC	<u>Habitats</u> - Coastal dune heathland (priority habitat); - Dune grassland (priority habitat); - Intertidal mudflats and sandflats; - Reefs; - Shallow inlets and bays; - Shifting dunes; - Shifting dunes with marram; and - Subtidal sandbanks	To avoid deterioration of the qualifying habitats (listed below) thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for each of the qualifying features; and To ensure for the qualifying habitats that the following are maintained in the long term: - Extent of the habitat on site; - Distribution of the habitat within site;

Site	Feature	Conservation Objectives
		- Structure and function of the habitat; - Processes supporting the habitat; - Distribution of typical species of the habitat; - Viability of typical species as components of the habitat; and - No significant disturbance of typical species of the habitat.

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