CLARUS OFFSHORE WIND FARM LIMITED

Investigative Foreshore Licence Application for Site Investigations: Reference FS006886

Risk Assessment for Annex IV Species

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GLOSSARY

BEIS
Department for Business, Energy & Industrial Strategy

COWF
Clarus Offshore Wind Farm

DAHG
Department of Arts, Heritage and the Gaeltacht

EDR
Effective Deterrence Range

EMODnet
European Marine Observation Data Network

EU
European Union

HF
High Frequency (Cetaceans)

HZ
Hertz

IWDG
Irish Whale and Dolphin Group

JNCC
Joint Nature Conservation Committee

kHZ
Kilohertz

LF
Low Frequency (Cetaceans)

MBES
Multibeam Echosounder

NM
Nautical Mile

MU
Management Unit

NPWS
National Parks & Wildlife Service

OCW
Other Carnivores in the Water

PCW
Phocid Carnivores in Water

PTS
Permanent Threshold Shift

SAC
Special Area of Conservation

SBP
Sub-bottom Profiler

SEL
Sound Exposure Level

SMRU
Sea Mammals Research Unit

SPL
Sound Pressure Level

SSS
Side Scan Sonar

TTS
Temporary Threshold Shift

VHF
Very High Frequency (Cetaceans)

1. INTRODUCTION

1.1 Introduction

Clarus Offshore Wind Farm Limited, a subsidiary project company of DP Energy Ireland, is investigating the feasibility of developing an offshore wind farm off the west coast of Ireland, the Clarus Offshore Wind Farm (COWF). Clarus Offshore Wind Farm is a key part of a wider portfolio of offshore wind projects that DPEI is developing with joint venture partner Iberdrola.

The Foreshore Licence Application Area covers the area within territorial waters (from the 12 nautical mile (NM) limit to the high-water mark along both County Kerry and County Clare), which contains the Cable Investigation Area associated with the COWF. The Foreshore Licence Application Area covers 93,622 hectares (ha) and is illustrated in Map 1 (Figure 1-1, Map 1).

Clarus Offshore Wind Farm Limited intends to carry out the proposed site investigations within this Foreshore Licence Application Area, under Foreshore Licence application FS006886, to investigate potential export cable corridors and landfall areas, and to assess the associated seabed. Geophysical and geotechnical survey equipment, and noise generated by vessels for all surveys have the potential to affect Annex IV species. The proposed site investigations are described in Section 1.3 below.

Under the European Communities (Birds and Natural Habitats) Regulations 2011 (S.I No. 477 of 2011), it is an offence to deliberately disturb Annex IV species, particularly during the period of breeding, rearing, hibernation or migration. This Risk Assessment for Annex IV Species is intended to provide necessary information to establish whether there is a risk of an offence being committed and if a derogation licence will be required for the proposed site investigations.

1.2 Guidance

Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (the Habitats Directive) provides a strict protection regime for species listed in Annex IV of the Directive, across their entire natural range within the European Union, both within and outside of European protected sites.

The requirements of the Habitats Directive are transposed into Irish statute through the European Communities (Birds and Natural Habitats) Regulations 2011 (S.I No. 477 of 2011). With regard to Annex IV species, it is an offence under Section 51(2) of the Regulations to:

a. deliberately capture or kill any specimen of these species in the wild,

b. deliberately disturb these species particularly during the period of breeding, rearing, hibernation and migration,

c. deliberately take or destroy eggs of those species from the wild,

d. damage or destroy a breeding site or resting place of such an animal, or

e. keep, transport, sell, exchange, offer for sale or offer for exchange any specimen of these species taken in the wild, other than those taken legally as referred to in Article 12(2) of the Habitats Directive.

Derogation licences may be granted by the Minister for Housing, Local Government and Heritage which would allow an otherwise illegal activity to go ahead in a controlled manner provided that:

- there is no satisfactory alternative; and
- the derogation is not detrimental to the maintenance of the populations of the species to which the Habitats Directive relates at a favourable conservation status in their natural range.

Favourable conservation status (of a species) is defined in the European Communities (Birds and Natural Habitats) Regulations 2011 as the conservation status of a species when –

a. population dynamics data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats, and

f. the natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future, and

g. there is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis.

The Department of Arts, Heritage and the Gaeltacht "Guidance to Manage the Risk to Marine Mammals from Man-made Sound Sources in Irish Waters" published in 2014, was provided as official guidelines and codes of practice under Regulation 71 of the European Communities (Birds and Natural Habitats) Regulations 2011. This reference has been used to determine the content required for this Risk Assessment of Annex IV Species.

1.3 Objective and Scope

The DAHG (2014) guidance considers that certain activities that produce loud noises in areas where Annex IV species could be present, have the potential to result in an injury or disturbance offence unless appropriate mitigation is implemented. The aspects of the proposed site investigations which have the potential to effect Annex IV species are:

- Increased underwater noise from geophysical survey.
- Increased underwater noise from the geotechnical survey.
- Increased underwater noise from survey vessels and equipment associated with other survey activities.
- Increased collision risk (from presence of vessel(s) and equipment).

Marine species which are Annex IV and have been considered by the risk assessment are:

- All cetaceans
- Marine turtles (*Caretta caretta, Chelonia mydas, Lepidochelys kempii, Eretmochelys imbricate, Dermochelys coriacea*)
- European otter (*Lutra lutra*)
- Atlantic sturgeon (*Acipenser sturio*)

For the purposes of this assessment, a qualitative approach has been taken using existing literature as this was considered proportionate to the proposed site investigations and their potential to generate underwater sound changes which could affect Annex IV species.

405000 420000 435000 450000 465000 480000 495000 510000

685000 670000 655000 640000 625000

N

510000 E, 695000 N

Foreshore Licence Area 93,622 ha

405000 E, 625000 N

0 3 6 12 Kilometers

Foreshore Licence Map 1

Clarus Offshore Wind Farm

File Number: FS006886

Legend

- Foreshore Licence Application Area
- Contiguous Project Area
- High Water of Medium Tides
- Irish Territorial Sea 12 nm Limit

Ver	Date	Drawn by	Checked	Approved
V2	30/09/2021	[redacted]	[redacted]	[redacted]

Map prepared by: [redacted]
MEngSc in Environmental Engineering, PGD in Sustainable Energy, HDGGIS

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2. PROJECT DESCRIPTION

2.1 Overview

The proposed site investigations will involve geophysical, geotechnical, archaeological, ecological, wind resource and metocean surveys. The main sources of underwater noise are from the geophysical survey, geotechnical survey, and vessel engines for all surveys. The equipment deployed for the other surveys does not generate underwater noise. The only noise associated with it is from the machinery e.g. cranes and winches used to deploy the equipment. This noise will be masked by the use of the vessel thrusters and engines required to hold the vessel on station whilst equipment is deployed.

2.2 Geophysical Survey

2.2.1 Purpose

The purpose of the proposed geophysical surveys is to determine the geophysical characteristics of the Foreshore Licence Application Area. The geophysical surveys will involve:

- Mapping the water depth to the seabed (bathymetry) within the Foreshore Licence Application Area;
- Mapping the seabed and sub-surface to optimise cable routing within the Foreshore Licence Application Area. This will also enable assessment of cable burial depth;
- Planning the scope and positioning of the geotechnical sampling programme within the Foreshore Licence Application Area;
- Identifying marine habitat areas within which the benthic survey could be undertaken.
- Determining sensitive marine habitats that may need to be avoided during geotechnical and environmental sampling and potential infrastructure installation; and
- Providing the geophysical data from which a marine archaeological assessment can be undertaken to inform future Environmental Impact Assessment as part of any future consenting process.

2.2.2 Equipment

Indicative equipment for the geophysical surveys, along with its characteristics is set out in Table 2-1 below.

Table 2-1 Characteristics of geophysical survey equipment

Equipment type	Purpose	Frequency (kHz)	Source level SPL (peak) in dB re 1 µPa	Source
Multibeam Echosounder (MBES)	A remote sensing acoustic device typically attached to a vessel's hull. The purpose is to map the water depth to seabed (bathymetry).	200 - 500	210 - 245	Danson (2005), Hopkins (2007), Genesis (2011), Lurton and DeReutier (2011), BEIS (2020)
Side Scan Sonar (SSS)	Sends and receives acoustic pulses to detect objects (pipelines, shipwrecks etc) and enable classification of surficial marine geology	300 -900	200 - 240	BOEM (2019), BEIS (2020), DAHG (2014)

Equipment type	Purpose	Frequency (kHz)	Source level SPL (peak) in dB re 1 µPa	Source
	(sediment type, outcrops, bedforms)			
Sub-Bottom Profiler (SBP)	Sends short pulses to the seafloor and are used to image geological layers and sediment thicknesses beneath the seabed. Types of SBP systems include pingers, boomers and Chirp, which have different frequencies.	Overall: 0.5 – 40 Pingers: 2.5 - 7 Boomers: 0.5 - 5 Chirp: 3-40	196 – 225	Danson (2005), King (2013), BOEM (2016), BEIS (2020)
Magnetometer/ Gradiometer	Detects ferromagnetic anomalies in the seafloor such as pipelines, cables, debris and unexploded ordnance	No sound emitted	No sound emitted	N/A

2.2.3 Survey points and spacing

The swathe width for each piece of equipment will vary depending on water depth. It is anticipated that the width of each swathe will allow for a 50% overlap between each swathe.

2.2.4 Vessel

Geophysical survey vessels are typically between 15m and 60m in length and typically have an endurance of approximately 14 days. These vessels are likely to use a local port for mobilisation and replenishment. Continuous underwater noise will be produced by the survey vessel and the use of thrusters for dynamic positioning. Typically, continuous sound will be non-pulsed and can be broadband, narrowband or tonal and will be continuous over a period of 24-hours. For vessels such as those used for geophysical survey the frequency range is 50-300 kHz with a sound pressure level (RMS) of 160-175 dB re 1 μPa^2 @ 1m (NPWS, 2014).

2.2.5 Duration

The exact timings and duration of the survey is yet to be determined. This assessment takes a precautionary approach and assumes the survey could be conducted at any time of year, realistically operations are more likely to take place between the months of April and October for best weather and sea conditions.

The survey is expected to take approximately 3 months.

2.3 Geotechnical Survey

2.3.1 Purpose

The purpose of the proposed geotechnical survey is to evaluate the nature and mechanical properties of the superficial seabed sediments and intertidal sediments within the Foreshore Licence Application Area.

Geotechnical sampling will comprise of the following:

a. Up to 130 no. Vibrocore Samples
b. Up to 130 no. Cone Penetration Tests (CPT)
c. Up to approximately 6 no. Boreholes

Of these, only vibrocore sampling and borehole drilling will generate significant noise which has potential to affect marine mammals.

2.3.2 Equipment

Indicative equipment for the geotechnical surveys, along with its characteristics is set out in Table 2-2 below.

Table 2-2 Characteristics of geophysical survey equipment

Equipment type	Purpose	Frequency (kHz)	Source level SPL (peak) in dB re 1 µPa	Source
Vibrocore	Used to retrieve a soil sample by penetrating the seabed with a tube using a vibration mechanism.	<1	Up to 180-190	BOEM (2017), Reiser (2017)
Cone Penetration Test	A CPT will be used to test the characteristics of the soil by pushing an instrumented cone into the ground at a constant speed, with continuous measurement of the cone end resistance, the friction along the sleeve of the cone and the pore water pressure.	No sound emitted	No sound emitted	BOEM (2017)
Borehole Drilling	Drilling into the seabed to recover samples and to enable downhole geotechnical testing to be completed. A drilling head is lowered to the seabed via a drill string. The drill string is then rotated to commence boring. Tools are lowered into the drill string to recover samples or conduct in-situ soil and rock testing.	0.002 - 50	142 - 190	BEIS (2020) DAHG (2014) Erbe and McPherson (2017)

2.3.3 Survey points and spacing

The exact location, quantity, type, and penetration of the geotechnical samples will be determined following interpretation of geophysical survey data. This will be undertaken on board the survey vessel, if the geophysical and benthic surveys are undertaken as one campaign. Proposed geotechnical sample locations will be communicated to the Underwater Archaeology Unit in the Department of Housing, Local Government and Heritage for approval ahead of works commencing. Proposed locations will be accompanied by an assessment of the geophysical data by a qualified and experienced marine archaeologist.

2.3.4 Vessel

Geotechnical survey vessels are typically between 55m and 90m in length and typically have an endurance of approximately 28 days. The port of mobilisation for the geotechnical survey vessels will depend on where those vessels are deployed for preceding work packages. As such, the port of mobilisation may be Irish, UK, or another European location.

2.3.5 Duration

The exact timings and duration of the survey is yet to be determined. This assessment takes a precautionary approach and assumes the survey could be conducted at any time of year, realistically operations are more likely to take place between the months of April and October for best weather and sea conditions. The survey is expected to take approximately 3 months.

3. WEST COAST IRELAND MARINE SPECIES BASELINE

3.1 Cetaceans

Of the 24 species of cetacean recorded in Irish waters, approximately 10 of these had been recorded off the west coast and may be present in the Foreshore Licence Application Area at least on a seasonal basis. These species are listed in Table 3-1. The most commonly sighted species are common dolphin (*Delphinus delphis*), common bottlenose dolphin (*Tursiops truncates*) and harbour porpoise (*Phocoena phocoena*), with other species rare or occasional visitors. It is unlikely that deep water species such as the blue whale (*Balaenoptera musculus)* and long-fined pilot whale (*Globicephala melas)* will be present (Reid et al. 2003).

The Irish Whale and Dolphin Group (IWDG) website (http://www.iwdg.ie/) has 370 records of cetacean sightings either within the Foreshore Licence Application Area or within an approximately 20km radius of the Foreshore Licence Application Area for the period November 2019 to October 2021. Species identified included harbour porpoise; minke whale (*Balaenoptera acutorostrata)*; Risso's dolphin (*Grampus griseus)*; common bottlenose dolphin; common dolphin; fin whale (*Balaenoptera physalus)* and humpback whale (*Megaptera novaeangliae)*. Minke whale and humpback whale were frequently sighted south of the Foreshore Licence Application Area on a seasonal basis. Observations of species within the Foreshore Licence Application Area have been included in Table 3-1.

Most cetaceans are wide-ranging, and individuals encountered within Irish waters form part of a much larger biological population whose range extends into adjacent jurisdictions. As a result, management units (MUs) have been outlined for seven of the common regularly occurring species following advice from the Sea Mammals Research Unit (SMRU) and the International Council for the Exploration of the Sea (ICES). These provide an indication of the spatial scales at which effects of anthropogenic activities should be taken into consideration. The relevant MUs are listed in Table 3-1.

Table 3-1 Sightings and strandings for commonly occurring cetaceans within the Foreshore Licence Application Area and surrounding waters

Species	Frequency of sightings*	IWDG sightings (November 2019 – October 2021)**	Applicable MU***	Abundance of animals in MU***
Short-beaked common dolphin (*Delphinus delphis*)	Peak period is summer and Autumn and November peak on the south coast associated with prey items.	73 sightings some of which are within the Foreshore Licence Application Area. Recorded during all months of the year.	Celtic & Greater North Seas	56,556
Common bottlenose dolphin (*Tursiops truncatus*)	Common year round but most frequent in summer.	76 sightings some of which are within the Foreshore Licence Application Area. Recorded during all months of the year.	West Coast of Ireland. Shannon Estuary	No data available
Harbour porpoise (*Phocoena phocoena*)	Common from June through the autumn. Peak period in July and August. Low numbers recorded for the remainder of the year.	29 sightings some of which are within the Foreshore Licence Application Area. Recorded during all months of the year.	Celtic and Irish Seas	47,229

Species	Frequency of sightings*	IWDG sightings (November 2019 – October 2021)**	Applicable MU***	Abundance of animals in MU***
Risso's dolphin (*Grampus griseus*)	Occasional sightings, peak sightings in May and July	10 sightings to the south of the Foreshore Licence Application Area; May-November	Celtic & Greater North Seas	No data available
Long-finned pilot whale (*Globicephala melas*)	Primarily occur in deep waters, highest number of sightings in summer and autumn.	No sightings	N/A	No data available
White-beaked dolphin (*Lagenorhynchus albirostris*	Irregular in Irish Sea. More regular in late summer – autumn.	No sightings	Celtic & Greater North Seas	15,895
Killer whale (*Orcinus orca*)	Occasional sightings in Irish Sea waters.	No sightings	N/A	No data available
Minke whale (*Balaenoptera acutorostrata*)	Peak period July and August, less common throughout the year.	77 sightings; March - November	Celtic & Greater North Seas	23,528
Humpback whale (*Megaptera novaeangliae*)	Occasional sightings from February to March	65 sightings; May – December. The majority of which are to the south of the Foreshore Licence Application Area.	N/A	No data available
Fin whale (*Balaenoptera physalus*)	Occasional sightings with the highest number of sightings recorded from October to December.	9 sightings to the south of the Foreshore Licence Application Area ; July – August	N/A	No data available

Sources: * Marine Institute (2020b) and Reid et al. (2003); ** IWDG (2020) ***ICES Management Units D (Irish seas) and DECC (2016).

The following summarises the species regularly sighted within the Foreshore Licence Application Area:

3.1.2 Short-beaked common dolphin

Common dolphin are one of the most abundant species off the west coast of Ireland and are permanent residents within Irish waters, being recorded all year round. Within the Foreshore Licence Application Area, the IWDG recorded 73 sightings of common dolphin between 2019 – 2021 with sightings occurring in all months of the year with a peak period in summer and autumn. The population is part of the Celtic & Greater North Seas Management Unit (JNCC, 2015), but there are no European protected sites for this species in Irish waters.

3.1.3 Common bottlenose dolphin

This species is also a frequent sighting off the west coast of Ireland and is a permanent resident within Irish waters, being recorded all year round. Within the Foreshore Licence Application Area, the IWDG recorded 76 sightings of common bottlenose dolphin between 2019-2021 with sightings occurring in all months of the year, though most frequently in summer. The Foreshore Licence Application Area overlaps the Lower River Shannon SAC which is designated for populations of common bottlenose dolphin. The Shannon Estuary is a typical and important habitat for the species, with research showing that dolphins are resident, occur throughout the year and that the estuary is an important calving area (Berrow et al. 1996; Ingram 2000). The latest summer abundance estimate for the lower Shannon Estuary SAC is 139 (±15 standard error (SE)) (Rogan et al. 2018), with smaller numbers using the estuary in the wintertime (Rogan et al. 2018; Englund et al., 2008). Within the framework of the

species' range, current population definition and its ecology, the Shannon Estuary is therefore a critical habitat for bottlenose dolphins (Rogan et al 2002) in both a national and a European context.

The Foreshore Licence Application Area lies within two MUs for common bottlenose dolphin, the West Coast of Ireland Management Unit and the Shannon Estuary Management Unit (JNCC, 2015).

A further four SACs list common bottlenose dolphin as a Qualifying Interest in Irish waters, namely: Slyne Head Islands SAC, Slyne Head Peninsula SAC, Duvillaun Islands SAC and West Connacht Coast SAC.

3.1.4 Harbour porpoise

Harbour porpoise were commonly sighted of the west coast of Ireland and are common from June through the Autumn with low numbers recorded for the remainder of the year. The IWDG recorded 29 sightings within the Foreshore Licence Application Area and approximately 20km radius between 2019 – 2021. The Foreshore Licence Application Area is within the Celtic and Irish Sea Management Unit for harbour porpoise. Within this Management Unit, there are five SACs designated for the conservation of harbour porpoise; Rockabill to Dalkey Island SAC and the Roaringwater Bay and Islands SAC in Irish waters; and the Bristol Channel Approaches / Dynesfeydd Môr Hafren SAC, West Wales Marine / Gorllewin Cymru Forol SAC; North Anglesey Marine/ Gogledd Môn Forol SAC in UK waters (Joint Nature Conservation Committee, JNCC 2020a). As harbour porpoise are highly mobile species, animals from these European Sites may be visitors to the Foreshore Licence Application Area.

3.2 European Otter

European otter are protected within Ireland under the Wildlife Amendment Act (2000) where it is illegal to hunt, disturb, or intentionally kill otter. The otter is also listed on Annex II and Annex IV of the EU Habitats Directive (92/43/EEC). A review of the National Biodiversity Data Centre (https://maps.biodiversityireland.ie/) for 2005 to 2021 showed occurrences of otter and otter signs along the coastline adjacent to the Foreshore Licence Application Area with the oldest recording from 1905 and the latest in 2019 (National Biodiversity Data, 2021). Otter are also listed as a Qualifying Interest of the Lower River Shannon SAC.

3.3 Common Sturgeon

Common sturgeon (*Acipenser sturio*) migrate along the Atlantic coast of Europe from the Bay of Biscay to the Bristol Channel and North Sea. Based on the small population size, sturgeon are a rare visitor to North European waters, with the National Biodiversity Data Centre only having seven records of sightings within Irish waters since 1960, with the most recent sighting recorded for 1983. All records are on the east coast of Ireland in the Celtic or Irish Sea. It is extremely unlikely that common sturgeon will be present within the Foreshore Licence Application Area.

3.4 Chelonians

There are few recordings of sea turtle species in Ireland. Of the seven sea turtle species, only leatherbacks (*Dermochelys coriacea*) are found to forage widely in temperate waters visiting Ireland's coast in summer and autumn. Biodiversity maps from the National Biodiversity Data Centre (www.maps.biodiversityireland.ie), with data from 1838 to present, highlight the distribution of marine turtle records around the coast of Ireland but with low numbers, with just three sightings in the 1980s in the vicinity of the Foreshore Licence Application Area. A review of turtle occurrences by Botterell et al (2020) reports less than 120 sightings, strandings and captures of leatherback turtles along the west coast of Ireland between 1910 and 2018.

4. RISK ASSESSMENT

4.1 Risk of Injury or Disturbance from Underwater Noise Changes

4.1.1 Receptor Sensitivity

4.1.1.1 Cetaceans and otter

Cetaceans have evolved to use sound as an important aid in navigation, communication, and hunting (Richardson et al., 1995).

High intensity or prolonged noise can cause temporary or permanent changes to animals' hearing. Where the threshold of hearing is temporarily altered, it is considered a temporary threshold shift (TTS), and the animal is expected to recover. If there is permanent aural damage (permanent threshold shift (PTS) where the animal does not recover, social isolation and a restricted ability to locate food may occur (Southall et al., 2007).

Behavioural disturbance from underwater sound sources is more difficult to assess than injury and is dependent upon many factors related to the circumstances of the exposure. An animal's ability to detect sound depends on its hearing sensitivity and the magnitude of the sound compared to the background. In simple terms, for a sound to be detected it must be louder than background and above the animal's hearing sensitivity at the relevant sound frequency. The direction of the sound is also important. Cetacean are considered to have generalised hearing ranges. Minke whale hear in the range between 7Hz to 35kHz (low frequency (LF) cetacean). Dolphin and toothed whales hear in the range between 150Hz to 160kHz (high frequency (HF) cetacean). Harbour porpoise have hearing within the range 275Hz to 160kHz (very high frequency (VHF) cetacean) (Southall et al., 2019).

Introduced sound may cause behavioural responses in animals, such as individuals moving away from the sound source and remaining at a distance until the activities have passed. There may also be changes in foraging, migratory or breeding behaviours; all factors that can affect the local distribution or abundance of a species. Introduced sound may also cause masking or disruption of the animal's own signals, whether used for communication, foraging or other purposes. This may in turn affect foraging and reproductive opportunities. Behavioural disturbance to a marine mammal is hereafter considered as the disruption of natural behavioural patterns, for example: feeding, migration, breeding and nursing.

There are currently no studies which record the hearing range of Eurasian otters. Otter hearing is primarily adapted to air and is not underwater specialised, with lower sensitivity than in other amphibious marine carnivores such as seals and sea lions (Ghoul and Reichmuth, 2016). A study observing hearing in sea otters (*Enhydra lutris*) reported the otters aerial hearing at >22 kHz and low frequency at <2 kHz with reduced under-water hearing at frequencies below 1 kHz (Ghoul and Reichmuth 2016).

Southall et al (2019) separated marine mammals into auditory groups based on their functional hearing sensitivity. The generalised hearing ranges of these groups are provided by NMFS (2018) as summarised in Table 4-1.

Table 4-1 Marine mammal groups based on auditory bandwidth

Group (based on auditory bandwidth)	Species observed within and in proximity to the Foreshore Licence Application Area	Auditory range
Low-frequency cetaceans (LF)	Minke whale, Humpback whale, Fin whale	7Hz – 35kHz
High frequency cetaceans (HF)	Short-beaked common dolphin, Common bottlenose dolphin, White-beaked dolphin, Long-finned pilot whale, Northern bottlenose whale	150Hz – 160kHz
Very high frequency cetaceans (VHF)	Harbour porpoise	275Hz – 86kHz
Other carnivores in water (OCW)	European otter	60Hz – 39kHz

The thresholds for the onset of PTS and TTS, as published in Southall et al. (2019) are provided in Table 4-2. These reflect the current peer-reviewed published state of scientific knowledge.

Table 4-2 Injury thresholds for marine mammals from impulsive (SPL, unweighted) and continuous (SEL, weighted) sound

Auditory group	Impulsive noise		Continuous noise	
	SPL (unweighted) – dB re 1 µPa (peak)		SEL (24 hr, weighted) - dB re 1 µPa-2s	
	PTS onset	TTS onset	PTS onset	TTS onset
LF	219	213	199	179
HF	230	224	198	178
VHF	202	196	173	153
OCW	232	226	219	199

4.1.1.2 Marine turtles

Sea turtles are known to be able to detect (Ridgway et al. 1969, Bartol et al. 1999, Bartol & Ketten 2006) and respond to acoustic stimuli (Lavender et al. 2014, Martin et al. 2012, O'Hara & Wilcox 1990, DeRuitter & Doukara 2012), which they may use for navigation, prey location, predator avoidance as well as general environmental awareness (Piniak et al. 2016). Sea turtles have adapted their hearing for use underwater. It is likely that their body serves as a receptor while the turtle is underwater (Lenhardt 1983).

Electrophysiological and behavioural studies have demonstrated that sea turtles are able to detect low-frequency sounds both underwater and in air (Piniak et al. 2016). Sea turtles respond to aerial sounds between 50 and 2000 Hz and vibrational stimuli between 30 and 700 Hz, with maximum sensitivity values recorded between 300 and 500 Hz for both sounds (Ridgway et al. 1969). Leatherback turtles respond to underwater noise underwater noise stimuli between 50 and 1200 Hz, with a maximum sensitivity between 100 and 400 Hz (Piniak et al. 2012).

Overall, the biological significance of hearing in sea turtles remains poorly understood, but as low-frequency sound is most prevalent and travels the farthest in the marine environment, there may be some advantage to sea turtles in specializing in low-frequency sound detection. It is therefore believed that acoustic sound may provide important environmental cues for sea turtles (Piniak et al. 2016).

Data and discussions provided in Popper et al. (2014) indicate that the sensitivities applicable to fish are also applicable to sea turtles. Popper et al. (2014), Table 7.6 provides an impairment threshold of 210dB RMS re 1 µPa in relation to geophysical survey, whilst Table 7.7 indicates a recoverable injury

threshold of 170 dB re 1 µPa RMS for exposure of 48 hours, and a TTS threshold of 158 dB re 1 µPa RMS for exposure of 12 hours for continuous sound.

4.1.2 Assessment

4.1.2.1 Overview

Marine mammals

Background levels of sound will influence how marine species react to the temporary introduction of sound from the survey campaign. Parts of the Foreshore Licence Application Area experience high levels of marine traffic associated with the River Shannon navigation and approach channels and therefore the marine environment will already experience elevated levels of anthropogenic sound in addition to natural ambient sound levels. Most research has described changes in behaviour or damage (or not) to hearing in marine mammals due to underwater sound. In extreme cases, physical injury has also been reported due to underwater sound, but this effect has not been found associated with the proposed site investigations and therefore, has not been considered further in the assessment.

Marine turtles

Few data exist on the effects of geophysical survey on marine turtles. It is possible that exposure to seismic airguns would cause mortal injury if marine turtles are very close to the source. Behavioural responses in caged animals include rising to the surface and altered swimming patterns (Popper et al. 2014). As marine turtles detect sound at less than 1kHz, any effect will be in response to low frequency activities such as the boomer if used on the lowest operating frequency and the geotechnical sampling. Popper at al. (2014) class the relative risk of mortal injury or recoverable injury from low and mid-frequency sonar to turtles as low, and from seismic survey as high near to the source and low in the intermediate to far field. There is no information available for geotechnical sampling. As an analogy the threshold for injury from pile driving is 207dB peak (Popper et al. 2014). Sound pressure levels from the geotechnical survey will not exceed this threshold. Due to the rarity of marine turtles, including leatherback turtles, in the Foreshore Licence Application Area, and the discussion above, it is highly unlikely that marine turtles will experience any injurious or disturbance effects from the proposed site investigations.

Otter

The threshold for auditory injury in otter is similar to high frequency cetaceans. As physical injury to cetaceans is not considered further (as described above), otter have also not been considered further.

4.1.2.2 Vessel movements

For vessels such as those used for surveys the frequency range is 50-300 Hz with a sound pressure level (RMS) of 160-175 dB re 1 μPa^2 @ 1m (NPWS, 2014). The survey vessels will use thrusters sporadically throughout the proposed site investigations; therefore, the source level will fluctuate throughout the duration of the proposed site investigations within this range. The estimated sound levels exceed the thresholds for the onset of a temporary threshold shift, indicating that there is the potential for temporary auditory injury in cetaceans. However, the likelihood of potential injury has been assessed as low and limited to discrete windows during the proposed site investigations and only in close vicinity (<10m) to the works. It is assumed that all marine mammals will move away at a speed of 1.5m/s (Otani et al. 2000, Lepper et al. 2012) from a sound source level. This is considered conservative as there is data (McGarry et al. 2017, Kastelein et al. 2019, van Beest et al. 2018) to suggest that animals will, at least initially, move away at much higher speeds (e.g. harbour porpoise at 1.9m/s, Kastelein et al. 2019). During the proposed site investigations, the survey vessel will be operating at lower speeds, therefore it is expected that any individuals in proximity to the survey vessel will be able to move away from the area affected to avoid injurious noise levels. However, the

action of moving away from a sound level is a behavioural response. Whether this can be considered disturbance relates to whether the animal(s) is significantly affected by the response e.g. whether the sound will lead to a change in the animals' condition. Immediately following either the vessels transit through the area or the proposed site investigations overall, individuals will be able to return to the area.

There are no published guidelines available on disturbance thresholds due to the complexity and variability of the responses of cetaceans to anthropogenic disturbance. For the purposes of this assessment, the threshold for behavioural disturbance is 120dB re 1 µPa-2s (RMS) (Gomez et al. 2016, BOEM 2017, NMFS 2018) and has been used for continuous sound for all cetacean species. The likelihood of disturbance from continuous noise will depend on the types of vessel and cumulative effect of several vessels operating in the area.

The proposed site investigations should be considered in the context of the existing baseline sound environment. Shipping density within the Foreshore Licence Application Area is generally low, at approximately 1 -10 routes per 0.02km^2 per year (Marine Institute, 2020). However, there is a distinct area that intersects the centre of Foreshore Licence Application Area, running parallel to the coast, where there are approximately 42 to >250,000 routes per 0.02km^2 per year. Furthermore, it should be noted that marine traffic density originating from the River Shannon Estuary is high, ranging from 251 to >250,000 routes per 0.02km^2 per year. Shipping density within the Foreshore Licence Application Area is generally lower, however the high coastal shipping density in the surrounding coastal region suggests marine mammals are already habituated to higher levels of underwater sound. The change in underwater sound caused by the addition of the survey vessels for the proposed site investigations will not be noticeable above natural and anthropogenic noise in the region.

4.1.2.3 MBES

MBES are widely used in the marine environment to measure water depth by emitting rapid pulses of sound towards the seabed and measuring the sound reflected (BEIS 2020). Sound frequencies emitted, in water depths of less than 200m, are typically between 300 and 400kHz (Danson 2005, Hopkins 2007, Lurton and DeReutier 2011). The equipment which will be used in the surveys has a minimum frequency of 200 kHz. Sound source levels have been reported ranging from 210 – 245dB re 1µPa-m (Genesis 2011, Lurton and DeReutier 2011). Evidence has shown that MBES operating at greater than 200kHz do not cause behavioural responses in harbour porpoise (Dyndo et al. 2015). This is because the frequency range falls outside the hearing thresholds of cetaceans and the sound attenuates more swiftly than lower frequencies and operate at a lower power (JNCC 2017). The MBES survey will have a minimum frequency of 200kHz and will therefore not cause injurious or disturbance effects to cetacean. For the same reason, otter will also not be affected.

4.1.2.4 Side Scan Sonar and Sub-bottom Profiler

Side Scan Sonar systems operate at relatively high frequencies (between 300 - 900kHz) with the higher frequencies (above 160kHz) being outside the hearing thresholds of cetaceans and other marine mammals (Genesis 2011, JNCC 2010). Maximum source levels for Side Scan Sonar can be up to 200-240 dB re 1 µPa-m (peak SPL) (SCAR 2002). Little evidence of potential effects to marine mammals from Side Scan Sonar exists. The relatively high frequencies at which Side Scan Sonar operates will attenuate more swiftly than lower frequencies with sound levels reducing rapidly from the source.

Sub-bottom Profiler systems are used to produce images of the seabed. The resolution and type of images required determines which system is required. Pingers operate on a range of single frequencies between 3.5 kHz and 7 kHz. Boomers have a broader frequency between 500 Hz to 5 kHz and sparkers generate lower frequencies for maximum penetration in the seabed. CHIRP systems are modern systems designed to replace pingers and boomers. Chirp systems operate around a central frequency but alternate through a range of frequencies between 3 kHz to 40 kHz. Sub-bottom Profilers produce sound source levels between 196 and 225 dB re 1 µPa - 1m (rms SPL) which are therefore

audible to some marine mammals, particularly harbour porpoise (Danson 2005; King 2013; BOEM 2016).

Most sound energy generated by Side Scan Sonar and Sub-bottom Profilers will be directed towards the seabed and the pulse duration is very short with the survey constantly moving. Lower frequencies generated by Sub-bottom Profilers are within the hearing range of cetaceans, therefore this type of equipment could have localised, temporary effects on behaviour. The UK Department for Business, Energy & Industrial Strategy (BEIS) undertook noise modelling as part of a review of consented offshore wind farms in the Southern North Sea SAC (designated to conserve harbour porpoise) which was based on the maximum source levels and bandwidths obtained from a range of Sub-bottom Profilers. The results of the noise modelling demonstrated that for harbour porpoise in particular, the onset of Permanent Threshold Shift (PTS) could arise from between 17 m and 23 m from source and potential behavioural effects within 2.4 km and 2.5 km (BEIS 2020). This was a worst-case scenario based on the use of a Chirper with a peak SPL of 267 dB re 1 µPa-m.

The zone of ensonification based on the above survey methods are within proximity to the source, therefore cetaceans would need to be present in close proximity to the survey vessel and remain within the localised zone of ensonification for an extended period of time to experience injurious effects. Research has shown that cetaceans can swim away from a sound source level at a speed of 1.5m/s (Otani et al. 2000, Lepper et al. 2012). This is considered conservative as there is research to suggest that animals will move away at much higher speeds e.g. harbour porpoise at 1.9m/s (McGarry et al. 2017, van Beest et al. 2018; Kastelein et al. 2019), at least initially. During the proposed site investigations, the survey vessel will be operating at lower speeds, therefore it is expected that any individuals in proximity of the survey vessel will be able to move outside of the zone of ensonification to avoid injurious noise levels.

There are no published guidelines on disturbance thresholds due to the complexity and variability of the responses of marine mammals to anthropogenic disturbance. The UK JNCC have established an effective deterrent range (EDR) of 5km for geophysical surveys (JNCC 2020). The EDR represents the limit range at which disturbance effects have been detected (for example avoidance behaviour), specifically for harbour porpoise (Crocker & Fratantonio 2016, Crocker et al. 2019). On this basis, there is the potential for the proposed site investigations to induce a disturbance response in marine mammals, in particular very high and high frequency cetacean species. There is also the potential that as the EDR is wider in places than the River Shannon Estuary, there could be a barrier effect, preventing the Qualifying Interest common bottlenose dolphin accessing parts of the Lower River Shannon SAC.

The common bottlenose dolphin within the Lower River Shannon SAC are a genetically distinct population of approximately 107 individuals (NPWS, 2012). There is a seasonal migration out of the estuary during winter indicating that the SAC does not cover the entire home range of the population (Rogan et al. 2018). However, as the proposed site investigations are most likely to take place between the months of April to October, it can be expected that the highest numbers of animals will be present during the proposed geophysical surveys.

Evidence suggests that avoidance behaviour will be temporary, with individuals returning to the area affected once the sound has ceased (Bowles et al. 1994; Morton and Symonds 2002; Stone and Tasker 2006; Gailey et al. 2007; Stone et al. 2017). It is important to note that the proposed site investigations are temporary, being undertaken intermittently over the course of 3 months. Therefore, any individuals that are disturbed will be able to return to the Foreshore Licence Application Area as soon as the survey activity has ceased. However, as best practice, certain mitigation can be adopted into the design of the proposed site investigations to reduce the potential for a significant effect on cetaceans and specifically the common bottlenose dolphin of the Lower River Shannon SAC. This project specific mitigation is set out in Section 5 below. Implementation of the project specific mitigation, combined with the localised zone of influence and temporary nature of the proposed site investigations, will mean that disturbance effects to cetaceans will be temporary and not significant.

4.1.2.5 Vibrocore and Borehole Drilling

Vibrocores are used to retrieve soil samples by penetrating the seabed with a tube using a vibration mechanism. A pneumatic or electric vibrahead vibrates the tube, causing the sediment to liquify and facilitating penetration into the sediment. These vibrations emit low levels of noise, with a frequency of up to 1kHz, and a SPL of up to 180 to 190 dB re 1 µPa (BOEM, 2017). Borehole drilling has a wider frequency range up to 50kHz, but similar peak SPLs.

There is limited publicly available data on noise generated by geotechnical borehole. Underwater noise measurements were recorded from a jack-up barge undertaking geotechnical boreholes in Swansea Bay, Wales. This activity involved a percussion corer used to take soft sediment samples and rotary coring used for hard rock samples. Sediment varied through the site from soft muds to coarse sand. Sediments were typically 20m thick overlying sedimentary mud rock or shale. These conditions are similar to those identified in the EMODnet 2021 data within the Investigative Foreshore Licence Application Area and therefore the noise measurements provided below have been used as an analogy.

During soft sediment coring, in the Swansea survey, the highest sound pressure level recorded (at 23m from the JUB) was 107db re 1µPa (peak) at 10Hz. For hard rock drilling the highest sound pressure level was also 107dB re 1µPa (peak) at 10Hz but it was recorded at 7.5m from the JUB (Willis et al. 2010).

Noise measurements during geotechnical site investigations involving shallow core drilling to 16-17m in sand and mudstone, recorded source levels of 142–145 dB re 1 µPa rms @ 1 m (30–2000 Hz) (Erbe and McPherson 2017).

The sound pressure levels recorded for similar type geotechnical activity as the proposed site investigations are below the threshold at which auditory injury would occur in cetaceans. For the same reason, otter will also not be affected.

Evidence reported in Nedwell and Brooker (2008) from a drilling operation with a comparable SPL of 162dB dB re 1 µPa concluded that avoidance ranges for cetaceans were <100m from the activity.

The threshold for disturbance is lower than for injury, but activity will be short in duration at each location (<1 hour for vibrocores, and 12 hours for geotechnical boreholes). Cetaceans are therefore unlikely to be disturbed by noise from the geotechnical survey, unless they are in close proximity to the work. This is unlikely given that the presence of the survey vessel will likely lead to small-scale temporary displacement of cetaceans.

However, as best practice, certain mitigation can be adopted into the design of the proposed site investigations to reduce the potential for a significant effect on cetaceans and specifically the common bottlenose dolphin of the Lower River Shannon SAC. This project specific mitigation is set out in Section 5 below. Implementation of the project specific mitigation, combined with the localised zone of influence and temporary nature of the proposed site investigations, will mean that disturbance effects to cetaceans will be temporary and not significant.

4.1.2.6 Cumulative effects

The document submitted in support of this application as 'Environmental Supporting Information' identifies other projects in the region which could potentially interact with the proposed site investigations. These include potential site investigations for other offshore renewable projects which overlap with the Foreshore Licence Application Area.

For the purposes of assessment, it has been assumed that one or more site investigations could be undertaken in the same region as the Foreshore Licence Application Area simultaneously or consecutively. The assessment above concluded that the significance of the effect of the proposed site investigations on Annex IV species, with the implementation of mitigation measures, is not significant. However, there remains the possibility that if considered alongside other activities

occurring within the same region, the proposed site investigations could give rise to significant cumulative effects. This potential is discussed below.

Cumulative effects are likely to result where localised disturbance from more than one activity either occurs simultaneously, resulting in a wider zone of disturbance restricting foraging, migratory or breeding behaviour; or consecutively within a restricted area resulting in an extended period of disturbance or the production of a barrier restricting movements.

The intention is to commence the proposed site investigation activities as soon as feasible following award of Foreshore Licence, with a staged programme of site investigations over the next number of years to capitalise on suitable weather windows over this time period, likely during Spring and Summer. At this time, it is not known when the Foreshore Licences will be awarded or when the other project's site investigations will be conducted. As such, two scenarios were considered by this assessment. Firstly, that the proposed site investigations are conducted at the same time as another project, and secondly that they occur consecutively to another project. The first scenario is highly unlikely as data acquisition can be impaired if two or more geophysical surveys occur at the same time in proximity due to equipment interference. It is therefore more likely that site investigations would occur consecutively. This would result in an extension of the time period that marine mammals would be disturbed.

Given that Lower River Shannon SAC Lies (partially) within the Foreshore Licence Application Area, the greatest potential for a significant cumulative effect would be on common bottlenose dolphin within this SAC. The confined nature of the SAC within the estuary, and the fact that animals form a discrete genetic population, means that barrier effects or extended periods of disturbance could have a greater effect than would be normally experienced in open coastal waters.

Taking this into consideration, to reduce the significance of potential effects, mitigation has been proposed in Section 5 of this document. Implementation of this mitigation, combined with the temporary nature of the proposed site investigations, will mean that within the River Shannon Estuary cumulative effects to Annex IV species will be temporary and slight.

In open coastal waters, the potential cumulative effect has been assessed as temporary and not significant. This is based on the results of a study in the UK Southern North Sea SAC on the potential cumulative effects from a number of nearby windfarms on harbour porpoise (BEIS 2020). The study found that harbour porpoise displacement was temporary and harbour porpoise relocated elsewhere. It was concluded that seismic surveys would not have an adverse effect upon the integrity of the Southern North Sea SAC. The same behavioural response is likely in open coastal waters where marine mammals have the ability to avoid the temporary site investigation works.

4.2 Risk of Injury from Collision

There is the risk that animals could collide with survey vessels. Shipping collision is a recognised cause of marine mammal mortality worldwide, the key factor influencing the injury or mortality caused by collisions is the ship size and its travelling speed. A review of vessel collisions with marine animals undertaken by Schoeman et al (2020) identified that most important influences on severity of any potential impact are vessel size and speed, with small vessels being more likely to cause injury. Reduction of speeds to less than 10 knots was observed to reduce risk of lethal injury to marine animals by 50% (Vancerlaan and Taggart, 2007 within Schoeman et al, 2020). Several organisations recommend reduction of vessel speeds to less than 10-13 knots to reduce the risk of collision with marine mammals, basking shark and other marine species (e.g. Federal Register, 2008; JNCC, 2021; Ports of Auckland, 2015).

Vessels undertaking the surveys will be either stationary or travelling at a standard survey speed of approximately 5-7km/h, which is equivalent to approximately 2.7-3.8 knots, which is significantly slower than speeds associated with high marine mammal collision risk. Additionally, the collision risk

is lower than that posed by commercial shipping activity which typically operates at 14 knots. Therefore, risk of injury to Annex IV species from collision is very low, and the significance of any effects will be imperceptible.

5. PROJECT MITIGATION

The following mitigation is proposed:

- The contractor for the proposed site investigations will follow the Department of Arts, Heritage and the Gaeltacht (DAHG) 'Guidance to Manage the Risk to Marine Mammals from Man-made sound sources in Irish Waters' (DAHG 2014); specifically, Section 4.3.4 Geophysical Acoustic Surveys, and Section 4.3.2 Drilling.
- Clarus Offshore Wind Farm Limited will co-ordinate with any developers that are granted a Foreshore Licence within the region on the timing of site investigations to minimise cumulative impacts.

6. CONCLUSION

This risk assessment of the potential effects of proposed site investigations on Annex IV species (increased underwater noise from the survey equipment and vessels and risk of injury from collision with vessels) concluded that:

- The potential for auditory injury is nil or negligible.
- The potential for disturbance in open waters is negligible.
- The potential for disturbance of common bottlenose dolphin in the Lower River Shannon SAC is temporary and slight.
- The potential for physical injury from vessels is nil or negligible.
- There is the potential for cumulative effects on Annex IV species and mitigation has been proposed.
- There are no effects to fish or marine turtles from the proposed site investigations.

Temporary behavioural impacts (disturbance) to cetaceans will not be extensive, severe or biologically significant, given the transient and short-term nature of the activities. It is highly unlikely that disturbance would negatively impact upon the Favourable Conservation Status (FCS) of any species which may be present in the Investigative Foreshore Licence Application Area. The activities are temporary and transitory and set within a region where shipping noise is common, suggesting animals will exhibit a degree of habituation.

Implementation of best practice industry standard mitigation in the form of implementation of the DAHG 'Guidance to Manage the Risk to Marine Mammals from Man-made sound sources in Irish Waters' (DAHG 2014); in particular Section 4.3.4 Geophysical Acoustic Surveys and Section 4.3.2 Drilling, will reduce the risk of deliberate injury and disturbance to cetaceans to negligible levels.

It is considered that a Derogation Licence to disturb marine Annex IV species will not be required.

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