LIRIC MARINE GEOPHYSICAL & GEOTECHNICAL SURVEY

EPS and Wildlife Licence Supporting Information

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Contents

Glossary iv
Acronyms v
Units vi

1 INTRODUCTION 1
1.1 Background 1
1.2 Purpose of this document 1
1.3 Legislative Context 2
1.3.1 Scotland 2
1.3.2 Northern Ireland 3
1.4 Guidance 4
1.5 Licensable Operations 4
1.6 Sound Sources 4
1.7 Overriding Public Interest 9
1.8 No Satisfactory Alternatives 9
1.8.1 Do nothing 10
1.8.2 Reprocessing existing data 10
1.8.3 Alternative Vessel 10
1.8.4 Alternative Parameters 10
1.8.5 Alternative Location, Timing and Duration 11

2 SUBSEA NOISE ASSESSMENT 12
2.1 Assessment Criteria 12
2.2 Injury (Permanent Threshold Shift) 12
2.3 Behaviour 14
2.4 Injury and Disturbance to Fish and Sea Turtles 14
2.5 Modelling Assumptions and Approach 15
2.6 Results 15
2.6.1 Geophysical 15
2.6.2 Geotechnical 16

3 RISK ASSESSMENT 17
3.1 Harbour Porpoise 17
3.1.1 Baseline 17
3.1.2 Risk Assessment 17
3.2 Bottlenose Dolphin 19
3.2.1 Baseline 19
3.2.2 Risk Assessment 19
3.3 Short-beaked common dolphin 20
3.3.1 Baseline 20
3.3.2 Risk Assessment 21
3.4 Risso's Dolphin 22
3.4.1 Baseline 22
3.4.2 Risk Assessment 22
3.5 Minke Whale 23
3.5.1 Baseline 23
3.5.2 Risk Assessment 24
3.6 Grey seal 25
3.6.1 Baseline 25
3.6.2 Risk Assessment 25
3.7 Harbour seal 26
3.7.1 Baseline 26
3.7.2 Risk Assessment 27

3.8 Leatherback turtles 28
3.8.1 Baseline 28
3.8.2 Risk Assessment 28
3.9 Basking sharks 28
3.9.1 Baseline 28
3.9.2 Risk Assessment 28
3.10 Mitigation 29
4 CONCLUSIONS 31
5 REFERENCES 32

Tables

Table 1-1: Survey Types, Specifications, Equipment and Durations for the Proposed Survey Works 6
Table 1-2: Summary of Noise Sources and Activities Included in the Subsea Noise Assessment 7
Table 1-3: Generalised hearing ranges of marine mammals based upon NMFS (2016). 8
Table 1-4: Example ADCPs which may be deployed on the seabed. 8
Table 2-1: PTS and TTS onset acoustic thresholds (Southall *et al. 2019*; Tables 6 and 7) 14
Table 2-2: Disturbance Criteria for Marine Mammals Used in this Study based on National Marine Fisheries Service (NMFS) Level B harassment (NMFS 2005). 14
Table 2-3: Criteria for onset of injury to fish and sea turtles due to impulsive noise 15
Table 2-4: Criteria for fish due to non-impulsive noise from Popper et al. 2014. 15
Table 2-5: Geophysical – Shallow-mud, summary of minimal starting ranges for fleeing animals in an unmitigated scenario. 16
Table 2-6: Geotechnical – Shallow-mud, summary of minimal starting ranges for fleeing animals. 16

Glossary

Term	Meaning
Cetaceans	Aquatic mammals constituting the infraorder Cetacea (whales, dolphins, porpoises).
Decibel (dB)	A customary scale most commonly used (in various ways) for reporting levels of sound. The actual sound measurement is compared to a fixed reference level and the "decibel" value is defined to be $10 \cdot \log_{10}$(actual/reference), where (actual/reference) is a power ratio. The standard reference for underwater sound pressure is 1 micro-Pascal (µPa), and 20 micro-Pascals is the standard for airborne sound. The dB symbol is followed by a second symbol identifying the specific reference value (i.e. re 1µPa).
Impact Area	The area associated with the modelled PTS or TTS range for the species being discussed, defined as a circular area centred on the sound source with a radius equal to the modelled sound threshold contour for the onset of PTS or TTS.
Marine Mammal Management Unit	Marine Mammal Management Unit (MUs) for marine mammals in UK waters, provide an indication of the spatial scales at which impacts of plans and projects alone, cumulatively and in combination, need to be assessed for the key cetacean species in UK waters. For cetaceans, these management units are defined by the Inter-Agency Marine Mammal Working Group. For seal species (harbour and grey seal), the Special Committee on Seals (SCOS) provided advice on seal Mus.
Marine Mammal Study Area (MMSA)	An area encompassing the Offshore Cable Corridor plus a buffer of 10km.
Offshore Cable Corridor	At its maximum a 500m corridor centred around the route list position of the centreline in water depth greater than 10m below lowest astronomical tide (LAT) or a 250m corridor centred around the route list position of the centreline in water depth between 10m below and 1m above LAT.
Permanent Threshold Shift (PTS)	A total or partial permanent loss of hearing caused by some kind of acoustic trauma. PTS results in irreversible damage to the sensory hair cells of the ear, and thus a permanent reduction of hearing acuity.
Pinnipeds	Infraorder of marine mammals including true and eared seals, sealions and walrus.
Temporary Threshold Shift (TTS)	Temporary loss of hearing as a result of exposure to sound over time. Exposure to high levels of sound over relatively short time periods will cause the same amount of TTS as exposure to lower levels of sound over longer time periods. The mechanisms underlying TTS are not well understood, but there may be some temporary damage to the sensory cells. The duration of TTS varies depending on the nature of the stimulus, but there is generally recovery of full hearing over time.
Sound Pressure level (SPL)	The average sound energy over a specified period of time, formally: “ten times the base-ten logarithm of the arithmetic mean of the squared pressures divided by the squared reference pressure”. Equal to the deprecated “RMS level”, “dB_{rms}” and to L_{eq} if the period is equal to the whole duration of an event. Defined in ISO 18405:2017, 3.2.1.1
Zone of Injury	The zone of injury in this study is classified as the distance over which a marine mammal can suffer PTS leading to non-reversible auditory injury.

Acronyms

Term	Meaning
CGNS	Celtic and Greater North Seas
CIS	Celtic and Irish Seas
CPT	Cone Penetration Test
CS-D	Celtic Sea - Block D
CS-F	Celtic Sea - Block F
CWSH	Coastal West Scotland and the Hebrides
DAERA	Department of Agriculture, Environment and Rural Affairs
EPS	European Protected Species
FCS	Favourable Conservation Status
HF	High Frequency
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
IS	Irish Sea
I-SEM	Integrated Single Energy Market
JNCC	Joint Nature Conservation Committee
LAT	Lowest Astronomical Tide
LF	Low Frequency
MAG	Magnetometer
MBES	Multibeam Echosounder
MMO	Marine Mammal Observer
MSFD	Marine Strategy Framework Directive
MU	Management Unit
NMFS	National Marine Fisheries Service
NRW	Natural Resources Wales
OCW	Other Carnivores in Water
PAM	Passive Acoustic Monitoring
PCW	Phocid Carnivores in Water
PTS	Permanent Threshold Shift
PWC	Phocid Carnivores in Water
RMS	Root Mean Squared
RPL	Route Position List
TTS	Temporary Threshold Shift
SBP	Sub-Bottom Profiler
SCANS	Small Cetaceans in European Atlantic Waters
SCOS	Special Committee on Seals
SEL	Sound Exposure Level
SPL	Sound Pressure Level
SSS	Side Scan Sonar
UK	United Kingdom
USBL	Ultra Short Baseline Subsea positioning
UXO	Unexploded Ordnance
VHF	Very High Frequency
WS	Western Scotland

Units

Unit	Description
dB	Decibel
Hz	Hertz
kHz	Kilohertz
km	Kilometre
km^2	Kilometres squared
kV	Kilovolt
m	Metre
ms^{-1}	Metres per second
MW	Megawatt
nm	Nautical Mile
µPa	Micro pascal

1 INTRODUCTION

1.1 Background

1.1 TI LirIC Limited (the Applicant), a wholly owned subsidiary in the Transmission Investment Group, is developing a proposed 700 megawatt (MW) High Voltage Direct Current (HVDC) electricity interconnector project to connect the Irish Integrated Single Electricity Market (I-SEM) to the Great Britain (GB) wholesale electricity market through a link between Northern Ireland (NI) and Scotland (the LirIC Project, herein referred to as the Development), which is scheduled to be fully operational around the end of this decade.

1.2 The Development comprises of two HVDC converter stations, one located in Scotland and the other in Northern Ireland that will be connected via two 320kV HVDC cables running underground and subsea. The converter stations will transition the HVDC system to alternating current and facilitate connection to the 275kV High-Voltage Alternating Current (HVAC) grid network in Northern Ireland and the 400kV HVAC grid network in Scotland. The total length of the Offshore Cable Corridor for the Development is approximately 142 kilometres (km).

1.3 The Applicant is looking to conduct landfall and marine surveys, including the following:

- Marine Geophysical Survey/Benthic Survey;
- Marine Geotechnical;
- Marine Unexploded Ordnance (UXO) Survey;
- Landfall Geophysical Survey; and
- Landfall Geotechnical Survey.

1.4 The surveys aim to provide comprehensive data to the Applicant to inform cable design and routing and identify potential constraints within the Offshore Cable Corridor. The Offshore Cable Corridor is defined at its maximum as a 500m corridor centred around the route list position for the Offshore Cable Corridor centreline in water depth greater than 10m below lowest astronomical tide (LAT) or a 250m wide corridor centred around the route list position for the Offshore Cable Corridor centreline in water depth between 10m and 1m above LAT.

1.5 The surveys will collect baseline data to understand the ground conditions within the Offshore Cable Corridor, input to the development of the design and installation process and inform the design of any future surveys such as further pre-construction surveys to support activities such as boulder clearance.

1.6 The expected duration of survey operations is estimated to be circa 69 days in total (subject to weather and vessel availability constraints).

1.2 Purpose of this document

1.7 This Supporting Information Document provides a summary of the legislative context with respect to marine European Protected Species (EPS) and Wildlife Licencing (Section 1.3) and an overview of the licensable operations that will be undertaken as part of the geophysical and geotechnical surveys (Section 1.5). The relevant EPS that have been identified within the search area are discussed in Section 1.7.

1.8 The purpose of this document is to describe the survey activities and noise levels produced by the proposed activities; present results of subsea noise modelling and assess the risk of injury or disturbance (following mitigation) to marine EPS likely to be present in or in the vicinity of, the Offshore Cable Corridor.

1.3 Legislative Context

1.3.1 Scotland

1.3.1.1 EPS Licence

1.9 The European Commission Habitats Directive (92/43/EEC) lists all cetaceans for which a system of strict protection needs to be established in Annex IV. There is a requirement to consider EPS through the Habitats Directive which is transposed into UK law in Scotland by the Conservation (Natural Habitats) Regulations 1994 (as amended) (out to 12 nautical miles (nm)) (the "Habitats Regulations"). Beyond 12nm, for all UK administrations, the Conservation of Offshore Marine Habitats and Species Regulations 2017 consolidate and update the Offshore Marine Conservation (Natural Habitats &c) Regulations 2007 (the "Offshore Marine Regulations") and introduce a similar requirement in terms of EPS.

1.10 An EPS Licence can only be granted for specific purposes set out in the Conservation (Natural Habitats) Regulations 1994 (as amended). This protects all cetacean species listed as EPS throughout their range by making it an offence under these regulations to:

- Deliberately capture, injure or kill any EPS;
- Deliberately disturb them; or
- Deliberately damage or destroy a breeding site or resting place.

1.11 For the Licence to be granted, the relevant regulations provide that the regulating authority will need to be satisfied the following criteria are met:

- Test 1 (Overriding Public Interest Test) – If the competent authority is satisfied that, there being no alternative solutions, the plan or project must be carried out for imperative reasons of overriding public interest, which may be of a social or economic nature (Regulation 44(2));
- Test 2 (No Satisfactory Alternatives Test) – There are no satisfactory alternative locations for the Development or alternative methods to the Licensable Operations (Regulation 44(3)(a)); and
- Test 3 (Favourable Conservation Status (FCS) Test) – The Licensable Operations will not be detrimental to the maintenance of the population of the species concerned at an FCS in their natural range (Regulation 44(3)(b)). The EU Habitats Directive includes the definitions for FCS below:
  - the "conservation status" of a species means, "the sum of the influences acting on the species concerned that may affect the long-term distribution and abundance of its populations […]";
  - the "favourable conservation status" of a species means: "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 the natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future, and there is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis."

1.12 This risk assessment considers dolphins, porpoises and whales as cetacean EPS. Five cetacean species have the potential to occur in the vicinity of the Offshore Cable Corridor and have been considered in the risk assessment. These include harbour porpoise (*Phocoena phocoena*), bottlenose dolphin (*Tursiops truncates*), short-beaked common dolphin (*Delphinus delphis*), Risso's dolphin (*Grampus griseus*) and minke whale (*Balaenoptera acutorostrata*).

1.13 The Habitats Regulations and the Offshore Marine Regulations make it an offence to deliberately kill, injure, or capture an EPS, as listed under Annex IV of the Habitats Directive.

In addition, the Habitats Regulations 1994 (as amended in Scotland) make it an offence to deliberately disturb wild animals or EPS.

1.14 Regulation 39(2) provides additional protection to cetaceans to ensure protection at all times, regardless of the circumstances of the mammal at the time of the disturbance. Therefore, this is a catch-all regulation that goes beyond the specific circumstances set out in Regulation 39(1).

1.15 If there is a risk of injury or disturbance to EPS that cannot be removed or sufficiently reduced by using alternative methods to those associated with the activity and/or mitigation measures, then the activity may still be able to go ahead under licence provided that the three tests described in 1.11 above are satisfied.

1.16 Article 1(i) of the Habitats Directive defines FCS of a species. The status of each EPS considered in this Licence has been presented in the species-specific risk assessments in Section 3.

1.17 In addition to the protection of cetacean species in Scotland the Conservation (Natural Habitats, &c.) Regulations 1994, The Conservation of Offshore Marine Habitats and Species Regulations 2017 and the Wildlife and Countryside Act 1981 covers licensing for basking sharks (*Cetorhinus maximus*). If any activity is likely to cause disturbance or injury to a basking shark a licence is required to undertake the activity legally.

1.18 The conditions for granting consent to a project are similar to those required for an EPS licence, starting with the application covering a licensable purpose followed by a justification that there are no satisfactory alternatives and that the licensable actions will not be detrimental to the maintenance of the population of the species concerned at favourable conservation status in their natural range.

1.3.2 Northern Ireland

1.3.2.1 EPS Licence

1.19 The Conservation (Natural Habitats, etc) Regulations (Northern Ireland) 1995 (as amended) enacts Annex IV of the Habitats Directive (92/43/EEC). This protects EPS in the same way as detailed for Scotland in Section 1.3.1. In Northern Ireland however EPS licences cover cetaceans as well as all marine turtles.

1.20 An EPS license is required under the Habitats Regulations if the risk of injury or disturbance to cetacean species, from any potential effect (i.e., underwater noise) is assessed as likely, following the application of mitigation.

1.21 It is also an offence to intentionally or recklessly:

- Damage or destroy, or obstruct access to, any structure or place which any such animal uses for shelter or protection,
- Damage or destroy anything which conceals or protects any such structure,
- Disturb any such animal while it is occupying a structure or place which it uses for shelter or protection; or
- To have in possession or control any live or dead wild animal included in Schedule 5 or any part of, or anything derived from, such an animal.

1.22 Where impact cannot be avoided or mitigated, a licence may be required for operations to be undertaken.

1.3.2.2 Wildlife Licence

1.23 In addition to an EPS licence a wildlife licence may also be required. The species which are protected through wildlife licencing are those listed under The Conservation (Natural Habitats, etc.) Regulations (Northern Ireland) 1995 and the Wildlife (Northern Ireland) Order 1985 including all cetaceans, seals (harbour seals (*Phoca vitulina*) and grey seals (*Halichoerus grypus*)), marine turtles (leatherback turtles (*Dermochelys coriacea*)) and basking sharks. A wildlife licence may be issued to authorise what would otherwise be an

offence under the nature conservation legislation including causing disturbance or injury to a licensable species.

1.24 A wildlife licence may be granted by the DAERA Marine and Fisheries Division, should it be found necessary for a development requiring marine construction for reasons of overriding public interest where there is no satisfactory alternative, and the activity will not be detrimental to the maintenance of the population of the species concerned.

1.4 Guidance

1.25 The Joint Nature Conservation Committee (JNCC), Natural England and Natural Resources Wales (NRW) have produced draft guidance concerning the Habitat Regulations and protection of marine EPS from injury and disturbance (JNCC *et al*. 2010). The guidance document provides an example of a preventative approach to ensuring the strict protection of EPS in their natural range as required by Article 12 of the Habitats Directive. Additional guidance also provides an interpretation of the regulations in greater detail for seismic surveys (JNCC 2017), including mitigation measures designed to reduce the risk of deliberate injury to marine mammals and relevant measures are incorporated as part of the consenting regimes for geophysical activities within the UK waters.

1.26 The 2010 guidance defines disturbance as significant when “it is likely to be detrimental to the animals of an EPS or significantly affect their local abundance or distribution”. It also highlights that “trivial disturbance” should not be considered as a disturbance offence under Article 12. Trivial disturbance is described as “sporadic disturbances without any likely negative impact on the animals such as that resulting in short term behavioural reactions which is not likely to result in an offence being committed.” (JNCC *et al*. 2010).

1.5 Licensable Operations

1.27 The Offshore Cable Corridor will be surveyed using a range of geophysical and geotechnical survey equipment, summarised in Table 1-1. The exact number and specification of the survey vessels and final equipment specifications for use in the surveys have yet to be decided, however they will be within the equipment specifications outlined in Table 1-1. Additionally two Acoustic Doppler Current Profilers (ADCP) may be deployed on the seabed for approximately a month and removed upon completion.

1.28 Further detail on sound sources can be found in Section 1.6. The exact equipment to be used will be confirmed before the surveys commence, based on decisions by the survey contractor.

1.6 Sound Sources

1.29 Details of the potential sound sources to be used in the survey are presented below in Table 1-2, including information on the sound produced by each piece of sound-producing survey equipment. It should be noted that these equipment specifications are only indicative but are representative of the sound levels from various equipment, as exact equipment specification will not be confirmed until a contractor is appointed.

1.30 The sound sources included in the assessment have been classified according to the following sound types.

- Impulsive sounds which are typically transient, brief (less than one second), broadband, and consist of high peak sound pressure with rapid rise time and rapid decay (American National Standards Institute (American National Standards Institute 1986, NIOSH 1998, American National Standards Institute 2005). This category includes sound sources such as air guns used in seismic surveys, impact piling and underwater explosions.
- Non-impulsive (continuous) sounds which can be broadband, narrowband or tonal, brief or prolonged, continuous or intermittent and typically do not have a high peak sound pressure with rapid rise/decay time that impulsive sounds do (NIOSH 1998, American

National Standards Institute 1995). This category includes sound sources such as continuous vibro-piling, running machinery, some sonar and vessels.

Table 1-1: Survey Types, Specifications, Equipment and Durations for the Proposed Survey Works

Survey Type	Associated Vessels	Survey Specifications	Survey Equipment	Estimated Duration
Geophysical	Survey vessel specifications to be confirmed by the survey contractor. Likely to be two vessels one for offshore and one for inshore.	• 500m-wide corridor centred on the Route Position List (RPL) in water depths greater than 10 m below LAT. • 250m-wide corridor centred on the RPL between 10m below LAT and 1 m above LAT. • Additional survey lines at existing infrastructure crossings. • Additional survey lines to extend the survey corridor, if required.	• Multibeam echosounder (MBES) • Side Scan Sonar (SSS) • Sub-Bottom Profiler (SBP) • Magnetometer (MAG) • Ultra Short Baseline Subsea positioning (USBL)	27-34 days
Geotechnical	Survey vessel specifications to be confirmed by the survey contractor. Likely to be two vessels one for offshore and one for inshore.	• Approximately 20-30 Cone Penetration Test (CPTs) and Vibrocores to 3m below seafloor.	• Geotechnical, Vibro-coring, drilling, cone penetration testing	6-12 days
Benthic Grab Samples and Drop-Down Video Stills	Survey vessel specifications to be confirmed by the survey contractor. Likely to be two vessels one for offshore and one for inshore.	• Approximately 40x benthic grab samples and co-located drop-down video stills.	• 0.1m^2 day grab • Suitable high-quality	6-8 days
UXO Survey	Survey vessel specifications to be confirmed by the survey contractor. Likely to be two vessels one for offshore and one for inshore.	• 30m-wide corridor over a refined RPL; • Acquisition up to 2m below LAT. • Additional survey lines to extend the survey corridor, if required.	• MBES • SSS • SBP • MAG • USBL	15 days

Table 1-2: Summary of Noise Sources and Activities Included in the Subsea Noise Assessment

Equipment	Source level [SPL] (as used in model)	Primary decidecade bands (-20 dB width)	Source model details	Impulsive/non-impulsive
Survey vessel (based on "quiet" vessel)	186 dB SPL	10-1,600 Hz	Maximal allowable to qualify as "quiet" or "research" with large vessel classification companies.	Non-impulsive
Side scan sonar (Edgetech FS4200 or equivalent)	203 dB SPL	100,000 Hz & 900,000 Hz	Based on all frequency modes available to the FS4200, covering 100 kHz to 900 kHz.	Impulsive
Multibeam echosounder (Reson Seabat T51R & Kongsberg EM 2040-4 MKII or equivalent)	205-213 dB SPL (ping rate dependent, spherical level)	200,000 – 800,000 Hz	Model based on frequency modulated tone bursts, but representative for constant frequency tone bursts, von Hann window, ping rate determined by local depth.	Impulsive
Parametric sub-bottom profiler (Innomar 2000-Medium)	Primary: 208-210 dB SPL Secondary: 148-154 dB SPL	4,000 – 15,000 Hz & 85,000 – 115,000 Hz	Manufacturer. Model based on frequency modulated tone bursts, but representative for constant frequency tone bursts, von Hann window, ping rate determined by local depth. Source level used for modelling adjusted for beam pattern and local sediment properties.	Impulsive
Boomer type sub-bottom profiler	169-177 dB SPL	125 – 16,000 Hz	Model based on similar sources. Ping rate determined by local depth. Source level used for modelling adjusted for beam pattern and local sediment properties.	Impulsive
Sparker type sub-bottom profiler	182-190 dB SPL	400 – 6300 Hz	Model based on similar sources. Ping rate determined by local depth. Source level used for modelling adjusted for beam pattern and local sediment properties.	Impulsive
Ultra Short Baseline (USBL) positioning system	180 dB SPL	19,000 – 34,000 Hz	Manufacturer. 3 x 8 ms pulses per second.	Impulsive
Geotechnical, Vibro-coring, drilling, cone penetration testing	195 dB SPL	10 – 4,000 Hz	Based on review of available data.	Non-impulsive

1.31 Whilst the exact frequency range of ADCPs that may be deployed is dependent on the water depth, typically ADCP instruments range between 38 kHZ to several mHz, with lower frequencies used in deep water and higher frequencies in shallower water. In coastal and shelf seas they are most likely to use an operating frequency between 150-500 kHz and therefore will mostly exceed the upper hearing limits of all marine mammal hearing groups (Table 1-3). Signals from ADCPs are weaker than those from echosounders or airguns, with narrow bandwidth (~10% or less of the central frequency) and narrow beam widths and therefore generate limited sound fields, and are unlikely to produce sound levels strong enough to cause TTS, and no risk of PTS. For the depths around the Offshore Cable Corridor (steep terrain in the Irish Sea with depths up to 250m and flatter underwater terrain in the Firth of Clyde, with typical depths of 40-80 m) typical instruments include those in Table 1-4 and are all above the hearing range of all marine mammal species (Table 1-3), including all key species found in the Marine Mammal Study Area. Pulses do not overlap with predominant hearing frequencies and therefore will not mask marine mammal communications.

Table 1-3: Generalised hearing ranges of marine mammals based upon NMFS (2016).

Hearing Group	Generalised Hearing Range (from NMFS (2016)
Low-frequency cetaceans (minke whale)	7 Hz to 35 kHz
High frequency cetaceans (bottlenose, short-beaked common and Risso's dolphin)	150 Hz to 160 kHz
Very high-frequency cetaceans (harbour porpoise)	275 Hz to 160 kHz
Phocid pinnipeds underwater (grey and harbour seal)	50 Hz to 86 kHz

Table 1-4: Example ADCPs which may be deployed on the seabed.

Example ADCP	Acoustic frequency (general)
Nortek AWAC 600	600 kHz
Nortek AD2CP 500	500 kHz
Nortek Signature 500	500 kHz
Nortek Aquadopp	400 kHz to 2000 kHz
Teledyne Sentinel V ADCP	300 kHz to 1000 kHz

1.32 ADCPs are not known to elicit any behaviour responses from marine mammals. In a study of a 150 kHz ADCP in the Eastern Tropical Pacific, low frequency baleen whales showed no significant responses to a 150 kHz ADCP, and high frequency cetaceans were detected more often during visual surveys.

1.33 Marine mammal communications will not be masked by ADCP signals due to low power output, low duty cycle and very brief period in which a mobile marine mammal would be within the area of effect. Behavioural responses are not anticipated unless marine mammals are very close to the source and remain for a substantial period of time. Scientific studies characterising acoustic emissions an ADCP with a central frequency of 500 kHz and from two different MBES, estimated that a harbour porpoise would need to remain within a few metres of the transducer and close to the centre of the beam (i.e. stationary) for multiple hours in order to receive sufficient energy to exceed the cumulative threshold for TTS. The anticipated disturbance radii of the ADCP are less than other survey equipment, with a very small ZoI in comparison to wider available habitat in Irish Sea for such mobile species. Once a sound pulse has been emitted the intensity is greatly reduced within a few metres due to scattering and absorption. Given ADCP is also typically a static deployment, the risk of a marine mammal remaining within the small ZoI is further reduced.

1.34 Overall, ADCP noise will be highly localised, very short term, intermittent and will be active during the surveys for very limited duration (70 days). Marine mammals are expected to exhibit no more than short-term and inconsequential responses to ADCPs given their characteristics and therefore the risk of any effects is low and hence the impact of ADCPs is excluded from further consideration in the Risk Assessment, Section 3.

1.7 Overriding Public Interest

1.35 Electricity interconnectors allow for the transfer of electricity between markets, in this case between Northern Ireland/ I-SEM and Scotland/GB. Interconnectors can deliver benefits through a greater security of supply allowing both markets to secure their energy needs. Specifically interconnectors can increase access to renewably generated electricity and widen the routes to market for energy traders, allowing controllability and flexibility. This facilitates lower costs for energy and promotes uptake of decarbonised sources of electricity allowing a reduced dependence on non-renewable generation.

1.36 The Development will provide much needed support to the UK and Irish governments plans for the expansion of renewable energy generation and underpin national and international commitments to reduce greenhouse gases. The UK currently aims to reach their zero emissions target by 2050 and a new plan is aiming for at least 68% reduction in greenhouse gas emissions by the end of the decade, compared to 1990 levels. The Development will facilitate improved distribution of renewable energy throughout the UK, connecting Scotland which has rapidly developed its offshore wind industry in the past decade (as of 2023 the renewable energy capacity of Scotland is 14.2 GW (Scottish Government,2023)) and Northern Ireland which is underdeveloped in terms of its renewable energy capacity (the current renewable energy capacity of Northern Ireland is 1.8 GW (RenewableNI, 2024). Additionally the Development will provide opportunities for employment over the course of the project lifetime.

1.37 If the Development's geophysical, geotechnical and marine UXO surveys do not proceed the progression of the Development would not be possible making it more difficult for the UK to reach its ambitious net zero goals.

1.8 No Satisfactory Alternatives

1.38 Regulation 55(7)(a) of the Conservation of Offshore Marine Habitats and Species Regulations 2017 requires the regulating authority to be satisfied that there is no satisfactory alternative before an EPS Licence can be issued for a Licensable Operation. This section provides an assessment of the alternatives that were considered as part of the design of the proposed geophysical, geotechnical and marine UXO surveys. After consideration of all alternatives, it was concluded that there was no suitable alternative to the survey design proposed.

1.39 As noted elsewhere, the purpose of the surveys is to progress the design and inform the EIA of the Development. The information gathered during the surveys is essential to allow the Development to progress and allow alternatives for the offshore cable installation within the Offshore Cable Corridor to be evaluated to ensure environmental impacts are minimised.

1.40 Consideration was given to possible alternative methodologies to gather seabed and benthic information which would provide the level of detail required to facilitate engineering decisions on the location/routing and safe construction/installation of subsea cables and cable protection.

1.41 The selected survey techniques represent the only available practical methods of acquiring the required data. The Development design will be dependent on site specific data collected using MBES, SSS, SBP and magnetometer.

1.42 The use of USBL is a commonly used methodology in the offshore industry as it determines the position of subsea survey items. No other equipment, for example, pressure transducers, provides the degree of spatial accuracy required. The USBL equipment will be operated at the lowest practicable sound levels to minimise disturbance risk and will be operated over the shortest practicable period of time required to obtain the necessary measurements and achieve the survey objectives. USBL are always required when using towed equipment therefore a satisfactory alternative could not be identified.

1.43 Surveys will be undertaken in line with the mitigation measures detailed within the EPS Risk Assessment and Report to ensure that they are undertaken in the most environmentally sensitive manner.

1.8.1 Do nothing

1.44 TI LirIC Limited consider the ‘do nothing’ scenario is not a viable alternative for the reasons detailed below.

1.45 It is acknowledged that not undertaking the survey would result in no impact on EPS, however the information gathered during the surveys is essential for determining the project design and in terms of being able to undertake a robust EIA to inform subsequent consent applications.

1.46 Data collected from the geophysical surveys, which are the primary tool used by companies to investigate the ground conditions of the seabed, will provide high-resolution detail of the bathymetry and seabed (and record seabed features, objects, topography and archaeological features) in addition to characterising layers of sediment or rock below the seabed.

1.47 Without this detailed information, it would be impossible to determine important factors within the Offshore Cable Corridor. This would result in an inability to accurately design a constructable interconnector project in terms of the application of appropriate infrastructure installation techniques and construction methodology, and the identification of appropriate operation and maintenance programmes. There would also be insufficient site-specific information available to inform and support a robust EIA and consent application. Therefore, doing nothing is not a viable option to enable the successful installation of the Development and hence contribute to the achievement of the government’s net zero targets by connecting markets and increasing access renewable energy.

1.48 There is also a requirement for UXO surveys from a safety perspective, to construct the Development without conducting UXO surveys could present a risk to life and/or damage to infrastructure.

1.8.2 Reprocessing existing data

1.49 Although other surveys may have been previously conducted in the area, they are unlikely to have fully covered the area of the Development and therefore will not sufficiently address the needs of the Development to alleviate any technical or safety issues which would be addressed by project specific geophysical, geotechnical and marine UXO surveys. Reprocessing of historic data would also not be satisfactory since the data coverage is limited and varying in quality.

1.8.3 Alternative Vessel

1.50 All vessels that have been identified for the survey will conform to industry and regulatory standards. The proposed vessels allow for both accurate and high quality data collection and while representing a relatively low impact on the marine environment, given the remote offshore nature of the survey area, and dispersive potential of the associated emissions. The proposed vessels are robust in adverse weather, allowing the survey to be completed in less time than would be possible with smaller vessels, thereby minimising the potential for disturbance to the marine environment by adhering to the shortest possible campaign to achieve the required data acquisition.

1.8.4 Alternative Parameters

1.51 To ensure good quality data collection, the survey techniques and parameters have been determined by the LirIC’s geophysicists. Any changes in these parameters will mean that the survey will not fulfil its purpose.

1.52 The proposed source noise output (using equipment and techniques such as USBL) is as low as possible and has been chosen specifically in view of the water depths, geology and setting of the Offshore Cable Corridor. Equipment with a smaller acoustic output would not be able to provide the necessary image of the deeper strata.

1.8.5 Alternative Location, Timing and Duration

1.53 Consideration has been given to alternative locations and timings for the survey work. A significant amount of work has been undertaken to define the Offshore Cable Corridor within which the LirIC offshore cables will be located. This corridor has been defined as 500m wide and has been located so as to avoid sensitive areas. The Offshore Cable Corridor has been identified from detailed desk top studies, feasibility studies, and routing studies based on all relevant and available information at the time.

1.54 An initial feasibility study for the offshore cable route was undertaken to identify and map characteristics and constraints between Northern Ireland and Scotland, based on publicly available and purchased datasets, scientific papers, and regional offshore reports. Multiple potential offshore routes were identified and ranked based on route length, number of infrastructure crossings, environmental, technical, and economic constraints. Each constraint was identified and categorised according to the likely impact on the permitting, installation, and operation of the interconnector cable. Constraints were categorised as Primary ('major') and Secondary (divided into 'moderate' and 'minor').

1.55 Preferred landfall locations were also selected and combined with the assessment in order to develop the preferred route options from Kilroot to Hunterston. Constraints considered included (but were not limited to) designated areas, subsea assets, aggregate dredge extraction and spoil areas, designated anchorages, known steep slopes and high density shipping. Following the initial feasibility study, further refinement of the preferred route options was undertaken to develop the Offshore Cable Corridor.

1.8.5.1 General Location

1.56 Overall, it is not possible to consider an alternative location for the survey; the Offshore Cable Corridor is the subject of the investigation and has to connect the grid connection points in Scotland (Hunterston) and Northern Ireland (Kilroot). Therefore, the overall location of the proposed geophysical, geotechnical and marine UXO surveys is pre-determined. The ultimate purpose of the surveys is to confirm the final cable route, by obtaining sufficient detail to enable micro siting and reduce the risks associated with cable installation.

1.8.5.2 Timing Constraints and Considerations

1.57 TI LirIC Limited has applied for consent to survey between March 2025 - March 2026, although surveys typically occur in the spring and summer months to avoid or minimise any delays due to weather downtime and this is the expectation for the LirIC surveys. However, survey timing is significantly influenced by vessel/contractor availability and to a lesser degree ensuring survey data is available to inform the project design at an appropriate stage in the design process, hence the application for a longer survey period. Undertaking a survey at an alternative time such as winter months would likely result in delays and therefore the vessel being onsite for longer.

1.58 The actual survey duration is estimated to be approximately 69 days, based on the anticipated number of samples, the sampling activities proposed and vessel transit times. Subject to operational constraints, as well as favourable weather and sea conditions, TI LirIC will seek to minimise the duration of the survey where feasible.

1.8.5.3 Survey Coverage

1.59 The environmental sensitivity of the Offshore Cable Corridor was considered as part of the survey feasibility assessment and was selected to minimise interaction with particularly sensitive areas, where possible. To this end the extent of the proposed survey has been minimise and any further reduction of the Offshore Cable Corridor would not fulfil the objectives of survey.

2 SUBSEA NOISE ASSESSMENT

2.1 A subsea noise modelling desktop study was undertaken to determine the potential short term effects of underwater noise from the geophysical survey and geotechnical survey associated with the Development on the marine environment between Scotland and NI. The Offshore Cable Corridor covers steep and deep underwater terrain in the Irish Sea with depths up to 250m and flatter underwater terrain in the Firth of Clyde, with typical depths of 40-80m. The sediment varies from fine mud and silt in the Firth of Clyde to coarse sand and gravel in the Irish Sea.

2.2 Sound is readily transmitted into the underwater environment and there is potential for the sound emissions from anthropogenic sources to adversely affect marine mammals and fish. Near a noise source with high noise levels, permanent or temporary hearing damage may occur to marine species, while at a very close range gross physical trauma is possible. At long ranges (several kms) the introduction of any additional noise could, for the duration of the activity, potentially cause behavioural changes, changes to the ability of species to communicate and to determine the presence of predators, food, underwater features, and obstructions.

2.3 This Section provides an overview of the potential effects due to underwater noise from the surveys on the surrounding marine environment based on the Southall *et al*. (2019) and Popper *et al.* (2014) framework for assessing impact from noise on marine mammals and fishes, focussing mainly on effects related to hearing impact.

2.4 The primary purpose of the underwater noise assessment is to predict the likely range of onset for potential physiological and behavioural effects due to increased anthropogenic noise as a result of the geophysical and geotechnical surveys.

2.1 Assessment Criteria

2.5 To determine the potential spatial range of injury and disturbance, assessment criteria have been developed based on a review of available evidence including national and international guidance and scientific literature. The following Sections summarise the relevant assessment criteria and describe the evidence base used to derive them.

2.6 Underwater noise has the potential to affect marine life in different ways depending on its noise level and characteristics. Assessment criteria generally separate sound into two distinct types, impulsive and non-impulsive as detailed in Section 1.6. Additionally included here are sounds under 1 second in duration with a weighted kurtosis over 40[1].

2.7 The acoustic assessment criteria for marine mammals in the noise modelling study followed the latest international guidance (based on the best available scientific information), that are widely accepted for assessments in the UK, Europe and worldwide.

2.2 Injury (Permanent Threshold Shift)

2.8 Underwater noise has the potential to affect marine life in different ways depending on the noise level and characteristics. (Richardson et al., 1995) defined four zones of noise influence which vary with distance from the source and level.

[1] Note that the European Guidance: “Monitoring Guidance for Underwater Noise in European Seas, Part II: Monitoring Guidance Specifications” (MSFD Technical Subgroup on Underwater Noise 2014) includes sonar as impulsive sources (section 2.2 of the guidance document). However, the guidance suggests that “all loud sounds of duration less than 10 seconds should be included” as impulsive. This contradicts research on impact from impulsive sounds suggesting that a limit for “impulsiveness” can be set at a kurtosis of 40 (Martin et al. 2020). This latter criterion has been used for classification of impulsive versus non-impulsive for sonars and similar sources. The justification for departing from the MSFD criterion is that the Southall 2019 framework limits are based on the narrower definition of impulsive as given above under “Impulsive sounds”.

- **The zone of audibility**: this is the area within which the animal can detect the sound. Audibility itself does not implicitly mean that the sound will affect the marine mammal.
- **The zone of masking**: this is defined as the area within which noise can interfere with the detection of other sounds such as communication or echolocation clicks. This zone is very hard to estimate due to a paucity of data relating to how marine mammals detect sound in relation to masking levels (for example, humans can hear tones well below the numeric value of the overall noise level).
- **The zone of responsiveness**: this is defined as the area within which the animal responds either behaviourally or physiologically. The zone of responsiveness is usually smaller than the zone of audibility because, as stated previously, audibility does not necessarily evoke a reaction. For most species there is very little data on response, but for species like harbour porpoise there are several studies showing a relationship between received level and probability of response.
- **The zone of injury / permanent hearing loss**: this is the area where the sound level is high enough to cause tissue damage in the ear. This is usually classified as permanent threshold shift (PTS). At even closer ranges, and for very high intensity sound sources (e.g. underwater explosions), physical trauma or acute mortal injuries are possible.

2.9 For this study, it is the zones of injury (PTS) that are of primary interest, along with estimates of behavioural impact ranges. To determine the potential spatial range of injury and behavioural change, a review has been undertaken of available evidence, including international guidance and scientific literature. The following Sections summarise the relevant thresholds for onset of effects and describe the evidence base used to derive them.

2.10 The zone of injury in this study is classified as the distance over which a marine mammal can suffer PTS leading to non-reversible auditory injury. Injury thresholds are based on a dual criteria approach using both un-weighted L_P (maximal instantaneous SPL) and marine mammal hearing weighted L_E. The hearing weighting function is designed to represent the sensitivity for each group within which acoustic exposures can have auditory effects. The categories (Southall *et al*. 2019) include:

- **Low Frequency (LF) cetaceans**: Marine mammal species such as baleen whales (e.g. minke whale).
- **High Frequency (HF) cetaceans**: Marine mammal species such as dolphins, toothed whales, beaked whales and bottlenose whales (e.g. bottlenose dolphin, short-beaked common dolphin and Risso's dolphin).
- **Very High Frequency (VHF) cetaceans**: Marine mammal species such as true porpoises, river dolphins and pygmy/dwarf sperm whales and some oceanic dolphins, generally with auditory centre frequencies above 100kHz) (e.g. harbour porpoise).
- **Phocid Carnivores in Water (PCW)**: True seals, earless seals (e.g. harbour seal *Phoca vitulina* and grey seal *Halichoreus grypus*); hearing in air is considered separately in the group PCW but is not relevant here.

2.11 Both the criteria for impulsive and non-impulsive sound are relevant for this study given the nature of the sound sources proposed to be used during the surveys. The relevant PTS and TTS criteria proposed by Southall *et al*. (2019) are summarised in Table 2-1.

Table 2-1: PTS and TTS onset acoustic thresholds (Southall *et al. 2019*; Tables 6 and 7)

Hearing Group	Parameter	Impulsive [dB]		Non-impulsive [dB]	
		PTS	TTS	PTS	TTS
LF cetaceans	L_P, (unweighted)	219	213	-	-
	L_E, (LF weighted)	183	168	199	179
HF cetaceans	L_P, (unweighted)	230	224	-	-
	L_E, (MF weighted)	185	170	198	178
VHF cetaceans	L_P, (unweighted)	202	196	-	-
	L_E, (HF weighted)	155	140	173	153
PCW	L_P, (unweighted)	218	212	-	-
	L_E, (PW weighted)	185	170	201	181

2.3 Behaviour

2.12 Disturbance thresholds for marine mammals are summarised in Table 2-2. Note that the non-impulsive threshold can often be lower than ambient noise for coastal waters with some human activity, meaning that ranges determined using this limit will tend to be higher than actual ranges. Also, as the levels are unweighted the ranges will be dominated by low-frequency noise, which for most hearing groups is outside their hearing range.

Table 2-2: Disturbance Criteria for Marine Mammals Used in this Study based on National Marine Fisheries Service (NMFS) Level B harassment (NMFS 2005).

Effect	Non-Impulsive Threshold	Impulsive Threshold
Disturbance (all marine mammals)	120 dB SPL	160 dB $L_{E\ single\ impulse}$ or 1-second L_E

2.4 Injury and Disturbance to Fish and Sea Turtles

2.13 The injury criteria used in this noise assessment are given in Table 2-3 and Table 2-4 for impulsive noises and continuous noise respectively. L_P and L_E criteria presented in the tables are unweighted. Physiological effects relating to injury criteria are described below:

- **Mortality and potential mortal injury**: either immediate mortality or tissue and/or physiological damage that is sufficiently severe (e.g. a barotrauma) that death occurs sometime later due to decreased fitness. Mortality has a direct effect upon animal populations, especially if it affects individuals close to maturity.

- **Recoverable injury ("PTS" in tables and figures)**: Tissue damage and other physical damage or physiological effects, that are recoverable, but which may place animals at lower levels of fitness, may render them more open to predation, impaired feeding and growth, or lack of breeding success, until recovery takes place.

  The PTS term is used here to describe this, more serious impact, even though it is not strictly permanent for fish. This is to better reflect the fact that this level of impact is perceived as serious and detrimental to the fish.

- **Temporary Threshold Shift (TTS)**: Short term changes (minutes to a few hours) in hearing sensitivity may, or may not, reduce fitness and survival. Impairment of hearing may affect the ability of animals to capture prey and avoid predators, and also cause deterioration in communication between individuals, affecting growth, survival, and reproductive success. After termination of a sound that causes TTS, normal hearing ability returns over a period that is variable, depending on many factors, including the intensity and duration of sound exposure.

Table 2-3: Criteria for onset of injury to fish and sea turtles due to impulsive noise

Type of animal	Unit	Mortality and potential mortal injury [dB]	Recoverable injury (PTS) [dB]	TTS [dB]	Behavioural [dB]
Fish: no swim bladder (particle motion detection)	L_E	219[1]	216[1]	186[1]	150[3]
	L_P	213[1]	213[1]	193[2]	189[2]
Sea turtles	L_E	210[1]	(*Near*) High (*Intermediate*) Low (*Far*) Low	-	-
	L_P	207[1]		-	-

[1] (Popper *et al.* 2014)

[2](Worcester, 2006)

[3] (WSDOT, 2017)

2.14 Where Popper *et al*. 2014 present limits as ">" 207 or ">>" 186, we have ignored the "greater than" and used the threshold level as given.

2.15 Relevant limits for fishes relating to PTS, TTS, and behaviour are given in the table below. Note that for the behaviour limit we have used the impulsive limit as basis for the continuous noise limit, in absence of better evidence.

Table 2-4: Criteria for fish due to non-impulsive noise from Popper et al. 2014.

Type of animal	Unit	Mortality and potential mortal injury	Recoverable injury (PTS) [dB]	TTS [dB]	Behavioural [dB]
All fishes	L_E	-	222	210	150 [SPL]*

*This is based on the impulsive criteria.

2.5 Modelling Assumptions and Approach

2.16 The propagation and sound exposure calculations were conducted over a range of water column depths to determine the likely range for injury and disturbance across the varying conditions along the Offshore Cable Corridor during the surveys. It should be noted that the effect of directivity has a strong bearing on the calculated zones for injury and disturbance because a marine mammal could be directly underneath the sound source for greater distances in deep water compared to shallow water.

2.17 Exposure modelling assumed a marine mammal swimming at a constant speed (1.5ms^{-1}) in a perpendicular direction away from a moving vessel.

2.18 Full details of the noise modelling approach and assumptions can be found in the Subsea Noise Technical Report (RPS, 2023).

2.6 Results

2.6.1 Geophysical

2.19 Starting ranges to avoid PTS for fleeing animals of the VHF group extend to approximately 940m, with the remaining groups having ranges below 110m (Table 2-5). Behavioural response ranges are 260m and 460m for marine mammals and fishes respectively.

Table 2-5: Geophysical – Shallow-mud, summary of minimal starting ranges for fleeing animals in an unmitigated scenario.

Site/Condition	LF (TTS / PTS) [m]	HF (TTS / PTS) [m]	VHF (TTS / PTS) [m]	PCW (TTS / PTS) [m]	Fish (TTS / PTS) [m]
Shallow-Mud	83 / 2	279 / 54	2193 / 704	65 / <10	162 / 18
Shallow-Sand	389 / <10	344 / 83	2563 / 804	140 / <10	207 / 27
Deep-Coarse	356 / <10	390 / 104	2880 / 909	153 / <10	246 / 36
90th percentile[2]	490 / **<10**	410 / **110**	2990 / **940**	180 / **<10**	260 / **40**
Peak level range (max from all sites)	<10	<10	50 / 30	<10	150 / 25
Behavioural response range			260		460

2.6.2 Geotechnical

2.20 Starting ranges to avoid PTS for fleeing animals extend to <10m. Behavioural response ranges are 23km and 500m for marine mammals and fishes respectively. Note that the large behavioural response range for marine mammals is based on the 120 dB SPL (unweighted) limit (Table 2-6). As this source has most energy at lower frequencies, it's unlikely that any group except for the LF group can hear the source to this distance.

Table 2-6: Geotechnical – Shallow-mud, summary of minimal starting ranges for fleeing animals.

Site/Condition	LF (TTS / PTS) [m]	HF (TTS / PTS) [m]	VHF (TTS / PTS) [m]	PCW (TTS / PTS) [m]	Fish (TTS / PTS) [m]
Shallow-Mud	87 / <10	<10	27 / <10	<10	<10
Shallow-Sand	164 / <10	<10	51 / <10	<10	<10
Deep-Coarse	452 / <10	<10	135 / <10	<10	<10
90th percentile[3]	480 / <10	<10	140 / <10	<10	<10
Behavioural response range			23km		500

[2] Note that the risk range used for the assessment is the 90th percentile range, a statistical approximation based on the results from the modelled scenarios. This is to account for the uncertainty when only modelling a subset of possible scenarios, representing a more conservative estimate than simply choosing the largest risk range.

[3] Note that the risk range used for the assessment is the 90th percentile range, a statistical approximation based on the results from the modelled scenarios. This to account for the uncertainty when only modelling a subset of possible scenarios. This represents a more conservative estimate than simply choosing the largest risk range.

3 RISK ASSESSMENT

3.1 A Marine Mammal Study Area (MMSA) has been used to determine which species to include in this risk assessment, this is defined as the area encompassing the Offshore Cable Corridor plus a buffer of 10km. The MMSA enables this risk assessment to capture the species most commonly identified within the Offshore Cable Corridor as well as transient species that may occasionally be present in the vicinity of the Offshore Cable Corridor.

3.2 Within the MMSA, the more commonly recorded cetacean species include harbour porpoise, bottlenose dolphin, short-beaked dolphin, Risso's dolphin and minke whale. Additionally grey seals, harbour seals, sea turtles and basking sharks may occur within the MMSA. A summary of the distribution and abundance for each of the key cetacean EPS is provided below together with an assessment of the risk of injury or disturbance based on the results of the subsea noise assessment (Section 1.7).

3.1 Harbour Porpoise

3.1.1 Baseline

3.3 The harbour porpoise is the most commonly observed cetacean species in UK waters, with high densities in the Irish Sea and its Northern and Southern Channels. Sightings occur year-round throughout the Irish Sea (Wall *et al*. 2013). Harbour porpoise has been found to prefer habitats where depths range from 5 - 150m in highly sloped regions (Baines and Evans 2009, Booth *et al*. 2013). Water depth and hydrodynamic variables have been found to have the greatest influence on distribution of the species within the Irish Sea (Buttifant 2021).

3.4 The Offshore Cable Corridor is located across both the West Scotland (WS) and the Celtic and Irish Seas (CIS) Management Units (MUs) for Harbour porpoise, with populations of 28,936 and 62,517 respectively (Heinänen and Skov 2015). The Small Cetaceans in European Atlantic Waters (SCANS) IV density estimate for the relevant survey blocks that cover the Offshore Cable Corridor (CS-D and CS-F) are 0.2803 and 0.2010 harbour porpoises per km^2 respectively. To ensure the assessment of the impact of underwater noise on harbour porpoises is undertaken using the most precautionary values the higher density value has been taken forward and applied throughout the risk assessment (CS-D: 0.2803).

3.5 Seasonal data gathered for this initial desktop study suggests that harbour porpoise is likely to occur year-round within the MMSA (Wall *et al*. 2013, IAMMWG 2022, Reid et al. 2003, Baines and Evans 2012).

3.1.2 Risk Assessment

3.6 Audiogram data for the harbour porpoise indicate that it is responsive to noise at frequencies from 100Hz – 170kHz, with peak hearing sensitivity occurring over the frequency range 20kHz – 150kHz. Thresholds for SPLs at which injury and behavioural disturbance may be induced are described in Table 2-1.

3.7 The noise assessment (Section 1.7) showed that a harbour porpoise exposed to subsea noise from the geophysical and geotechnical surveys may experience permanent auditory injury at a range of up to 940m (worst case geophysical surveys; PTS SEL). Recoverable auditory injury and fleeing response has the potential to occur out to a maximum distance of 2,880m (worst case geophysical surveys in deep coarse sediment conditions; TTS SEL). Behavioural disturbance also has the potential to occur as a result of these geophysical and geotechnical surveys.

3.8 The noise modelling provided the impact ranges associated with the sound sources which may be used for the surveys and allowed for the calculation of the impact area. The impact area (km^2) has then been combined with the density of harbour porpoise individuals in the area (individuals per km^2) to determine how many animals may be affected by underwater

noise from these surveys. Less than one harbour porpoise is predicted to have the potential to experience PTS at any one time within the impact area during the surveys. Due to the small area over which injury could occur and the low number of animals which may be affected, the risk of injury to harbour porpoise is considered to be negligible. It is likely that animals will be displaced from the area of injury risk prior to commencement of the geophysical and geotechnical surveys due to audible and visual cues during movement of the boats. Up to eight harbour porpoises may experience TTS (recoverable injury) at any one time within the impact area during the surveys. Proposed mitigation to further reduce potential for impact is presented in Section 3.10.

3.9 Scientific literature shows that responses to disturbance by harbour porpoise, vary between and within the species' and depend on the individual characteristics (body size, condition, sex and personality) and extrinsic factors (environmental context, repeated exposure, prior experience and acclimatisation) (Harding *et al*. 2019). These factors will affect whether an individual exhibits an aversive response to sound, particularly in an area with high sound levels related to human activities.

3.10 Typically, a 'strong disturbance' is one which has the potential to disturb a marine mammal or marine stock in the wild by causing disruption of behavioural patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering (NMFS 2005; JNCC 2010). The United States NMFS (NMFS 2005) define strong disturbance in all marine mammals as 'Level B harassment' and for impulsive sound (such as from geophysical surveys) suggests a threshold of 160 dB re 1µPa (root mean square (rms)). This threshold meets the criteria defined by JNCC (2010) as a 'non-trivial' (i.e., significant) disturbance and is equivalent to the Southall *et al*. (2007) severity score of five (on a scale of one to nine) or more on the behavioural response scale. Below this threshold, behavioural responses are considered trivial, and unlikely to significantly impact the marine animal, or alter its population status in the wild. For example, these responses often include minor changes in swimming speed, direction and/or dive profile, modification of vocal behaviour and minor changes to respiratory rate (Southall, *et al*. 2007). For continuous sound, such as vessel noise or geotechnical surveys, NMFS (2005) guidance sets the marine mammal level B harassment threshold for continuous noise at 120dB re 1µPa (rms).

3.11 Based upon NMFS criteria, disturbance thresholds in this assessment for marine mammals were 120dB SPL and 160dB L_E single impulse or 1-second L_E for non-impulsive and impulsive sound, respectively. It is noted that non-impulsive thresholds can often be lower than ambient noise for coastal waters with some human activity, meaning that ranges determined using this limit will tend to be higher than actual ranges.

3.12 The behavioural response ranges for all species assessed (which do not account for different species hearing weightings) were 260m and 23km for the geophysical and geotechnical surveys respectively, with the geophysical surveys being characterised as an impulsive sound source and the geotechnical surveys as a continuous (non-impulsive) sound source. Despite the large ranges associated with the geotechnical surveys, which is likely due to the conservative threshold applied to continuous sound sources (detailed in section 2.6.2), potential disturbance of cetaceans as a result of these surveys is unlikely due to the very low frequency nature of the geotechnical work, which is likely to fall outside the most sensitive hearing range of harbour porpoise (section 2.2). Additionally it is likely that the vessel noise generated before the geophysical and geotechnical surveys start will result in disturbance (avoidance behaviour) and cause marine mammals to move away, further reducing the likelihood of adverse impacts.

3.13 It is possible that the relevant EPS may experience some limited behavioural effects as a result of impulsive sound, however no strong disturbance is expected. These effects are unlikely to result in any significant disturbance or displacement for these species. In addition, it is expected that, to some extent, since marine mammals are mobile species, they will be able to adapt their behaviour to reduce any effects, for example through avoidance behaviour. The risk of behavioural effects was therefore considered to be low.

3.14 The proposed geophysical, geotechnical and marine UXO surveys will be short-term, taking place over a maximum of 69 days and will remain within the Offshore Cable Corridor with only a small proportion of that total area affected at any one time in the context of the WS and CIS MUs. The use of geophysical survey equipment is not expected to create a barrier

to movement for harbour porpoise and is therefore not expected to reduce the range of the local harbour porpoise population (reported as “Favourable” in the most recent FCS status assessment), with the “natural range of the species neither being reduced nor likely to be reduced for the foreseeable future”, as defined by the FCS status test. Harbour porpoises are highly mobile, inhabiting relevant habitat across the region. Any habitat likely to be affected therefore will constitute a very small proportion of the habitats available to the harbour porpoise population. The survey area is not likely to represent a key habitat in the context of the wider region. As such, it is predicted that the FCS test, namely that “there is, and will probably continue to be, a sufficiently large habitat to maintain harbour porpoise populations on a long-term basis”, will be satisfied.

3.2 Bottlenose Dolphin

3.2.1 Baseline

3.15 The bottlenose dolphin is relatively common in the Irish Sea. High concentration of sightings occur in Cardigan Bay to the south of the Offshore Cable Corridor (Waggitt *et al*. 2020, CMACS 2005), due to semi-resident populations. Seasonally, higher sightings occur in coastal regions during summer and autumn (Baines and Evans 2009). Bottlenose dolphin is predominantly found in coastal regions, with low densities often recorded offshore (Baines and Evans 2009). Studies conducted within the UK have found that bottlenose dolphin prefer estuarine areas with the steepest slope and greatest depth (Baines and Evans 2012).

3.16 Most sightings that occur in UK waters take place between July and September, with a secondary peak in April (Ingram and Rogan 2002). The species often occur in small groups in coastal areas, moving offshore during winter months to feed on benthic and pelagic fish species (CMACS 2005). In coastal waters, bottlenose dolphins have been found to prefer headlands, river estuaries, or sandbanks, where there is typically uneven bottom relief and/or strong tidal currents (Reid *et al*. 2003). High sighting rates are observed in Cardigan Bay and off the North Wales Coast, and regular sightings are seen in the Coastal West of Scotland and Hebrides MU.

3.17 The Offshore Cable Corridor is located across the Coastal West Scotland and the Hebrides (CWSH) and Irish Sea (IS) MU for bottlenose dolphin. There is estimated to be a population of 293 animals within the IS MU however no estimate is provided for the CWSH MU (Reid *et al*. 2003). The SCANS IV density estimate for the relevant survey blocks that cover the Offshore Cable Corridor (CS-D and CS-F) are 0.2352 and 0.0425 bottlenose dolphins per km^2 respectively. To ensure the assessment of the impact of underwater noise on bottlenose dolphin is undertaken using the most precautionary values the higher density value has been taken forward and applied throughout the risk assessment (CS-D: 0.2352).

3.18 Given the evidence gathered from the initial desktop study bottlenose dolphin is considered likely to occur year-round within the MMSA (Wall *et al*. 2013, IAMMWG 2022, Reid *et al*. 2003, Baines and Evans 2012).

3.2.2 Risk Assessment

3.19 Audiogram data for the bottlenose dolphin indicate that it is responsive to noise at frequencies from 150Hz – 160kHz. Thresholds for SPLs at which injury and behavioural disturbance may be induced are described in Table 2-1.

3.20 The noise assessment (Section 1.7) showed that a bottlenose dolphin exposed to subsea noise from the survey equipment would be likely to experience permanent auditory injury at a range of up to 104m (worst case geophysical surveys; PTS SEL). Recoverable auditory injury and fleeing response has the potential to occur out to a maximum distance of 390m (worst case geophysical surveys; TTS SEL). Behavioural disturbance also has the potential to occur as a result of these geophysical and geotechnical surveys.

3.21 The noise modelling provided the impact ranges associated with the sound sources which may be used for the surveys and allowed for the calculation of the impact area. The impact

area (km^2) has then been combined with the density of bottlenose dolphin individuals in the area (individuals per km^2) to determine how many animals may be affected by underwater noise from these surveys. Less than one bottlenose dolphin is predicted to have the potential to experience PTS at any one time within the impact area during the surveys. Due to the small area over which injury could occur and the low number of animals which may be affected (<1), the risk of injury to bottlenose dolphin is considered to be negligible. It is likely that animals will be displaced from the area of injury risk prior to commencement of the geophysical and geotechnical surveys due to audible and visual cues during movement of the boats. Less than one bottlenose dolphin is predicted to have the potential to experience TTS at any one time within the impact area during the surveys. Proposed mitigation to further reduce potential for impact is presented in Section 3.10.

3.22 Scientific literature shows that bottlenose dolphin responses to disturbance vary between and within species' and depend on the individual characteristics and extrinsic factors (Harding *et al*. 2019). The behavioural response ranges for all species assessed (which do not account for different species hearing weightings) were 260m and 23km for the geophysical and geotechnical surveys respectively with the geophysical surveys being characterised as impulsive sound source and the geotechnical surveys as continuous (non-impulsive) sound source. Despite the large ranges associated with the geotechnical surveys, which is likely due to the conservative threshold applied to continuous sound sources (detailed in section 2.6.2), potential disturbance of bottlenose dolphin as a result of these surveys is unlikely due to the very low frequency nature of the geotechnical work, which is likely to fall outside the most sensitive hearing range of bottlenose dolphin (section 2.2). It is possible that the relevant EPS may experience some limited behavioural effects as a result of impulsive sound however no strong disturbance is expected. These effects are unlikely to result in any significant disturbance or displacement for bottlenose dolphin, therefore the risk of behavioural effects was therefore considered to be low.

3.23 The proposed geophysical, geotechnical and marine UXO surveys will be short-term, taking place over a maximum of 69 days and will remain within the Offshore Cable Corridor with only a small proportion of that total area affected at any one time in the context of the CWSH and IS MUs. On this basis, the proposed geophysical surveys are not anticipated to prevent the bottlenose dolphin population from continuing to "maintain itself on a long-term basis as a viable element of its natural habitats", as defined by the FCS test. The use of geophysical, geotechnical and marine UXO survey equipment is not expected to create a barrier to movement for bottlenose dolphin and is therefore not expected to reduce the range of the local bottlenose population (reported as "Favourable" in the most recent FCS status assessment), with the "natural range of the species neither being reduced nor likely to be reduced for the foreseeable future", as defined by the FCS status test. Bottlenose dolphin have been known to exhibit flexibility in their habitat use and therefore any habitat likely to be affected by the geophysical, geotechnical and marine UXO surveys will constitute a very small proportion of the habitat available to the bottlenose dolphin population. The survey area is not likely to represent a key habitat in the context of the wider region. As such, it is predicted that the FCS test, namely that "there is, and will probably continue to be, a sufficiently large habitat to maintain bottlenose dolphin populations on a long-term basis", will be satisfied.

3.3 Short-beaked common dolphin

3.3.1 Baseline

3.24 Short-beaked common dolphin has a large offshore distribution, predominantly occurring at the southern-end of the Irish Sea (Waggitt *et al*. 2020). They have been recorded in Irish waters all year round, but strong seasonal shifts in their distribution have been noted, with winter inshore movements onto the Celtic Shelf and into the western English Channel and St. George's Channel resulting in pronounced concentrations (Baines and Evans 2012).

3.25 Short-beaked common dolphin typically prefer offshore habitats with geologic features such as underwater ridges and seamounts where upwelling occurs, increasing nutrient concentrations and supporting higher productivity (Northridge *et al*. 2004, NOAA 2022a). Short-beaked common dolphins have additionally been found more frequently along shelf

edges and in areas comprised of sharp bottom relief, such as seamounts and escarpments (NOAA 2022a).

3.26 Sightings predominantly occur along the west coast of Scotland, Ireland and to the southwest of England (NOAA 2022a). Infrequent sightings in the Irish Sea typically occur between June and September (Reid *et al*. 2003). Prey species tend to be pelagic fish such as mackerel, sardine and sprat. Research undertaken to analyse short-beaked common dolphin foraging habits illustrated that the species is abundant in both neritic and oceanic habitats, suggesting a highly variable habitat preference and associated foraging strategies (CMACS 2005).

3.27 A single MU, the Celtic and Greater North Seas (CGNS), has been defined for short-beaked common dolphin, white-beaked dolphin, Atlantic white-sided dolphin, Risso's dolphin and minke whale (Pusineri *et al*. 2007). The population estimates for this MU are for 102,656 short-beaked common dolphins. The SCANS IV density estimate for the relevant survey blocks that cover the Offshore Cable Corridor (CS-D and CS-F) are 0.0272 and 0.0544 short-beaked common dolphins per km2 respectively. To ensure the assessment of the impact of underwater noise on short-beaked common dolphin is undertaken using the most precautionary values the higher density value has been taken forward and applied throughout the risk assessment (CS-F: 0.0544).

3.28 Given the evidence gathered from the initial desktop study short-beaked common dolphin is considered likely to occur year-round within the marine mammal study area (Wall *et al*. 2013, Reid *et al*. 2003, Baines and Evans 2012, IAMMWG. *et al*. 2015).

3.3.2 Risk Assessment

3.29 Thresholds for SPLs at which injury and behavioural disturbance may be induced in HF cetacean species, such as the short-beaked common dolphin are described in Table 2-1.

3.30 The noise assessment (Section 1.7) showed that a short-beaked common dolphin exposed to subsea noise from the survey equipment would be likely to experience permanent auditory injury at a range of up to 104m (worst case geophysical surveys; PTS SEL). Recoverable auditory injury and fleeing response has the potential to occur out to a maximum distance of 390m (worst case geophysical surveys; TTS SEL). Behavioural disturbance also has the potential to occur as a result of the geophysical and geotechnical surveys.

3.31 The noise modelling provided the impact ranges associated with the sound sources which may be used for the surveys and allowed for the calculation of the impact area. The impact area (km^2) has then been combined with the density of short-beaked common dolphin individuals in the area (individuals per km^2) to determine how many animals may be affected by underwater noise from these surveys. less than one short-beaked common dolphin is predicted to have the potential to experience PTS at any one time within the impact area during the surveys. Due to the small area over which injury could occur and the low number of animals which may be affected, the risk of injury to short-beaked common dolphin is considered to be negligible. It is likely that animals will be displaced from the area of injury risk prior to commencement of the geophysical and geotechnical surveys due to audible and visual cues during movement of the boats. Less than one short-beaked common dolphin is predicted to have the potential to experience TTS at any one time within the impact area during the surveys. Proposed mitigation to further reduce potential for impact is presented in Section 3.10.

3.32 Similarly to other cetacean species scientific literature shows that behaviour disturbance response by short-beaked common dolphin varies between and within species' and depends on the individual characteristics and extrinsic factors (Harding *et al*. 2019). The behavioural response ranges for all species assessed (which do not account for different species hearing weightings) were 260m and 23km for the geophysical and geotechnical surveys respectively with the geophysical surveys being characterised as impulsive sound source and the geotechnical surveys as continuous (non-impulsive) sound source. Despite the large ranges associated with the geotechnical surveys, which is likely due to the conservative threshold applied to continuous sound sources (detailed in section 2.6.2), potential disturbance of short-beaked common dolphin as a result of these surveys is

unlikely due to the very low frequency nature of the geotechnical work, which is likely to fall outside the most sensitive hearing range of short-beaked common dolphin (section 2.2). It is possible that the relevant EPS may experience some limited behavioural effects as a result of impulsive sound however no strong disturbance is expected. These effects are unlikely to result in any significant disturbance or displacement for short-beaked common dolphin, therefore the risk of behavioural effects was therefore considered to be low.

3.33 The proposed geophysical, geotechnical and marine UXO surveys will be short-term, taking place over a maximum of 69 days and will remain within the Offshore Cable Corridor, with only a small proportion of that total area affected at any one time) in the context of the CGNS MU. The use of geophysical, geotechnical and marine UXO survey equipment is not expected to create a barrier to movement for short-beaked common dolphin and is therefore not expected to reduce the range of the local common dolphin population (reported as "Favourable" in the most recent FCS status assessment), with the "natural range of the species neither being reduced nor likely to be reduced for the foreseeable future", as defined by the FCS status test. Common dolphin is a highly mobile and widely distributed species encountered along the west coast of Scotland, Ireland and to the southwest of England (Reid *et al*., 2003). Any habitat likely to be affected therefore will constitute a very small proportion of the habitat available to the short-beaked common dolphin population. The survey area is not likely to represent a key habitat in the context of the wider region. As such, it is predicted that the FCS test, namely that "there is, and will probably continue to be, a sufficiently large habitat to maintain common dolphin populations on a long-term basis", will be satisfied.

3.4 Risso's Dolphin

3.4.1 Baseline

3.34 Risso's dolphin is frequently sighted in nearshore waters in the northern Irish Sea and in the southern Irish Sea, particularly off the north-west coast of Wales, and off south-west Ireland. Risso's dolphin tend to prefer shelf-edge offshore waters and are typically found at depths ranging from 400 – 1,000m (Waggitt *et al*, 2020).

3.35 This species has been found to predominantly be a nocturnal forager, targeting deep dwelling benthic organisms (NOAA 2022b). However, Risso's dolphin is known to perform 'prey switching' between deeper diving for squid and shallow water foraging. As stated, the species will often feed at night to benefit from vertical migrations of squid as they can then stay nearer surface to breathe and conserve energy (Visser *et al*. 2021).

3.36 A single MU the CGNS, has been defined for Risso's dolphin (Benoit-Bird *et al*. 2019). Population estimates for the CGNS MU are 12,262 for Risso's dolphin. The SCANS IV density estimate for the relevant survey blocks that cover the Offshore Cable Corridor (CS-D and CS-F) are 0.0022 and 0.0027 Risso's dolphin per km^2 respectively. To ensure the assessment of the impact of underwater noise on Risso's dolphin is undertaken using the most precautionary values the higher density value has been taken forward and applied throughout the risk assessment (CS-F: 0.0027).

3.37 Given the evidence gathered from the initial desktop study Risso's dolphin is considered likely to occur year-round within the MMSA (Wall *et al*. 2013, Reid *et al*. 2003, Baines and Evans 2012, IAMMWG. *et al*. 2015).

3.4.2 Risk Assessment

3.38 Thresholds for SPLs at which injury and behavioural disturbance may be induced in HF cetacean species, such as the Risso's dolphin are described in Table 2-1.

3.39 The noise assessment (Section 1.7) showed that an Risso's dolphin exposed to subsea noise from the survey equipment may experience permanent auditory injury at a range of up to 104m (worst case geophysical surveys; PTS SEL). Recoverable auditory injury and fleeing response has the potential to occur out to a maximum distance of 390m (worst case

geophysical surveys; TTS SEL). Behavioural disturbance also has the potential to occur as a result of the geophysical and geotechnical surveys.

3.40 The noise modelling provided the impact ranges associated with the sound sources which may be used for the surveys and allowed for the calculation of the impact area. The impact area (km^2) has then been combined with the density of short-beaked common dolphin individuals in the area (individuals per km^2) to determine how many animals may be affected by underwater noise from the surveys. Less than one Risso's dolphin is predicted to have the potential to experience PTS at any one time within the impact area during the surveys. Due to the small area over which injury could occur and the low number of animals which may be affected (<1), the risk of injury to Risso's dolphin is considered to be negligible. It is likely that animals will be displaced from the area of injury risk prior to commencement of the geophysical and geotechnical surveys due to audible and visual cues during movement of the boats. Less than one Risso's dolphin is predicted to have the potential to experience TTS at any one time within the impact area during the surveys. Proposed mitigation to further reduce potential for impact is presented in Section 3.10.

3.41 In terms of behaviour disturbance to Risso's dolphin, scientific literature again shows that responses to disturbance vary between and within species' and depend on the individual characteristics and extrinsic factors (Harding *et al*. 2019). The behavioural response ranges for all species assessed (which do not account for different species hearing weightings) were 260m and 23km for the geophysical and geotechnical surveys respectively with the geophysical surveys being characterised as impulsive sound source and the geotechnical surveys as continuous (non-impulsive) sound source. Despite the large ranges associated with the geotechnical surveys, which is likely due to the conservative threshold applied to continuous sound sources (detailed in section 2.6.2), potential disturbance of Risso's dolphin as a result of these surveys is unlikely due to the very low frequency nature of the geotechnical work, which is likely to fall outside the most sensitive hearing range of Risso's dolphin (section 2.2). It is possible that the relevant EPS may experience some limited behavioural effects as a result of impulsive sound however no strong disturbance is expected. These effects are unlikely to result in any significant disturbance or displacement for Risso's dolphin, therefore the risk of behavioural effects was therefore considered to be low.

3.42 The proposed geophysical, geotechnical and marine UXO surveys will be short-term, taking place over a maximum of 69 days and will remain within the Offshore Cable Corridor, with only a small proportion of that total area affected at any one time) in the context of the CGNS MU. The use of geophysical, geotechnical and marine UXO survey equipment is not expected to create a barrier to movement for Risso's dolphin and is therefore not expected to reduce the range of the local Risso's dolphin population (reported as "Favourable" in the most recent FCS status assessment), with the "natural range of the species neither being reduced nor likely to be reduced for the foreseeable future", as defined by the FCS status test. Risso's dolphin is known to be highly mobile and can travel long distances. Any habitat likely to be affected therefore will constitute a very small proportion of the habitat available to the Risso's dolphin population. The survey area is not likely to represent a key habitat in the context of the wider region. As such, it is predicted that the FCS test, namely that "there is, and will probably continue to be, a sufficiently large habitat to maintain Risso's dolphin populations on a long-term basis", will be satisfied.

3.5 Minke Whale

3.5.1 Baseline

3.43 Minke whale has a largely offshore distribution, with the highest density of sighting occurring in the area of the Celtic Deep (Waggitt *et al*. 2020). The species predominantly visits the Irish Sea during summer months, with few sightings occurring in the winter. This seasonal variation in observance within the Irish Sea has been linked to changes in oceanographic conditions and prey availability (Baines and Evans 2012).

3.44 The minke whale is known to have a largely offshore distribution, typically found in deep water areas over 50m in depth (Reeves *et al*. 2002). Their low energetic cost of swimming

allows the species to switch between prey species according to seasonal availability, ultimately affecting their habitat preferences throughout the year (Baines and Evans 2012).

3.45 Minke whales can be observed in the western Irish Sea and Celtic sea in summer months and most often alone or in small groups (Anderwald *et al*. 2012). The lesser sandeel (*Ammodytes marinus)* is known to have both spawning and nursery grounds which are to the south of the Offshore Cable Corridor, and are a key food source for minke whale (Reeves *et al*. 2002).

3.46 A single MU the CGNS, has been defined for minke whale (Green 2017). Population estimates for the CGNS MU are 20,118 for minke whale. The SCANS IV density estimate for the relevant survey blocks that cover the Offshore Cable Corridor (CS-D and CS-F) are 0.0137 and 0.0137 minke whale per km^2 respectively. To ensure the assessment of the impact of underwater noise on minke whale is undertaken using the most precautionary values the higher density value has been taken forward and applied throughout the risk assessment (CS-F: 0.0137).

3.47 Given densities are comparatively high in the North Channel area, minke whale is considered likely to occur in the summer months within the MMSA (Wall *et al*. 2013, Reid *et al*. 2003, Baines and Evans 2012, IAMMWG. *et al*. 2015).

3.5.2 Risk Assessment

3.48 The minke whale, a baleen whale, is most sensitive to noise frequencies in the range from 40Hz to 15kHz (Ketten and Mountain, unpublished). Thresholds for SPLs at which injury and behavioural disturbance may be induced are described in Table 2-1.

3.49 The noise assessment (Section 1.7) showed that a minke whale exposed to subsea noise from the survey equipment may experience permanent auditory injury at a range of <10m (worst case geophysical and geotechnical surveys; PTS SEL). Recoverable auditory injury and fleeing response has the potential to occur out to a maximum distance of 452m (worst case geophysical surveys; TTS SEL). Behavioural disturbance also has the potential to occur as a result of the geophysical and geotechnical surveys.

3.50 The noise modelling provided the impact ranges associated with the sound sources which may be used for the surveys and allowed for the calculation of the impact area. The impact area (km^2) has then been combined with the density of minke whale individuals in the area (individuals per km^2) to determine how many animals may be affected by underwater noise from these surveys. Less than one minke whale is predicted to have the potential to experience PTS at any one time within the impact area during the surveys. Due to the small area over which injury could occur and the low number of animals which may be affected (<1), the risk of injury to minke whale is considered to be negligible. It is likely that animals will be displaced from the area of injury risk prior to commencement of the geophysical and geotechnical survey due to audible and visual cues during movement of the boats. Less than one minke whale is predicted to have the potential to experience TTS at any one time within the impact area during the surveys. Proposed mitigation to further reduce potential for impact is presented in Section 3.10.

3.51 Regarding behaviour disturbance to minke whale, scientific literature shows that responses to disturbance vary between and within species' and depend on the individual characteristics and extrinsic factors (Harding *et al*. 2019). The behavioural response ranges for all species assessed (which do not account for different species hearing weightings) were 260m and 23km for the geophysical and geotechnical surveys respectively with the geophysical surveys being characterised as impulsive sound source and the geotechnical surveys as continuous (non-impulsive) sound source. As a low frequency species (section 2.2) minke whale may be affected by the continuous noise from the geotechnical surveys as well as the geophysical surveys. It is however likely that the vessel noise generated before the geophysical and geotechnical surveys start will result in disturbance (avoidance behaviour) and cause marine mammals to flee, further reducing the likelihood of adverse impacts from the surveys themselves. It is possible that the relevant EPS may experience some limited behavioural effects as a result of impulsive and non-impulsive sound, however no strong disturbance is expected. These effects are unlikely to result in any significant

disturbance or displacement for minke whale, therefore the risk of behavioural effects was therefore considered to be low.

3.52 The proposed geophysical, geotechnical and marine UXO surveys will be short-term, taking place over a maximum of 69 days and will remain within the Offshore Cable Corridor, with only a small proportion of that total area affected at any one time, in the context of the CGNS MU. The use of geophysical, geotechnical and marine UXO survey equipment is not expected to create a barrier to movement for minke whale and is therefore not expected to reduce the range of the local minke whale population (reported as "Favourable" in the most recent FCS status assessment), with the "natural range of the species neither being reduced nor likely to be reduced for the foreseeable future", as defined by the FCS status test. Minke whale is known to have a large spatial distribution, undergoing seasonal movements between foraging grounds in the higher latitudes and breeding grounds in the lower latitudes. Any habitat likely to be affected therefore will constitute a very small proportion of the habitat available to the minke whale population. The survey area is not likely to represent a key habitat in the context of the wider region. As such, it is predicted that the FCS test, namely that "there is, and will probably continue to be, a sufficiently large habitat to maintain minke whale populations on a long-term basis", will be satisfied.

3.6 Grey seal

3.6.1 Baseline

3.53 Grey seals are the most commonly observed pinniped species in UK waters, accounting for approximately 34% of the world population (SCOS 2022). The main grey seal breeding colonies close to the Offshore Cable Corridor are those in the Inner Hebrides, though smaller breeding colonies exist off the coast of Northern Ireland, the Isle of Man, and North Wales. The latest UK grey seal population estimate is 162,000 individuals (SCOS 2022).

3.54 Grey seals regularly forage in the open sea at depths of up to 100m and return to haul-out sites where they rest, moult and breed (SCOS 2022). The species generally prefers isolated habitats, away from the presence of humans and other terrestrial predators (Kierly *et al*. 2000). These environments are typically more exposed to the elements and grey seals tend to favour haul-out sites in remote mainland areas (SCOS 2021). Prey species include flatfish and pelagic fish species such as herring and mackerel as well as invertebrates and squid (SCOS 2022; CMACS 2005).

3.6.2 Risk Assessment

3.55 Grey seals are likely to be present in the MMSA and have an estimated auditory band width of 50Hz to 86kHz. Thresholds for SPLs at which injury and behavioural disturbance may be induced are described in Table 2-1.

3.56 The noise assessment (Section 1.7) showed that grey seals exposed to subsea noise from the survey equipment may experience permanent auditory injury at a range of <10m (worst case geophysical and geotechnical surveys; PTS SEL). Recoverable auditory injury and fleeing response has the potential to occur out to a maximum distance of 180m (worst case geophysical surveys; TTS SEL). Behavioural disturbance also has the potential to occur as a result of the geophysical and geotechnical surveys.

3.57 The noise modelling provided the impact ranges associated with the sound sources which may be used for the surveys and allowed for the calculation of the impact area. The impact area (km^2) has then been combined with the density of grey seal individuals in the area (individuals per km^2) to determine how many animals may be affected by underwater noise from these surveys. Less than one grey seal is predicted to have the potential to experience PTS at any one time within the impact area during the surveys. Due to the small area over which injury could occur and the low number of animals which may be affected (<1), the risk of injury to grey seal is considered to be negligible. It is likely that animals will be displaced from the area of injury prior to commencement of the geophysical and geotechnical survey due to audible and visual cues during movement of the boats. Less than one grey seal is predicted to have the potential to experience TTS at any one time

within the impact area during the surveys. Proposed mitigation to further reduce potential for impact is presented in Section 3.10.

3.58 Regarding behaviour disturbance to grey seal, scientific literature shows that responses to disturbance vary between and within the species' and depends on the individual characteristics and extrinsic factors (Harding *et al*. 2019). The behavioural response ranges for all species assessed (which do not account for different species hearing weightings) were 260m and 23km for the geophysical and geotechnical surveys respectively with the geophysical surveys being characterised as impulsive sound source and the geotechnical surveys as continuous (non-impulsive) sound source. Similarly to minke whale, grey seals have a relatively low hearing range (section 2.2) and may be affected by the continuous noise from the geotechnical surveys as well as the geophysical surveys. It is however likely that the vessel noise generated before the geophysical and geotechnical surveys start will result in disturbance (avoidance behaviour) and cause marine mammals to flee, further reducing the likelihood of adverse impacts from the surveys themselves. It is possible that the relevant EPS may experience some limited behavioural effects as a result of impulsive and non-impulsive sound however no strong disturbance is expected. These effects are unlikely to result in any significant disturbance or displacement for grey seal, therefore the risk of behavioural effects was therefore considered to be low.

3.59 The proposed geophysical, geotechnical and marine UXO surveys will be short-term, taking place over a maximum of 69 days and will remain within the Offshore Cable Corridor, with only a small proportion of that total area affected at any one time. The use of geophysical, geotechnical and marine UXO survey equipment is not expected to create a barrier to movement for grey seal and is therefore not expected to reduce the range of the local grey seal population (reported as "Favourable" in the most recent FCS status assessment), with the "natural range of the species neither being reduced nor likely to be reduced for the foreseeable future", as defined by the FCS status test. Grey seal is known to have a large spatial distribution throughout the UK. Any habitat likely to be affected therefore will constitute a very small proportion of the habitat available to the grey seal population. The survey area is not likely to represent a key habitat in the context of the wider region. As such, it is predicted that the FCS test, namely that "there is, and will probably continue to be, a sufficiently large habitat to maintain grey seal populations on a long-term basis", will be satisfied.

3.7 Harbour seal

3.7.1 Baseline

3.60 Harbour seal is the most widely distributed pinniped species in the world and is known to inhabit North Atlantic and North Pacific seas (CMACS, 2005; Thompson *et al*. 2019). Results indicate that the current UK harbour seal population is similar to the estimate made in 1990, with significant regional declines or increases depending on the location (Thompson *et al*. 2019). In Northern Ireland, the population appears to have declined slowly after 2002 but has apparently been stable since 2011 (SCOS 2021).

3.61 The largest concentrations of haul-out sites are found in Scotland, primarily on the West coast, Inner and Outer Hebrides, Orkney and Shetland, but other important haul out sites are found on the east coast of Northern Ireland.

3.62 The most recent harbour seal August moult count presented for seal management unit (SMU) 1 (Southwest Scotland) is 1,709 (2016-2019 count period) (SCOS, 2022), 818 for SMU 14 (given as Northern Ireland total in SCOS 2022 Report), 15,600 for SMU 2 (West Scotland) and a rough estimate of 5 for SMU 13 (Northwest England). Harbour seal at-sea usage maps from Carter *et al*. (2020) shows higher relative areas of predicted seal distribution around the Offshore Cable Corridor towards the Hunterston and Kilroot landfalls, with lower density areas within offshore waters.

3.7.2 Risk Assessment

3.63 Harbour seals are likely to present in the MMSA and have the same auditory band width as grey seals of 50Hz to 86kHz. Thresholds for SPLs at which injury and behavioural disturbance may be induced are described in Table 2-1.

3.64 The noise assessment (Section 1.7) showed that harbour seals exposed to subsea noise from the survey equipment may experience permanent auditory injury at a range of <10m (worst case geophysical and geotechnical surveys; PTS SEL). Recoverable auditory injury and fleeing response has the potential to occur out to a maximum distance of 180m (worst case geophysical surveys; TTS SEL). Behavioural disturbance also has the potential to occur as a result of the geophysical and geotechnical surveys.

3.65 The noise modelling provided the impact ranges associated with the sound sources which may be used for the surveys and allowed for the calculation of the impact area. The impact area (km^2) has then been combined with the density of harbour seal individuals in the area (individuals per km^2) to determine how many animals may be affected by underwater noise from these surveys. Less than one grey seal is predicted to have the potential to experience PTS at any one time within the impact area during the surveys. Due to the small area over which injury could occur and the low number of animals which may be affected (<1), the risk of injury to harbour seal is considered to be negligible. It is likely that animals will be displaced from the area of injury risk prior to commencement of the geophysical and geotechnical survey due to audible and visual cues during movement of the boats. Less than one harbour seal is predicted to have the potential to experience TTS at any one time within the impact area during the surveys. Proposed mitigation to further reduce potential for impact is presented in Section 3.10.

3.66 Regarding behaviour disturbance to harbour seal, scientific literature shows that responses to disturbance vary between and within the species' and depends on the individual characteristics and extrinsic factors (Harding *et al*. 2019). The behavioural response ranges for all species assessed (which do not account for different species hearing weightings) were 260m and 23km for the geophysical and geotechnical surveys respectively with the geophysical surveys being characterised as impulsive sound source and the geotechnical surveys as continuous (non-impulsive) sound source. Similarly to minke whale, harbour seals have a relatively low hearing range (section 2.2) and may be affected by the continuous noise from the geotechnical surveys as well as the geophysical surveys. It is however likely that the vessel noise created before the geophysical and geotechnical surveys start will result in disturbance and cause marine mammals to flee, further reducing the likelihood of adverse impacts from the surveys themselves. . It is possible that the relevant EPS may experience some limited behavioural effects as a result of impulsive and non-impulsive sound, however no strong disturbance is expected. These effects are unlikely to result in any significant disturbance or displacement for harbour seal, therefore the risk of behavioural effects was therefore considered to be low.

3.67 The proposed geophysical, geotechnical and marine UXO surveys will be short-term, taking place over a maximum of 69 days and will remain within the Offshore Cable Corridor, with only a small proportion of that total area affected at any one time. The use of geophysical, geotechnical and marine UXO survey equipment is not expected to create a barrier to movement for harbour seal and is therefore not expected to reduce the range of the local minke whale population (reported as "Favourable" in the most recent FCS status assessment), with the "natural range of the species neither being reduced nor likely to be reduced for the foreseeable future", as defined by the FCS status test. Harbour seal is known to have a large spatial distribution throughout the UK. Any habitat likely to be affected therefore will constitute a very small proportion of the habitat available to the harbour seal population. The survey area is not likely to represent a key habitat in the context of the wider region. As such, it is predicted that the FCS test, namely that "there is, and will probably continue to be, a sufficiently large habitat to maintain harbour seal populations on a long-term basis", will be satisfied.

3.8 Leatherback turtles

3.8.1 Baseline

3.68 Leatherback turtles have been sighted and therefore may to occur in the Irish Sea between July and September, and further north between August and October, however their occurrence is considered rare for example, in August 2000, 26 individuals were sighted in the Irish Sea (Pierpoint 2000). There are also visual observation records of leatherback turtles in the channel between Northern Ireland and Scotland, recorded through citizen science and compiled in the NBN atlas, which shows some recordings of the species between 1995 and 2017, the majority of which take place between the summer months (NBN 2023). Generally their occurrence in Northern Ireland however is considered rare (King 2009) and usually being a result of a current taking them off their usually route which doesn't typically take them so far north.

3.8.2 Risk Assessment

3.69 Due to their rare occurrence, marine turtles, such as leatherbacks, will not be considered further in this risk assessment. However, should any marine turtles be encountered during the survey works, best practice will be followed including:

- An immediate notification to DAERA of the marine turtle sighting; and
- Following the UK Turtle Code, which gives guidance on how to report approach, handle and rescue individuals (Marine Conservation Society 2023).

3.9 Basking sharks

3.9.1 Baseline

3.70 Basking sharks are known to inhabit the Irish Sea and have been observed most often on the surface in summer and spring months with the species typically undergoing a north-south migration through the Irish Sea (Sims *et al*. 2008; Wilson *et al*. 2020).

3.71 The Irish Basking Shark Group is a dedicated group which studies the distribution of the species in Irish Seas; they have an abundance of ongoing projects, including the Malin Head Survey and tag deployment surveys which aim to better understand the distributions of Basking sharks in Irish Waters. Results suggest that the species could be present in the search area. Furthermore, data from individual sightings reported by Sharrock, *et al*. (2023), which took place between 1987 and 2006, shows that basking sharks have been sighted abundantly in the channel between Northern Ireland and Scotland. These sightings were linked to social interaction and to courtship and feeding behaviour (Sharrock, *et al*. 2023). Southall, *et al*. (2005) presented density information for basking shark to the north of the Isle of Man in densities of 11-50 individuals per 50km by 50km grid square.

3.9.2 Risk Assessment

3.72 The hearing range of basking sharks is not known; however, five other elasmobranchs have been found to have a hearing range between 20Hz to 1kHz with greatest sensitivities at lower frequencies (Mickle *et al*. 2020). Therefore, it is unlikely this species will be affected by the noise produced during these surveys, especially considering there is no evidence of sound causing mortality or stress in this species. In addition, this species is highly mobile and so significant adverse impacts to this species are considered unlikely. Despite the unlikelihood of being affected by noise, JNCC guidelines and best practice are still advised to reduce the pressures associated with scientific acoustic surveys, to ensure to the highest degree of confidence that basking sharks are not disrupted (JNCC 2017).

3.73 Behavioural disturbance ranges for fishes may occur within a wide survey corridor (up to 500m), therefore the potential for behavioural effects has been considered. Basking sharks are not known to use sound for feeding or communication (Booth, *et al*. 2013) although

some behavioural effects (e.g. startle response) may occur in the very nearfield (up to 500m).

3.74 The proposed geophysical, geotechnical and marine UXO surveys will be short-term, taking place over a maximum of 69 days and will remain within the Offshore Cable Corridor, with only a small proportion of that total area affected at any one time. The use of geophysical, geotechnical and marine UXO survey equipment is not expected to create a barrier to movement for basking sharks and is therefore not expected to reduce the range of the local minke whale population (reported as "Favourable" in the most recent FCS status assessment), with the "natural range of the species neither being reduced nor likely to be reduced for the foreseeable future", as defined by the FCS status test. Basking shark is known to have a large spatial distribution, undergoing seasonal movements and only occurring in the waters most often in the spring and summer months in the Irish sea. Any habitat likely to be affected therefore will constitute a very small proportion of the habitat available to the basking shark population. The survey area is not likely to represent a key habitat in the context of the wider region. As such, it is predicted that the FCS test, namely that "there is, and will probably continue to be, a sufficiently large habitat to maintain basking shark populations on a long-term basis", will be satisfied.

3.10 Mitigation

3.75 Marine mammal mitigation activities will be conducted in the field following the JNCC Guidelines for Minimising the Risk of Injury and Disturbance to Marine Mammals from seismic surveys (Waggitt *et al. 2020)*. The following specific mitigation measures are proposed for the planned geophysical and geotechnical surveys.

3.76 A 30 minute search to establish the absence of marine mammals is required before start of geophysical equipment. Thus dedicated marine mammal observers (MMO)/passive acoustic monitoring (PAM) operatives (potentially dual role for PAM) will operate from the vessel bridge during daylight hours as per current JNCC guidelines (JNCC 2017). Given the water depth of the Offshore Cable Corridor (up to 250m), monitoring will be carried out with particular attention given to a 1,000m exclusion zone for harbour porpoise around the geophysical survey equipment source to account for the 940m PTS for harbour porpoise in the absence of a soft start procedure being employed. A 100m exclusion zone is required for other marine mammals.

3.77 Alternatively a 30 minute soft-start period, can be employed each time the seismic source is activated, during which there will be a gradual build -up (or soft-start) of source power over the 30 minute period with power reduced to 10% of modelled power, as per the soft-start procedures and current JNCC guidelines (JNCC 2017). This soft-start procedure is utilised while commencing underwater activities to gradually increase the sound intensity over a specific period of time and area. Effectively, this procedure aims to deter marine mammals from the surrounding area prior to full volume being reached so that the noise exposure to marine mammals and the associated risk of injury is reduced and/or mitigated. The adoption of a 30 minute soft-start period enables the PTS for harbour porpoise to reduce to within 500m. However the search for absence within 500m should still commence 30 minutes prior to the commencement of the soft start thus there will circa 1 hour lead time until the start of acquisition.

3.78 Towed PAM provides an opportunity to detect and indicate the location of marine mammal vocalisations at sea relative to a towed hydrophone streamer and is useful when visual searching is not possible (i.e. during periods of low visibility or darkness). Marine mammal species are identified by the specific characteristics of the detected click and whistle sounds, the interpretation of which requires a specialised operator. PAM can be used to detect vocalising cetaceans, but it is not applicable for detection of pinnipeds or non-vocalising animals.

3.79 The MMO/PAM operative(s) will monitor an agreed mitigation zone and advise if any marine mammals are present within the zone. The standard radius of the mitigation zone is 500m, estimated from the centre of the noise source location (noting that this does not exceed the 940m maximum modelled unmitigated injury zone as described in Table 2-1).

3.80 The flexibility of the PAM towing arrangement and ease of deployment/recovery methods must also be considered in relation to existing in-sea equipment in order to ensure that the PAM system can be used without additional risk to vessel personnel and equipment either during geophysical data acquisition or equipment maintenance schedules during typical line changes or periods of poor weather.

3.81 It should be noted that PAM in-sea equipment deployment is dependent on operational constraints. Therefore, PAM will be used as practically and continuously as possible. The Applicant will advise Marine Directorate Scotland and NatureScot or the Department of Agriculture, Environment and Rural Affairs (DAERA) in the event of any significant periods where PAM is not available. PAM efforts will focus on providing a marine mammal monitoring capability of the area within 500m of the source array, during the 30-minute monitoring period prior to soft-start at night or during periods of poor visibility.

3.82 In the event that marine mammals are detected within the mitigation zone, the procedures outlined in the JNCC (2017) guidance will be followed with respect to delaying the soft start (i.e. there must be a minimum of a 20 minute delay from the time of the last detection within the mitigation zone and the commencement of the soft -start).

4 CONCLUSIONS

4.1 This EPS licence and Wildlife licence Risk Assessment has investigated the likelihood of the Development's proposed geophysical and geotechnical surveys in the Offshore Cable Corridor presenting a risk of injury or disturbance to relevant protected marine species. The noise sources included in the assessment were noise from the vessel, Side Scan Sonar (SSS) (not included in the underwater sound modelling), Multi Beam Echo Sounder (MBES), Sub Bottom Profiler (SBP) and Ultra Short Baseline subsea positioning (USBL), which were assessed in combination using the criteria for impulsive and non-impulsive noise.

4.2 The hearing group most at risk of injury from the underwater sound produced by the geophysical surveys was identified to be the VHF group, which for the Offshore Cable Corridor was the harbour porpoise. The starting range for the onset of PTS for a moving animal of the VHF group during these surveys extended to 940m, resulting in a maximum of eight harbour porpoises being affected. Overall, the results of the underwater noise modelling, summarised in this report, indicate that the overall risk of PTS and TTS to harbour porpoise, bottlenose dolphin, short-beaked common dolphin, Risso's dolphin, minke whale, grey seals and harbour seals was low as few individuals were predicted to be affected by survey noise based on animal densities as determined by the SCANS-III surveys. Basking sharks were also considered however due to their highly mobile nature and the lack of evidence regarding sound causing mortality or stress in this species the impact was deemed to be negligible. Furthermore leatherback turtles were also identified as potentially being present in the area however their presence was considered rare enough to be screened out of the risk assessment.

4.3 This low risk will be further reduced as a result of the mitigation measures proposed for these surveys. These mitigation measures include the use of MMOs and PAM to determine if any marine mammals are present within or adjacent to the Offshore Cable Corridor during the surveys. In addition, provided slow start procedures are put in place, it is expected that the animals should have sufficient time to flee from the vessel and effectively vacate the 500m exclusion zone prior to surveys. While there is little risk of exceedance of the injury limits, we note that the surveys use high-powered sound sources that, while not likely to cause auditory harm, are likely to exceed the behavioural response limits as well as temporary hearing impact limits.

4.4 The potential disturbance effects from these surveys on protected marine species are unlikely to qualify as a 'non-trivial disturbance' (JNCC *et al*. (2010) defines "sporadic disturbances without any likely negative impact on the animals" as trivial disturbance) and are therefore unlikely to significantly impact the marine animal, or its population status in the wild. Therefore, it is concluded that there is a **negligible risk of disturbance to the species of concern**.

4.5 On the basis of this risk assessment, it is concluded that there is no licensing requirement for EPS and protected Marine Wildlife.

5 REFERENCES

American National Standards Institute. (1986). S12.7-1986 Method for Measurement of Impulsive Noise.

American National Standards Institute. (1995). S3.20-1995 Bioacoustical Terminology.

American National Standards Institute. (2005). S1.13-2005 Measurement of Sound Pressure Levels in Air.

Anderwald, P., Evans, P., Dyer, R., Dale, A., Wright, P. and Hoelzel, A. (2012). *Spatial scale and environmental determinants in minke whale habitat use and foraging*. Marine Ecology Progress Series, 450, pp.259-274. DOI:10.3354/meps09573.

Baines and Evans. (2009). *Atlas of the Marine Mammals of Wales.* CCW Monitoring Report

Baines, M. E. and Evans, P. G. H. (2012). *Atlas of the Marine Mammals of Wales.* CCW Monitoring Report pp.139.

Benoit-Bird, K., Southall, B. and Moline, M. A. (2019). *Dynamic foraging in Risso's dolphins revealed in 4-dimensions*. Marine Ecology Progress Series, 632. DOI:10.3354/meps13157.

Booth, C., Embling, C., Gordon, J. and P.S, H. (2013). *Habitat preferences and distribution of the harbour porpoise Phocoena phocoena west of Scotland*. Marine Ecology Progress Series, 478, pp.273-285. DOI:10.3354/meps10239.

Buttifant, J. L. (2021). *Habitat modelling of the harbour porpoise (Phocoena phocoena) in southwest UK: effects of depth, slope and tidal state*. The Plymouth Student Scientist, 14(2), pp.27-47.

Carter, M. I. D., Boehme, L., Duck, C. D., Grecian, W. J., Hastie, G. D., McConnell, B. J., Miller, D. L., Morris, C.D., Moss, S. E. W., Thompson, D. and Russell, D. J. F. (2020). *Habitat-based predictions of at-sea distribution for grey and harbour seals in the British Isles*. Sea Mammal Research Unit, University of St Andrews, Report to BEIS, OESEA-16-76/OESEA-17-78

CMACS. (2005). *Gwynt y Môr Offshore Wind Farm Marine Ecology Technical Report.* Document Number J3004/2005.

Green, E. (2017). *A literature review of the lesser (Raitt's) sandeel Ammodytes marinus in European waters.*

Harding, H. R., *et al.* (2019). "*Causes and consequences of intraspecific variation in animal responses to anthropogenic noise*." Behav Ecol 30(6): 1501-1511.

Heinänen, S. and Skov, H. (2015). *The identification of discrete and persistent areas of relatively high harbour porpoise density in the wider UK marine area.* JNCC Report No: 544. Peterborough, UK

IAMMWG. (2022). *Updated abundance estimates for cetacean Management Units in UK waters.* JNCC Report No. 680 (Revised March 2022). JNCC. Peterborough. Document Number 0963-8091.

IAMMWG., Camphuysen, C. J. and Siemensma, M. L. (2015). *A Conservation Literature Review for the Harbour Porpoise (Phocoena phocoena).* JNCC. Peterbourough, Scotland pp.96pp.

Ingram, S. and Rogan, E. (2002). *Identifying critical areas and habitat preferences of bottlenose dolphins Tursiops truncatus*. Marine Ecology Progress Series, 244, pp.247-255. DOI:10.3354/meps244247.

JNCC, Natural England and Countryside Council for Wales. (2010). *The protection of marine European Protected Species from injury and disturbance. Guidance for the marine area in England and Wales and the UK offshore marine area.* pp.118.

JNCC. (2017). *JNCC guidelines for minimising the risk of injury to marine mammals from geophysical surveys.* Joint Nature Conservation Committee. Aberdeen, Scotland pp.28.

JNCC (2024) Grey seal *Halichoerus grypus*. Available at : https://sac.jncc.gov.uk/species/S1364/ Accessed January 2024.

Ketten, D. R. and Mountain D. (Unpublished). *Modelling minke whale hearing*. Report to E&P Sound and Marine Life Programme.

Kierly, O., Lidgard, D., McKibben, M., Connolly, N. and Baines, M. (2000). *Grey Seals: Status and Monitoring in the Irish and Celtic Seas*.

King, G. L., & Berrow, S. D. (2009). *Marine turtles in Irish waters.* The Irish Naturalists' Journal, 30, 1–30. Available at: http://www.jstor.org/stable/20764555.

Marine Conservation Society (2023). T*he United Kingdom and RoI Turtle Code: advice for sea users on how to deal with marine turtle encounters*. Available at https://strandings.com/wp-content/uploads/simple-file-list/UK-Turtle-Code-2023.pdf (Accessed 30.01.2024)

Martin, S. B., Lucke, K. and Barclay, D. R. (2020). *Techniques for distinguishing between impulsive and non-impulsive sound in the context of regulating sound exposure for marine mammals*. J Acoust Soc Am*,* 147 (4)**,** pp.2159. DOI:10.1121/10.0000971.

Mickle, M.F., Pieniazek, R.H. and Higgs, D.M. (2020). *Field assessment of behavioural responses of southern stingrays (Hypanus americanus) to acoustic stimuli*. Royal Society open science, 7(1), p.191544.

MSFD Technical Subgroup on Underwater Noise. (2014). *Monitoring guidance for underwater noise in european seas, Part II: Monitoring guidance specifications.*

National Biodiversity Network (NBN) (2023) *Online Resource: National biodiversity database*. Available at: https://nbnatlas.org/

NIOSH. (1998). Criteria for a recommended standard: occupational noise exposure. DHHS (NIOSH) Publication Number 98-126.

NMFS (2005). Scoping Report for NMFS EIS for the National Acoustic Guidelines on Marine Mammals, National Marine Fisheries Service.

NMFS. (2018). *2018 Revisions to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts.* U.S. Dept. of Commer., NOAA. Document Number NOAA Technical Memorandum NMFS-OPR-59.

NOAA. (2022a). *SPECIES DIRECTORY: Short-Beaked Common Dolphin* [Online]. Available at: https://www.fisheries.noaa.gov/species/short-beaked-common-dolphin. Accessed January 2024.

NOAA. (2022b). *SPECIES DIRECTORY: Risso's Dolphin* [Online]. Available at: https://www.fisheries.noaa.gov/species/rissos-dolphin. Accessed January 2024.

Northridge, S., Mackay, A., Sanderson, D., Woodcock, R. and Kingston, A. (2004). *A review of dolphin and porpoise bycatch issues in the Southwest of England.*

Pierpoint, C. J. L. *(2008). Harbour porpoise (Phocoena phocoena) foraging strategy at a high energy, near-shore site in south-west Wales, UK.* Journal of the Marine Biological Association of the United Kingdom, 88, Special Issue 6, 1167-1173.

Popper, A., Hawkins, A., Fay, R., Mann, D., Bartol, S., Carlson, T., Coombs, S., Ellison, W., Gentry, R., Halvorsen, M., Løkkeborg, S., Rogers, P., Southall, B., Zeddies, D. and Tavolga, W. (2014). *Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI.* Springer.

Pusineri, C., Magnin, V., Meynier, L., Spitz, J., Hassani, S. and Ridoux, V. (2007). *Food and feeding ecology of the common dolphin (Delphinus delphis) in the oceanic Northeast Atlantic and comparison with its diet in neritic areas*. Marine Mammal Science*,* 23 (1)**,** pp.30-47.

Reeves, R. R., Stewart, B. S., Clapham, P. J. and Powell, J. A. (2002). *Sea Mammals of the World.* London, A & C Publishers.

Reid, J., Evans, P. G. H. and Northridge, S. P. (2003). *Cetacean Distribution Atlas.* JNCC. Peterborough pp.68.

RenewableNI (2024) About RenewableNI, The RenewableNI Ambition, Available at: https://renewableni.com/about-renewableni/#:~:text=The%20RenewableNI%20Ambition&text=Northern%20Ireland%20has%20one%20of,positioned%20to%20meet%20this%20target.&text=We%20currently%20have%20a%201.8,of%2080%25%20renewables%20by%202030, Accessed May 2024

Richardson, W. J., Malme, C. I., Green, J. C. R. and Thomson, D. H. (1995). *Marine mammals and noise.* San Diego, California, USA, Vol 1. Academic Press.

RPS (2023). LirIC Marine Geophysical & Geotechnical Survey; Subsea Noise Technical Report

SCOS (2020). *Scientific Advice on Matters Related to the Management of Seal Populations: 2019*, Natural Environment Research Council, Special Committee on Seals: 154.

SCOS (2021). *Scientific Advice on Matters Related to the Management of Seal Populations: 2020* Natural Environment Research Council Special Committee on Seals.

SCOS (2022). *Scientific Advice on Matters Related to the Management of Seal Populations: 2021*, Natural Environment Research Council, Special Committee on Seals: 266.

Scottish Government (2023) Energy Statistics for Scotland - Q1 2023, Available at: https://www.gov.scot/publications/energy-statistics-for-scotland-q1-2023/pages/renewable-electricity-capacity/, Accessed May 2024

Sharrock, Sally & Bloomfield, Angus & Solandt, Jean-Luc. (2023). *The Marine Conservation Society Basking Shark Watch 20-year report (1987-2006).*

Sims, D. W., et al. (2008). "*Scaling laws of marine predator search behaviour*." Nature 451(7182): 1098-1102.

Southall, B. L., *et al*. (2007). "*Marine mammal noise-exposure criteria: initial scientific recommendations*." Aquatic Mammals 33(4).

Southall, B. L., Finneran, J. J., Reichmuth, C., Nachtigall, P. E., Ketten, D. R., Bowles, A. E., Ellison, W. T., Nowacek, D. P. and Tyack, P. L. (2019). *Marine Mammal Noise Exposure Criteria: Updated Scientific Recommendations for Residual Hearing Effects*. Aquatic Mammals*,* 45 (2)**,** pp.125-232. DOI:10.1578/am.45.2.2019.125.

The Department for Energy Security and Net Zero and Ofgem. (2023). *Connections Action Plan Speeding up connections to the electricity network across Great Britain.*

Thompson, D., Duck, C.D., Morris, C.D. and Russell, D.J. (2019). *The status of harbour seals (Phoca vitulina) in the UK. Aquatic Conservation: Marine and Freshwater Ecosystems*, 29, pp.40-60.

Visser, F., Merten, V., Bayer, T., Oudejans, M., de Jonge, D., Puebla, O., Reusch, T., Fuss, J. and Hoving, H. (2021). *Deep-sea predator niche segregation revealed by combined cetacean biologging and eDNA analysis of cephalopod prey*. Science Advances*,* 7**,** pp.eabf5908. DOI:10.1126/sciadv.abf5908.

Waggitt, J. J., Evans, P. G. H., Andrade, J., Banks, A. N., Boisseau, O., Bolton, M., Bradbury, G., Brereton, T., Camphuysen, C. J., Durinck, J., Felce, T., Fijn, R. C., Garcia-Baron, I., Garthe, S., Geelhoed, S. C. V., Gilles, A., Goodall, M., Haelters, J., Hamilton, S., Hartny-Mills, L., Hodgins, N., James, K., Jessopp, M., Kavanagh, A. S., Leopold, M., Lohrengel, K., Louzao, M., Markones, N., Martínez-Cedeira, J., Ó Cadhla, O., Perry, S. L., Pierce, G. J., Ridoux, V., Robinson, K. P., Santos, M. B., Saavedra, C., Skov, H., Stienen, E. W. M., Sveegaard, S., Thompson, P., Vanermen, N., Wall, D., Webb, A., Wilson, J., Wanless, S. and Hiddink, J. G. (2020). *Distribution maps of cetacean and seabird populations in the North-East Atlantic*. Journal of Applied Ecology*,* 57 (2)**,** pp.253-269. DOI:10.1111/1365-2664.13525.

Wall, Murray C., O'Brien J., Kavanagh L., Wilson C., Ryan C., Glanville B., Williams D., Enlander I., O'Connor I., McGrath D., Whooley P. and Berrow S. (2013). *Atlas of the distribution and relative abundance of marine mammals in Irish offshore waters 2005 - 2011.* Irish Whale and Dolphin Group. Merchants Quay, Kilrush, Co Clare.

Wilson, C.M., Wilding, C.M. and Tyler-Walters, H. (2020). Basking shark (*Cetorhinus maximus*).

Worcester T. Effects of Seismic Energy on Fish; A Literature Review [Report]. - Dartmouth, Canada : Department of Fisheries and Oceans, Bedford Institute of Oceanography, 2006.

WSDOT (2017). Washington State Department of Transport Biological Assessment Preparation for Transport Projects Advanced Training Manual, Washington State Department of Transport.