LLŶR

LLŶR FLOATING OFFSHORE WIND PROJECT

Llŷr 1 Floating Offshore Wind Farm

Environmental Statement

Volume 3 : Chapter 21 – Marine Mammals

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Prepared by: Llŷr Floating Wind Ltd

FLOVENTIS ENERGY

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Acronyms and abbreviations

Acronym or Abbreviation	Definition	Acronym or Abbreviation	Definition
%	Percent	MPCP	Marine Pollution Contingency Plan
AA	Appropriate Assessment	MU	Management Unit
AC	Alternating Current	MW	Megawatt
BEIS	Department for Business, Energy and Industrial Strategy	n	Number
CEA	Cumulative Effects Assessment	NCMPA	Nature Conservation Marine Protected Area
CEMP	Construction Environmental Management Plan	NEQ	Net Explosive Quantity
CFD	Contract for Difference	NM	nautical mile
CGNS	Celtic and Greater North Seas	NMFS	National Marine Fisheries Service
CI	Confidence Interval	NPS	National Policy Statement
CIS	Celtic and Irish Sea	NRW (A)	Natural Resources Wales Advisory
CSIP	Cetacean Strandings Investigation Programme	NSIP	National Significant Infrastructure Project
CTV	Crew Transfer Vessel	OCSW	Offshore Channel, Celtic Sea and south west England
CV	Coefficient of Variation	OSPAR	Oslo-Paris Convention
DAS	Digital Aerial Survey	PDE	Project Design Envelope
DC	Direct Current	peak	Zero to peak sound pressure level
DCO	Development Consent Order	PEMP	Project Environmental Monitoring Programme
DEFRA	Department for Environment, Food and Rural Affairs	pk-pk	Peak to peak sound pressure level
DESNZ	Department for Energy Security and Net Zero	PTS	Permanent Threshold Shift
DP	Dynamic positioning.	PW	Phocid pinnipeds
DR	Dose-response	PWC	Phocid carnivores in water
EDR	Effective Deterrent Radius	Q	Quarter
EEA	European Economic Area	RIAA	Report to Inform Appropriate Assessment
EEC	European Economic Community	RIB	Rigid hulled Inflatable Boat
EEZ	Exclusive Economic Zone	RMS	Root Mean Square
EIA	Environmental Impact Assessment	ROV	Remotely Operated Vehicle
EMF	Electromagnetic Field	SAC	Special Area of Conservation
EPS	European Protected Species	SBP	Sub-bottom Profiling
ES	Environmental Statement	SCANS	Small Cetaceans in the European Atlantic and North Sea
EU	European Union	SCOS	Special Committee on Seals
FLOW	Floating offshore wind	SEL_{sound}	Sound Exposure Level
HDD	Horizontal Directional Drilling	SEL_{CUM}	Cumulative Sound Exposure Level
HF	High Frequency (cetacean)	SNCB	Statutory Nature Conservation Body
HiDef	HiDef Aerial Surveying Ltd	SPL	Sound Pressure Level

Acronym or Abbreviation	Definition	Acronym or Abbreviation	Definition
HRA	Habitats Regulations Appraisal	SSS	Side scan sonar
Hz	Hertz	SSSI	Site of Special Scientific Interest
IMO	International Maritime Organization	TEL	Tidal Energy Ltd
INNS	Invasive Non-Native Species	TTS	Temporary Threshold Shift
IPC	Infrastructure Planning Commissions	UK	United Kingdom
JNCC	Joint Nature Conservation Committee	USBL	Ultra-short baseline
kHz	Kilo hertz	UXO	Unexploded Ordnance
kJ	Kilo joules	VHF	Very High Frequency (cetacean)
km	kilometre	VMP	Vessel Management Plan
km^2	square kilometre	WNMP	Welsh National Marine Plan
LF	Low Frequency (cetacean)	WTG	Wind Turbine Generator
LSE	Likely Significant Effects	ZoI	Zone of Influence
m	metre		
MARPOL	The International Convention for the Prevention of Pollution from Ships		
MBES	Multibeam echosounder		
MCZ	Marine Conservation Zone		
MF	Mid- frequency (cetacean)		
MLT	Marine Licensing Team		
MMMP	Marine Mammal Mitigation Plan		
MPA	Marine Protected Area		

Glossary of project terms

Term	Definition
The Applicant	The developer of the Project, Llŷr Floating Wind Limited.
Array	All wind turbine generators, inter array cables, mooring lines, floating sub-structures and supporting subsea infrastructure within the Array Area, as defined, when considered collectively, excluding the offshore export cable(s).
Array Area	The area within which the wind turbine generators, inter array cables, mooring lines, floating sub-structures and supporting subsea infrastructure will be located.
Floventis Energy	A joint venture company between Cierco Ltd and SBM Offshore Ltd of which Llŷr Floating Wind Limited is a wholly owned subsidiary.
Landfall	The location where the offshore export cable(s) from the Array Area, as defined, are brought onshore and connected to the onshore export cables (as defined) via the transition joint bays (TJB).

Term	Definition
Llŷr 1	The proposed Project, for which the Applicant is applying for Section 36 and Marine Licence consents. Including all offshore and onshore infrastructure and activities, and all project phases.
Marine Licence	A licence required under the Marine and Coastal Access Act 2009 for marine works which is administered by Natural Resources Wales (NRW) Marine Licensing Team (MLT) on behalf of the Welsh Ministers.
Offshore Development Area	The footprint of the offshore infrastructure and associated temporary works, comprised of the Array Area and the Offshore Export Cable Corridor, as defined, that forms the offshore boundary for the S36 Consent and Marine Licence application.
Offshore Export Cable	The cable(s) that transmit electricity produced by the WTGs to landfall.
Offshore Export Cable Corridor (OfECC)	The area within which the offshore export cable circuit(s) will be located, from the Array Area to the Landfall.
Onshore Development Area	The footprint of the onshore infrastructure and associated temporary works, comprised of the Onshore Export Cable Corridor and the Onshore Substation, as defined, and including new access routes and visibility splays, that forms the onshore boundary for the planning application.
Onshore Export Cable(s)	The cable(s) that transmit electricity from the landfall to the onshore substation.
Onshore Export Cable Corridor (OnECC)	The area within which the onshore export cable circuit(s) will be located.
proposed Project	All aspects of the Llŷr 1 development (i.e. the onshore and offshore components).
Onshore Substation	Located within the Onshore Development Area, converts high voltage generated electricity into low voltage electricity that can be used for the grid and domestic consumption.
Section 36 consent	Consent to construct and operate an offshore generating station, under Section 36 (S.36) of the Electricity Act 1989. This includes deemed planning permission for onshore works.

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21.1 Introduction

1. Llŷr Floating Wind Limited (hereafter the Applicant) is proposing to develop the Llŷr 1 Floating Offshore Wind Farm (hereafter referred to as the 'proposed Project'), located approximately 35 km off the coast of Pembrokeshire in the Celtic Sea.
2. The proposed Project is a test and demonstration wind farm development, comprising up to ten wind turbine generators (WTGs). The proposed Project will make landfall at Freshwater West before connecting into Pembroke Dock power station and the national grid network.
3. The Applicant is seeking a Section 36 consent and Marine Licence for Llŷr 1, and this chapter forms part of the Environmental Statement (ES) which is submitted in support of those consent applications. This chapter describes the potential impacts and effects of the proposed Project on marine mammals during the construction, operation and maintenance and decommissioning phases, and includes mitigation and good practice measures to reduce the impacts of the proposed Project on marine mammals.
4. An assessment of basking shark is provided in **Chapter 20: Fish and Shellfish Ecology**. The likely occurrence of leatherback turtles was considered in **Appendix 21A: Marine Mammal and Megafauna Baseline**. However, turtles have been scoped out from further assessment as the likely occurrence in the Celtic Sea was found to be very low.
5. **Section 21.4** of this ES Chapter provides a summary of the impact assessment undertaken and any residual significant effects on marine mammals following consideration of any mitigation measures. **Section 21.12** of this ES chapter provides an assessment of the potential impacts of the proposed Project when considered cumulatively with other plans and projects.
6. The assessment presented in this chapter should be read in conjunction with the following linked and supporting chapters:

- **Chapter 02: Legislation Policy and Guidance**;
- **Chapter 03: Alternatives;**
- **Chapter 04: Description of the Proposed Project**;
- **Chapter 17: Physical Environment**;
- **Chapter 18: Marine Water Quality and Sediment Quality**
- **Chapter 19: Benthic Ecology**;
- **Chapter 20: Fish and Shellfish Ecology**;
- **Chapter 28: Shipping and Navigation**;
- **Chapter 31: Inter-related and Cumulative Effects**;
- **Appendix 4A: Outline Construction Environmental Management Plan**
- **Appendix 8D: HRA Screening;**
- **Appendix 8E: HRA RIAA**;
- **Appendix 20A: MCZ Assessment**
- **Appendix 21A: Marine Mammal and Megafauna Baseline**;
- **Appendix 21B: Marine Mammal Underwater Noise Modelling**; and
- **Appendix 21C: Marine Mammal Underwater Noise Assessment.**

7. The assessment has been undertaken by HiDef Aerial Surveying Limited (hereafter 'HiDef'). Further details of the proposed Project Team's competency are provided in **Appendix 1A: Statement of Competence.**

21.2 Legislation, Policy and Guidance

8. The following sections identify specific legislation, policy and guidance that are applicable to the assessment of marine mammals. Further detail on the wider legislation, policy and guidance relevant to this ES is provided in **Chapter 02: Regulatory and Planning Policy Context**.

21.2.1 Legislation

9. The legislation that is applicable to the assessment of marine mammals is summarised below.

- **The Planning Act 2008, Marine Works (Environmental Impact Assessment; EIA) Regulations 2007 (as amended), the Infrastructure Planning (EIA) Regulations 2017 (collectively referred to as 'the EIA Regulations'), and the Environment Act 1995** have been considered in this chapter, along with legislation relevant to marine mammal receptors which have been detailed below:
    - **Conservation of Habitats and Species Regulations (as amended) 2017,** which transposes the Habitats Directive (92/43/EEC) into UK national legislation[1], covering the marine environment to 12 nm offshore:
    - All cetaceans (whales, dolphins and porpoises) are listed as Annex IV species of the Habitats Directive, which affords them protection as European Protected Species (EPS);
    - Harbour porpoise *Phocoena phocoena*, bottlenose dolphin *Tursiops truncatus*, grey seal *Halichoerus grypus* and harbour seal *Phoca vitulina* are listed as Annex II species of the Habitats Directive and can therefore be protected under the designation of Special Conservation Areas (SACs); and
    - Grey seal and harbour seal are also listed under Annex V of the Habitats Directive, which requires any exploitation to be managed;
- **Conservation of Offshore Marine Habitats and Species Regulations 2017** also transposes the Habitats Directive (92/43/EEC) into UK national legislation2, covering the marine environment beyond 12 nm;
- **The Convention on the Conservation of Migratory Species of Wild Animals 1979 (the Bonn Convention),** which aims to conserve migratory species throughout their ranges, including 16 cetacean species such as common dolphin *Delphinus delphis*;
- **Convention on the Conservation of European Wildlife and Natural Habitats (the Bern Convention; 1979),** which aims to ensure conservation and protection of wild plant and animal species and their natural habitats, including affording protection to cetacean and pinniped species;
- The **Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas (ASCOBANS) 1994**, which aims to achieve and maintain a favourable conservation status for small cetaceans throughout the agreement area;

1 Following the UK exit from the European Union, the Conservation of Habitats and Species (Amendment) (EU Exit) Regulations 2019 (known as the 'Habitats Regulations') provide amendments to the 2017 Habitats Regulations to transfer functions from the European Commission to the appropriate UK Authorities.

2 Following Brexit, the Conservation of Habitats and Species (Amendment) (EU Exit) Regulations 2019 (known as the 'Habitats Regulations') provide amendments to the 2017 Habitats Regulations to transfer functions from the European Commission to the appropriate UK Authorities.

- **The Environment (Wales) Act 2016**, which provides a framework for sustainable management and protection of the environment in Wales, including measures for biodiversity conservation, climate change mitigation, and promoting the well-being of future generations;
- **Marine and Coastal Access Act 2009**, which provides the legal mechanism to help ensure clean, healthy, safe and productive and biological diverse oceans and seas;
- **The Wildlife and Countryside Act 1981 (as amended)**, which includes provisions relating to nature conservation:
    - Cetaceans and pinnipeds are listed under Schedule 5, which makes it an offence to intentionally or recklessly kill, injure or take any wild animal as well as to disturb or interfere with places used for their shelter or protection;
- **UK Biodiversity Action Plan and the UK Post-2010 Biodiversity Framework, 2012**, which identifies species which are most threatened and require conservation and includes cetacean and pinniped species present in UK waters;
- **Conservation of Seals Act 1970**, which provides seasonal protection to seals and prohibits taking or killing seals except under licence;
- **Convention for the Protection of the Marine Environment of the North-East Atlantic OSPAR Convention 1992**, which aims to protect the marine environment of the Northeast Atlantic through international cooperation and the implementation of measures to prevent pollution and conserve marine ecosystems;
- **Convention of International Trade in Endangered Species (CITES) 1975**, which aims to regulate and monitor international trade of endangered species to ensure their survival and prevent their exploitation; and
- **The Marine Strategy Regulations 2010**, which transpose the Marine Strategy Framework Directive (2008/56/EC) into UK legislation and includes the following requirements which are relevant to marine mammals:
    - Biological diversity is maintained;
    - The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic, and climatic conditions;
    - All elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity;
    - Concentrations of contaminants are at levels not giving rise to pollution effects; and
    - Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment.

21.2.2 National Planning Policy

10. The overarching National Policy Statement for Energy (EN-1) and for Renewable Energy Infrastructure (EN-3) (2023) have been reviewed, and sections which are relevant to the assessment of marine mammals are listed **Table 21-1**, alongside a reference to how and where each point has been considered within this chapter .

Table 21-1. Relevant National Policy Statements and context within this ES Chapter 21

NPS Ref.	Summary of policy	How and where it is considered in the chapter
The Overarching NPS for Energy (EN-1)		
Par. 5.4.7	Many Sites of Special Scientific Interest (SSSIs) are also designated as sites of international importance and will be protected accordingly. Those that are not, or those features of SSSIs not covered by an international designation, should be given a high degree of protection. Most National Nature Reserves are notified as SSSIs.	There are no SSSIs with marine mammal interests relevant to the proposed Project. SACs have been considered in **Section 21.5.1**, **Appendix 8D: HRA Screening** and assessed in **Appendix 8E: HRA RIAA.**
Par. 5.4.9	Marine Conservation Zones (MCZs) (Marine Protected Areas in Scotland), introduced under the Marine and Coastal Access Act 2009, are areas that have been designated for the purpose of conserving marine flora or fauna, marine habitats or types of marine habitat or features of geological or geomorphological interest. The protected feature or features and the conservation objectives for the MCZ are stated in the designation order for the MCZ.	The potential for effect from the construction, operation or decommissioning of the proposed Project to grey seal at Skomer MCZ has been assessed in **Appendix 20A: MCZ Assessment**
Par. 5.4.16	Many individual wildlife species receive statutory protection under a range of legislative provisions. Other species and habitats have been identified as being of principal importance for the conservation of biodiversity in England and Wales, as well as for their continued benefit for climate mitigation and adaptation and thereby requiring conservation action.	All relevant policy and legislation, as listed in **Section 21.2** of this chapter has been considered in the assessment of marine mammals.
Par. 5.4.17	Where the development is subject to EIA the applicant should ensure that the ES clearly sets out any effects on internationally, nationally, and locally designated sites of ecological or geological conservation importance on protected species and on habitats and other species identified as being of principal importance for the conservation of biodiversity, including irreplaceable habitats.	Effects on marine mammal qualifying features of SACs have been considered in the **Appendix 8D: HRA Screening** and, where required, in the **Appendix 8E: HRA RIAA**.
Par. 5.4.22	The design of Energy National Significant Infrastructure Project (NSIP) proposals will need to consider the movement of mobile / migratory species such as birds, fish and marine and terrestrial mammals and their potential to interact with infrastructure. As energy infrastructure could occur anywhere within England and Wales, both inland and onshore and offshore, the potential to affect mobile and migratory species across the UK and more widely across Europe (transboundary effects) requires consideration, depending on the location of development.	The potential transboundary effects from the proposed Project on marine mammals are considered in **Section 21.14**. of this chapter. The potential for the offshore infrastructure to cause barrier effects specifically are considered in **Section 21.9.2**. The potential for entanglement of marine mammals with WTG mooring

NPS Ref.	Summary of policy	How and where it is considered in the chapter
		lines and cables is considered in **Section 21.9.2**.
Par. 5.4.24	In Wales, applicants should consider the guidance set out in Section 6.4 of Planning Policy Wales and the relevant policies in the Wales National Marine Plan.	As detailed in **Section 21.2**, the Welsh National Marine Plan, Future Wales – The National Plan and the Planning Policy Wales have been considered in this **ES Chapter 21**.
Par. 5.4.35	Applicants should include appropriate avoidance, mitigation, compensation and enhancement measures as an integral part of the proposed development. In particular, the applicant should demonstrate that: • During construction, they will seek to ensure that activities will be confined to the minimum areas required for the works; • The timing of construction has been planned to avoid or limit disturbance; • During construction and operation best practice will be followed to ensure that risk of disturbance or damage to species or habitats is minimised, including as a consequence of transport access arrangements; • Habitats will, where practicable, be restored after construction works have finished ; and • Opportunities will be taken to enhance existing habitats rather than replace them, and where practicable, create new habitats of value within the site landscaping proposals. Where habitat creation is required as mitigation, compensation, or enhancement the location and quality will be of key importance. In this regard habitat creation should be focused on areas where the most ecological and ecosystems benefits can be realised.	Embedded and good practice measures to be adopted as part of the proposed Project which are relevant to marine mammals are presented in **Section 21.8**. Summary of additional mitigation measures are presented in **Section 21.9.** Marine mammal mitigation measures are presented in the Marine Mammal Mitigation Plan (**Appendix 4A: Outline Construction Environmental Management Plan**)
Par. 5.4.46	Development proposals provide many opportunities for building-in beneficial biodiversity or geological features as part of good design. The Secretary of State* should give appropriate weight to environmental and biodiversity enhancements, although any weight given to gains provided to meet a legal requirement (for example under the Environment Act 2021) is likely to be limited.	Embedded and good practice measures to be adopted as part of the proposed Project which are relevant to marine mammals are presented in **Section 21.8**.
The Overarching NPS for Renewable Energy Infrastructure (EN-3)		
Par. 2.8.104	Applicants should consult at an early stage of pre-application with relevant statutory consultees, as appropriate, on the assessment methodologies, baseline data collection, and potential avoidance, mitigation and compensation options should be undertaken.	Consultations with relevant statutory and non-statutory stakeholders have been conducted throughout the

NPS Ref.	Summary of policy	How and where it is considered in the chapter
		proposed Project, as outlined in **Section 21.3**.
Par. 2.8.127 to 2.8.129	Construction activities, including installing wind turbine foundations by pile driving, geophysical surveys, and clearing the site and cable route of unexploded ordinance (UXOs) may reach noise levels which are high enough to cause disturbance, injury, or even death to marine mammals. All marine mammals are protected under Part 3 of the Habitats Regulations. If construction and associated noise levels are likely to lead to an offence under Part 3 of the Habitats Regulations (which would include deliberately disturbing, injuring or killing), applicants will need to apply for a wildlife licence to allow the activity to take place	Assessment of underwater noise on marine mammal receptors during construction is conducted in **Section 21.9.1**.Mitigation required to reduce auditory injury is detailed in the outline marine mammal mitigation plan (**Appendix 4A: Outline Construction Environmental Management Plan**) The Applicant understands the requirement for a European Protected Species Licence for disturbance.
Par. 2.8.130	The development of offshore wind farms can also impact fish species (see paragraphs 2.8.129 – 2.8.133), which can have indirect impacts on marine mammals if those fish are prey species.	The potential indirect impacts on marine mammals through impacts to prey species have been assessed (see **Sections 21.9.1** and**21.9.2**).
Par. 3.8.143	There is also the risk of collision with construction and maintenance vessels and potential entanglement risks from floating wind structures.	The potential impacts on marine mammals from collision with the proposed Project vessels has been assessed in **Sections 21.9.1** and **21.9.2**, and entanglement with mooring lines and cables has been assessed in **Section 21.9.2**.
Par. 2.8.131	Where necessary, assessment of the effects on marine mammals should include details of: • Likely feeding areas and impacts on prey species and prey habitat; • Known birthing areas / haul-out sites for breeding and pupping; • Migration routes; • Protected sites; • Baseline noise levels; • Predicted construction and soft start noise levels in relation to mortality, permanent threshold shift (pts), temporary threshold shift (tts) and disturbance; • Operational noise;	The existing baseline for marine mammals (including consideration of feeding, breeding and migration) is summarised in **Section 21.5**, and detailed in**, Appendix 21A: Marine Mammal and Megafauna Baseline**. The potential effects on marine mammals, including underwater noise, collision risk, barrier effects and entanglement, have been assessed in **Section 21.9**. Effects on marine mammal qualifying features of SACs

NPS Ref.	Summary of policy	How and where it is considered in the chapter
	• Duration and spatial extent of the impacting activities including cumulative / in-combination effects with other plans or projects; • Collision risk; • Entanglement risk; and • Barrier risk.	have also been considered in **Appendix 8D: HRA Screening** and, in the **Appendix 8E:** HRA **RIAA**.
Par. 2.8.132	The scope, effort and methods required for marine mammal surveys should be discussed with the relevant Statutory Nature Conservation Body (SNCB).	The site-specific survey data was agreed to be sufficient with Natural Resources Wales Advisory (NRW (A)) (written advice received 17 February 2023, see **Section 21.3**)
Par. 2.8.133 to 2.8.134	The applicant should discuss any proposed noisy activities with the relevant statutory body and must reference the joint SNCB and Joint Nature Conservation Committee (JNCC) underwater noise guidance in relation to noisy activities (alone and in-combination with other plans or projects) within HRA sites, in addition to the JNCC mitigation guidelines to piling, explosive use, and geophysical surveys. Where the assessment identifies that noise from construction and UXO clearance may reach noise levels likely to lead to noise thresholds being exceeded (as detailed in the JNCC guidance) or an offence as described in paragraph 2.8.138 above, the applicant will be expected to look at possible alternatives or appropriate mitigation.	Assessment of underwater noise on marine mammal receptors during construction is summarised in **Section 21.9.1** and methods detailed in **Appendix 21C: Marine Mammal Underwater Noise Assessment**. Effects on marine mammal qualifying features of SACs have been considered in the **Appendix 8D: HRA Screening** and, in the **Appendix 8E: HRA RIAA**. These include consideration of the relevant JNCC and SNCB guidance (**Section 21.3.1**), and the potential impacts from UXO clearance.
Par. 2.8.237	Monitoring of the surrounding area before and during the piling procedure can be undertaken by various methods including marine mammal observers and passive acoustic monitoring. Active displacement of marine mammals outside potential injury zones can be undertaken using equipment such as acoustic deterrent devices. Soft start procedures during pile driving may be implemented. This enables marine mammals in the area disturbed by the sound levels to move away from the piling before physical or auditory injury is caused.	The outline Marine Mammal Mitigation Plan (MMMP) provides details of the proposed mitigation pre-impact piling (**Appendix 4A: Outline Construction Environmental Management Plan**).
Par. 2.8.238 to 2.8.239	Where noise impacts cannot be avoided, other mitigation should be considered, including alternative installation methods and noise abatement technology, spatial / temporal restrictions on noisy activities, alternative foundation types.	Alternative installation methods, have been considered in **Chapter 03: Alternatives**.

NPS Ref.	Summary of policy	How and where it is considered in the chapter
	Applicants should undertake a review of up-to-date research and all potential mitigation options presented as part of the application, having consulted the relevant JNCC mitigation guidelines[3].	
Par. 2.8.312	The Secretary of State* should be satisfied that the preferred methods of construction, in particular the construction method needed for the proposed foundations and the preferred foundation type, where known at the time of application, are designed to reasonably minimise significant impacts on marine mammals	The maximum potential impact associated with construction, operation and maintenance and decommissioning of the proposed Project are assessed in **Section 21.9.** Mitigation measures to minimise potential significant impacts are discussed in **Section 21.8** and **Appendix 4A: Outline Construction Environmental Management Plan.**
Par. 2.8.313	Unless suitable noise mitigation measures can be imposed by requirements to any development consent the Secretary of State* may refuse the application.	
Par. 2.8.314	The conservation status of cetaceans and seals are of relevance and the Secretary of State* should be satisfied that cumulative and in-combination impacts on marine mammals have been considered.	The conservation status of marine mammals has been considered (**Section 21.5**). Cumulative impacts are considered in **Section 21.12**. In-combination impacts are considered in the accompanying **Appendix 8E: HRA RIAA**.
Par. 2.8.106	Any relevant data that has been collected as part of post-construction ecological monitoring from existing, operational offshore wind farms should be referred to where appropriate.	Relevant post-construction monitoring data from other offshore wind farm projects have been considered in the assessment of potential impacts of the proposed Project, where available and relevant and this is referenced in **Section 21.9**.
Par. 2.11.40	Applicants should assess the potential of their proposed development to have net positive effects on marine ecology and biodiversity, as well as negative effects.	Both potential positive and negative effects of the proposed Project on marine mammals have been assessed, as per the Assessment Methodology in **Section 21.4**
Par. 3.8.321	The Secretary of State* should be satisfied that, in the development of their proposal, the applicant has made appropriate, and extensive, use of up-to-date evidence from previous deployments and research results from	The baseline characterisation and assessment have been based on the most up-to-date available evidence, listed in

[3] See https://jncc.gov.uk/our-work/marine-mammals-and-noise-mitigation/

NPS Ref.	Summary of policy	How and where it is considered in the chapter
	scientific peer reviewed papers and the programmes listed in paragraph 2.8.121 and assessed through HRA / MCZ processes, the impact on any protected species or habitats.	**Section 21.4.4** and as referenced within the assessments in **Section 21.5** and within the **Appendix 8D: HRA Screening** the **Appendix 8E: HRA RIAA and Appendix 20A: MCZ Assessment.**
Par. 2.8.213	Applicants must always employ the mitigation hierarchy, to avoid as far as is possible the need to find compensatory measures for coastal, inshore and offshore developments affecting HRA sites and / or MCZs. It is essential that applicants involve SNCBs and Defra as early as possible in the planning process to enable discussions of what is and isn't a significant and / or adverse effect, subsequent implications, and if required, mitigation and / or compensation.	The Outline Marine Mammal Mitigation Plan details the proposed mitigation required to minimise impacts on marine mammals **(Appendix 4A: Outline construction Environmental Management Plan)**. Impacts under HRA are presented in **Appendix 8E: HRA RIAA.**
Par. 2.8.83 to 2.8.85	Where requested by the Secretary of State* applicants are required to undertake environmental monitoring (e.g. ornithological surveys, geomorphological surveys, archaeological surveys) prior to and during construction and operation. Monitoring must measure and document the effects of the development and the efficacy of any associated mitigation or compensation. This will enable an assessment of the accuracy of the original predictions and improve the evidence base for future mitigation and compensation measures enabling better decision-making in future EIAs and HRAs.	The requirement for marine mammal monitoring has been assessed in **Section 21.8** and **Section 21.10.1.**

**For the proposed Project, the NRW Marine Licencing Team (MLT) is applicable here rather than the Secretary of State, given that the proposed Project is not a NSIP / DCO. Refer to Volume 1, Chapter 02: Regulatory and Planning Policy Context.*

21.2.3 Welsh Planning Policy

11. The Welsh planning policy applicable to the assessment of marine mammals is summarised below.

- **Planning Policy Wales** sets out the land use planning policies of the Welsh Government, forming a strategic framework to guide development. The Planning Policy Wales documentation highlights the importance of biodiversity for natural services, sustainability and the Welsh economy. Although it does not explicitly mention marine mammals, it does include relevant objectives to achieve efficient use and protection of natural resources and enhancing biodiversity, relative to coastal development and the interface between land and sea. This policy links to the Welsh National Marine Plan for the sustainable developments of Wales's seas (Planning Policy Wales, 2024);
- **Future Wales – The National Plan 2040** is Wales's national development framework, which aims to set the direction for development in Wales to 2040. Whilst it does not specifically relate to marine mammals, it is a development plan with a strategy for addressing key national priorities through the planning system, including sustaining and developing a

vibrant economy, achieving decarbonisation and climate-resilience, developing strong ecosystems and improving the health and well-being of Wales's communities (Welsh Government, 2021);

- **Welsh National Marine Plan (WNMP)** aims to achieve sustainable development in the UK marine area. It sets out a single framework for sustainable development within Wales's marine area. This includes sector objectives for renewable energy generation, including offshore wind farms, and considers the potential for adverse impacts to marine mammals in relation to underwater noise production (Welsh Government, 2019). Policies with specific reference to marine mammals are provided in **Table 21-2**, alongside a reference to how and where each point has been considered by the proposed Project.

Table 21-2. Requirements from the Welsh National Marine Plan which are of relevance to marine mammal receptors

WNMP Ref.	Policy Description	Project reference
ENV_02	**Marine Protected Areas:** Proposals should demonstrate how they avoid adverse impacts on individual Marine Protected Areas (MPAs) and the coherence of the network as a whole; have regard to the measures to manage MPAs; and avoid adverse impacts ton designated sites that are not part of the MPA network.	Impacts to MPAs have been assessed in **Appendix 8E: HRA RIAA**
ENV_05	**Underwater noise:** Proposals should demonstrate that they have considered man-made noise impacts on the marine environment and, in order of preference: a. avoid adverse impacts; and / or b. minimise impacts where they cannot be avoided; and / or c. mitigate impacts where they cannot be minimised. If significant adverse impacts cannot be avoided, minimised or mitigated, proposals must present a clear and convincing case for proceeding.	The potential impact of underwater noise on marine mammals has been assessed **Sections 21.9.1** and **219.2** for construction and operation stages, respectively. Mitigation measures are also considered in these sections, as well as in the accompanying outline MMMP **(Appendix 4A: Outline Construction Environmental Management Plan)**.
ENV_07	**Fish species and Habitats:** Proposals potentially affecting important feeding, breeding (including spawning and nursery) and migration areas or habitats for key fish and shellfish species of commercial or ecological importance should demonstrate how they, in order of preference: a. avoid adverse impacts on those areas; and / or b. minimise adverse impacts where they cannot be avoided; and / or c. mitigate adverse impacts where they cannot be minimised. If significant adverse impacts cannot be avoided, minimised or mitigated, proposals must present a clear and convincing case for proceeding.	The potential impacts on fish species are assessed in **Chapter 20: Fish and Shellfish Ecology**. This assessment has been used to inform the assessment of indirect effects on marine mammals through impacts to prey species in **Sections 21.9.1** and **21.9.2**.
GOV_01	**Cumulative effects:** Proposals should demonstrate that they have assessed potential cumulative effects and should, in order of preference: a. avoid adverse effects; and / or b. minimise effects where they cannot be avoided;	Potential cumulative impacts on marine mammals have been assessed in **Section 21.12**.

WNMP Ref.	Policy Description	Project reference
	and / or c. mitigate effects where they cannot be minimised. If significant adverse effects cannot be avoided, minimised or mitigated, proposals must present a clear and convincing case for proceeding. Proposals that contribute to positive cumulative effects are encouraged.	

21.2.4 Local Planning Policy

12. Local planning policy that is applicable to the assessment of marine mammals is summarised below.

- **Pembrokeshire Coast National Park Development Plan**, sets out policies for local developments in Pembrokeshire to support decision making for planning applications; and
- **South West Wales Area Statement**, which includes identification of the key risks, opportunities and priorities for building resilient ecosystems, reverse the decline of biodiversity and support sustainable management of the natural resources.

21.2.5 Guidance

13. The following best practice guidelines and guidance have been considered in the assessment of marine mammals presented in this **ES Chapter** (**Table 21-3**).

Table 21-3. A summary of guidance relevant to marine mammals

Summary of Guidance	How and where it is considered in the chapter
Draft guidance on 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 (JNCC *et al*., 2010a).	Considered to inform assessment of impacts from geophysical survey equipment in **Appendix 21C: Marine Mammal Underwater Noise Assessment** (**Appendix 4A: Outline Construction Environmental Management Plan**)
Estimating the effects of pile driving sounds on seals: Pitfalls and possibilities (Whyte *et al*., 2020a).	Used to assess the disturbance impact to seals **Appendix 21C: Marine Mammal Underwater Noise Assessment** and **Section 21.9.1**
Guidance for assessing the significance of noise disturbance against Conservation Objectives of harbour porpoise SACs (JNCC *et al*., 2020).	Key guidance in the assessment of adverse effect on site integrity for harbour porpoise **Appendix 21C: Marine Mammal Underwater Noise Assessment** and **Appendix 8E: HRA RIAA**
Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater, Coastal and Marine (CIEEM, 2018).	To inform significance criteria **Section 21.4.2**

Summary of Guidance	How and where it is considered in the chapter
JNCC guidelines for minimising the risk of injury to marine mammals from using explosives (JNCC, 2010b).	Standard mitigation guidance used to inform outline marine mammal mitigation for UXO clearance activities (MMMP in **Appendix 4A: Outline Construction Environmental Management Plan**)
Policy paper, Marine environment: unexploded ordnance clearance joint interim position statement (BEIS, 2022).	Informed approach taken in the assessment of UXO clearance activities **(Appendix 21C: Marine Mammal Underwater Noise Assessment** and **Section 21.9.1)**
Marine Mammal Noise Exposure Criteria: Updated Scientific Recommendations for Residual Hearing Effects (Southall *et al*., 2019).	Key reference impact criteria used in the assessment **Appendix 21C: Marine Mammal Underwater Noise Assessment**
NRW's Position on Assessing Behavioural Disturbance of Harbour Porpoise (*Phocoena phocoena*) from underwater noise (NRW, 2023).	Used to inform assessment for harbour porpoise **Appendix 21C: Marine Mammal Underwater Noise Assessment**
NRW's position on the use of Marine Mammal Management Units for screening and assessment in Habitats Regulations Assessments for Special Areas of Conservation with marine mammal features (NRW, 2020).	Used to inform assessment for harbour porpoise **Appendix 8E: HRA RIAA**
PINS Advice note 17: Cumulative Effects Assessment relevant to nationally significant infrastructure projects (PINS, 2019).	Informed Cumulative Effect Assessment **Section 21.12**
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 (National Marine Fisheries Service NMFS, 2018).	Key reference impact criteria used in the assessment **Appendix 21C: Marine Mammal Underwater Noise Assessment Sections 21.9.1** and **21.9.2**
Statutory Nature Conservation Agency Protocol for Minimising the Risk of Injury to Marine Mammals from Piling Noise (JNCC, 2010c).	Standard mitigation guidance used to inform outline marine mammal mitigation for impact piling activities (**Appendix 4A: Outline Construction Environmental Management Plan**)

21.3 Stakeholder Engagement and Consultation

14. Consultation with statutory and non-statutory organisations is a key element of the EIA process. Consultation with regards to marine mammals has been undertaken to inform the approach to, and scope of, the assessment.

15. Stakeholders for the proposed Project include statutory consultees, landowners, local communities and other sea users. In addition to the statutory consultation process, there has been ongoing engagement with statutory and non-statutory consultees to steer the development of the proposed Project.

21.3.1 Summary of Stakeholder Consultations

16. The proposed Project EIA Scoping Report was submitted to NRW (MLT) on 06 April 2022, and the report was circulated to relevant statutory bodies and key stakeholders. The Scoping Opinion was received on 05 July 2022. Comments from the Scoping Opinion relevant to marine mammals have been summarised in **Table 21-4**, in addition to a high-level response on how these comments have been addressed and a reference to the location of the relevant information within this Chapter.

17. Further consultation with NRW (A) and JNCC has also been undertaken throughout the pre-application stage. Consultation activities which are relevant to marine mammals have been summarised in **Table 21-5,** alongside a summary of any key decisions or information from those activities.

Table 21-4. Summary of the key issues raised by consultees and how each was addressed

Consultee	Main matter raised	How the issue has been addressed	Location of response in chapter
Scoping Opinion (05 July 2022)			
NRW (A)	NRW (A) does not agree with the rationale of using an impact range for scoping of SACs, or for screening for the cumulative / in-combination assessment and advise that the Management Unit (MU) is used.	In line with NRW (A) advice, the species-specific Inter-Agency Marine Mammal Working Group (IAMMWG,2015; 2022) MUs have been considered in the assessment of cetaceans, and OSPAR Region III interim MU in the assessment of seal species within this **ES Chapter**, as well as in the identification of SACs designated for marine mammal features which require assessment as part of the HRA process.	Study areas used in the assessments are defined in **Section 21.4.3**. The cumulative assessment methodology is detailed in **Section 21.12**. See **Appendix 8D: HRA Screening** and **Appendix 8E: HRA RIAA** for detail of the HRA assessment process.
NRW (A)	NRW (A) agree that the Study Area will take into consideration marine mammal MUs published by the IAMMWG (2015).		
NRW (A)	NRW (A) does not agree with the rationale of using buffers for scoping purposes for cetaceans or grey seals. NRW (A) consider the MUs and the SACs within them as functionally linked areas (Chapman and Tyldesley, 2016)		
NRW (A)	NRW (A) advise that the following SACs should be scoped into the assessment (NRW, 2020): • North Anglesey Marine SAC; • West Wales Marine SAC; • Bristol Channel Approaches SAC; • Lleyn Peninsula and the Sarnau SAC; • Cardigan Bay SAC; and • Pembrokeshire Marine SAC.	NRW (2020) has been considered in the screening of SACs designated for marine mammal features in the HRA process. The listed SACs have been scoped into the assessment in the HRA screening and have been assessed in the RIAA.	See A**ppendix 8D: HRA Screening** and **Appendix 8E: HRA RIAA** for detail of the HRA assessment process.
NRW (A)	Where the MUs include SACs outside of UK waters, transboundary impacts must also be	Transboundary impacts on marine mammals have been considered in terms of EIA within	Transboundary effects are considered in **Section 21.14**.

Consultee	Main matter raised	How the issue has been addressed	Location of response in chapter
	considered, and the potential impacts on SACs within other jurisdictions should be assessed. Details of these sites can be found in NRW (2020).	**Section 21.14** of this **ES Chapter**, and in the HRA process as presented in the **Appendix 8D: HRA Screening** and **Appendix 8E: HRA RIAA**.	See the **Appendix 8D: HRA Screening** and **Appendix 8E: HRA RIAA** for detail of the HRA assessment process.
NRW (A)	There are no SACs with bottlenose dolphin features within the Offshore Channel, Celtic Sea & SW England MU. NRW (A) does not consider that the bottlenose dolphin features from SACs are likely to be found within the proposed Project impact area and therefore advise that there is no likely significant effect on this feature.	There is no potential for Likely Significant Effect (LSE) on any bottlenose dolphin feature of a SAC; therefore, they have been screened out from further assessment in the HRA screening report.	See **Appendix 8D: HRA Screening** and **Appendix 8E: HRA RIAA** for detail of the HRA assessment.
NRW (A)	NRW (A) advise that the proposed works are likely to have a significant effect (either alone or in combination with other plans or projects) on the aforementioned SACs and therefore recommend that an Appropriate Assessment (AA) is carried out on all of the sites listed.	Following NRW (2020), the SACs therein have been considered in the HRA screening process and have been assessed under Stage 2 of the HRA process (AA) in the RIAA.	See **Appendix 8D: HRA Screening** and **Appendix 8E: HRA RIAA** for detail of the HRA assessment.
NRW (A)	NRW (A) supports the inclusion of the Embedded and Good Practice Measures detailed to minimise the risk of impact to marine mammals.	Noted. These measures have been included in this **ES Chapter**.	Embedded mitigation and Good Practice Measures are listed in **Section 21.8**.
NRW (A)	NRW (A) agrees with the list of impact pathways as detailed in the scoping report, to be scoped into the assessment for marine mammals.	Noted. These impact pathways have been scoped in for assessment for marine mammals in this **ES Chapter**.	These impacts are assessed in **Section 21.9**
NRW (A)	Assessment Methodology: This section states that the assessment methodology for marine mammals will follow the standard	The environmental impact assessment principles laid out in CIEEM (2018) have been adapted in this marine mammal **ES Chapter**, to better	The methodology used in the assessments are defined in **Section 21.4** and are specific to marine mammals, and include definition

Consultee	Main matter raised	How the issue has been addressed	Location of response in chapter
	methodology outlined for ecological receptors which is in line with CIEEM guidance for ecological impact assessments (CIEEM, 2018). However, this assessment methodology relates to terrestrial receptors, and some of the criteria are not appropriate for marine mammals. For example, the sensitivity of the receptor is noted as assessed based on geographical frames of reference, some of which are not relevant in the marine environment. We recommend further clarity is requested on the frames of reference that will be used for marine receptors.	reflect marine mammal receptors. The frames of reference used in the assessments are the Marine Mammal Study Area, and species-specific management units from IAMMWG (2022) for cetaceans and the OSPAR Region III for grey seals, as defined in **Section 21.4.3**.	of the Study Areas used in the assessment of marine mammals defined in **Section 21.4.3**.
NRW (A)	We agree with the use of the data sources listed. It is not clear what data source IAMMWG, (2021) refers to as this reference is not listed in the reference list.	IAMMWG (2021) has now been superseded by IAMMWG (2022), which been referenced in this **ES Chapter**.	Key data sources are listed in **Section 21.4.4**.
NRW (A)	We note the intention to use project specific survey data but there is no further information on what surveys are intended, or what data will be collected. We strongly recommend further engagement with NRW (A) to discuss what surveys are proposed, to avoid the risk of there being inadequate data to form an assessment.	NRW (A) and JNCC have been consulted with and the method for determining Project-specific marine mammal densities were discussed.	As presented in **Appendix 21A: Marine Mammal and Megafauna Baseline** the project-specific DAS data helps to characterise the area, however, the densities thus derived only feed through into the quantitative noise modelling in respect of harbour porpoise. **Technical Paper 1c: Marine Mammals – Comparison of Model (Inlabru) and Design-based estimates from Digital Arial Survey Work** discusses these matters for marine mammals and was provided to NRW (A) and

Consultee	Main matter raised	How the issue has been addressed	Location of response in chapter
			JNCC on 14 June 2023 **(**see **Table 21-4** below). It is included for reference (alongside other data analysis papers primarily referencing marine ornithology) in **Annex B** of **Appendix 22A: Marine Ornithology Baseline**. Note that **Technical Paper 1c** predated the issue of SCANS IV density estimates and that the subsequent liaison over selection of input densities for noise modelling is summarised in **Table 21-4.**
NRW (A)	NRW (A) recommend that the applicant should refer to the joint interim position statement on UXO clearance.	The unexploded ordnance clearance joint interim position statement (BEIS, 2022) has been referred to in the assessment of underwater noise for UXO.	Potential underwater noise from UXO has been assessed in **Section 21.9.1**.
NRW (A)	NRW (A) does not agree with the scoping boundaries and therefore does not agree with the cumulative assessment search areas described. We advise that the MU is the appropriate scale for consideration of offsite impacts for marine mammals, and that all plans and projects within the relevant MU (IAMMWG, 2015) should be scoped into the assessment as they have the potential to affect the same marine mammal populations.	The cumulative assessment has scoped in plans and projects within the species-specific management units, except for common dolphin and minke whale, where it was agreed with NRW (A) (advice note received 23 May 2023) that the Celtic and Irish Sea MU could be used instead as a more proportionate approach to assessment.	Scope of the cumulative assessment is presented in **Section 21.12**.
NRW (A)	Morlais Tidal Energy Development Zone, Project TIGER, Whitecross FLOW and Awel y Mor have the potential to act cumulatively /	The listed developments, have been considered in the cumulative assessment in this **ES Chapter**,	The cumulative assessment is detailed in **Section 21.12**.

Consultee	Main matter raised	How the issue has been addressed	Location of response in chapter
	in-combination with the relevant MU populations	and in the in-combination assessment within **Appendix 8E: HRA RIAA**.	See **Appendix 8D**: **HRA Screening** and **Appendix 8E: HRA RIAA** for detail of the HRA assessment process.
NRW (A)	The cumulative and in combination assessment should also consider transboundary impacts from other plans or projects within the relevant marine mammal management units (NRW, 2020)		
JNCC	Potential impacts scoped in and out for the EIA are appropriate but need more detail added as this is a Floating Offshore Wind (FLOW) project, and some impacts are still poorly understood.	Additional detail has been provided within **Section 21.8** to justify the scoping of impacts, in addition to acknowledgement of limitations to our understanding of FLOW impacts.	Scoping of impacts is detailed in **Section 21.6**. Assumptions and limitations are detailed in **Section 21.7.2**.
JNCC	Note the Small Cetaceans in the European Atlantic and North Sea (SCANS) surveys represent a snapshot of cetacean presence, as they represent a single survey conducted in each area. There may be other species present, for example, Risso's dolphins.	We acknowledge that SCANS represents only a snapshot of cetacean presence. Other data sources, including site-specific surveys, have also been considered within a comprehensive desk study, to inform the scoping of species for assessment.	Details of species scoped in for assessment given in **Appendix 21A: Marine Mammal and Megafauna Baseline** And **Section 21.5** of this chapter.
JNCC	It would be beneficial if the distance between Marine Protected Areas (MPAs) and the array / cable scoping areas were separated as the potential impacts associated with each area could be different.	The distance to protected sites, including MPAs and SACs, has now been presented separately for the array and offshore cable route corridor.	Relevant protected sites together with distances are noted in **Section 21.5.1** within the species accounts, and in **Appendix 8D**: **HRA Screening** and **Appendix 8E: HRA RIAA**
JNCC	Underwater noise during the operational stage is not included as a potential impact pathway; this should be added. Please note that cable "thrums" have not been well characterised in terms of underwater sound levels and potential to impact marine mammals either for individual turbines or	Operational noise has been scoped in for assessment and is assessed in **Appendix 21C: Marine Mammal Underwater Noise Assessment** which is summarised in **Section 21.9.2**. This assessment considers underwater noise modelling, which is presented in **Appendix 21B: Marine Mammal Underwater Noise Modelling**.	A summary of the assessment of operational noise is presented in **Section 21.9.2**.

Consultee	Main matter raised	How the issue has been addressed	Location of response in chapter
	arrays. This may require specific modelling or other studies. How turbine operating noise propagates from floating turbines is also poorly understood.		
JNCC	We note the likelihood of finding UXOs, especially in the inshore part of the study area, is considered high. We highlight a position statement published by Defra and signed by (amongst others) JNCC and NRW regarding UXO clearance methods.	The unexploded ordnance clearance joint interim position statement (BEIS, 2022) has informed the assessment of underwater noise from UXO.	Potential underwater noise from UXO has been assessed in **Section 21.9.1**.
JNCC	Note that species and project specific surveys must be conducted for the area in question.	Project-specific surveys have been undertaken. Digital aerial surveys were flown between March 2020 and March 2012.	Project-specific surveys are detailed in **Appendix 21A: Marine Mammal and Megafauna Baseline**.

Table 21-5. A summary of additional consultation undertaken for marine mammals

Consultation / Consultee	Date	Summary of key information and decisions
Paper issued to NRW (A)	20 January 2023	'Survey summary paper' outlining the methods and results from the site-specific digital aerial surveys (DAS) undertaken, in addition to proposed method for availability bias correction for common dolphin and harbour porpoise.
Meeting with NRW (A)	8 February 2023	Meeting to discuss the 'Survey summary paper'. It was agreed that density and population estimates for common dolphin and harbour porpoise will be corrected for availability bias as outlined in the paper.
Written advice from NRW (A)	17 February 2023	Written advice from NRW (A) in response to the 'Survey summary paper' and meeting held on 8 February 2023. For marine mammals, this included: • Confirming the suitability of the site-specific DAS for marine mammals; and • Advice to include seasonal modelling of marine mammals.
Paper issued to NRW (A) and JNCC	3 March 2023	'Marine Mammal Assessment Methodology Paper' circulated to NRW (A) and JNCC (3 March 2023) outlining: • Proposed approach to density and population estimation; • Proposed reference populations; and • Proposed approach to assessment of underwater noise.
Paper issued to NRW (A)	16 March 2023	'Design and model-based analysis methods HiDef advice to NRW' outlining the proposed method for using inlabru [modelling] for calculation of model-based density and abundance estimates from DAS.
Meeting with NRW (A) and JNCC	9 May 2023	Meeting to discuss the 'Marine Mammal Assessment Methodology Paper', which included agreement on the marine mammal species to be scoped in for assessment and discussion on other matters such as density estimation, reference populations and underwater noise modelling choices and parameters.
Email response from NRW (A) and JNCC	10 May 2023 (NRW (A)) / 19 May 2023 (JNCC)	Email confirmation of the fleeing speeds to be used in the marine mammal underwater noise modelling.
Written advice from NRW (A)	23 May 2023	Written advice from NRW (A) in response to the discussions of the meeting on 09 May 2023, which included: • Agreement on the IAMMWG MUs to define cetacean reference populations and search areas for the Cumulative Effects Assessment (CEA); • Agreement on OSPAR Region III for grey seals, with densities extracted from Carter *et al.* (2022) and the reference population from SCOS (2020; 2021);

Consultation / Consultee	Date	Summary of key information and decisions
		• Agreement with the use of the Graham (2017) dose-response curves in EIA assessment; and • The approach to assessment from non-impulsive sources and geophysical surveys.
Meeting with NRW (A) and JNCC	24 May 2023	Meeting with NRW (A) and JNCC ornithology advisors to introduce and outline the proposed method for using inlabru for calculation of model-based density and abundance estimates from DAS. The inlabru presentation from this meeting was recorded and circulated to the marine mammal advisors from NRW (A) and JNCC.
Paper issued to NRW (A) and JNCC	14 June 2023	'Comparison of Model (inlabru) and Design-Based Estimates from Digital Aerial Survey Work and Advice on Density Estimates to Use in Noise Assessment' paper containing: • A comparison of the design-based and model-based (inlabru) density estimates from the site-specific DAS, and other sources from the literature; and • Proposed density estimates to be taken forward in the quantitative underwater noise impact assessments, with rationale.
Written advice from NRW (A)	11 September 2023	Marine mammal density estimates: • Whilst NRW(A) prefer the use of Welsh Atlas density estimates, the use of SCANS III density estimates is considered acceptable as these are more precautionary. • Recommend that the DAS density estimates for common dolphin are also presented as a comparison to account for the occasional transitory presence of 'super pods'.
Papers issued to NRW (A) and JNCC	12 March 2023	Including a technical paper* to investigate survey coverage (12.5% *cf.* 25%) as requested by NRW (A) and JNCC at the meeting on 16 August 2023. This paper primarily relates to marine ornithology but does include context on these matters for marine mammals (i.e., harbour porpoise as the only species where the densities derived from DAS data are input into noise modelling). ***Technical Paper 2: Survey Coverage Comparison (12.5% and 25%)** in **Annex B** of **Appendix 22A: Marine Ornithology Baseline**.
Email from NRW (A) and JNCC	28 March 2024	NRW (A) and JNCC providing summary comments on the technical papers issued on 12 March 2024 including Technical Paper 2: Survey Coverage Comparison (12.5% and 25%) as discussed in the preceding row. The SNCBs advise that they will provide their full comments following review of the submitted application.

21.4 Approach to Assessment

21.4.1 Assessment Methodology

18. **Chapter 05: EIA Approach and Methodology** provides a summary of the general impact assessment methodology applied in this ES. The following sections provide further detail on the specific methodology used to assess the potential impacts on marine mammals.

19. The approach to the assessment of cumulative impacts, transboundary impacts and interrelated effects is provided in **Sections 21.12, 21.13** and **21.14**.

20. The significance of potential effects has been evaluated using a systematic approach together with the expert judgement of the specialist consultant. The systematic approach is based upon the identification of the importance / value of receptors and their sensitivity to the proposed Project together with the predicted magnitude of the potential impact.

21. The criteria used for marine mammals vary from the example criteria presented in **Chapter 05: EIA Approaches and Methodology**, as they have been developed specifically for assessment of marine mammals, based on specialist knowledge and experience from HiDef as the authors of this Chapter.

21.4.2 Significance Criteria

Magnitude of Impact

22. The scale or magnitude of potential impacts (both beneficial and adverse) is determined by the consideration of the scale, spatial extent, and duration of change together with the temporal extent, to inform the criteria categories from ‘negligible’ to ‘large’. The criteria used for identifying the magnitude of impact for the purpose of this assessment is given in **Table 21-6.**

Table 21-6. Magnitude criteria for marine mammal receptors

Magnitude Criteria	Definition
Large	• Major change to the conservation status or integrity of the receptor or key elements / features of the baseline conditions; • High incidence (occurring repeatedly or continuously over long durations) and / or at high intensity; • Impact on the receptor or baseline conditions occur over a large spatial geographical extent; and / or • The temporal extent is predicted to be long-term (i.e. 15 years or more) or permanent in nature.
Medium	• Moderate change to the conservation status or integrity of the receptor or key elements / features of the baseline conditions; • Medium to high incidence (occurring repeatedly or continuously over moderate durations) and / or at moderate intensity, or over a short duration at high intensity; • Impact on the receptor or baseline conditions occur over a medium spatial geographical extent; and / or • The temporal extent is predicted to be of medium-term (i.e. 6 to 14 years).
Small	• Minor shift from the baseline conditions which is unlikely to affect the conservation status or integrity of the receptor; • Low incidence (occurring occasionally or intermittently for short durations) and / or at low intensity; • Impact on the receptor or baseline conditions occur over a local spatial extent; and / or • The temporal extent is predicted to be of short-term (i.e. 1 to 5 years).

Magnitude Criteria	Definition
Negligible	• Slight or imperceptible shift from the baseline conditions that will not affect the conservation status or integrity of the receptor; • Any impact is unlikely to occur or impact may occur at very low incidence or intensity; • Any impact on the receptor or baseline conditions occur are highly localised; and / or • The temporal extent is predicted to be of very short term with a full rapid recovery (i.e. within 1 year or less).

Sensitivity of Receptor

23. Receptor sensitivity is defined as the degree to which a receptor would be affected by an impact. The sensitivity of the receptor is characterised by three factors: vulnerability, recoverability and importance, as outlined in **Chapter 05: EIA Approaches and Methodology**.

24. The criteria for defining receptor sensitivity for the purpose of the assessment on marine mammals are provided in **Table 21-7**.

Table 21-7. Sensitivity criteria for marine mammal receptors

Sensitivity Criteria	Definitions
Very High	• Receptor has no ability to adapt, so that individual survival and reproductive rates are highly likely to be affected. • Receptor has no ability to tolerate the effect, so there is likely to be a significant change in individual survival and reproductive rates. • Receptor has no ability to recover from the effect.
High	• Receptor has a limited ability to adapt so that individual survival and reproductive rates may be affected. • Receptor has limited tolerance, so the effect may cause a significant change in individual survival and reproductive rates. • Receptor has a limited ability to recover from the effect.
Medium	• Receptor can adapt so that individual reproductive rates may be affected, but without any effect on survival rates. • Receptor has some tolerance, with no significant change in individual survival and reproductive rates. • Receptor can recover from the effect.
Low	• Receptor can adapt their behaviour so that there is no effect on individual survival or reproductive rates. • Receptor is able to tolerate the effect with no impact to individual survival and reproductive rates. • Receptor can return to their previous behavioural state or activity once the activity has ceased.
Negligible	• No perceptible effect on the behaviour of the receptor.

Significance of Effect

25. As set out in **Chapter 05: EIA Approaches and Methodology**, an Impact Assessment Matrix (IAM) is used to determine the significance of effect which is a function of the sensitivity of the receptor and the magnitude of the impact, as shown in **Table 21-8**.

26. The matrix provides a framework for the consistent and transparent assessment of predicted effects across all receptor topics; however, it is important to note that the IAM acts as a guide and that assessments also allow for the application of expert judgement. Criteria are therefore assigned to consider the likely effects, rather than a check list whereby all definitions are met for the category to be used.

Table 21-8. Significance matrix

		Value / Sensitivity				
		Very High	High	Medium	Low	Negligible
Magnitude	Large	Major	Major	Moderate	Minor	Minor
	Medium	Major	Moderate	Moderate	Minor	Negligible
	Small	Moderate	Moderate	Minor	Negligible	Negligible
	Negligible	Minor	Minor	Negligible	Negligible	Negligible

27. The IAM provides levels of effect significance ranging from major to negligible. Assignment of significance is carried out with consideration of embedded mitigation measures relevant to marine mammals. Embedded mitigation measures (including project design measures and best practice) are presented within **Section 21.8**. For the purposes of this assessment, Moderate and Major levels of significance are defined as significant, and where relevant additional mitigation measures may be required, whilst Negligible or Minor impacts are defined as not significant (**Table 21-9**).

Table 21-9. A summary of the definitions of each significant of effect criteria

Significance Category	Definitions	Significant / Not Significant Effect
Major	• A large and detrimental change likely to adversely affect the marine mammals' biological fitness. • These effects are likely to be important considerations at a regional or district scale and may represent key factors in the decision-making process.	Significant
Moderate	• A medium scale change with potential to adversely affect the marine mammals' biological fitness, but that there is some tolerance or recoverability. • These effects, if adverse, are likely to be important at a local scale and on their own could have a material influence on decision making.	Significant (unless otherwise specified)

Significance Category	Definitions	Significant / Not Significant Effect
Minor	• A small change that, whilst adverse, is not expected to result in negative impacts to marine mammals' biological fitness. • These effects may be raised as local issues and may be of relevance in the detailed design of a project but are unlikely to be critical in the decision-making process.	Not Significant
Negligible	• A very small change that is so small and unimportant that it is considered acceptable to disregard. • These effects are unlikely to influence decision making irrespective of other effects.	Not Significant

21.4.3 Study Area

28. The study areas relevant to the assessment of marine mammals have been defined on a species-by-species basis, considering the ecology, behaviour, scale of movement and population structure for each species. The marine mammals likely to be present in the study are for the proposed Project include harbour porpoise, common dolphin, bottlenose dolphin, minke whale and grey seal (see baseline description **Section 21.5.1**).

29. The study areas have been defined at two spatial scales (**Figure 21-1**):

- The Marine Mammal Study Area for all species is comprised of the Llŷr marine megafauna survey area and is used to indicate site-specific local abundance and densities (see site-specific survey **Section 21.4.4** below for more detail); and
- The species-specific Management Units (MMMU) take account of the wider distribution, density and abundance of marine mammals and are used as the reference population for the assessment of potential impact at the population scale.

30. For dolphins, harbour porpoise and minke whale, the MMMUs published by the Inter Agency Marine Mammal Working Group (IAMMWG, 2022) have been used. These MUs have been defined by the IAMMWG based on their understanding of the biological population structure of these species, and the ecological differentiation of these populations.

31. There are currently no IAMMWG agreed marine mammal MUs for grey seals; therefore, OSPAR Region III has been used (**Figure 21-1**). This area has been used in accordance with the advice received from NRW (Scoping Opinion received 23 May 2022).

32. MUs relevant to each species taken forward for assessment are as follows:

- Harbour porpoise - Celtic and Irish Sea;
- Common dolphin - Celtic and Greater North Seas;
- Bottlenose dolphin - Offshore Channel and SW England;
- Minke whale - Celtic and Greater North Seas; and
- Grey seal - OSPAR Region III.

21.4.4 Data Sources

Site Specific Surveys

33. Site-specific high-resolution Digital Aerial Surveys (DAS) were conducted by HiDef to determine the marine mammal (and offshore ornithology) species which are present within the proposed Project Marine Mammal Study Area and to estimate recent and robust density and abundance estimates for the key marine mammal species identified within the surveyed area.

34. A total of 24 monthly surveys were flown between March 2020 and March 2022 over the 640 km^2 Llŷr marine megafauna survey area, along 23, 2 km-spaced survey transects (**Figure 21-2**). The surveys provided broad coverage of the proposed Array Area to provide a representative sample to characterise baseline conditions.

35. Full details of the site-specific survey methodology used is presented in **Appendix 21A: Marine Mammal and Megafauna Baseline**.

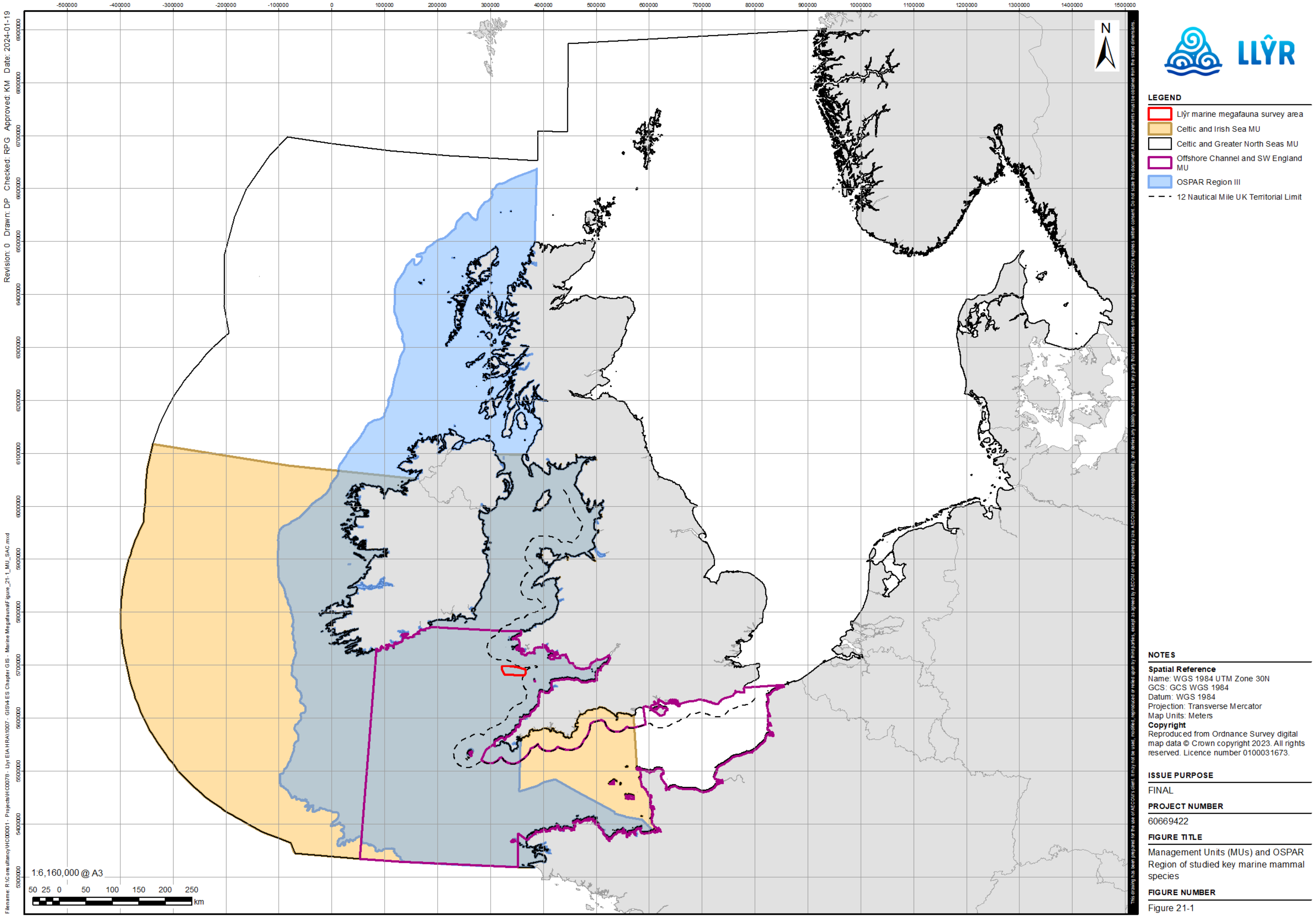

Figure 21-1. Management Units (MUs) and OSPAR Region of studied key marine mammal species

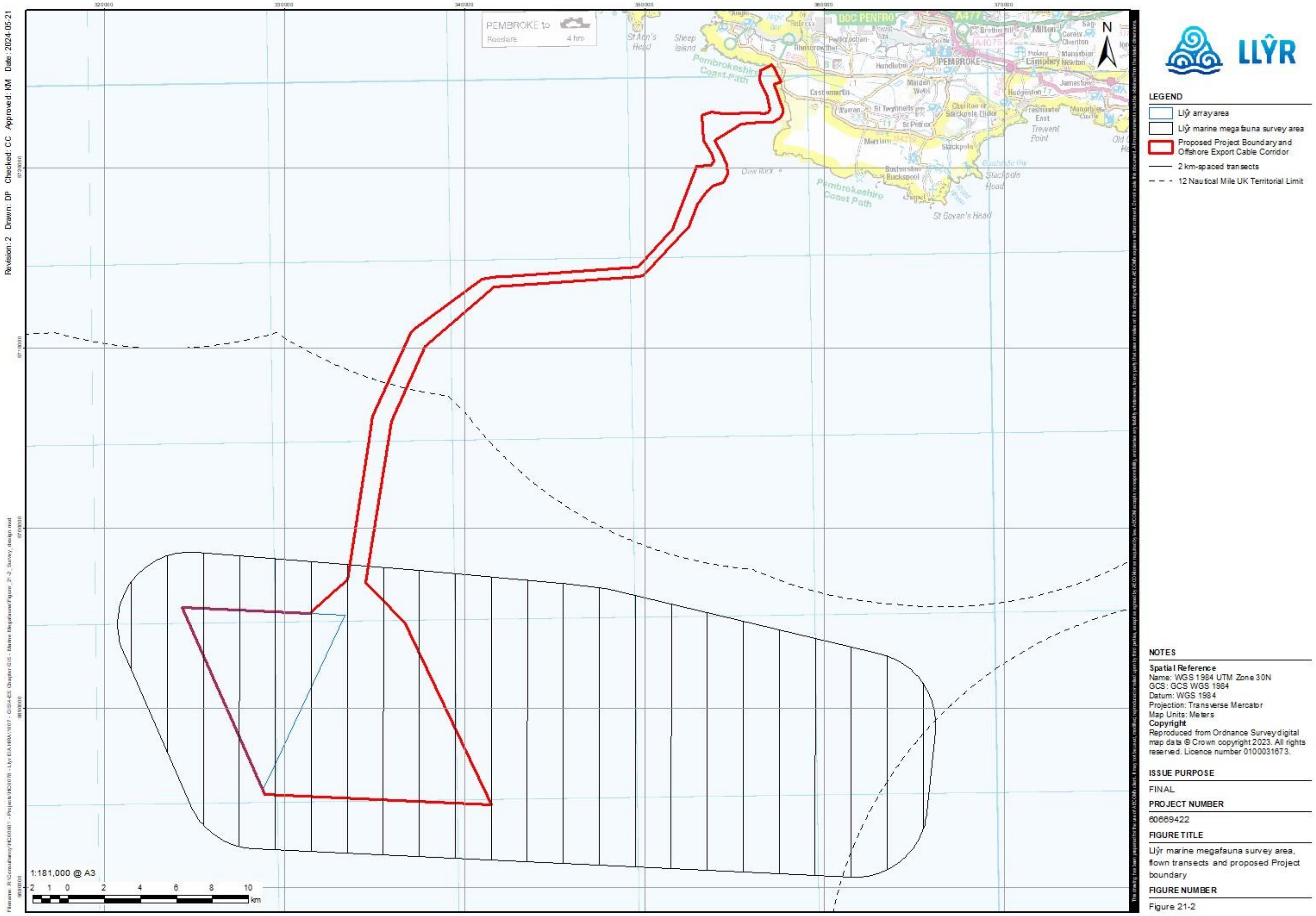

Figure 21-2. Llŷr Offshore Development Area including the marine megafaunal survey area and associated survey design (transects flown)

Desk Study

36. A detailed baseline characterisation for marine mammals is given in **Appendix 21A: Marine Mammal and Megafauna Baseline**, which has been informed by a desk-based review of existing data sources in addition to site-specific surveys. Data sources which have been used to inform this assessment are summarised in **Table 21-10**.

Table 21-10. Data sources used to inform the baseline characterisation for marine mammals

Data source	Date	Type of data	Coverage
Site-specific survey	Mar 2020 – Mar 2022	Digital video aerial surveys (DAS)	Llŷr marine megafauna survey area
Project Erebus site-specific surveys (Darias-O'Hara *et al.*, 2021)	Oct 2019 – Sep 2021	Digital video aerial surveys (DAS)	Project Erebus and 4 km buffer
Welsh Marine Atlas (Baines and Evans, 2012)	1990 – 2009	Visual aerial, vessel and land-based visual surveys	Welsh waters
Cetaceans and Seabirds of Wales (Evans and Waggitt, 2023)	1990 – 2020	Vessel, visual and digital aerial surveys	Welsh waters
Small Cetaceans in European Atlantic waters and the North Sea (SCANS-III) (Hammond *et al.*, 2021)	Jun - Aug 2016	Visual aerial and vessel surveys	European Atlantic waters
Small Cetaceans in European Atlantic waters and the North Sea (SCANS-IV) (Gilles *et al.*, 2023)	Jun – Oct 2022	Visual aerial and vessel surveys	European Atlantic waters
ObSERVE (Rogan *et al.*, 2018)	Summer/ Winter 2015 and 2016	Visual aerial surveys	Offshore waters within and beyond Irish continental shelf
Sea Watch Foundation bottlenose dolphin surveys (Lohrengel *et al.*, 2018)	2014 – 2016	Vessel and photo-ID surveys	Cardigan Bay SAC and wider Cardigan Bay
Joint Cetacean Protocol (JCP) Phase III (Paxton *et al.*, 2016)	1994 – 2010	Visual and digital aerial, vessel and land-based surveys	Northern European shelf
Harbour porpoise densities (Heinänen and Skov, 2015)	1994 – 2011	Vessel and visual aerial surveys	UK waters
Marine Ecosystems Research Programme (MERP) maps (Waggitt *et al.*, 2019)	1980 – 2018	Visual and digital aerial and vessel visual surveys	European Atlantic waters
Scientific advice on matters related to management of seal populations: 2022 (SCOS, 2022)	2022	Collation of data on counts and population estimates	UK coastline

Data source	Date	Type of data	Coverage
Natural Resources Wales grey seal pup counts (Bull *et al*., 2017a; 2017b; Morgan *et al*., 2018)	1983 – 2015	Pup counts	Skomer Marine Conservation Zone (MCZ) and Pembrokeshire Marine SAC
Natural Resources Wales grey seal breeding census (Büche, 2021)	1983 -2021	Breeding census	Skomer MCZ
EIRPHOT database (Langlay *et al*., 2018; 2020)	1992 – 2016	Adult grey seal photo ID	Welsh and Irish coastlines
Seal at-sea distribution (Vincent *et al*., 2017)	1999 – 2014	Telemetry data	East Atlantic and North Sea
Foraging habitat selection of grey and harbour seals (Huon *et al*., 2021)	2008 – 2014	Telemetry data	East Atlantic
Grey seal at-sea density (Russel *et al.* 2017	1988 - 2016	Telemetry data	UK, Irish and French waters
Grey seal at-sea density (Carter *et al*., 2020; 2022)	1991 – 2019	Habitat-based predictions using telemetry and count data	UK and Irish waters
Wildfowl and Wetland Trust aerial surveys (WWT Consulting, 2009)	2001 – 2008	Visual aerial surveys	UK waters

21.5 Baseline

37. The following sections describe the baseline environment relating to marine mammals.

21.5.1 Existing Baseline

38. A technical report has been prepared which provides a detailed characterisation of the baseline relating to marine mammal receptors, which should be read in conjunction with this **ES Chapter** (**Appendix 21A: Marine Mammal and Megafauna Baseline**). The technical report includes details of the marine mammals potentially present within the marine mammal study areas, as informed by 24 months of DAS, a review of data collected across other wind farms and other available literature as outlined in **Section 21.4.4**. This section summarises the key findings from **Appendix 21A: Marine Mammal and Megafauna Baseline**.

39. The available data show that the following species are likely to be present within the proposed Project study areas. These species have therefore been taken forward for impact assessment (as agreed with NRW (A) and JNCC in the meeting on 09 May 2023):

- Grey seal,
- Harbour porpoise,
- Common dolphin,
- Bottlenose dolphin; and
- Minke whale.

40. A review of available data was undertaken, and the most robust and relevant density estimates within the relevant MMMU were determined for each of the identified species. These have been carried forward into the quantitative assessment (**Table 21-11**). A summary of the baseline for each of these species has been given in the sections below.

41. This chapter has focused on marine mammals only. Due to the rare occurrence of sea turtles, including leatherback turtles, within the proposed Project area, and as detailed in **Appendix 21A: Marine Mammal and Megafauna Baseline**, this species has been scoped out and is not considered further within this assessment because there were no sightings in the site-specific DAS, and therefore, no density estimates due to insufficient sightings. Basking sharks are assessed within the Fish and Shellfish (**Chapter 20 – Fish and Shellfish Ecology**).

Table 21-11. Species, MU and density estimates (n/km^2) taken forward for use in the quantitative impact assessment for marine mammals.

Species	Reference population (abundance)	Density (n/km^2) relevant to the proposed Project	Density source
Harbour porpoise	Celtic and Irish Sea (62,517; IAMMWG, 2022)	0.137 (95% CI 0.02 – 0.54; Llŷr marine megafauna survey area)	Site-specific digital video aerial survey (Absolute model-based overall average)
Common dolphin[4]	Celtic and Greater North Seas (102,656; IAMMWG, 2022)	0.841 (CV 0.264)	SCANS-IV survey block CS-C (Absolute design-based estimates; Gilles *et al*., 2023)
Bottlenose dolphin	Offshore Channel and SW England (10,947; IAMMWG, 2022)	0.4195 (CV 0.406)	SCANS-IV survey block CS-C (Absolute design-based estimates; Gilles *et al*., 2023)
Minke whale	Celtic and Greater North Seas (20,118; IAMMWG, 2022)	0.011 (0.755 CV)	SCANS-III survey block D (Absolute design-based estimates; Hammond *et al*., 2021)
Grey seal	OSPAR III Region (62,358; SCOS, 2021; Carter *et al*., 2022)	Grid cell specific (Carter *et al.,* 2022)	At-sea densities (Carter *et al*., 2022)

Harbour Porpoise

42. Harbour porpoise is the most abundant cetacean in UK waters and are widely distributed, year-round on the UK continental shelf (Hammond *et al.,* 2021; Gilles et al. 2023). They occur as single animals or in small groups and feed on a variety of fish including gadoids and clupeoids (Leopold, 2015). The most recent abundance estimate for the Celtic and Irish Sea MU is 62,517 (CV; 0.13) individuals based on SCANS-III surveys in July 2016. This compares

[4] DAS site-specific survey density estimates have been considered in in **Appendix 21C: Annex B – Common Dolphin Impact Assessment Comparison Using Site-Specific Density**

with an estimate based on SCANS-II 2005 surveys of 98,807 individuals (IAMMWG, 2015). Murphy *et al*. (2020) suggested that the population in the Celtic and Irish Seas area may be in decline, based on analysis of age-structure from strandings and estimates of mortality rates.

43. Knowledge on breeding behaviour and habits is limited; however, the main period for mating and calving in harbour porpoise usually occurs between May and August (IAMMWG et al., 2015).

44. There are currently 15 SACs with harbour porpoise features within the Celtic and Irish Seas MU, the closest of which are West Wales Marine SAC/ Gorllewin Cymru Forol SAC (which overlaps the offshore cable corridor, and is 8.4km from the array area) and Bristol Channel Approaches SAC / Dynesfeydd Môr Hafren SAC (12km east of the proposed Project and offshore cable route), reflecting the importance of this area to the species (see **Appendix 8D**: **HRA Screening** for full details). The next closest SAC with harbour porpoise features is the North Anglesey Marine/ Gogledd Môn Forol SAC which is 223.7km from the array area and 186.4km from the offshore cable corridor.

45. The average model-based absolute densities from the site-specific DAS across the survey period were estimated at 0.137 animals/km^2 in the Llŷr marine megafauna survey area, which is comparable with densities from SCANS-III Block D (0.118 animals/km^2; Hammond *et al*., 2021). SCANS-IV density estimate is lower 0.0157 animals/km^2 (CV 0.506). Therefore, because site-specific DAS represent fine-scale data, and estimates are consistent with regional scale SCANS-III, it was concluded that this was the most appropriate density estimate to take forward for the quantitative impact assessment in keeping with the precautionary principle.

46. Advice received from NRW(A) and JNCC (01 December 2023 and 09 December 2023) queried the use of the site-based model estimates based on *Inlabru* modelling. In this advice, the suggestion was to use the Evans and Waggitt (2023) density estimates (see **Appendix 21A: Marine Mammal and Megafauna Baseline**). The density estimate from this source relative to the Llŷr marine megafauna survey area was 0.087 animals/km^2. The MERP mapping project methodology (Waggitt et al. 2020) employed for this project was designed to predict typical distribution from data obtained across several years and / or several decades. The modelled outputs indicate areas of higher density between north Anglesey and the Isle of Man, the outer part of Cardigan Bay and west Pembrokeshire. These areas are to the north of the proposed Project. The spatial context of the maps would require consideration as a density surface rather than a single point density estimate as advised by NRW(A) and JNCC (**Table 21-5**). However, comparison analysis demonstrates that use of the model-based site absolute density, is precautionary and will provide worst-case scenario. Therefore, it is considered that use of the model-based site absolute density is robust and can be used as the basis for assessment of harbour porpoise.

Common Dolphin

47. Common dolphin is found both within coastal and in deeper offshore waters, where they feed on a variety of prey including sardine (*Sardina* spp.) and anchovy (*Engraulis* spp.) (Murphy *et al.,* 2013). Within the Irish Sea, the highest abundance is recorded in the Celtic Deep, towards the south of the Irish Sea and northwest of the proposed Project (Evans and Waggitt, 2023). Based on data from SCANS-III and ObSERVE, it is estimated that the Celtic and Greater North Seas MU has a population of 102,656 (CV; 0.29) common dolphin in 2021, which is a lower than the 181,880 in 2015 (IAMMWG, 2015; 2022). There are no designated protected sites for common dolphin in the UK. Site-specific DAS, as well as surveys conducted by Baines and Evans (2012), indicate seasonal variation in abundance, with higher densities estimated in the summer compared to winter.

48. Reproduction is seasonal, with mating and calving mainly between May and September[5]. It is thought that common dolphin movements into the Celtic Sea are associated with feeding opportunities (Brophy et al., 2009).

49. The average model-based absolute densities, corrected for availability bias (see **Appendix 21A: Marine Mammal and Megafauna Baseline** for full detail), from the site-specific DAS across the survey period for common dolphin were estimated at 15.97 animals/km^2, which was significantly higher than density estimates from other sources, such as SCANS-III (0.374 animals/km^2; Hammond *et al*., 2021) and SCANS-IV (0.841 animals/km^2, Gilles *et al.,* 2023). Whilst these model-based absolute densities reflect sightings data within the Llŷr marine megafauna survey area, the average is biased due to the large number of common dolphins sighted in June 2020.

50. Common dolphins were the most abundant marine mammal encountered in the DAS, with a major peak in June 2020. Monthly sightings ranged from 5 - 608 animals in Year 1, and 0 - 179 animals in Year 2. The peak occurrence of animals in both years was June / July and is consistent with the pattern of occurrence presented in Evans and Waggitt (2023). The use of the peak observed density, as the representative density would lead to an unrealistic overestimation of population impacts.

51. Availability bias for common dolphin was derived using the equation provided by Paxton *et al.* (2016) after Laake *et al.* (1997). The approach was applied using estimated common dolphin mean surface and dive times taken from Evans, P. (*pers comm*) as cited in Paxton *et al.* (2016).

52. Model-based estimates calculated average relative (uncorrected) and absolute (corrected for availability bias) densities for the whole survey period of 1.06 animals/km^2 (95% CI 0.64 – 1.70) and 15.97 animals/km^2 (95% CI 9.65 – 25.62), respectively. This equates to mean abundance estimates of 793 animals (95% CI 723 – 862) and 11,966 animals (95% CI 10,911 – 13,008), respectively. Mean densities were estimated to be higher in the summer than the winter for both relative and absolute estimates over the Llŷr marine megafauna survey area (**Appendix 21A: Marine Mammal and Megafauna Baseline**).

53. There is a lack of information relating to availability bias for common dolphins, therefore there is high uncertainty associated with applying an availability bias correction to sightings data. To HiDef's knowledge, there are only two sources of information; Evans, P. (*pers comm*) as cited in Paxton et al, (2016), and an estimate based on common dolphin school visibility (Bilgman *et al*., 2018).

54. As noted above, the DAS densities reflect sightings data within the Llŷr marine megafauna survey area, during the time of the survey. The variability and seasonal patterns of animals present is informative in terms of site characterisation. However, it is not appropriate to assume that the resultant density estimates will be consistent beyond the site survey area (unless, as in the case for harbour porpoise, there are other data to support this as the chosen density estimate). The large number of common dolphin DAS observations is likely to reflect a group of animals passing through at the time of the survey. It therefore would not be appropriate to extend the DAS derived density estimates beyond the Llŷr marine megafauna survey area.

55. In response to JNCC written advice 04 August 2023 "we recommend taking the precautionary approach and using densities based on the survey data for common dolphins. An alternative option would be to take both densities forward to the assessment to enable a comparison". A comparative assessment based on the site-based DAS density estimates in presented in

[5] Species – Common Dolphin – The Mammal Society [Accessed 27/02/2024]

Appendix 21A: Annex B – Common Dolphin Impact Assessment Comparison Using Site-Specific Density.

56. A regional scale density estimate has been taken forward for the quantitative impact assessment, using the most recent density estimates from SCANS-IV block CS-C 0.841 animals/km^2 (Gilles *et al.,* 2023).

Bottlenose Dolphin

57. Bottlenose dolphin is a globally distributed species found in offshore, coastal and shelf waters, and have a generalist diet including fish, squid and crustaceans. One of the two UK resident coastal populations is located on the west and north coasts of Wales. The population is highly variable with seasonal, diurnal and tidal cycle fluctuations relating to prey availability and conditions needed for calving (Nuuttila *et al*., 2017). To the north of the proposed project, information obtained from observations in Cardigan Bay SAC, designated for bottlenose dolphin, suggest that prey availability in the area is the key driver for their presence (Lohrengel *et al.,* 2017).

58. Based on data from SCANS-III and ObSERVE, the most recent population estimate for the Offshore Channel and SW England MU is 10,947 (CV = 0.25) bottlenose dolphins (IAMMWG 2022), which is an increase compared with to previous estimates in IAMMWG, (2015) (4,856 individuals; IAMMWG, 2015; 2022). There are no protected sites designated for bottlenose dolphins within the Offshore Channel and SW England MU.

59. There were no bottlenose dolphins detected during the site-specific DAS, although there were 13 unidentified cetaceans and three unidentified dolphin species observed.

60. The most recent SCANS-IV survey noted that the distribution of bottlenose dolphin was different in 2022 in comparison to SCANS-III, with more sightings in the northern Celtic Sea. It is therefore precautionary to use the SCANS-IV density estimate of 0.4195 animals/km^2 (Gilles *et al.,* 2023).

61. There are no SACs with bottlenose dolphin features within the Offshore Channel, Celtic Sea and SW England MU. The closest SACs are Pen Llyn a`r Sarnau/ Lleyn Peninsula and the Sarnau SAC at 155.1km from the array area, and 117.8km from the offshore cable corridor, and Cardigan Bay/ Bae Ceredigion SAC at 107.2km from the array area and 69.9km from the offshore cable corridor (see **Appendix 8D: HRA Screening** for full details).

Minke Whale

62. Minke whales are the most common whale species in UK waters and are found throughout the UK, typically in relatively shallow and coastal areas (Anderwald *et al.,* 2012). They have a varied diet and feed on small shoaling species (e.g. sprat, sandeel, herring, sprat, haddock, saithe, whiting and small cod) as well as euphasiids, with strong seasonal distribution patterns likely related to prey availability (Macleod et al., 2004; Anderwald *et al*., 2012). Based on data from SCANS-III and ObSERVE, the most recent population estimate for the Celtic and Greater North Seas MU is 20,118 (CV; 0.18) minke whale, which is comparable with previous estimates in IAMMWG 2015 (20,136 individuals; IAMMWG, 2015; 2022). The data collated by Evans and Waggitt (2023) in the Celtic Sea indicate that most sightings occur between April and September, with no observations between January and March. Within the MU, there are two Nature Conservation Marine Protected Areas (NCMPAs) with minke whale as a protected feature in Scottish waters (Southern Trench NCMPA and Sea of Hebrides NCMPA). There are no protected sites for minke whale in Welsh waters.

63. Minke whales tend to be recorded in the summer months, while migratory patterns are not well understood, it is thought that they undertake large-scale seasonal migrations between summer feeding grounds at higher latitudes, and breeding grounds at lower latitudes in winter months (Risch *et al.,* 2014; Kavanagh *et al.,* 2018). There are occasional sightings of what has been described as young calves in British and Irish waters in spring and summer, and so there is speculation that some females may calve in these more northerly waters at this time of year (Kavanagh *et al.,* 2018).

64. The most recent site-specific surveys by HiDef between 2020 and 2022 indicate minke whales are present in the vicinity of the proposed Project in relatively low densities. The estimates gave an average relative design-based density for the full survey period of 0.003 animals/km^2 in the Llŷr marine megafauna survey area, with peak estimates recorded during the summer period (0.04 animals/km^2 [June S02 2020]). Estimated densities from the site-specific surveys data are lower overall than those presented in SCANS and ObSERVE (Rogan *et al*., 2018; Hammond *et al*., 2021; Gilles *et al.,* 2023) when comparing summer months estimates, but noting that the DAS estimates have not been corrected for visibility bias.

65. The SCANS-III density estimate was 0.0112 animals/km^2(Hammond *et al*., 2021) whereas SCANS-IV density estimate for block CS-C was 0.0079 animals/km^2 (Gilles *et al.*, 2023). Therefore, in line with the precautionary principle, the SCANS-III block D absolute density estimate of 0.0112 animals/km^2 (Hammond *et al*., 2021) has been taken forward for the quantitative impact assessment.

Grey Seal

66. Grey seal is one of two resident seal species in the UK. They have a generalist diet and feed throughout continental shelf waters and will travel large distances in search of prey, with foraging trips at sea for up to 30 days (JNCC, 2019; SCOS, 2021). They generally haul-out between December and April to moult and have a strong association with haul-out sites from August to December for the breeding season. There are several confirmed haul-out and breeding sites in Wales, including at Ramsey Island, Skomer MCZ, north Pembrokeshire and north Wales (SCOS, 2020; 2021), with Skomer MCZ being closest to the proposed Project.

67. According to SCOS (2022), the latest population estimate is 5,400 grey seals in Wales, and 162,000 across the UK in 2022, the latter of which equates to approximately 35% of the world population. Data suggests there has been a significant increase in pup production between 2016 and 2019 in Wales, resulting in an increasing population trend (SCOS, 2022). There are 21 SACs with grey seal qualifying features within the OSPAR III region, the closest of which are Pembrokeshire Marine/ Sir Benfro Forol SAC (overlapping the offshore cable corridor) and Lundy SAC (approximately 53 km southeast of the proposed Project; see **Appendix 8D: HRA Screening** for full details).

68. There were few observations of grey seal within the Llŷr marine megafauna survey area during the site-specific DAS. Relative design-based density estimates of 0.04 animals/km^2 (95% CI 0.00 – 0.08) are presented in **Appendix 21A: Marine Mammal and Megafauna Baseline**; however, this was based on a total of 11 records of grey seal. Therefore, at-sea grey seal density data from Carter *et al*. (2022) are more appropriate to support the impact assessment and cell specific densities have been taken forward for the quantitative impact assessment. As an indication of the density of grey seals present, the average density of animals within the Llŷr marine megafauna survey area from Carter *et al*. (2022) is 0.011 animals/km^2. The reference population for the OSPAR Region III area (Table 21-11) has also been estimated with densities extracted from Carter *et al*. (2022).

21.5.2 Future Baseline

69. This section considers any changes to the baseline conditions described above that might occur over the lifespan of the proposed Project, if the proposed Project is not installed.

70. Marine mammal abundance and distribution is driven by a complex web of environmental and anthropogenic factors. This includes direct factors, such as competition for resource, bycatch in commercial fisheries and habitat change, as well as indirect pressures on prey from commercial fisheries and climate change (Avila *et al*., 2018; Albouy *et al*., 2020). There is also a limited understanding of the drivers of population changes to date, and a lack of appropriate monitoring over large temporal and spatial scales to understand the dynamics of marine mammal populations (Evans and Bjørge, 2013; Russell *et al*., 2017). Therefore, it is challenging to predict how marine mammal populations may change over the lifetime of the proposed Project and beyond.

71. The most recent assessment of conservation status, undertaken by JNCC in 2019 under the requirements of Article 17 of the Habitats Directive, concluded that the conservation status and overall trend was 'unknown' for all assessed cetacean species (**Table 21-12**; JNCC, 2019b). This conclusion is due to a lack of data to inform an assessment of population trends. Grey seals were the only relevant marine mammal species assessed as having a 'favourable' conservation status. This is consistent with SCOS (2021), which estimated an increase in pup production at local significant haul-out sites (e.g. Skomer MCZ, Marloes Peninsula and Ramsey Island).

72. Whilst harbour porpoise were assessed as having 'favourable' future prospects (JNCC, 2019b), the SCANS-III survey (Hammond *et al*., 2021), supported by Murphy *et al*. (2020), suggest the population in the Celtic and Irish Seas area may have been declining slowly since 2009 (see **Section 21.5.1**). The apparent reduction in abundance in UK waters is due to lower densities on the UK portion of the Celtic shelf (JNCC, 2019). However, JNCC (2019) also state that once the results from the ObSERVE programme (Rogan *et al.,* 2018) are considered, there is no evidence of a statistically significant difference between SCANS-II (flown in 2005; Hammond *et al.,* 2013) and SCANS-III (flown in 2016; Hammond *et al.,* 2021). SCANS-IV (flown in 2022; Gilles *et al.,* 2023) cannot currently provide an update as the latest results from ObSERVE2 are not yet available. The 'unknown' category across all species is because the conclusions are based on an extrapolation from a limited amount of data (JNCC, 2019b).

Table 21-12. Conservation status of key marine mammal species included in the assessment of the proposed Project (JNCC, 2019b)

Species	Range	Population	Habitat	Future Prospects	Conservation Status	Overall Trend
Harbour porpoise	Favourable	Unknown	Unknown	Favourable	Unknown	Unknown
Common dolphin	Favourable	Unknown	Unknown	Unknown	Unknown	Unknown
Bottlenose dolphin	Favourable	Unknown	Unknown	Unknown	Unknown	Unknown
Minke whale	Favourable	Unknown	Unknown	Unknown	Unknown	Unknown
Grey seal	Favourable	Favourable	Favourable	Favourable	Favourable	Improving

73. Albouy *et al*. (2020) carried out an assessment of the vulnerability of all marine mammal species to global warming based on traits such as range, habitat and diet specialisation and produced a ranked list of species by vulnerability to climate change effects. Grey seal (ranked number 16) and harbour porpoise (ranked number 18) were ranked within the top twenty most vulnerable species of marine mammals to climate change extinction risk.

74. One of the most significant factors which affects marine mammal populations is likely to be changes to prey abundance and distribution, particularly wide-scale changes resulting from an increase in sea temperature due to climate change (Evans and Bjørge, 2013). Changes in sea temperatures may result in regional shifts in fish to deeper and colder waters, thus affecting their availability and distribution as prey for marine mammals (BEIS, 2022). Species with relatively narrow habitat preference such as shelf sea species (e.g. harbour porpoise and minke whale) may be particularly vulnerable to prey range-shifts (Evans and Bjørge, 2013). The baseline and future baseline for several prey species is further described in **Chapter 20: Fish and Shellfish Ecology**.

75. Climate change may also impact seal haul-out sites that are important for breeding. Sea level rise and associated wave surges could affect the availability of haul-out sites for seals and increased storm frequency and associated conditions could result in increased pup and calf mortality (Prime 1985; Gazo *et al*., 2000; Lea *et al*., 2009)

76. Studies have highlighted that during construction there may be a reduction in marine mammal use of the offshore development area (e.g. Skeate *et al.,* 2012; Dahne *et al,* 2013;). Although, the avoidance response from impact piling may reduce over time (Graham *et al.,* 2019), and once constructed, the offshore wind farm structures may provide increased foraging opportunities and shelter (Russell *et al.,* 2014).

77. Due to the complexity of marine mammal population drivers, and the inherent interactions, it is not possible to predict accurately how the distribution and abundance of these species may change in the future with or without the development of the proposed Project. In general, there are too few data points to be able to confidently conclude trends with sufficient power to detect change.

21.6 Underwater Noise Modelling Approach

78. Sound is used by marine mammals for key life purposes e.g., communication, foraging, navigation, and predator prey interactions (e.g., Tougaard *et al.,* 2015). Anthropogenic noise input into the marine environment can have a range of impacts for marine mammals. If anthropogenic noise is sufficiently loud, it can result in injury or mortality (Robinson *et al.,* 2022; **Appendix 21C: Marine Mammal Underwater Noise Assessment**). Lower levels of noise can result in animals being disturbed / displaced or the masking of important acoustic signals, with the potential to impact their health and fitness (NRC, 2003; **Appendix 21C: Marine Mammal Underwater Noise Assessment**).

79. The noise modelling methodology is detailed in **Appendix 21B: Marine Mammal Underwater Noise Modelling** prepared by Award Environmental Consultants Ltd, and in **Appendix 21C: Marine Mammal Underwater Noise Assessment**; a summary is presented here.

80. Modelling of underwater sound is an established discipline which has been undertaken for several decades and has its origins in military sonar applications (Farcas *et al.,* 2016). There are many modelling approaches that have been developed over the years. However, there is not one single recommended approach because of the requirement to tailor it's suitability to the frequency characteristics being modelled, and the environmental considerations (e.g., water depth, salinity) (Farcas *et al.,* 2016). For environmental assessments, modelling is

usually conducted with limited environmental data, and without field measurements to enable calibration of the model used. The aim of the model is to predict the amount of noise a noise-generating activity will produce in the surrounding area. Essentially, the model predicts the loss of intensity of the noise as it propagates from a source through the environment where it is received by a receptor.

81. There are several propagation models based on mathematical concepts that describe how sound moves through the environment. The modelling presented in **Appendix 21B: Marine Mammal Underwater Noise Modelling** used a combination of RAM and BELLHOP acoustic models. Both models are established and have been used extensively since the early 1990s. The two models are used in combination to best represent the full range of frequencies likely to be emitted from the noise generating activities under consideration for the proposed Project. RAM is based on a parabolic equation and is best suited for shallow water propagation and for low frequencies. BELLHOP is based on Ray theory and is most applicable in shallow water for higher frequencies. The models used require input data to describe the local oceanographic conditions, e.g., water depth, temperature, salinity, as these have influence over the sound speed in the marine environment.

82. The source level of the noise generating activity is the starting point for any noise model. This represents the apparent strength of the noise source. This cannot be measured and so is usually either inferred by back calculating the noise at source using a set of far-field noise levels, or for impact piling, by using a numerical model that converts the hammer energy used into underwater acoustic energy. The modelling conducted for the proposed Project has used proxy source levels for all activities obtained from similar examples in the literature (see **Appendix 21B: Marine Mammal Underwater Noise Modelling**). The proxy characteristics have included both noise 'volume' and the frequency spectrum which details the typical frequency content for all noise generating activities.

83. There are several metrics and terms used to measure and assess the impact of underwater noise in the marine environment. These are defined in the **Acronym and Abbreviation** table above, as well as in **Appendix 21B: Marine Mammal Underwater Noise Modelling**; however, to aid the reader, the key metrics and terminology used and referred to in this chapter are described below.

84. Sound levels are detailed in terms of Sound Pressure Level (SPL) and Sound Energy Level (SEL) and in units of decibel (dB). The dB is a ratio unit, therefore the 're 1µPa' details the reference unit in terms of Pascals (pressure). Where a source level is referenced '@1m' is included to indicate the apparent level at source. There are numerous acoustic processing methods to derive underwater noise metrics. Commonly subscript are used with both SPL and SEL, to detail more information on the noise metrics themselves. Peak is used to indicate the maximum sound pressure level. RMS stands for root mean square, and this is an averaged level of noise over a defined period. SEL_{cum} describes the accumulated noise level over a maximum period of 24 hours. More detailed information / explanation is provided in the underwater noise modelling report (**Appendix 21B: Marine Mammal Underwater Noise Modelling**) and the underwater noise assessment (**Appendix 21C: Marine Mammal Underwater Noise Assessment**).

85. Representative source levels were used (**Table 21-13**) for each of the noise generating activities assessed in this Environmental Assessment.

Table 21-13. Acoustic source levels used in noise modelling for key activities

Phase	Noise generating activity	Acoustic source level (SPLpeak; dB re re 1µPa @1m)
Pre-installation geophysical survey	Multi-beam echo sounder (MBES)	221
	Side scan sonar (SSS)	226
	Sub-bottom profiler (SBP)	238
	Ultra-short baseline (USBL) positioning sonar	207
UXO clearance	High order detonation	284.9 - 296.2
	Low order deflagration	266.7 - 276.7
Vessel movements	Cable-laying	197
	Project vessel (large)	180
	Project vessel (medium)	170
Cable installation	Jet trenching	181
	Backhoe dredging	165
	Suction dredging	186
	Rock emplacement	172
Turbine construction and installation	Impact piling for a 3 m diameter pile	234.8
	Drilling	170.1
Turbine operation	Wind turbine operational	167.2

86. Key assumptions used within the modelling approach are detailed where relevant within each noise generating activity assessment (**Section 21.9**).

87. Propagation modelling was carried out using a total of 36 transects radiating from the source modelling site, using the speed of sound profiles for February and August. The assessment in **Appendix 21B: Marine Mammal Underwater Noise Modelling** concluded that sound would propagate furthest in February, with the shortest distance in August due to the oceanographic conditions in these months. The modelling approach was therefore to present the maximum and minimum conditions and in doing so would 'bracket' propagation conditions for any intermediate month.

88. Potential effects from underwater noise generated by pre-construction and construction activities are assessed using agreed auditory injury and disturbance threshold criteria (Southall *et al.,* 2019; NRW, 2023a; **Appendix 21C: Marine Mammal Underwater Noise Assessment**). In the UK, a permanent threshold shift in hearing ability (PTS-onset) is considered injury (JNCC, 2010b). PTS-onset is the level at which there is a risk of a permanent loss of hearing sensitivity; however, this does not equate to total deafness across the full range of hearing, but to a loss of hearing ability within a certain range of frequencies resulting from the volume and frequency content of the source (Booth and Heinis, 2019).

89. Disturbance is assessed using acoustic thresholds thought to reflect the noise level at which a behavioural response is observed and are based on the best available information. Behavioural responses are varied and are highly context specific. Factors such as the individual's prior experience to the noise source, the sex and age of the individual, and the activity of the individual at that time (e.g., foraging, travelling) can all influence the degree of response. The thresholds are used to identify levels at which a behavioural response may be observed and are assumed to result in a biological meaningful effect such that there could be

an impact to the individual's health and fitness. Due to the highly varied nature of disturbance, there is no one disturbance threshold. This assessment has therefore used multiple thresholds relevant to each noise type as recommended in NRW (2023b).

90. Marine mammal hearing ability is classified in Functional Hearing Groups (**Table 21-14;** NMFS, 2018; Southall *et al.,* 2019). Any noise source emitting sound within these frequencies has the potential to impact marine mammals. The **Appendix 21C: Marine Mammal Underwater Noise Assessment** assessed noise impact to marine mammals using the injury thresholds and nomenclature as detailed in Southall *et al.* (2019).

Table 21-14. Marine mammal hearing groups (NMFS, 2018)

Functional hearing group		Example species	Generalised Hearing Range	Range of best hearing
Southall *et al.* (2019)	NMFS (2018)			
Low-frequency cetaceans (LF)	Low Frequency cetaceans (LF)	Minke whale	7 Hz to 35 kHz	200 Hz to 19 kHz
High-frequency cetaceans (HF)	Mid- frequency cetaceans (MF)	Bottlenose dolphin; Common dolphin	150 Hz to 160 kHz	8.8 kHz to 110 kHz
Very high-frequency cetaceans (VHF)	High-frequency cetaceans (HF)	Harbour porpoise	275 Hz to 160 kHz	12 kHz to 140 kHz
Phocid carnivores in water (PCW)	Phocid pinnipeds (PW) underwater	Harbour seal; Grey seal	50 Hz to 86 kHz	1.9 kHz to 140 kHz

91. Injury through Permanent Threshold Shift (PTS)-onset is assessed using the dual criteria of 'instantaneous' PTS-onset (SPL_{peak}) and 'cumulative' PTS-onset ($SEL_{cum;}$ weighted and unweighted), as outlined in **Appendix 21C: Marine Mammal Underwater Noise Assessment**. The cumulative PTS-onset is a metric representing noise accumulated during a length of time (up to a max of 24 hours) and modelled using a static and fleeing animal approach (**Appendix 21B: Marine Mammal Underwater Noise Modelling; Appendix 21C: Marine Mammal Underwater Noise Assessment).**

92. The assessment of disturbance has used thresholds relevant for each of the noise generating activities informed by NRW guidance (NRW, 2023**; Table 21-15**).

Table 21-15. Summary of disturbance thresholds used in quantitative assessment

Disturbance threshold	Activity
NMFS (2005) – Level B 120 dB re 1µPa (rms)	Other construction activities Vessel activity Turbine operational noise
NMFS (2005) – Level B 160 dB re 1µPa (rms)	Pre-installation geophysical surveys Impact piling
JNCC (2020b) – Effective Deterrent Range (EDR) 5 km	Pre-installation geophysical surveys
Southall *et al.* (2019) – Temporary Threshold Shift (TTS)	Unexploded Ordnance Clearance
NRW (2023) Fixed – 143 dB re 1µPa^2.s	Impact piling (harbour porpoise)
Graham *et al.* (2017), Whyte *et al.* (2020) Dose response curves*	Impact piling (all marine mammals)

** Dose response curves apply the probability of a response, at certain noise levels, and thus the proportion of animals that experience a behavioural response (Sinclair et al., 2023).*

21.7 Scope of the Assessment

93. An EIA Scoping Report for the proposed Project was submitted to NRW MLT in April 2022. The Scoping Report was also shared with relevant consultees, inviting comment on the proposed approach adopted by the Applicant. A Scoping Opinion was provided to the Applicant by NRW MLT in July 2022. Based on the Scoping Opinion received, and further consultation undertaken, potential impacts on marine mammals scoped into the assessment are listed below in **Table 21-16**. Impacts scoped out of the assessment are listed in **Table 21-17**.

94. As set out in **Section 21.4.1**, this assessment considers the design parameters of the proposed Project which are predicted to result in the greatest environmental impact, known as the 'realistic worst-case scenario'. The realistic worst-case scenario represents, for any given receptor and potential impact on that receptor, various options in the Design Envelope that would result in the greatest potential for change to the receptor in question. Given that the realistic worst-case scenario is based on the design option (or combination of options) that represents the greatest potential for change, confidence can be held that the development of any alternative options within the design parameters will give rise to effects no greater or worse than those included in this impact assessment.

95. Accordingly, the design scenarios identified in **Table 21-16** have been selected as those having the potential to result in the greatest effect on marine mammals. These scenarios have been selected from the details provided in **Chapter 04: Description of the Project**.

96. Where the realistic worst-case scenario is defined by the underwater noise impacts, the acoustic characteristics of the noise sources relevant for the assessment are detailed in **Table 21-16**.

Table 21-16. Realistic worst-case parameters considered for the quantitative assessment

Potential Impact	Realistic worst-case scenario	Justification
Construction		
Effects of underwater noise (permanent Threshold Shift (PTS-onset) and disturbance) – geophysical surveys	Indicative acoustic characteristics used to assess level of impact were: *Sound pressure levels (dB re 1µPa):* • Multi-Beam Echo Sounder (MBES) - 221 SPL_{peak} • Side-Scan Sonar (SSS) – 226 SPL_{peak} • Sub-bottom Profiling (SBP) – 238 SPL_{peak} • Ultra-Short Baseline (USBL) – 207 SPL_{peak} Likely worst case in terms of survey duration of activity is 20 days for the Offshore Export Cable Corridor, and 10 days for the array area.	There is potential for PTS-onset (injury) and disturbance from geophysical surveys, dependant on the equipment used. The specific equipment which will be used during geophysical surveys is currently unknown. Therefore, indicative sound pressure levels and operating frequencies have been collated from specification sheets for equipment which is comparable to what is anticipated to be used, as detailed in **Appendix 21B: Marine Mammal Underwater Noise Modelling** and **Appendix 21C: Marine Mammal Underwater Noise Assessment**.
Effects of underwater noise (PTS-onset and disturbance) – UXO	The presence of UXOs that will require clearance is not known at the time of writing. Therefore, it has been assumed for the purposes of assessment that there would be one clearance event for the proposed Project based on Erebus assessment (Barham and Mason, 2021). *Low-order (realistic worst-case):* • Up to 2 kg Net Explosive Quantity (NEQ) *High-order (unrealistic worst-case):* • Up to 794 kg NEQ	Potential for PTS-onset (injury) and disturbance. Predicted worst-case for UXO is based on the Erebus offshore wind farm underwater noise impact study (Barham and Mason, 2021), which is near the proposed Project and has a partially overlapping offshore cable corridor. A detailed UXO survey will be completed prior to construction. In line with advice from BEIS (2022), low noise alternatives to high-order clearance, will be prioritised and implemented where possible. Therefore, the realistic worst-case scenario modelled, is UXO clearance via low-order methods. High-order clearance up to a 794 kg device has also been modelled, assessed and presented although this is an unrealistic worst-case scenario.

Potential Impact	Realistic worst-case scenario	Justification
	A range of charge weights up to these amounts have been modelled and are presented in **Appendix 21B: Marine Mammal Underwater Noise Modelling**. The Applicant is committed to the utilisation of low-order clearance methodology.	
Effects of underwater noise (PTS-onset and disturbance) – Piling	*Driven Pile Anchors:* • Eight driven pile anchors per WTG (up to 80 piles) • Maximum pile diameter 3m • Maximum hammer energy 800 kJ • Piling in one location at a time ;(no concurrent piling) • Approximately four hours to drive one pile to the design the maximum penetration depth of 9-32m • Max 10 piling days within 20 months of offshore installation *Estimated source levels (***Appendix 21B: Marine Mammal Underwater Noise Modelling***):* • SPL_{peak} - 235 dB re 1 µPa @ 1 m • $SEL_{single\ strike}$ - 218 dB re 1 µPa^2.sec @ 1 m	Impact piling (if utilised) represents the worst-case scenario for assessment of both PTS (injury) and disturbance. Other types of anchors within the PDE (i.e. drag embedment anchors, suction bucket anchors or drilled and grouted piles) are expected to result in reduced impact to marine mammals than driven pile anchors.
Effects of underwater noise (disturbance) – Other construction activities (including route clearance, cable laying and seabed preparation)	*Source levels (SPL_{peak} dB re 1 µPa):* • Cable laying – 197 dB • Jet trenching – 181 dB • Backhoe dredging – 165 dB • Suction dredging – 186 dB	Indicative source levels for the proposed construction activities have been collated from the literature (see **Appendix 21B: Marine Mammal Underwater Noise Modelling** and **Appendix 21C Marine Mammal Underwater Noise Assessment**).

Potential Impact	Realistic worst-case scenario	Justification
	• Rock placement – 172 dB Overall offshore construction duration 20 months	
Effects of underwater noise – vessel disturbance	*Estimated source levels SPL_{peak} dB re 1 µPa:* • Large vessel (>100m)- 180 dB • Small vessel(<100m) - 170 dB • Maximum number of vessels working offshore at any one time estimated at 12.	Indicative source levels for the proposed Project vessels have been collated from the literature, these represent the noise levels for vessels that are typically used for offshore wind construction. Indicative levels for large and small have been used to provide the noise envelope of potential vessel use (see **Appendix 21B: Marine Mammal Underwater Noise Modelling**).
Airborne sound and visual disturbance (pinnipeds only)	*Cable landfall:* • Horizontal Directional Drilling (HDD) up to 800 m offshore and 500 m onshore • Duration of HDD up to 64 weeks • Total duration of construction at landfall up to 136 weeks. *Construction vessels:* • Maximum number of vessels working offshore at any one time estimated at 12.	Construction activity at the cable landfall has the potential to result in disturbance to hauled-out seals, in addition to an increase in vessel traffic from construction vessels near seal haul-out sites Assessed in
Collision with Project vessels	Construction of up to 20 months. Up to 12 construction vessels on site simultaneously	Greatest number of simultaneous vessel activities and duration resulting in the maximum scenario considered for collision risk (**Chapter 25: Shipping and Navigation**)
Accidental pollution or contamination	As per 'Collision with Project Vessels'	The worst-case scenario for accidental release of pollutants would be accidental release of vessel fuel from large vessels.
Potential for indirect effects through impacts to prey species	Potential impacts which are applicable to fish and shellfish (which represents many marine mammal prey species) may have an indirect effect on marine mammals. Therefore, the assessment is based on the worst-case parameters presented in **Chapter 20: Fish and Shellfish Ecology**.	

Potential Impact	Realistic worst-case scenario	Justification
Operation and maintenance		
Effects of underwater noise (disturbance) – WTG operational noise	*Estimated WTG operational noise source levels:* • SPL_{peak} – 167.2 dB re 1 µPa @ 1 m • SEL_{rms} - 161 dB re 1 µPa @ 1 m	There may be potential for disturbance from the noise generated by the turbines in operation. Indicative underwater noise source levels for operational WTGs have been estimated from the best available information in the literature, as presented in **Appendix 21B: Marine Mammal Underwater Noise Modelling**).
Effects of underwater noise (disturbance) – maintenance activities – vessel noise	Considered to be analogous with or less than those in the construction stage.	
Barrier effects from mooring lines and cables between platform and anchor	• 10 WTGs (minimum spacing 1140m) • 49,900m^2 array area • maximum 8 mooring lines per turbine • 17.6km total inter-array cables length	The maximum scale of the mooring lines and inter-array cables represents the maximum potential for barrier effects, entanglement and collision. There is no potential for barrier effects or entanglement with the offshore export cable, as this will be buried or laid along the seabed and subject to cable protection (e.g. rock placement).
Entanglement with mooring lines and cables		
Effects of electromagnetic field (EMF) emissions	EMF emissions will occur for the operational lifetime of the proposed Project. • Up to two electricity export cables transmitting electricity from the wind turbines to the shore over a distance of 49 km. • The export cables will be within separate trenches that are 10m apart and with a target depth of 1.2m. • Inter-array cables with a total length of 17.6km linking the turbines	The highest EMF emissions are expected to occur where the cable crossings are located. However, elevated EMF emissions are expected to be highly localised and cable protection will be used, which will mitigate effects. Dynamic cabling are exposed in the water column; however, it is anticipated that EMF effects are reduced to negligible at a distance of 2m from the cable (**Chapter 20: Fish and Shellfish**).
Airborne sound and visual disturbance (pinnipeds only)	*Maintenance vessels:* • As per 'Collision with Project vessels'	Maintenance activities may result in increased vessel activity near seal haul-out sites.

Potential Impact	Realistic worst-case scenario	Justification
Collision with Project vessels	Construction of up to 20 months. Up to 12 construction vessels on site simultaneously	Greatest number of simultaneous vessel activities and duration resulting in the maximum scenario considered for collision risk (**Chapter 25: Shipping and Navigation**)
Accidental pollution or contamination	As per 'Collision with Project Vessels'.	The worst-case scenario for accidental release of pollutants would be accidental release of vessel fuel from large vessels.
Potential for indirect effects through impacts to prey species	Potential impacts which are applicable to fish and shellfish (which represents many marine mammals prey species) may have an indirect effect on marine mammals. Therefore, the assessment is based on the worst-case parameters presented in **Chapter 20: Fish and Shellfish Ecology**.	
Decommissioning		
• The impacts during the decommissioning of the proposed Project are anticipated to be analogous with, or likely less than, those of the construction phase as decommissioning of proposed project infrastructure will be similar to construction but in reverse. The decommissioning phase is expected to be complete within 12 months. All infrastructure is assumed as a worst case scenario to be removed. A decommissioning plan will be required in consultation with NRW.		

21.7.1 Impacts Scoped Out of Assessment

97. All identified impact pathways have been scoped into the assessment with the exception of temporary increase in suspended sediment (as agreed in the Scoping response (NRW, 2022b)). This potential impact is outlined below, together with the justification for scoping them out, in **Table 21-17**.

Table 21-17. Potential impacts scoped out the assessment for marine mammals

Potential impact	Justification
Construction; Operation and Maintenance; Decommissioning	
Temporary increase in suspended sediment concentrations and sediment deposition leading to contaminant mobilisation	Suspended sediment is expected to be minimal and confined to the lower reaches of the water column, due to the depth at which works will occur (**Chapter 18: Marine Water and Sediment Quality**). Furthermore, marine mammals are frequent inhabitants of turbid environments with low visibility, and studies have indicated that they do not typically experience severe impact from increased suspended sediment concentrations (Marubini *et al.,* 2009; Hastie *et al.,* 2016). For most marine mammals, hearing rather than sight is their primary sensory modality. Further, seals can detect water movement with their vibrissae Murphy *et al.,* 2017), while odontocetes (toothed whales) primarily use echolocation to navigate and forage Madsen *et al.,* 2023). Indirect impacts to marine mammals such as effects on prey species are not scoped out and have been included in Section 21.8.1.

21.7.2 Assessment Assumptions and Limitations

98. Baseline data are presented in **Appendix 21A: Marine Mammal and Megafauna Baseline**. The information used to inform this study followed standard practice, and was taken from a range of available sources, all at different scales, locations, and methodologies. Some sources pooled data from different study methodologies to obtain estimates of densities and abundances over a wide area. Different methodologies are not necessarily directly comparable, and estimates are usually based on low sample sizes. Therefore, information is extrapolated using several assumptions, including the representativeness of the sample data. The source data used for the baseline characterisation, was obtained from a combination of aerial (visual and digital), vessel and land-based studies, and in addition for seals, haul-out surveys, and telemetry studies.

99. This assessment has used density estimates considered to be precautionary, but also representative for the proposed Project location, and the area over which impacts have been predicted.

100. There are a range of uncertainties relating to the underwater noise modelling and the subsequent impact assessment for underwater noise on marine mammal receptors. These include the uncertainty in predicting received levels of underwater noise by marine mammals, the response of animals to underwater noise, and the potential population-level consequences of impacts as a consequence of anthropogenic underwater noise. Therefore, the impact assessment has taken a highly precautionary approach which is likely to over-

estimate the potential underwater noise impacts on marine mammals. Details of the limitations to underwater noise assessment, and the assumptions made when conducting the quantitative underwater noise impact assessment are presented in **Appendix 21C: Marine Mammal Underwater Noise Assessment**.

101. In summary, the source level chosen although thought to be representative and based on available literature, is likely to be an overestimate. The modelling method used for impact piling does not account for the reducing noise levels as pin piles are installed (due to reducing surface area in the water column – see **Section 21.9.1**). UXO clearance is modelled based on an unhindered propagation model, and so does not account for any noise attenuation due to the UXO being situated on or in the seabed. Impact thresholds used to assess auditory injury, are based on an impulsive noise threshold (which represent the greater risk of injury) for the entire propagation range, however as a noise signal propagates, the impulsive characteristic transitions to non-impulsive, resulting in a less injurious noise characteristic. Cumulative injury is assessed with no accommodation for auditory recovery between pulses, and without accounting for the transition of noise from impulsive to non-impulsive. Disturbance thresholds are predominantly precautionary. There are a range of thresholds used depending on the scenario being assessed Some of which are close to the noise level already existing in the marine environment, so may reflect audibility rather than a level at which a disturbance response may occur.

102. The potential operational underwater noise, barrier effects and entanglement risk associated with Floating offshore wind (FLOW) are currently not well understood, given that this is a relatively novel technology. Therefore, these assessments have been conducted using the best available literature and resources related to subsea mooring lines and cables in combination with knowledge from post-construction monitoring for Hywind offshore wind farm, and from a range of fixed-turbine developments. Although it should be acknowledged that this assessment can only consider very limited existing evidence and empirical data specific to FLOW.

21.8 Embedded Mitigation, Management Plans and Best Practice

103. As part of the proposed Project design process, a number of designed-in measures have been proposed to reduce the potential for impacts on marine mammals (see **Table 21-18**). The design of the proposed Project therefore includes embedded mitigation measures and reference to various management plans that will be produced as conditions of consent, and which will further mitigate potential impacts. This approach has been employed in order to demonstrate commitment to mitigation measures by including them in the design of the proposed Project and as such, these measures have been considered within the assessment presented in **Section 21.9** below.

Table 21-18. Mitigation measures, management plans and best practice adopted as part of the proposed Project

Embedded Mitigation Measures, Management Plans and Best Practice	Justification
Design Embedded Measures	
Project design	Should impact piling be required, this will include soft-start and ramp up procedures in line with guidance (JNCC, 2010c). The Applicant has committed to Piling only at one location at a time to reduce potential impacts to marine mammal receptors

Embedded Mitigation Measures, Management Plans and Best Practice	Justification
Invasive non-native species (INNS)	All Project vessels shall adhere to the International Convention for the Control and Management of Ships' Ballast Water and Sediments with the aim of preventing the spread of marine invasive non-native species (IMO, 2017)
Biofouling guidelines	All Project vessels shall adhere to the International Maritime Organisation (IMO) Guidelines for the control and management of ships' biofouling to minimise the transfer of invasive aquatic species (IMO, 2011)
Management Plans	
Construction Environmental Management Plan (CEMP)	A CEMP is the overarching environmental management plan and will be prepared to address the specific requirements of the Conditions attached to the Marine Licence. This will cover the management measures to prevent adverse impacts, including pollution prevention (PEMP), marine invasive non-native species (INNS).
Project Environment Management Plan (PEMP)	A PEMP is proposed to ensure that the potential for any contaminant release is strictly controlled. All Project vessels shall comply with the International Regulations for Preventing Collisions at Sea (IMO, 1972) and regulations relating to International Convention for the Prevention of Pollution from Ships (the MARPOL Convention 73/78) (IMO,2021) with the aim of preventing and minimising pollution from ships. All vessels shall have a contingency plan for marine oil pollution (Shipboard Oil Pollution Emergency Plan). A PEMP will be secured as a condition of the Marine Licence.
Vessel Management Plan	Best practice vessel handling protocols will be adopted to minimise the potential for any impact on marine wildlife, including marine mammal receptors. For example, the Codes of Conduct provided by the WiSe Scheme, Scottish Marine Wildlife Watching Code and / or Best Practice for Watching Marine Wildlife will be adopted, as to be discussed and agreed with NRW (A) and JNCC.
Marine Mammal Mitigation Protocol (MMMP) (Piling specific)	In consultation with NRW (A) and JNCC, a MMMP will be developed and implemented and secured as a condition of the Marine Licence (A draft MMMP is provided in **Appendix 4A: Outline Construction Environmental Management Plan**). As a minimum, this will adhere to JNCC (2010c) Statutory nature conservation agency protocol for minimising the risk of injury to marine mammals from piling noise.
Marine Mammal Mitigation Protocol (MMMP) (UXO clearance specific)	In consultation with NRW(A) and JNCC, a MMMP will be developed and subject to a separate Licence application should UXO clearance be required. As a minimum this will adhere to JNCC (2010b) guidelines for minimising the risk of disturbance and injury to marine mammals whilst using explosives, and the BEIS *Marine Environment: unexploded ordnance clearance joint interim position statement* (2021) (A draft MMMP is provided in **Appendix 4A**: **Outline Construction Environmental Management Plan).**

Embedded Mitigation Measures, Management Plans and Best Practice	Justification
Decommissioning Environmental Management Plan	A decommissioning environmental management plan will be agreed with NRW at the relevant time prior to the start of offshore decommissioning. Decommissioning for the proposed Project is anticipated to be complete within 12 months. It is anticipated that all infrastructure will be removed as a worst case scenario

21.9 Assessment of Environmental Effects

104. The impacts and effects associated with the construction, operation and maintenance and decommissioning of the proposed Project are outlined in the sections below. The assessments take into account the embedded mitigation measures described in **Section 21.8**.

21.9.1 Construction Effects

105. Construction effects assessed include those resulting from;

- Underwater noise (geophysical surveys, UXO clearance, impact piling, vessel activity and various 'other' construction activities involved with seabed preparation and cable laying),
- Airborne sound and visual disturbance (pinnipeds only),
- Collision with Project vessels;
- Accidental pollution or contamination; and
- Potential for indirect effects through impacts to prey species.

Underwater Noise Effects

106. The risk to marine mammals from underwater noise related to the proposed Project has been assessed in **Appendix 21C: Marine Mammal Underwater Noise Assessment** for harbour porpoise, common dolphin, bottlenose dolphin, minke whale and grey seal. This Chapter section provides a summary of the assessment in **Appendix 21C** together with the assessment of significance under EIA Regulations.

107. The following activities relating to underwater noise have been identified as having the potential to result in auditory injury and / or disturbance to marine mammals and were taken forward for quantitative underwater noise assessment (**Appendix 21B: Marine Mammal Underwater Noise Modelling** and **Appendix 21C: Marine Mammal Underwater Noise Assessment**):

- Pre-installation geophysical surveys;
- Unexploded Ordnance (UXO);
- Impact piling;
- Other construction activities (drilling, dredging, cable laying, jetting, rock placement); and
- Disturbance from vessels.

Pre-installation geophysical Surveys

108. Geophysical surveys use sound to map the seabed characteristics prior to construction to inform installation requirement. There are several noise generating survey options typically employed: Multibeam Echosounders (MBES), Side Scan Sonar (SSS), Sub Bottom Profiling (SBP)

and Ultra-short Baseline (USBL) (see **Appendix 21C: Marine Mammal Underwater Noise Assessment** for more detail).

Injury (PTS-onset) from Pre-Construction Geophysical Surveys

109. Although the indicative source levels for MBES and SSS exceed injury threshold criteria, the two systems typically use an operating frequency that is above the generalised hearing range of all marine mammals considered (**Table 21-19**).

Table 21-19. Comparison of the typical acoustic characteristics from the example equipment and the overlap with marine mammal functional hearing groups (Appendix 21C)

Equipment	Operating frequency (kHz)	Sound Pressure Level (dB re 1µPa)	Marine Mammal Functional Hearing Group (P – PTS / D – Disturbance)			
			LF	HF	VHF	PCW
MBES	170 - 450	221 SPL_{peak}	Above all hearing ranges			
SSS	300 - 600	226 SPL_{peak}	Above all hearing ranges			
SBP	0.5 – 12	238 SPL_{peak}	P / D	P / D	P / D	P / D
USBL	21 - 31	207 SPL_{peak}	D	D	D	D

110. Additionally, high frequency noise is rapidly attenuated in the shallow water environment and therefore, the two systems present minimal injury risk to marine mammals (**Appendix 21C: Marine Mammal Underwater Noise Assessment**). Further, JNCC (2010a) EPS guidance states that "*MBES and SSS survey types are generally of a short-term nature, and therefore present a negligible risk of injury*".

111. Noise modelling has indicated a theoretical risk of injury to marine mammals from the SBP and USBL systems only. For the low frequency (LF) functional hearing group (e.g. minke whale), the predicted injury ranges are 82m and 100m for SBP and USBL respectively, and 10 m for all other functional hearing groups. All predicted ranges are highly localised. The temporal extent is likely to be of very short term (within 1 year or less) and therefore the magnitude has been assessed as **negligible.**

112. The sensitivity of marine mammals to any hearing damage is assessed as **medium**. Although by definition PTS-onset is permanent, and therefore there is no ability to recover, should an individual be exposed to noise at levels that could result in hearing damage, it would be within a relatively narrow frequency band, and would not mean the individual would become deaf as a result. Therefore, PTS-onset from exposure to geophysical surveys is unlikely to result in effects such that individual reproductive or survival rates are affected (Booth and Heinis, 2018). Medium has been selected for the sensitivity score as a precautionary measure, as auditory injury is unlikely to occur, and only technically possible based on the example equipment for SBP and USBL.

113. When combined, these scores result in a **negligible** conclusion which is **not significant** in EIA terms. Further, any potential risk of auditory injury can be fully mitigated using JNCC standard mitigation protocols (JNCC, 2017) if required, see MMMP (**Appendix 4A: Outline Construction Environmental Management Plan**).

Disturbance from Pre-Construction Geophysical Surveys

114. Based on the typical acoustic characteristics identified, the assessment suggests that there may be a disturbance risk from the SBP and the USBL only. For both systems a precautionary effective deterrent radius (EDR) of 5 km has been used to predict a possible disturbance range.

This suggests that at any one time, an area of 78.5 km^2 may be ensonified to the level that a disturbance response may be observed in all assessed marine mammals. The maximum number of individuals disturbed could be up to 66 common dolphins (**Table 21-20; Appendix 21C: Marine Mammal Underwater Noise Assessment**) which is 0.064% of the reference population.

Table 21-20. Number of animals predicted to be disturbed by geophysical surveys at any one time

Species	Density (n/km^2)	Area impacted (km^2)	Number impacted	% MU reference population
Grey seal	0.011	78.5	<1	0.001
Harbour porpoise	0.137	78.5	11	0.017
Common dolphin	0.841	78.5	66	0.064
Bottlenose dolphin	0.4195	78.5	33	0.301
Minke whale	0.011	78.5	<1	0.004

115. Short term disturbance from a two-dimensional seismic survey was assessed in Thompson *et al.* (2013), based on acoustic monitoring of harbour porpoise responses during a survey in the Moray Firth, Scotland. The authors concluded that no long-term displacement effects were evident. It is therefore unlikely that there will be any deleterious effects from short-term disturbance as a result of pre-construction geophysical surveys.

116. The magnitude for disturbance for all marine mammals has therefore been assessed as **negligible** because any impact is unlikely to occur, or if it does, it is of low intensity, and of short term with rapid recovery**.**

117. The sensitivity of marine mammals is **low**, as individuals are thought to be able to adapt behaviour during the activity, and once ceased, will be able to return to their previous behavioural state (Thompson *et al.,* 2013).

118. Therefore, the significance of disturbance from geophysical surveys is concluded to be **negligible**, which is **not significant** in EIA terms. The significance of effect for injury and disturbance risk is summarised in **Table 21-21.**

Table 21-21. Summary of significance conclusion for pre-construction geophysical activity

	Magnitude	Sensitivity	Consequence	Impact significance
PTS-onset risk from pre-construction geophysical survey				
All marine mammals	Negligible	medium	Negligible	**Not significant**
Disturbance risk from pre-construction geophysical surveys				
All marine mammals	Negligible	Low	Negligible	**Not Significant**

Unexploded Ordnance (UXO)

119. There is potential for unexploded ordnance (UXO) to be found within the development area and / or the cable corridor[6] An underwater explosion generates a very short (seconds), high amplitude broadband pulse of high intensity impulsive noise; therefore, depending on the size, the explosion can make a significant contribution to the soundscape over a wide area, at levels that may present a risk to marine mammals (Robinson *et al.,* 2022).

[6] Ordtek | UXO Specialists | Mine Map: Offshore UXO Contamination.

120. There is limited information at the time of writing as to the presence, number, or type of UXOs that may be present in the proposed Project area. Therefore, this assessment has modelled the potential impact using the same range of charge weights used in the Erebus offshore wind farm underwater noise impact study (Barham and Mason, 2021; **Appendix 21C: Marine Mammal Underwater Noise Assessment**). The Applicant has committed to a pre-construction UXO survey, and to provide an updated risk assessment and an MMMP tailored to the size/number of any UXOs found. This will accompany the Marine Licence and EPS licence applications required prior to clearance activities commencing.

121. Although there are several low-order clearance techniques that are now becoming commercially available, this assessment of clearance follows the *Marine environment: unexploded ordnance clearance joint interim position statement* (BEIS, 2022). Therefore, the potential impacts for both the unrealistic worst-case (high-order) and the realistic worst-case (low-order) have been presented (**Appendix 21C: Marine Mammal Underwater Noise Assessment**).

122. Further, the assessment is precautionary because the modelling methodology for UXO clearance is based on an explosive source located in the mid-water column (as detailed in **Appendix 21B: Marine Mammal Underwater Noise Modelling**). In reality, UXOs are on, or in the seafloor which will provide noise attenuation (Robinson *et al.,* 2022; **Appendix 21C: Marine Mammal Underwater Noise Assessment**). However, this method is standard practice and is the only currently available modelling approach.

Injury (PTS-onset) from UXO Clearance Activities

123. Noise modelling indicates that unrealistic worst-case risk for PTS-onset (injury) for marine mammals in the high-order scenario can occur up to 19.25 km for the VHF functional hearing group (harbour porpoise), and 10.75 km for the LF group (minke whale) (based on charge weight of 794 kg, see **Appendix 21C: Marine Mammal Underwater Noise Assessment**). In the low-order scenario (charge weight 2 kg) the impact range reduces to 2.6 km for VHF cetaceans, and 579 m for the LF cetacean functional hearing group.

124. Low-order detonation methods will be the preferred method employed. However, for the high-order scenario, as the unrealistic worst-case, the percentage of MU reference population at risk of PTS-onset for common dolphin, bottlenose dolphin and grey seal is negligible (less than 0.00% of the MU reference population). The percentage of the reference population at risk for harbour porpoise (using unweighted thresholds) and minke whale (using the weighted thresholds given by Southall *et al.,* 2019; **Table 21-22**) is less than 1% (0.225% and 0.02% respectively).

125. In comparison, the low-order clearance scenario (**Table 21-23**), the percentage of the reference population for all species at risk of PTS-onset is either zero or below 0.01% (**Appendix 21C: Marine Mammal Underwater Noise Assessment**).

Table 21-22. High-order detonation – summary of predicted number of individuals within PTS-onset area (km^2) (Injury) based on impulsive on SPL_{peak} thresholds and SELs weighted thresholds given by Southall et al., (2019),

Species	Density (n/km^2)	Metric	Area impacted (km^2)	Number impacted	% MU reference population
Harbour porpoise	0.137	SPL_{peak}	1,164	160	0.255
		SEL_{ss}	0.01	<1	0.000
	0.011	SPL_{peak}	28.27	<1	0.000

Species	Density (n/km²)	Metric	Area impacted (km²)	Number impacted	% MU reference population
Minke whale		SEL_{ss}	363.05	4	0.020
Common dolphin	0.841	SPL_{peak}	2.63	2	0.000
		SEL_{ss}	0.29	0	0.000
Bottlenose dolphin	0.4195	SPL_{peak}	2.63	1	0.000
		SEL_{ss}	0.29	0	0.000
Grey seal	Grid cell specific (Carter *et al.,* 2022)0.011	SPL_{peak}	35.26	<1	0.000
		SEL_{ss}	10.18	<1	0.000

Table 21-23. Low-order detonation – summary of predicted number of individuals within PTS-onset area (km²) (Injury) based on impulsive on SPL_{peak} thresholds and SELs weighted thresholds given by Southall et al., (2019

Species	Density (n/km²)		Area impacted (km²)	Number impacted	% MU reference population
Harbour porpoise	0.137	SPL_{peak}	21.24	3	0.005
		SEL_{ss}	0	0	0
Minke whale	0.011	SPL_{peak}	0.53	<1	0.000
		SEL_{ss}	1.05	<1	
Common dolphin	0.841	SPL_{peak}	0.05	<1	0.000
		SEL_{ss}	0	0	0
Bottlenose dolphin	0.4195	SPL_{peak}	0.05	<1	0.000
		SEL_{ss}	0	0	0
Grey seal	Grid cell specific (Carter *et al.,* 2022) 0.011	SPL_{peak}	0.66	<1	0.000
		SEL_{ss}	0.03	<1	0.000

126. Although the area potentially impacted by a high-order clearance event is large (unrealistic worst-case) the magnitude of impact has been assessed as **negligible** due to the low percentage of the reference population predicted to be affected, and therefore not expected to affect the conservation status of any of the species.

127. The noise generated by underwater explosions contains higher energy at low frequencies (< 1 kHz) (von Benda-Beckmann *et al.,* 2015) which are in the main lower than the frequency range of optimal hearing for all functional hearing groups with the exception of the LF (minke whale) category (**Table 21-14**). Should PTS-onset occur and result in a reduction in hearing ability (at 1.5 octaves higher than centre frequency of noise exposure; Booth and Heinis, 2019) this is not considered to result in a deleterious effect on vital rates. However, any impairment to hearing ability would be permanent, therefore, the sensitivity of the hearing groups HF, VHF and PCW (seals) has been assessed as **medium.** Due to the lower frequency hearing ability of the LF hearing group, the group has precautionarily been assessed as **high** sensitivity.

128. The combination of magnitude and sensitivity for all HF, VHF and PCW functional hearing groups results in **negligible significance** and is therefore **not significant** in EIA terms.

129. The combination of magnitude and sensitivity for the LF functional hearing groups results in **minor significance** and is therefore **not significant** in EIA terms.

130. Although not significant under EIA Regulations, in both the high and low-order scenarios, there is an auditory injury risk to individual animals from UXO clearance activities. The risk has been assessed without the inclusion of mitigation methods (Management Plans Section 21.7); however, JNCC mitigation (JNCC, 2010b) will be deployed as noted above (see **Appendix 4A: Outline Construction Environmental Management Plan**) during any clearance activities as required to further minimise any injury risk to individuals.

Disturbance from UXO Clearance Activities

131. The disturbance risk from UXO clearance has been assessed using the TTS-onset threshold (Southall *et al*., 2019; **Appendix 21C: Marine Mammal Underwater Noise Assessment**). Although TTS-onset is not a disturbance metric the use of the TTS-onset is considered appropriate for UXO clearance disturbance assessment because the noise resulting from a clearance event is short lived in the environment, i.e. in the order of seconds (Robinson *et al*., 2022). Further, Southall *et al*. (2007) state that "*due to the transient nature of a single pulse, the most severe behavioural reactions will usually be temporary responses, such as a startle, rather than prolonged effects such as modified habitat utilization"* (see **Appendix 21C: Marine Mammal Underwater Noise Assessment** for more information).

132. TTS-onset ranges for the unrealistic worst-case scenario (high-order; using charge weight of 794 kg (NEQ)) was 37.5 km for VHF (harbour porpoise) and 155 km for LF (minke whale). These impact ranges relate to 605 harbour porpoises (0.96% of the reference population) and 614 minke whales, (3.05% of the reference population) (**Table 21-24**).

133. In comparison, for the low-order scenario (realistic worst-case; **Table 21-25**) impact ranges are reduced to 5.1 km for VHF (harbour porpoise) and 8.2 km for LF (minke whale) for the highest charge weight modelled (2 kg) which relate to 11 harbour porpoise and three minke whales, both representing a negligible percentage of the MU reference population.

Table 21-24. High-order detonation of the unrealistic worst case (charge weight 794kg) – summary of number of individuals within TTS-onset area (km^2) (Disturbance) based on impulsive on SPL_{peak} thresholds and SELss weighted thresholds given by Southall et al., (2019

Species	Density (n/km^2)		Area impacted (km^2)	Number impacted	% MU reference population
Harbour porpoise	0.137	SPL_{peak}	4417	605	0.968
		SEL_{ss}	58.09	8	0.013
Minke whale	0.011	SPL_{peak}	102.07	1	0.006
		SEL_{ss}	55,836.87	614	3.053
Common dolphin	0.841	SPL_{peak}	9.62	48	0.008
		SEL_{ss}	0.08	<1	0.000
Bottlenose dolphin	0.4195	SPL_{peak}	9.62	4	0.037
		SEL_{ss}	0.08	<1	0.000
Grey seal	Grid cell specific (Carter *et al.,* 2022) 0.008	SPL_{peak}	128.68	2	0.002
		SEL_{ss}	2,042.82	17	0.028

Table 21-25. Low-order detonation (charge weight 794kg) – summary of number of individuals within TTS-onset area (km²) (Disturbance) based on impulsive on SPL_{peak} thresholds and SELss weighted thresholds given by Southall et al., (2019),

Species	Density (n/km²)		Area impacted (km²)	Number impacted	% MU reference population
Harbour porpoise	0.137	SPL_{peak}	81.71	11	0.018
		SEL_{ss}	0.16	<1	0.000
Minke whale	0.011	SPL_{peak}	1.96	<1	0.000
		SEL_{ss}	211	3	0.011
Common dolphin	0.841	SPL_{peak}	0.18	<1	0.000
		SEL_{ss}	0	0	0
Bottlenose dolphin	0.4195	SPL_{peak}	0.18	<1	0.001
		SEL_{ss}	0	0	0
Grey seal	Grid cell specific (Carter *et al.,* 2022)0.011	SPL_{peak}	2.43	<1	0.000
		SEL_{ss}	5.81	<1	0.000

134. It is not expected that UXO clearance events would result in any significant disturbance risk to marine mammals as any impact is likely to be of very short term with full rapid recovery to normal behaviour. Although, the noise assessment using the metric SELss has predicted a very large impact area (55,836.87km²) impact is assessed using the impulsive noise threshold. It is unlikely that the noise profile from a UXO clearance event will remain impulsive at this range (Hastie *et al.,* 2019).

135. Magnitude has been assessed as **negligible,** because any impact is not likely to occur at a level that can affect the conservation status or integrity of any marine mammal species.

136. Sensitivity has been assessed as **low,** because of the short time the noise is present in the environment, all marine mammals will be able to tolerate the startle response, and therefore it is not expected that there will be a negative impact on any species' survival or ability to reproduce**.**

137. Therefore, the significance of effect, of disturbance from UXO clearance is concluded to be of **negligible** significance, which is **not significant** in EIA terms.

Table 21-26. Summary of significance conclusion for Unexploded Ordnance Clearance activity

	Magnitude	Sensitivity	Consequence	Impact significance
PTS-onset risk from UXO Clearance				
Common dolphin Bottlenose dolphin Harbour porpoise Grey seal	Negligible	Medium	Negligible	**Not significant**
Minke whale	Negligible	High	Minor	
Disturbance risk from UXO Clearance				
All marine mammals	Negligible	Low	Negligible	**Not significant**

138. The impact significance has been presented above without considering any Management Plan. It is expected that the use of low noise clearance alternative will be prioritised over high-order methods (BEIS, 2022). Further, as noted above, once the number and size of UXO targets have

been identified, a risk assessment report covering injury and disturbance risk, together with a marine mammal mitigation plan (MMMP) will be produced based on an informed clearance scenario to support the EPS licence application. Together, this will further reduce the likelihood of risk.

Impact Piling

139. There is the option for the floating WTGs to be anchored to the seabed using impact piled pin-piles (**Chapter 04: Description of the Project**). Impact piling generates underwater noise with the potential to result in auditory injury and disturbance to marine mammals. Noise levels from impact piling can vary in intensity, the level of which depends on several parameters (e.g. pile diameter, hammer energy, bathymetry, seabed composition). The modelling approach used in **Appendix 21B: Marine Mammal Underwater Noise Modelling** was to apply two established propagation models 'Bellhop' based on ray theory, and 'RAM' based on parabolic equation in combination, to fully cover the range of frequencies emitted during impact piling (Farcas *et al.,* 2016). The propagation model accounts for changes in water depth, seabed geo-acoustics, and oceanographic parameters (i.e. water temperature) (see **Appendix 21B: Marine Mammal Underwater Noise Modelling** for more detail).

140. A single location to the east of the Array Area boundary was selected for modelling because it was considered to best represent the typical environmental conditions throughout the region (i.e. similar depths and oceanographic conditions) Noise modelling parameters and choices were presented to NRW (A) and JNCC on 9 May 2023 (**Section 21.3.1**). Noise propagation models were run for both February and August as detailed in **Appendix 21B: Marine Mammal Underwater Noise Modelling** and **Appendix 21C: Marine Mammal Underwater Noise Assessment,** to encompass the worst- and best-case noise propagation conditions in the region throughout the year, as both temperature and salinity affect the sound speed profile. **Appendix 21B: Marine Mammal Underwater Noise Modelling** reviewed oceanographic conditions in the region and found that noise would propagate furthest in February, and least in August.

141. **Appendix 21B: Marine Mammal Underwater Noise Modelling** sets out the technical details of the methods used for the modelling of pin piles, with a summary is presented in this Chapter. The source level and frequency content of impact piling were informed from literature reviews and a trendline fitted to the combined dataset was used to estimate an acoustic source level likely to arise during the piling of a 3 m pile (**Table 21-27**).

Table 21-27. Estimated source level used for the noise modelling of impact piling at the proposed Project (Appendix 21B)

Pile diameter	SPL_{peak}	SEL_{ss}
3 m	235 dB re 1 µPa @ 1 m	218 dB re 1 µPa^2.sec @ 1 m

142. The impact of noise levels leading to auditory injury (PTS-onset) was quantified using the dual criteria thresholds as defined in Southall *et al*. (2019). Noise modelling determined the instantaneous (SPL_{peak}) and cumulative (SEL_{cum}) impact ranges, together with the resulting numbers of individuals at risk based on agreed density estimates (**Table 21-5**). Cumulative PTS-onset ranges were calculated for two scenarios:

- A static animal scenario was modelled over a range of time periods (single strike, 0.5 hrs, 1 hr, 2 hrs, 3 hrs, and 4 hrs). The impact ranges calculated represent the area within which an animal, if it stayed in the same location, would accrue enough noise dose to reach PTS-onset; and

- A fleeing animal scenario was modelled, which assumed that the animal would be swimming away from the noise during the piling activity. Agreed flee speeds were used for the different species to estimate the spatial / temporal accumulation of noise (**Table 21-28**). This enabled the estimation of a 'safe-start' distance. Within the safe-start range, an animal will accrue PTS-onset even if swimming further away throughout the piling sequence. If an animal's starting position is outside the safe-start range, it will not accrue enough noise to reach PTS-onset.

Table 21-28. Representative swim speeds per marine mammal species of interest as used in the fleeing model

Functional hearing group	Modelled swim speeds (m/s)	Reference
LF cetacean	2.3	Boisseau *et al*., 2021
HF cetacean	1.52	Bailey *et al*., 2010
VHF cetacean	1.5	Otani *et al*., 2001
PCW pinniped	1.8	Thompson, 2015

143. Information on the soft start / ramp up procedure for the proposed Project was not available for the noise modelling report, therefore **Appendix 21B: Marine Mammal Underwater Noise Modelling** used a generic protocol, i.e. an initial source level of 13 dB lower that the maximum level, increasing in discrete steps of approximately 3.5 dB every 5 minutes to the maximum level after a 20-minute period (adapted from the nearby Erebus project). The parameters used in the modelling were:

- Maximum pile diameter 3m;
- minimum hammer energy 50 kJ and maximum hammer energy 800 kJ;
- piling in one location at a time, no concurrent piling events, and;
- approximately four hours to drive one pile to the design depth.

144. It is worth highlighting that the underwater noise modelling conducted for the proposed Project was based on the traditional approach for impact piling, in that noise levels emitted increase as hammer energy increases. Should impact pilling be the chosen installation methodology, pin piles will be used to secure the foundation. Pin piles differ from the traditional paradigm in that they do not occupy the full water column throughout the installation period (as would monopiles). It has been found that noise levels reduce during the pin piling sequence even when hammer energy increases (Thompson *et al.,* 2020; Verfuss *et al*., 2023). This is thought to be due to the reducing surface area of the pin pile present in the water column. **Figure 21-3** illustrates this effect and was reproduced from Verfuss *et al*. (2023).

145. Not accounting for the reduction in noise levels means that this impact assessment will be more precautionary than might be expected.

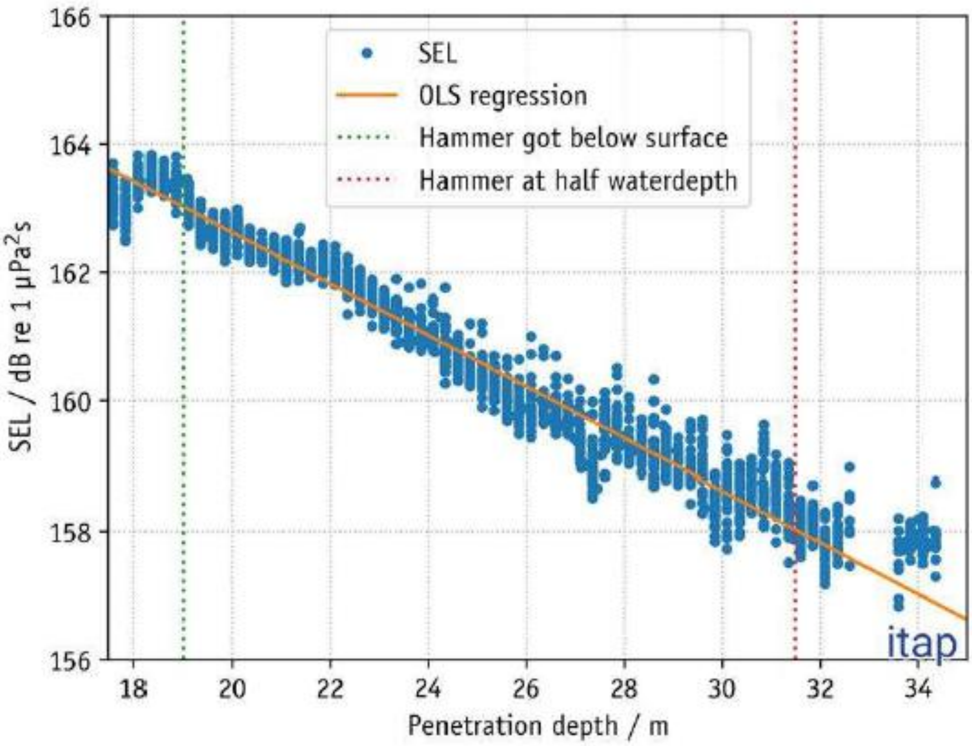

Figure 21-3. Single Strike SEL vs penetration depth from pin pile installation. The green vertical line represents the depth at which submerged hammering began. The red vertical line represents the depth at which the hammer reached half water depth (Verfuss et al., 2023)

146. The potential risk for disturbance from pin piling was modelled using a range of approaches. Two fixed noise thresholds were assessed together with assessment using dose response curves (**Appendix 21C: Marine Mammal underwater Noise Assessment**; **Table 21-29**).

Table 21-29. Summary of disturbance thresholds used in pin piling assessment

Disturbance threshold	Activity
NMFS (2005) – Level B 160 dB re 1µPa (rms)	Impact piling (all marine mammals)
NRW (2023) Fixed – 143 dB re 1µPa^2.s	Impact piling (harbour porpoise)[1]
Graham *et al.* (2017) Whyte *et al.* (2020) Dose response curves	Impact piling (all marine mammals)

[1] *Fixed threshold used for Harbour porpoise assesment under HRA*

147. The use of fixed noise thresholds assumes that all animals exposed to a certain level of sound are disturbed to a level that may impact life history features. Two scenarios were modelled; the first, using the NMFS fixed threshold to assess the disturbance risk to all marine mammal species under EIA regulations, and the second using the NRW recommended fixed threshold for harbour porpoise only for the assessment of the spatial extent within a Special Area of Conservation (SAC) that may experience significant disturbance. To represent the worst-case scenario, the piling location for disturbance impacts was nominally located at the boundary of the Array Area to result in the greatest noise overlap with West Wales Marine / Gorllewin Cymru Forol SAC and the Bristol Channel Approaches / Dynesfeydd Môr Hafren SACs (**Appendix 8E: HRA RIAA** and **Appendix 21C: Marine Mammal Underwater Noise Assessment**).

148. The third method used, i.e. dose response curves, allow for the natural variability in behavioural responses. The dose response curve from Graham *et al.* (2017) has been used for all cetacean species and is based on monitored harbour porpoise responses to pile driving in the Moray Firth. An updated dose response curve is presented in Graham *et al.* (2019) which documents a decreasing response to the piling stimuli over time. The 2017 data have been used for this assessment, as this represents a precautionary approach. Although based on harbour porpoise behavioural responses, this dose response curve has been applied for all cetacean species (as detailed in **Appendix 21C: Marine Mammal Underwater Noise Assessment**), as there is no species-specific response information available for other cetacean species. Therefore, this approach is considered to be a precautionary since harbour porpoises are thought to be one of the most sensitive species to disturbance (Tougaard *et al.,* 2015).

149. The dose response function for seals (Whyte *et al.,* 2020) although based on harbour seals, has been applied to grey seals. There are no equivalent data for grey seals. However, both seal species are categorised in the same functional hearing group. Further, it is likely that grey seals are less responsive than harbour seals (Booth *et al.,* 2019), and therefore the use of a harbour seal dose response curve is considered to be a precautionary approach (**Appendix 21C: Marine Mammal Underwater Noise Assessment**).

Auditory Injury Risk (PTS-onset) from Impact Piling

150. The impact of injury in terms of percentage of the reference population is negligible (< 0.01%) for all species under all metrics assessed, with the exception of harbour porpoise (at 0.024%) and minke whale (at 0.15%) using the static model (**Table 21-30**). However, a static model is highly unrealistic as it is unlikely these animals will remain stationary for the four-hour duration as modelled (Thompson et al., 2020). For all other metrics, modelling results predict less than one individual at risk, with the exception of one minke whale in the fleeing model scenario.

Table 21-30. Summary of area impact and numbers of individuals at risk of instantaneous or accumulated PTS-onset,

Species	Metric	Density (n/km²)	Area impacted (km²)	# impacted	% MU reference population
Grey seal	SPL_{peak}	Grid cell specific (Carter *et al.*, 2022) 0.011	0	0	0
	Static – SEL_{cum}		34.42	<1	0.001
	Flee - SEL_{cum}		0.01	<1	0.000
Harbour porpoise	SPL_{peak}	0.137	0.0478	<1	0.000
	Static - SEL_{cum}		107.48	15	0.024
	Flee - SEL_{cum}		0.03	<1	0.000
Common dolphin	SPL_{peak}	0.841	0	0	0
	Static - SEL_{cum}		0.09	<1	0.000
	Flee - SEL_{cum}		0.03	<1	0.000
Bottlenose dolphin	SPL_{peak}	0.4195	0	0	0
	Static - SEL_{cum}		0.09	<1	0.000
	Flee - SEL_{cum}		0.03	<1	0.000
Minke whale	SPL_{peak}	0.011	0	0	0
	Static - SEL_{cum}		2744.55	30	0.150
	Flee - SEL_{cum}		95.03	1	0.005

151. Whilst few individuals are predicted to experience PTS-onset, any that do will have experienced a permanent reduction in hearing ability within a certain frequency range. It is therefore useful to consider the potential consequences of any hearing damage. Booth and Heinis (2018) present findings of an expert elicitation workshop, that considered the consequences of PTS from piling noise. Most piling noise energy is concentrated between 30 Hz and 500 Hz, with some energy extending beyond 2 kHz. The workshop consensus was that hearing threshold shift tends to occur 1.5 octaves higher than centre frequency of noise exposure. Therefore, for piling, it was thought that the likely threshold shift would be between 2 and 10 kHz. The results of the workshop concluded that any hearing loss due to piling noise exposure was only likely to result in a low effect on survival and fecundity for all species. This was the conclusion for seal species, and harbour porpoise. Slight uncertainty was highlighted for dolphin species, which use lower frequencies for communication, and for low frequency cetaceans (e.g. minke whale) as they may be more sensitive to piling noise. However, the results of the workshop concluded that this is still unlikely to affect reproduction / survival rates, as any hearing loss within 2 – 10 kHz would only impact part of their overall hearing range.

152. Uncertainties relating to underwater noise assessment are set out in **Appendix 21C: Marine Mammal Underwater Noise Assessment** which highlight the over precautionary nature of this assessment. It is worth highlighting here that PTS-onset thresholds used are based on impulsive noise criteria, which is unlikely to hold true at distance due to the transition from impulsive noise to non-impulsive noise as the sound propagates (Hastie et al., 2019). The assumption is also made that all animals within the PTS-onset threshold will experience hearing loss. Donovan *et al*. (2017) suggested the term 'probability of effect' and that the number of individuals experiencing PTS-onset at the threshold was in the range of 8 to 19%.

153. Due to the low numbers of animals predicted to be at risk of PTS-onset and the small to negligible percentage of the reference population affected, the magnitude is considered to be **negligible.**

154. Although not thought to result in individual survival or reproductive rates, any hearing loss would be permanent. However, due to the frequency content of impact piling noise, it is likely that cetaceans would be able to adapt (as detailed above). The sensitivity of PTS-onset from piling is therefore considered to be **medium** for all marine mammals as a precaution.

155. The conclusion for significance is therefore **negligible** in which is **not significant** EIA terms.

156. Additionally, the injury risk to all marine mammals would be further reduced with the implementation of JNCC mitigation measures (Section 21.7; see **Appendix 4A: Outline Construction Environmental Management Plan**). Further, it is likely that a behavioural response from other construction activity (i.e. vessels) will act as a deterrence from the area, before piling starts, as has been observed in Germany, and in the Moray Firth, Scotland (Brandt *et al.,* 2018; Graham *et al.,* 2019; Benhemma-Le-Gall *et al.,* 2021).

Disturbance Risk from Impact Piling

157. Impact ranges are presented as minimum and maximum to reflect the best- and worst-case propagation conditions. As noted above, impact ranges were modelled for the oceanographic conditions found in February and August as these represent the largest differences in the sound speed profile and therefore bound the maximum and minimum propagation ranges.

158. Disturbance was modelled using several impact thresholds following the thresholds detailed in NRW (2023b) guidance (**Table 21-15**). This was to provide context for the varied predictions obtained using the suite of thresholds, together with the specific methodology that is

recommended, and used for the assessment of disturbance to harbour porpoise within SACs (**Appendix 8E - HRA RIAA**).

159. Modelling the impact using the NMFS Level B 160 dB re 1 mPa (rms) estimated impact ranges from 6,449 m to 9,271 m. The greatest number of animals predicted to be at risk of disturbance using this metric is 227 common dolphins, reflecting 0.22% of the reference population. The worst-case percentage of the relevant reference population affected is 1.03% of bottlenose dolphins, using the worst-case propagation conditions (**Table 21-31**).

Table 21-31. Summary of the number of individuals potentially at risk of disturbance using the NMFS Level B 160 dB re 1 mPa (rms) fixed threshold criteria, n

Species	Density (n/km^2)	Area impacted (km^2)		Number impacted	% MU reference population
Grey seal	Grid cell specific (Carter *et al.*, 2022) 0.011	Min	130.66	2	0.002
		max	270.02	3	0.005
Harbour porpoise	0.137	Min	130.66	18	0.029
		max	270.02	37	0.059
Common dolphin	0.841	Min	130.66	110	0.107
		max	270.02	227	0.221
Bottlenose dolphin	0.4195	Min	130.66	5	0.501
		max	270.02	113	1.035
Minke whale	0.011	Min	130.66	2	0.007
		max	270.02	3	0.015

160. Modelling using the fixed noise thresholds as recommended by NRW (2023) guidance for harbour porpoise SAC site integrity assessment (see **Appendix 8EHRA RIAA**) predicted the worst-case risk of disturbance range from 20,047 m to 39,279 m using the 143 dB re 1 mPa^2.s (unweighted) fixed threshold. The maximum number of harbour porpoise predicted to be within this fixed noise threshold under the worst-case scenario (February) is 649 individuals, relating to 1.04% of the reference population (**Appendix 21C: Marine Mammal Underwater Noise Assessment**). It is worth noting that this is the number within the fixed threshold contour, rather than the number of harbour porpoise affected within the SAC boundary. This is assessed in **Appendix 8E - HRA RIAA.**

161. The predicted number of cetaceans and seals at risk of disturbance using the dose response methodology for the worst-case scenario (February) are presented in **Table 21-32**. This scenario is considered precautionary for several reasons. The first, as noted above, **Appendix 21B: Marine Mammal Underwater Noise Modelling** modelled the scenario in February and in August to capture the full range of noise propagation conditions. Therefore, the results presented here based on the February model, are likely to overestimate the impacts should the piling be conducted in the summer months. Whilst all marine mammals are assessed on the entire area covered by the dose-response curves, bottlenose dolphins are considered a coastal species (Evans and Waggitt, 2023) and tend to be found within shallower waters (20-25 m depth) therefore the dose-response area has been clipped to the 25 m depth contour (see **Figure 21C-19** presented in **Appendix 21C: Annex A** for map).

Table 21-32. Summary of the worst-case (February) number of animals at risk of disturbance using dose-response curves (Graham et al., 2017) for all cetaceans and Whyte et al, (2020) for the grey seal). Bottlenose dolphin area based on dose-response curve overlap with the 25m contour

Species	Density (n/km^2)	Total area impacted (km^2)	Number impacted (CI)	% MU reference population
Grey seal	Average Grid cell specific (Carter et al., 2022) 0.069	42,142	848 (6-2185)	1.36
Harbour porpoise	0.137	42,142	1202	1.92
Common dolphin	0.841	42,142	7379	7.19
Bottlenose dolphin	0.419	933	35	0.32
Minke whale	0.011	42,142	97	0.48

162. Secondly, dose response curves include noise contours that relate to the 120-125 dB re 1µPa^{2}s (SELss) noise levels. These levels are likely to be close to background, ambient noise levels (**Appendix 21B: Marine Mammal Underwater Noise Modelling**) and therefore the extended area may relate to audibility rather than represent levels that elicit a disturbance response.

163. Common and bottlenose dolphin assessment has used the SCANS-IV density estimate as this is the most precautionary estimate. In both cases this is a significant increase in comparison to SCANS-III (0.3743 number/km^2 and 0.0605 number/km^2 respectively). An increase in density estimate will result in an increase in abundance in the same survey area, therefore it is worth noting that the percentage of the reference population is calculated using IAMMWG (2022) reference populations which were based on the SCANS-III density estimates. The recommendation to use IAMMWG (2022) is standard, and because this has not been updated following SCANS-IV, it is the only available reference population estimate. However, this means that there is additional precaution in the numbers of animals predicted to be at risk as a percentage of the population.

164. Because bottlenose dolphin has been assessed within the 25 m depth contour, the percentage of the management unit reference population is low. However, for common dolphin the prediction is for 7.18% of the MU at risk of disturbance. If the calculation was performed using SCANS-III densities, the percentage of the reference population affected would be reduced to 3.19% of the MU.

165. The predicted densities remain high in comparison to the predictions in Erebus-ES Chapter-12-Marine-Mammals[7] (as these were calculated using SCANS-III density estimates). The number of common dolphins potentially impacted was 2,067 relating to 1.01% of the reference population (IAMMWG, 2022).

166. The percentage of the reference population estimated using the dose response curve in this assessment comparatively appears to be an overestimate.

167. If the dose response curve is clipped to the contour containing the 143 dB re 1 mPa^2.s (unweighted) fixed threshold, then the area considered and numbers of individuals are all significantly reduced (**Table 21-33**).

[7] Project Erebus Environmental Statement (bluegemwind.com) [Accessed 18/12/2023]

Table 21-33. Summary of the worst-case (February) number of animals at risk of disturbance using dose-response curves clipped to exclude dB bins below 140 dB re 1 mPa²․s (Graham et al, (2017) for all cetaceans and Whyte et al, (2020) for the grey seal). Both SCANS-III[1] and SCANS-IV[2] density estimates presented for common dolphin and bottlenose dolphin. Bottlenose dolphin area based on density response curve overlap with the 25m contour

Species	Density (n/km^2)	Total area impacted (km^2)	Number impacted (CI)	% MU reference population
Grey seal	Average Grid cell specific (Carter et al., 2022) 0.069	5804.5	121 (3-304)	0.19
Harbour porpoise	0.137	5804.5	388	0.62
Common dolphin	0.841[2]	5804.5	2380	2.3
	0.374[1]		1058	1.03
Bottlenose dolphin	0.419[2]	17.8	3	0.04
	0.061[1]		1	0.01
Minke whale	0.011	5804.5	31	0.15

168. The predicted numbers of individuals at risk of disturbance are therefore highly dependent on the methodology used. **Table 21-34** presents a comparison of the percentage of the reference population at risk of disturbance from all methods used to illustrate the variability.

Table 21-34. Comparison of resulting % of reference population predicted to be disturbed from the different disturbance metrics assessed

Species	NMFS Level B 160 dB re 1 mPa (rms)	143 dB re 1 mPa^2.s unweighted	103 dB re 1 mPa^2.s weighted	Dose response curve	Dose response curve - clipped
	% MU				
Grey seal	0.005	N/A	N/A	1.4	0.05
Harbour porpoise	0.06	1.04	0.26	1.9	0.62
Common dolphin	0.09	N/A	N/A	7.1	2.3
Bottlenose dolphin	0.15	N/A	N/A	0.32	0.04
Minke whale	0.01	N/A	N/A	0.48	0.15

169. As noted previously, since 2017 additional data from the monitoring of pile driving events in the Moray Firth have been analysed (Graham *et al.,* 2019) which highlight that harbour porpoise responses to pin piling reduces over the construction period. This means using the probability of response from the Graham *et al.,* (2017) initial piling events provides an overly precautionary assessment.

170. Research based on noise monitoring data from the Moray Firth has indicated that harbour porpoise does not completely leave an area whilst offshore wind construction is occurring (Benhemma-Le-Gall *et al.,* 2021) as they regularly continued to use the site throughout the three-year construction period (Beatrice 2017; 2.4 m diameter pin pile – Moray Offshore Windfarm (East) Ltd, 2019; 2.5 m diameter pin pile). Graham *et al., (*2017) found that neither

harbour porpoise nor bottlenose dolphin were completely displaced by impact piling (piling source level 240 dB re 1 µPa @ 1 m $SPL_{peak-peak}$) from the region.

171. Harbour porpoise is thought to be the most sensitive cetacean species to underwater noise (Tyack, 2009; Tougaard et al., 2015); therefore, it is likely that the responses by other cetaceans would be less than those observed in the Moray Firth for harbour porpoise. The Moray Firth example is a useful comparison for the proposed Project in terms of a similar pin pile diameter, and estimation of the piling source level.

172. There are several studies that have reported the duration of effect following piling activity for harbour porpoise. Return times range from two to six hours after piling (Nabe-Nielsen *et al.,*2018) to between one to three days (Brandt *et al* 2011). Return time is likely to depend on the biological value of the area to the animal, any habituation to the noise (Graham *et al.,* 2019) and the noise characteristics themselves. It is therefore likely that any disturbance that occurs from pin piling at the Array Area will be temporary, and the assessment based on the assumption that all animals will remain disturbed at the same level throughout the piling construction period is precautionary.

Population modelling

173. The Interim Population Consequences of Disturbance (iPCoD) framework (Harwood et al. 2014; King et al. 2015) has been used to assess whether the predicted levels of disturbance would be sufficient to result in a population level effect. The model (Version 5.2[8]) was run using the worst-case numbers of animals at risk of disturbance generated from the dose response curve methodology for harbour porpoise only. Only grey seal, harbour porpoise and common dolphin were predicted to have potential disturbance effecting over 1% of the reference population, using the worst-case dose response results (**Table 21-32**).

174. There is no agreed threshold relating to the percentage of population impacted before population modelling is conducted. However, the use of 1% of a reference population is used in conservation assessments to infer significance (NRW 2022) and therefore has been used here to trigger the use of iPCoD. Using 1% of the reference population as a trigger to assess disturbance impacts is precautionary, ASCOBANS (Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas, passed two resolutions in the early 2000's related to bycatch. The first, defined 'unacceptable interactions' as being, in the short term, a total of anthropogenic removal above 1.7% of the best estimate of abundance. The second, underlined the intermediate precautionary objective to reduce by-catch to less than 1% of the best available population estimate (Genu et al., 2021). In both cases, this is in relation to mortality, rather than disturbance.

175. It is not currently possible to model common dolphin using the iPCoD framework, because species demographic rates are only available for five marine mammal species (harbour porpoise, grey seal, harbour seal, minke whale, and bottlenose dolphin see Sinclair et al., 2019).

176. An indicative piling schedule was not available at the time of writing; therefore, it was assumed that the installation of the pin pile foundations would take place during Q2 in 2026. The maximum number of turbines is ten, and therefore to inform the number of disturbance days used in the model, it was assumed that there would be one day of piling for each turbine. The input parameters for the model are presented in **Table 21-35** for harbour porpoise, and **Table 21-37** for grey seal (following the recommended parameters and metrics in Sinclair et al., 2019, a parameter description is given in each table, together with the model code relating to

[8] http://www.smruconsulting.com/products-tools/pcod/ipcod/

each parameter, and the value used in the model run, for more on iPCoD model parameters see Sinclair et al., 2019).

177. The results for harbour porpoise are presented in **Table 21-36** and **Figure 21-4** the results for grey seal are presented in **Table 21-38** and **Figure 21-5.**

Table 21-35. Harbour porpoise iPCOD modelling input parameters

Parameter description		Parameter	Value
Population	Number of simulations run	nboot	1000
	Species	spec	HP
	Proportion of population that is female	propfemale	0.5
	Population size at the start of simulations	pmean	62,517
Demographic	Calf survival rate	Surv[1]	0.6
	Juvenile survival rate	Surv[7]	0.85
	Adult survival rate	Surv[13]	0.85
	Fecundity rate	Fertility	0.958
	Age at independence	age1	1
	Age at first birth	age2	5
Piling and impacts	Number of piling years	pile_years	1
	Proportion of animals in vulnerable component	vulmean	C(1.0)
	Days of residual disturbance	days	0
	Number of piling operations	pilesx1	1
	Seasonal variation (1=no variation)	seasons	1
	Number of animals predicted to experience disturbance during 1 day of piling	numDt[1,]	1,202
	Number of animals predicted to experience PTS during 1 day of piling	numPt[1,]	0
	Number of collisions resulting in mortalities per year	Ncollisions	0
	Years for simulation	years	25
	Density dependence (0=no density dependence)	z	0
	Piling schedule	N/A	10 days

Table 21-36. Harbour porpoise iPCOD modelling results

Output variable	Value
Un-impacted population mean (after 1 year)	62,647
Impacted population mean (after 1 year)	62,643
Impacted population as % of un-impacted population (after 1 year)	99.99%
Median impacted: un-impacted population size (after 1 year)	1
Unimpacted population mean (after 6 years)	62,846
Impacted population mean (after 6 years)	62,843
Impacted population as % of un-impacted population (after 6 years)	99.99%
Median impacted: un-impacted population size (after 6 years)	1

Unimpacted population mean (after 12 years)	62,911
Impacted population mean (after 12 years)	62,908
Impacted population as % of un-impacted population (after 12 years)	99.99%
Median impacted: un-impacted population size (after 12 years)	0.999

Table 21-37. Grey seal iPCOD modelling input parameters

	Parameter description	Parameter	Value
Population	Number of simulations run	nboot	1000
	Species	spec	GS
	Proportion of population that is female	propfemale	0.5
	Population size at the start of simulations	pmean	62,358
Demographic	Calf survival rate	Surv[1]	0.222
	Juvenile survival rate	Surv[7]	0.94
	Adult survival rate	Surv[13]	0.94
	Fecundity rate	Fertility	0.84
	Age at independence	age1	1
	Age at first birth	age2	5
Piling and impacts	Number of piling years	pile_years	1
	Proportion of animals in vulnerable component	vulmean	C(1.0)
	Days of residual disturbance	days	0
	Number of piling operations	pilesx1	1
	Seasonal variation (1=no variation)	seasons	1
	Number of animals predicted to experience disturbance during 1 day of piling	numDt[1,]	848
	Number of animals predicted to experience PTS during 1 day of piling	numPt[1,]	0
	Number of collisions resulting in mortalities per year	Ncollisions	0
	Years for simulation	years	25
	Density dependence (0=no density dependence)	z	0
	Piling schedule	N/A	10 days

Table 21-38. Grey seal iPCOD modelling results

Output variable	Value
Un-impacted population mean (after 1 year)	63,038
Impacted population mean (after 1 year)	63,038
Impacted population as % of un-impacted population (after 1 year)	100
Median impacted: un-impacted population size (after 1 year)	1.00000
Unimpacted population mean (after 6 years)	66383
Impacted population mean (after 6 years)	66383
Impacted population as % of un-impacted population (after 6 years)	100%
Median impacted: un-impacted population size (after 6 years)	1

Unimpacted population mean (after 12 years)	70478
Impacted population mean (after 12 years)	70478
Impacted population as % of un-impacted population (after 12 years)	100%
Median impacted: un-impacted population size (after 12 years)	1

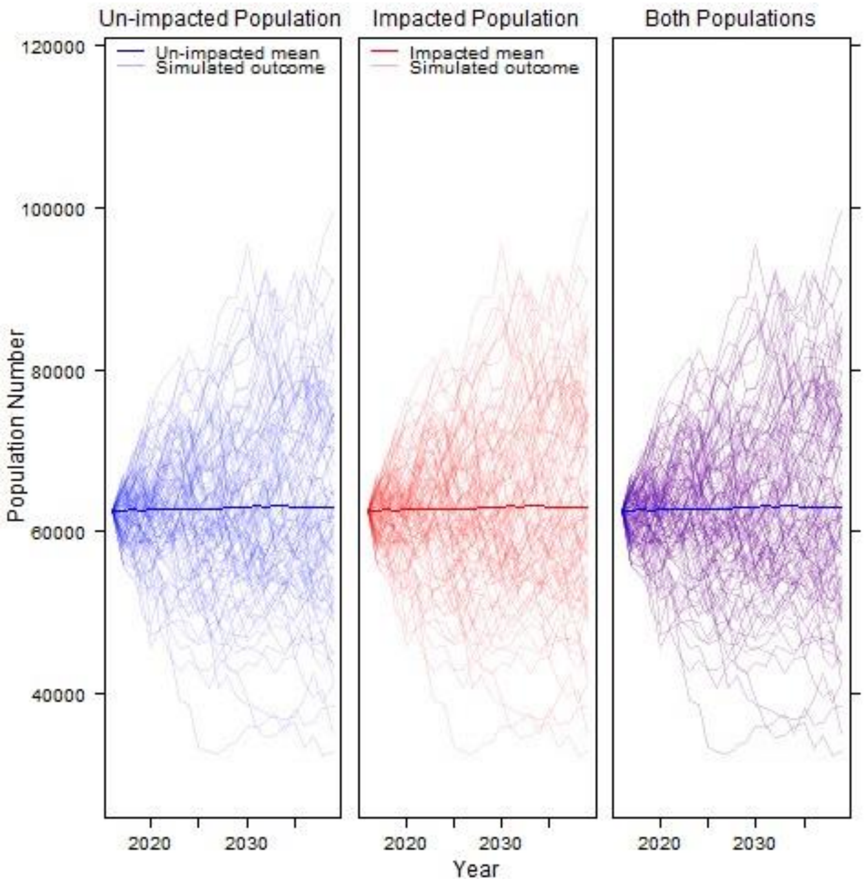

Figure 21-4. Population trajectory for both the impacted and unimpacted harbour porpoise population modelling

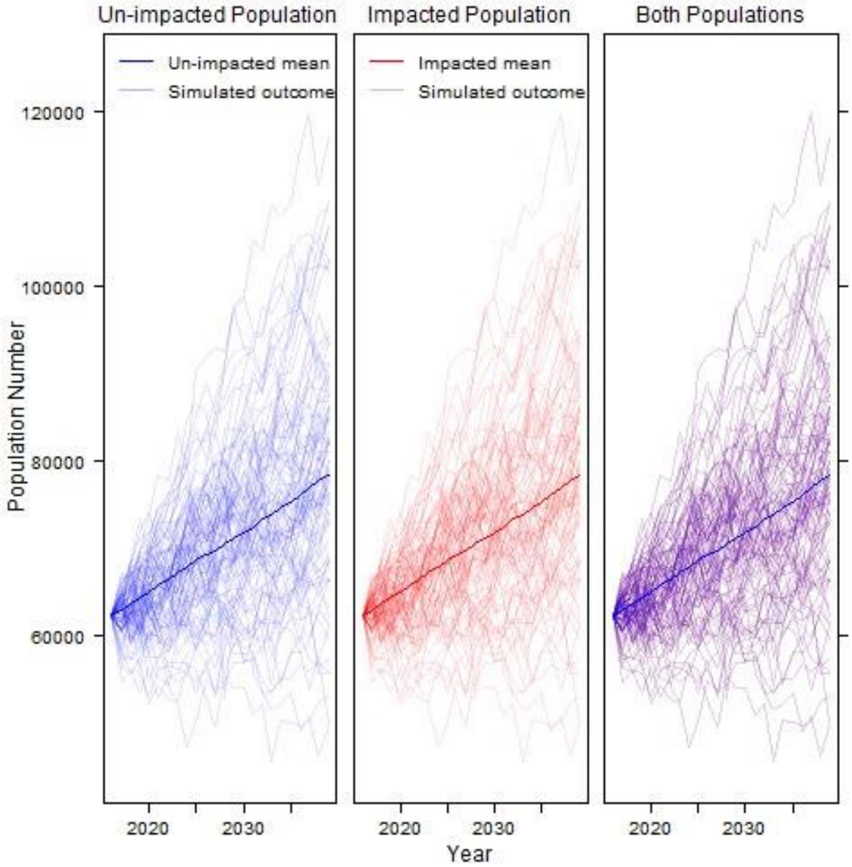

Figure 21-5. Population trajectory for both the impacted and unimpacted harbour porpoise population modelling

178. These results highlight that there is no anticipated population impact for either harbour porpoise or grey seal from impact piling conducted at the proposed Project. IPcoD considers the difference in population trajectory between an impacted (with construction) and an unimpacted (no construction) population, known as counterfactual assessment. For both harbour porpoise and grey seal, the ratio of impacted to non-impacted is 1, which means that there is no difference in modelled population trajectory as a result of the construction of the proposed project. This can also be clearly seen in **Figure 21-4** and **Figure 21-5**.

179. The comparison of the percentage of population impacted for each species from all methods employed is detailed above (**Table 21-34**). In all cases for bottlenose dolphin and minke whale the percentage at risk is under 1%, and therefore not likely to be detrimental at the population level. The population impact based on worst case for grey seal and harbour porpoise (1.4% and 1.9% respectively) has been investigated using iPCoD and has shown that there is no population impact.

180. Common dolphin cannot be modelled using iPCoD unfortunately, however, the range of percentage impacted predictions is from 0.09% to 7.1% depending on the threshold methodology used. As above, it is highlighted the precautionary nature of the assessment for common dolphin (i.e. using the increased density estimate from SCANS-IV together with the reference population based on SCANS-III). As detailed above if the worst-case dose response methods were calculated using SCANS-III density, this results in 3.19% of the reference population. This is likely to be an overestimate because the dose response curves, as used, include levels of noise that are similar to general background noise, and therefore likely to represent the area within which the impact piling is audible, rather than at levels that are likely to elicit a behavioural response. Further, the dose response curves are based on harbour

porpoise behaviour responses, and as detailed above, harbour porpoise are considered to be the cetacean species, most likely to respond with avoidance behaviour to noise (Tougaard et al., 2015). There are no equivalent dose response curves for common dolphin. The dose response curve information is based on unweighted single-pulse sound exposure levels, therefore there is no accounting for the hearing sensitivity of the different cetacean species (Graham et al., 2017). Consideration of the PTS-onset thresholds (although not disturbance) provides further evidence that dolphin species are less sensitivity to noise because the thresholds are higher for HF cetaceans (**Table 21-39**).

Table 21-39. Comparison of the PTS-onset thresholds for HF (dolphin) and VHF (harbour porpoise) (Southall et al, 2019)

Functional hearing group	Impulsive noise Instantaneous PTS-onset (SPL_{peak} dB re 1 µPa unweighted) PTS	Impulsive noise Cumulative PTS-onset (SEL_{cum} dB re 1 µPa^2.s weighted) PTS	Non-impulsive noise Cumulative PTS-onset (SEL_{cum} dB re 1 µPa^2.s weighted) PTS
HF cetaceans	230	185	198
VHF cetaceans	202	155	173

181. The combination of all precautions inherent in the assessment methodology means that the prediction for common dolphin is highly likely to be overestimated.

182. Therefore, to consider the magnitude of impact piling, the temporal extent is considered. This is predicted to be very short term (i.e., less than one year), with a full recovery anticipated. Any shift over the baseline condition is unlikely to affect the conservation status or integrity of any cetacean species considered, as the maximum number of WTGs is ten, and this means a maximum of ten days piling. The impacted range may be between 6 km and up to tens of km, depending on the disturbance metric considered. The worst-case area potentially at risk of disturbance, using the un-clipped dose response methodology is 42,142 km^2, this represents approximately 12% of the Celtic and Irish Sea area. Therefore, the impacted area can be considered as relatively local to medium spatial extent. The magnitude of the piling activity is assessed to be **negligible** for harbour porpoise, bottlenose dolphin, grey seal, and minke whale, and **medium** for common dolphin as a precautionary conclusion reflecting the uncertainty in the percentage of individuals at risk of disturbance.

183. Sensitivity of all marine mammals to disturbance has been assessed to be **low** because the receptor is able to adapt behaviour and will return to previous behavioural state once activity has ceased, with no likely effect on individual survival or reproductive states, Therefore the consequence of disturbance from pin piling has been assessed to be **negligible,** for harbour porpoise, grey seal, bottlenose dolphin and minke whale, and **mino**r for common dolphin, which is **not significant** in EIA terms.

Table 21-40. Summary of significance conclusion for impact piling activity

	Magnitude	Sensitivity	Consequence	Impact significance
PTS-onset risk from Impact piling				
All marine mammals	Negligible	Medium	Negligible	**Not significant**
Disturbance risk from impact piling				
Harbour porpoise Grey seal Bottlenose dolphin Minke whale	Negligible	Low	Negligible	**Not significant**
Common dolphin	Medium	Low	Minor	**Not significant**

Other Construction Activities

184. Underwater noise may be generated by a range of 'other construction' activities, with the potential to cause injury or disturbance to marine mammals. The other construction activities that were included in the underwater noise modelling report (**Appendix 21B: Marine Mammal Underwater Noise Modelling**) are drilling, dredging, cable laying, jetting, and rock placement activities. The noise generated through these other activities tend to be broadband, with the peak in noise energy being <1 kHz (**Appendix 21B: Marine Mammal Underwater Noise Modelling**) and at levels considered unlikely to cause auditory injury for marine mammals (Todd *et al.,* 2015; Culloch *et al.,* 2016).

Auditory Injury (PTS-onset) Risk from Other Construction Activities

185. The risk of auditory injury has been assessed using the SEL_{cum} (up to 24-hour exposure) (Southall *et al.,* 2019), for both static and fleeing model scenarios. The static model assumes that both the source and the receptor are stationary for the entire period assessed. Therefore, the longer the timeframe, the greater the predicted impact range.

186. Noise modelling was conducted based on two nominal locations, one representing the array area, and one to represent the offshore export cable route (**Figure 21-6**). The nominal location chosen for the array area was selected based on the consideration of water depths throughout the Offshore Development Area (approximately 55m nearest to the Welsh coast, to 80m further offshore) whereby the modelling location had a water depth of approximately halfway between the two extremes. The nominal location selected for the offshore export cable route, was selected to enable a modelling location that enabled consideration of the greatest range of water depths.

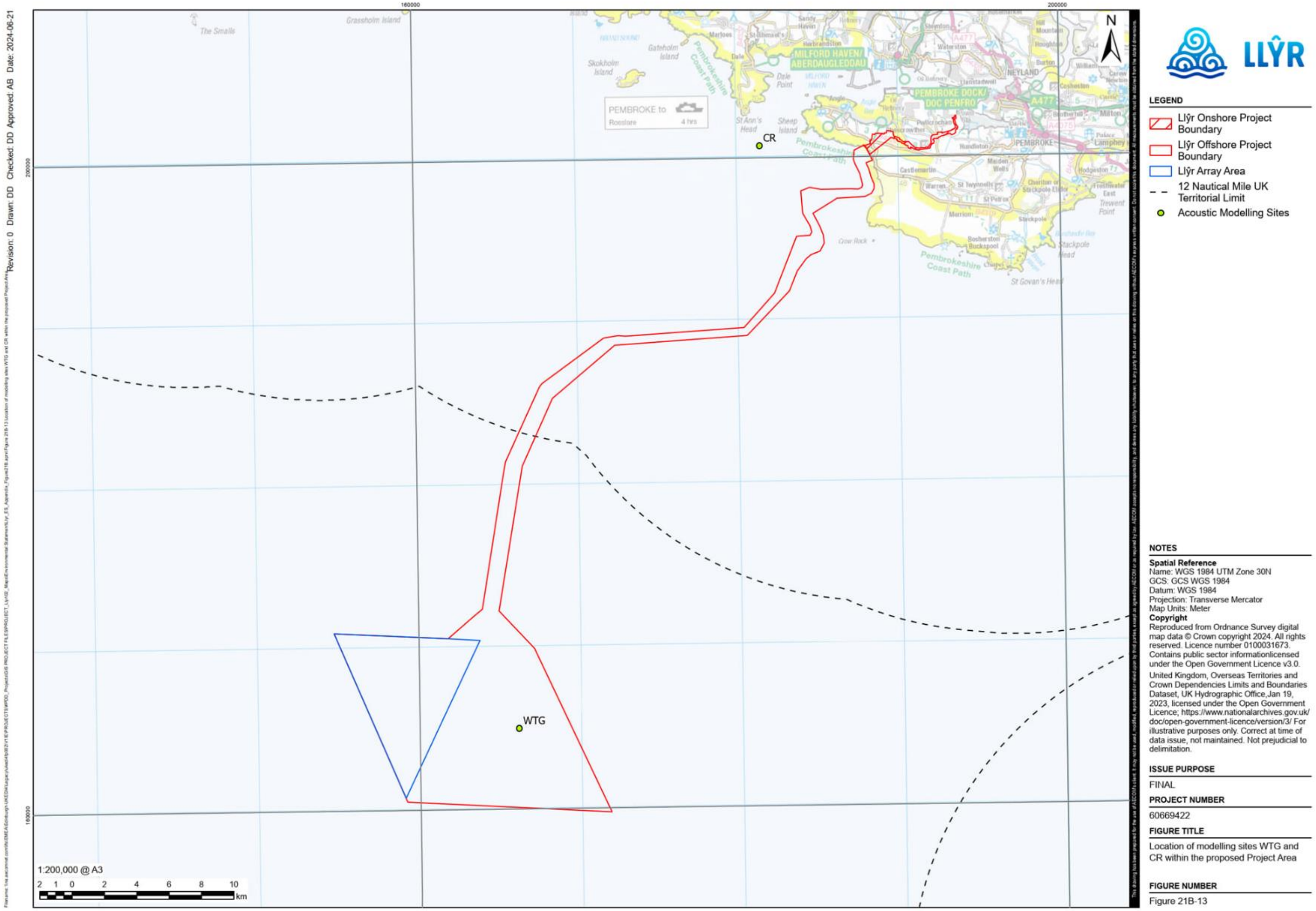

Figure 21-6. Location of modelling sites for wind turbine generators (WTG) and cable route (CR) within the proposed Project Area (hatched region) (Appendix 21).

187. Results from the static model indicated that PTS-onset levels were breached for LF and VHF functional hearing groups only (*i.e.,* minke whale and harbour porpoise) for all activities with the exception of dredging and rock placement activities. (See Table 21.35 in **Appendix 21C: Marine Mammal Underwater Noise Assessment** for full detail).

188. However, in most cases the maximum range within which PTS-onset was possible was in the order of tens of meters within an hour, to hundreds of meters, within 24 hours. The maximum PTS-onset range predicted for all 'other' construction activities modelled was 421m for the VHF (harbour porpoise) functional hearing group, over the 24-hour period for the cable laying activity scenario. It is highly unlikely that any individual animal would remain within 421m of a moving cable laying vessel and so the risk of injury is low. There was no PTS-onset impact predicted for HF (dolphins) or PCW (seals) functional hearing groups using the static model.

189. Further, there is no realistic risk of auditory injury to any of the assessed marine mammals under the fleeing model scenario. The worst-case prediction under this scenario also for VHF functional hearing group, was 35 m from the drilling activity (See **Table 21.31** in **Appendix 21C: Marine Mammal Underwater Noise Assessment**).

190. The magnitude of impact from PTS-onset due to the localised nature of these 'other' construction activities in space and time, has been assessed as **negligible**.

191. Sensitivity has been assessed as **low** for the HF, VHF and PCW frequency hearing groups, because their hearing sensitivity is relatively poor at frequencies below 1 kHz (Genesis, 2011).

192. However, low frequency noise generated by these other construction activities may overlap the hearing range of minke whales (LF). Should hearing be impaired at these frequencies there may be the potential to mask low frequency communication (Risch *et al.,* 2014), therefore sensitivity has been assessed as **medium**.

193. When the sensitivity scores are combined, injury from these other construction activities has been assessed as **negligible** for all marine mammal species, and so **not significant** in EIA terms.

<u>Disturbance Risk from Other Construction Activities</u>

194. The maximum impact range for disturbance using the NMFS Level B threshold for non-impulsive noise (120 dB re 1 µPa rms) (NRW, 2023) was 21.9 km for cable laying activity, based on the cable route modelling location. This relates to the worst-case estimate of 1,011 common dolphin at potential risk of disturbance from this activity, which is 0.98% of the reference population.

195. The source level for cable laying activity included noise generated by dynamic positioning (DP) (**Appendix 21B: Marine Mammal Underwater Noise Modelling**) which forms most of the noise output. As the assessment is based on the NMFS non-impulsive threshold, the range of ~22 km may be an overestimate because 120 dB re 1 µPa (rms) can be close to background noise levels (**Appendix 21B: Marine Mammal Underwater Noise Modelling**).

196. Thompson *et al.* (2013) monitored harbour porpoise during a 2D seismic survey in the Moray Firth. They found animals were affected within 5 – 10km of the noise source. The noise from a seismic survey is significantly louder than the DP from cable laying activity, although a different noise type (impulsive) it is worth considering in comparison with the resulting noise levels. The source level was back calculated from in-situ recordings to be 242 – 253 dB re 1µPa (pk-pk), and the noise levels measured coincident with a behavioural response were in the region of 148 – 155 dB re 1µPa (rms). The authors also noted that the animals were re-detected within the displaced area within hours after the survey had finished, as such there was no long-term displacement.

197. Graham et al., (2017) monitored the reactions of bottlenose dolphins and harbour porpoise to both impact and vibro-piling, conducted for a harbour development in the Cromarty Firth, Scotland. The source level for impact piling was 240 dB re 1µPa (pk-pk), and for vibro, it was 192 dB re 1µPa (rms). They found similar disturbance responses from both the impulsive noise source and the non-impulsive source. In this study, neither species were completely displaced from the area during construction, although the probability of occurrence for both species was lower during both impact and vibro piling.

198. The NMFS non-impulsive noise threshold is close to the levels of background noise in the marine environment without input from other sources. It is therefore possible that this is assessing the numbers of individuals that may hear 'other construction activities' rather than the number disturbed to the extent that would impact their biological fitness. Further, the NMFS thresholds are not weighted for hearing abilities, and because the predominant frequency content radiated from these other construction activities is below 1 kHz, and therefore below most ranges of best hearing for marine mammal species, it is unlikely that the level of noise at tens of km from the source will be sufficient to result in significant disturbance.

199. Therefore, the magnitude of impact has been assessed as **negligible**, any impact is unlikely to occur or may occur at a very low incidence or intensity.

200. Sensitivity has been assessed as **low** as it is anticipated that all marine mammals will be able to tolerate the levels of noise with no impact on individual survival or reproductive rates, and behaviour is anticipated to return to normal once activity has ceased.

201. The significance of drilling, dredging, cable laying, jetting, and rock placement activities during construction (**Table 21-41**) is therefore concluded to be of **negligible** significance, which is **not significant** in EIA terms.

Table 21-41. Summary of significance conclusion for 'other' construction activity

	Magnitude	Sensitivity	Consequence	Impact significance
PTS-onset risk from 'other' construction activities				
Harbour porpoise Grey seal Common dolphin Bottlenose dolphin	Negligible	Low	Negligible	**Not significant**
Minke whale	Negligible	Medium	Negligible	**Not significant**
Disturbance risk from 'other' construction activities				
All marine mammals	Negligible	Low	Negligible	**Not significant**

Vessel Activity

202. Disturbance from vessels may occur due to the noise levels or the presence of vessels, likely to be a result of the combination of both potential stressors. Noise levels from vessels depend on several parameters including vessel size and speed (Richardson *et al.,* 1995). Noise levels increase with increasing vessel size and increasing speed.

203. The risk of auditory injury has been assessed using SEL_{cum} (24-hour exposure) (Southall *et al.,* 2019). Both the static receptor model and the fleeing receptor model were run for noise levels reflecting large (~100m in length) and medium vessels (~50m in length) these modelling choices are expected to bound the likely types of vessels that will be used for the proposed Project (e.g. offshore construction vessels, support vessels, tugs and barges, and anchor handling vessels).

204. The worst-case prediction is for the static receptor model, where a VHF cetacean would have to remain within 164m of a large vessel for 24 hours to experience PTS-onset (**Table 21-42**).

205. The results from the fleeing receptor model show the risk of PTS-onset was negligible for all marine mammals, except for the VHF cetacean group (harbour porpoise), where the safe-start range of 12m for the large vessel scenario was predicted (**Appendix 21B: Marine Mammal Underwater Noise Modelling**). Therefore, this means an individual will need to be within 12m of the vessel before swimming away for any risk of PTS-onset to occur.

206. In both the static model and the fleeing model approaches, it is highly unlikely that any individual would remain in such close proximity given the vessel and receptor would be moving. Harbour porpoise is in the VHF cetacean functional hearing group and so it is relevant to the assessment of the PTS-onset risk as modelled to consider that harbour porpoises will naturally avoid vessels (e.g. Palka and Hammond, 2001), thereby reducing any potential of being close enough for PTS-onset risk. Benhemma-Le-Gall *et al.,* (2021) found that porpoise displacement was observed up to 4 km from general vessel activity.

Table 21-42. Summary of the maximum distance (m) for vessel activity, within which PTS-onset may occur. Stationary animals exposed to continuous noise for 24 hours (Appendix 21B)

Vessel size category	LF Cetacean	HF Cetacean	VHF Cetacean	PCW
Project vessel (large)	41	<10	**164**	<10
Project vessel (medium)	<10	<10	<10	<10

207. The maximum disturbance range predicted was 4.5 km for all marine mammals for vessel activity. Using this impact range, estimates of numbers of animals at risk of disturbance are low, with the largest predicted number being 54 common dolphins (**Table 21-43**; see **Appendix 21C: Marine Mammal Underwater Noise Assessment** for full details).

Table 21-43. Summary of the number of animals potentially at risk of disturbance using the fixed threshold of 120 dB re 1µPa (rms) Level B harassment threshold for both the worst-case scenario of the large project vessel

Species	Density (n/km^2)	Total area impacted (km^2)	Number impacted	% MU reference population
Grey seal	Grid cell specific (Carter *et al.*, 2022)	63.7	<1	0.001
Harbour porpoise	0.137	63.7	9	0.014
Common dolphin	0.841	63.7	54	0.052
Bottlenose dolphin	0.4195	63.7	27	0.244
Minke whale	0.011	63.7	<1	0.003

208. The magnitude for PTS-onset from vessel noise has therefore been assessed as **negligible.**

209. The sensitivity of receptors has been assessed as **low** because it would take 24 hours of close proximity to a working vessel to accrue enough noise to result in PTS-onset, which is highly unlikely.

210. The magnitude for disturbance has been assessed as **negligible** due to the localised and temporary level of risk.

211. The sensitivity of receptors is **low** for all marine mammals, as it is anticipated individuals are able to adapt behaviour to naturally avoid vessels.

212. Therefore, the significance of vessel activity for both injury and disturbance is concluded to be of **negligible** significance, which is **not significant** in EIA terms (**Table 21-44**).

Table 21-44. Summary of significance conclusion for vessel activity

	Magnitude	Sensitivity	Consequence	Impact significance
PTS-onset risk from vessel activity				
All marine mammals	Negligible	Low	Negligible	**Not significant**
Disturbance risk from vessel activity				
All marine mammals	Negligible	Low	Negligible	**Not significant**

Airborne Sound and Visual Disturbance (Pinnipeds Only)

213. During construction, there is potential for vessels and construction activities close to the coast within the cable corridor to cause disturbance to grey seals hauled-out. Grey seal haul-outs are locations on land where seals come ashore to rest, moult or breed. Disturbance to hauled-out grey seals can cause animals to flush into the water, resulting in energetic loss, as well as interrupt mother-pup bonding and breeding (Wilson, 2014).

214. According to SCOS (2021; 2022), there are three main haul-out sites utilised by breeding grey seals located close to the proposed Project: Ramsey Island, Skomer MCZ and north Pembrokeshire, with Skomer MCZ, the closest being Skomer MCZ (approximately 38 km from the Array Area, 7.5 km from the cable corridor and 13 km from the landfall site). Given the distances from this key grey seal haul-out / breeding site, to the Array Area, cable corridor and landfall site, it is unlikely that airborne sound from the pre-construction and construction works (e.g. pin-piling, UXO clearance, cable laying), will disturb hauled-out seals at these key haul-out sites.

215. A study of grey seal mothers found that increased boat speed was a significant factor in whether animals displayed a disturbance response or flushed into the water and observed movement into the water generally when boats were between 20 m and 70 m offshore, with no detectable disturbance at 150 m (Strong and Morris, 2010; Wilson, 2014). Although, grey seals have also been reported to move into the water when vessels are at a distance of approximately 200 - 300 m (Wilson, 2014).

216. At Ramsey Island, there are frequent tour boats which regularly transit near hauled-out seals; however, there has not been any reduction in reproductive rate observed in association with this which may indicate habituation to vessels (Strong and Morris, 2010). There is therefore the potential for vessels transiting from the port to the Array Area to cause disturbance to grey seal haul-outs. However, it is not expected that any vessels would pass close enough (within 200 – 300m) or be travelling at sufficient speed to result in any disturbance to hauled-out animals at these key sites. Additionally, there is no evidence that disturbance at haul-out sites is currently a concern at the population level (SCOS, 2021).

217. Grey seals also haul-out within the Pembrokeshire Marine / Sir Benfro Forol SAC, of which grey seal is a qualifying feature and which encompasses the proposed Project landfall location. The potential for impact to grey seals within the Pembrokeshire Marine SAC has been assessed in the accompanying **Appendix 8E: HRA RIAA**.

218. The indicative HDD landfall site is Freshwater West, and construction is anticipated to take between 24 and 64 weeks. Although the landfall location does not appear to be a key location

within the SAC for grey seals to haul out, as mentioned above, seals could be present anywhere along the Pembrokeshire coastline. All vessel crew will be made aware of seal disturbance indicators via toolbox talks and will adhere to good practice movement when close to shore. Furthermore, the cable laying vessel will be moving slowly when cable laying and therefore unlikely to cause flushing to any hauled-out seals.

219. In order to minimise any potential for disturbance, as additional mitigation, the Applicant will investigate whether a seasonal restriction is able to be put in place, such that activity on the shoreline will not take place between August and February. Alternatively, should construction be necessary during this period, the Applicant will commit to winter surveys of the landfall site post submission to obtain greater detail on the number of mum pup pairs likely to be in that specific location.

220. The magnitude of the impact has been assessed as **small,** there may be a minor shift from baseline for seals hauled out, but this is unlikely to affect conservation status. Any potential impacts will be localised and predicted to be short-term.

221. The sensitivity of grey seals has been assessed as **low** due to seals' ability to adapt and tolerate airborne sound and visual disturbance from construction vessel activity, and their ability to return to previous behavioural state, once vessels have moved further away.

222. Therefore, the significance of the effect from airborne sound and visual disturbance on grey seals during construction is concluded to be of **negligible significance**, which is **not significant** in EIA terms.

Table 21-45. Summary of significance conclusion for airborne sounds and visual disturbance

	Magnitude	Sensitivity	Consequence	Impact significance
Disturbance risk from airborne sound and visual disturbance				
Grey Seals	Small	Low	Negligible	**Not significant**

Collision with Project Vessels

223. During the construction stage (including pre-construction), there is potential for an increased risk of injury or mortality to marine mammals from vessel strike, related to the increase in localised vessel activity within the Offshore Development Area and along transit routes. Injury or mortality can result from blunt trauma or propellor strikes, with the severity influenced by factors such as the type and size of the vessel, and the speed at which the vessel is travelling (Laist *et al*., 2001; Peltier *et al*., 2019; Schoeman *et al*., 2020).

224. As detailed in **Chapter 25: Shipping and Navigation**, the proposed Project already experiences high levels of vessel traffic, including fishing vessels, tankers and recreational vessels.). During the 14 days assessed in the summer period, there was an average of 19 vessels within the study area, and 38 vessels within the OfECC. Therefore, the presence of vessels from the proposed Project will not be a novel impact for marine mammals in this area and mammals are likely to habituated to vessel presence.

225. Up to 168 additional transits are anticipated to be made during operation and maintenance. With a maximum of 12 construction vessels simultaneously at the site. However, the majority of vessels would be stationary or slow moving for significant periods and would therefore pose a low collision risk.

226. Most of the vessels used during the construction (including pre-construction) stage are relatively small in size (e.g. tugs, vessels carrying Remotely Operated Vehicles (ROVs), Crew Transfer Vessels (CTVs), barges and Rigid Hulled Inflatable Boats (RIBs)), which may have

higher speeds than larger vessels but are also highly manoeuvrable so can more easily stop or move to avoid animals, when detected. Larger vessels (e.g. cable lay vessel), whilst less manoeuvrable, will be travelling at lower speeds meaning they have more time to detect and avoid animals, and for any animals themselves to take evasive action (Schoeman *et al*., 2020).

227. Harbour porpoise, dolphin species, and seals are highly mobile and agile and have been observed to respond to underwater noise from vessels (Erbe *et al*., 2019). In the Moray Firth, seals were shown to utilise waters occupied by vessels when moving between foraging and haul-out sites; however, animals tended to remain beyond 20 m from vessels with only three instances of seals coming within 20 m of vessels over 2,241 days (Onoufriou *et al.,* 2016). Harbour porpoise displacement was observed up to 4km from vessel activity during offshore wind construction (Benhemma-Le Gall et al., 2021). Therefore, it is expected that harbour porpoise, dolphin species and seals will detect nearby vessels and take evasive action to avoid collision, provided that vessel movements are predictable (Nowacek *et al*., 2001; Lusseau, 2003). Larger, less agile marine species, such as minke whales, may be less able to take avoidance action.

228. Notwithstanding marine animals' ability to take avoidance action, should collision occur (although rare, given avoidance behaviour) it could result in injury or mortality. All marine mammal receptors are precautionarily assessed to have a **high sensitivity** to collision with Project vessels.

229. Estimating the frequency of vessel collisions is difficult since they frequently occur far offshore and may not be detected or reported (Cates *et al*., 2017; Peltier *et al*., 2019). The UK Cetacean Strandings Investigation Programme (CSIP) documents reported marine mammal strandings and the cause of death, where a post-mortem was performed, although few strandings have been attributed to vessel collision. For example, only two out of 148 animal strandings in 2017 were attributed to boat or ship strikes, and a further three to physical trauma of unidentified cause (which could include vessel strikes, by-catch or bottlenose dolphin attack; CSIP, 2017). Therefore, relative to other causes of death indicated through these post-mortem examinations, vessel collisions are unlikely to be a key cause of mortality for marine mammals in the UK.

230. The magnitude of the impact has therefore been assessed as **negligible** due to likely low incidence.

231. The sensitivity of all marine mammal receptors is assessed as **high** due to the injury / mortality consequences should a collision occur.

232. Therefore, the significance of the effect from collision with the proposed Project vessels during construction is concluded to be of **minor significance**, which is **not significant** in EIA terms.

Table 21-46. Summary of significance conclusion for collision with Project vessels

	Magnitude	Sensitivity	Consequence	Impact significance
Collision with Project vessels				
All marine mammals	Small	High	Minor	**Not significant**

233. Although not relied on for the significance assessment above, a vessel management plan will be agreed and implemented as an embedded mitigation measure for the proposed Project and secured through conditions of consent (**Section 21.8**). This will include measures to ensure that vessels move along predictable routes when transiting and define how vessels should be handled in the presence of marine mammals in order to minimise the risk of collision and allow

animals to safely take evasive action. Therefore, when considering the embedded mitigation measures, the risk of vessel collisions occurring as a result of construction traffic is minimal.

Accidental Pollution or Contamination

234. There is potential for pollutants, such as hydrocarbons from fuel, to be accidentally released from vessels, equipment, and machinery during the construction stage which has the potential to cause injury or mortality to marine mammals, or a reduction in their prey availability which may affect survival rates. The risk of pollution events has been assessed in **Chapter 18: Marine Water and sediment quality** and the conclusion was reached that no significant effect was identified.

235. The worst-case scenario for accidental release of pollutants would be accidental release of vessel fuel during the construction stage. Up to 168 additional transits are anticipated to be made during operation and maintenance. With a maximum of 12 construction vessels simultaneously at the site. However, this includes all vessel sizes, such as small vessels, which are unlikely to pose a significant pollution risk as they do not carry large amounts of fuel.

236. Marine mammals and their prey can be affected by accidental ingestion or inhalation of pollutants from accidental releases, which can block respiratory pathways or have direct toxic effects and impact respiration, digestion, and reproduction (Smith *et al.,* 2017; Colegrove *et al.,* 2016). However, marine mammals are also highly mobile and would be likely to vacate an area should an accidental spill or contamination occur, before experiencing significant effects. Therefore, all marine mammal receptors are assessed to have a **medium sensitivity** to accidental pollution or contamination events.

237. The amount of fuel which may be released from a vessel is small (**Chapter 28: Shipping and Navigation**). The maximum of 12 additional vessels on site at any one time does not increase the risk of accidental pollution in relation to the overall use of the area with baseline vessel activity. Therefore, in the unlikely event of an accidental release of pollutants, it is predicted that it would be localised, of short-term duration and low intensity. As a precautionary measure, the magnitude of the risk of accidental pollution or contamination occurring has been assessed as **small**, because it is likely to be of low incidence, with the potential of affecting marine mammals in a localised area.

Therefore, the significance of the effect accidental pollution or contamination from with Project vessels during construction is concluded be of **minor significance**, which is **not significant** in EIA terms.

Table 21-47. Summary of significance conclusion for accidental pollution or contamination

	Magnitude	Sensitivity	Consequence	Impact significance
Accidental pollution or contamination				
All marine mammals	Small	Medium	Minor	**Not significant**

238. The spatial extent, duration, intensity and likelihood of potential accidental release of pollutants will be reduced by the development of, and adherence to, an Environmental Management Plan which will include a Marine Pollution Contingency Plan (MPCP). This will include proper storage and containment of chemicals and hazardous substances, planning for accidental spills and accidental contaminant releases, among other legal requirements and good industry practice measures from OSPAR, International Maritime Organization (IMO) and International Convention for the Prevention of Pollution from Ships (MARPOL) requirements for preventing pollution at sea. If pollution were to occur, then the Shipboard Oil Pollution Emergency Plan will be implemented to minimise the environmental risk.

Potential for Indirect Effects through Impacts to Prey Species

239. There is potential for changes in the availability and / or distribution of marine mammal prey as a result of pre-construction and construction activities, such as those that physically disturb the seabed, and activities generating underwater noise. This could affect the foraging ability and success of marine mammals, resulting in indirect effects from the proposed Project.

240. Key prey species for the cetacean species considered in this assessment in the UK include clupeids (e.g. herring and sprat), gadoids (e.g. cod and whiting), sandeels and flatfish (Pierce *et al*., 2004; Canning *et al*., 2008; Tetley *et al*., 2008; Jansen *et al*., 2010; Evans and Hintner, 2013; Leopold *et al*., 2018). In Wales, grey seal predominantly feed on gadoids, flatfish and herring, but have also been observed to predate harbour porpoise, harbour seals and other grey seals (Evans and Hinter, 2013; Stringell *et al*., 2015; Nelms *et al*., 2019).

241. Relevant species identified within the Celtic Seas Ecoregion (**Chapter 20: Fish and Shellfish Ecology**) include; sprat (*Sprattus sprattus*), sardine (*Sardina pilchardus*), anchovy (*Engraulis encrasicolus*), herring (*Clupea harengus*), whiting (*Micromesistius poutassou*), mackerel (*Scomber scombrus*), sandeel spp. (*Amodytidae*), hake, haddock, whiting, pout (*Trisopterus spp*), anglerfish, dab (*Limanda limanda*), plaice (*Pleuronectes platessa*), sole (*Soleoidei*), lemon sole (*Microstomus kitt*), and megrim (*Lepidorhombus whiffiagonis*).

242. As assessed in **Chapter 20: Fish and Shellfish Ecology**, during construction activities there is potential for temporary direct loss of and physical disturbance to fish habitats; permanent direct loss of fish habitats, temporary physical disturbance from increased suspended sediments, changes to marine water quality, underwater sound and vibration, together with EMF effects. The assessment concluded that no significant impacts are predicted to any fish and shellfish receptors, including the identified prey species, either for the offshore Project alone, or cumulatively with other plans or developments. Therefore, the indirect effects on marine mammals relating to prey availability and / or distribution is considered to be of negligible magnitude.

243. Should prey availability or distribution be affected, marine mammals may have to forage different prey, or increase the time spent foraging resulting in adverse energetic consequences and a reduction in available time for resting or reproduction (Ransijn *et al*., 2022). However, marine mammals are highly mobile and wide-ranging and therefore, it is anticipated individuals would be able to forage in alternative areas, if required. All marine mammal species in this assessment are also considered to be generalist feeders, and thus are not dependent on a single prey species (Evans and Hintner, 2013). Therefore, it is likely that marine mammals can supplement their diet with other available species if required, making them resilient to changes in prey availability. Therefore, given the expected adaptability of marine mammals to find alternative prey species or locations, they are assessed to be of **low** sensitivity.

244. Therefore, considering that there are no significant impacts predicted to any fish or shellfish species the magnitude has been assessed as **negligible.**

245. Therefore, the significance of indirect effects through impact to prey species during construction is concluded be of **negligible** significance, which is **not significant** in EIA terms.

Table 21-48. Summary of significance conclusion for impacts to prey species

	Magnitude	Sensitivity	Consequence	Impact significance
Indirect effects from impacts to prey species				

	Magnitude	Sensitivity	Consequence	Impact significance
All marine mammals	Negligible	Low	Negligible	**Not significant**

21.9.2 Operation and Maintenance (O&M) Effects

Underwater Operational Noise Effects

246. Noise emitted from the mechanical components of the WTG, such as the gearbox and generator can travel through the WTG tower to the floating foundation and propagate to the surrounding water. Radiated noise from the WTG is predominantly low frequency and continuous (i.e. non-impulsive) in nature (Nedwell *et al*., 2003; Tougaard *et al*, 2020). In addition, there is potential for transient underwater noise to be generated by the re-tensioning of mooring lines and cables which connect the floating turbine to the foundations during higher wind speeds (Burns *et al.,* 2022; Risch *et al.,* 2023).

247. The frequency content of operational noise suggests detectability by marine mammals and therefore, could potentially lead to masking of communications or an alteration of their behaviour or distribution (Marmo *et al*., 2013). However, this is a relatively new technology and the noise characteristics and sound levels from different designs of floating WTGs are not fully understood.

248. The majority of the information on WTG operational noise comes from fixed foundation studies (e.g. Tougaard *et al.,* 2020). It is currently considered that the noise radiated from FLOW is likely to be similar to fixed foundation WTGs in terms of noise levels and frequency content. Using proxy information from fixed foundations is therefore considered to be an appropriate estimate for noise levels (Barham and Mason, 2021).

249. Underwater noise propagation modelling was undertaken using an acoustic source level and frequency spectrum based on noise sources from the Erebus ES and Hywind FLOW (Burn *et al.,* 2020; Barham and Mason, 2021) (see **Appendix 21B: Marine Mammal Underwater Noise Modelling**; **Appendix 21C: Marine Mammal Underwater Noise Assessment**). Quantitative assessment was not possible for the intermittent noise generated by the re-tensioning of the mooring lines because frequency spectra data are not available (**Appendix 21B: Marine Mammal Underwater Noise Modelling**) and because the noise levels are thought to be lower than PTS-onset criteria for marine mammals (Burns *et al.,*2022). The measurements taken by Statoil from the Hywind installation (Martin *et al.,* 2011) of the intermittent 'snapping' noise found that less than ten snaps over the two-month period exceeded 160 dB re 1 µPa $SPL_{peak.}$ It is therefore anticipated that the risk of disturbance from intermittent noise leading to avoidance behaviour in marine mammals is unlikely.

250. Modelling has indicated that there is negligible risk to any marine mammal 'functional hearing group' of accruing PTS-onset (less than 10 m impact range). The risk of disturbance is also low with a predicted range of impact for continuous noise (NMFS level B fixed threshold 120 dB re 1 mPa rms) reaching a maximum of 588 m for all marine mammal functional hearing groups (see **Appendix 21B: Marine Mammal Underwater Noise Modelling**).

251. While most species are thought to be capable of hearing the noise output from WTGs, the noise output will be linked to wind speed, and in anything other than calm weather conditions it is likely that the radiating noise will be masked within background noise levels. The low frequency noise emitted from operational wind farms is likely to be of lower impact to all marine mammals with the exception potentially for the LF functional hearing group (Southall *et al.,* 2019) which includes minke whale. An early modelling study (Marmo *et al*., 2013)

suggested that minke whales may be able to detect operational noise from fixed wind foundations up to 18 km in certain circumstances. The circumstances referred to was in very low background noise levels.

252. Harbour porpoise is thought to be generally more sensitive to noise than other species, and as such, Marmo *et al*. (2013) predicted that 10% may show an avoidance response, even at the low received levels. However, the authors concluded that seal and dolphin species are not considered at risk of displacement. Other studies predicted audibility of operational noise for harbour porpoise just beyond 70 m (Tougaard *et al*., 2009) which is far lower than the Marmo *et al*. (2013) modelling study, and likely due to the relative balance of noise radiated and background noise levels in the marine environment.

253. Whilst modelling studies are useful to explore risk, observational studies have recorded harbour porpoise within operational offshore wind farms (e.g. Horns Rev, Teilmann *et al*., 2006; Egmond aan Zee, Scheidat *et al*., 2011) which suggests a lack of a displacement effect for harbour porpoise.

254. Therefore, considering the limited impact ranges predicted for injury and disturbance, and the mobile nature of all marine mammals, any risk of injury and disturbance is likely to be highly localised, short term and not likely to occur.

255. Therefore, the magnitude for PTS-onset has been assessed as **negligible** and the sensitivity of receptors as **negligible**.

256. For disturbance, the magnitude has been assessed as **negligible** and the sensitivity of receptors as low.

257. Therefore, the significance of effect of operational WTF noise for both injury and disturbance is concluded to be of **negligible** significance, which is **not significant** in EIA terms.

Table 21-49. Summary of significance conclusion for operational noise

	Magnitude	Sensitivity	Consequence	Impact significance
PTS-onset risk from operational noise				
All marine mammals	Negligible	Negligible	Negligible	**Not significant**
Disturbance risk from operational noise				
All marine mammals	Negligible	Low	Negligible	**Not Significant**

Barrier Effects from Installation of Mooring Lines and Cables Between Platform and Anchor

258. There is potential for barrier effects to occur to marine mammals from the physical presence of the mooring lines and cables in the water column during the operation stage. The presence of these novel anthropogenic structures may affect the movement of animals and potentially affect access to key habitats, such as for foraging and reproduction, or restrict migratory movements.

259. There is no information specific to barrier effects resulting from floating WTG structures; however, there are several studies which have examined the impact on marine mammals in fixed-turbine wind farms. As noted above, a monitoring programme at the Egmond aan Zee Offshore Wind Farm in the Netherlands reported a significant increase in harbour porpoise activity within the offshore wind farm array compared to the reference area, suggesting no adverse impact on the presence of this species, or their ability to navigate between the WTG structures (Scheidat *et al*., 2011).

260. Long-term monitoring at the Horns Rev and Nysted offshore windfarms in Denmark frequently recorded harbour porpoise and harbour seals within the array area of the operational wind

farms, with populations comparable to pre-construction levels within two years of operation (Diederichs *et al*., 2008). Studies conducted at offshore wind farms in the Netherlands and Denmark also recorded harbour porpoise within the array areas, with potential attraction to the sites due to increased foraging opportunities (Lindeboom *et al*., 2011). Similarly, a tracking study undertaken by Russell *et al*. (2014) in Scotland and the Netherlands demonstrated that harbour and grey seals move between WTGs in a grid-like pattern, and often repeatedly return to the array area potentially for foraging. Studies from parallel industries indicated that the physical presence of FLOW is unlikely to cause a barrier effect (OSC, 2022).

261. The length of marine mammal species scoped in for assessment in this ES Chapter typically range between 1.4-1.9 m for harbour porpoise, to a 7-9 m for a minke whale (Clapham, 2000; Marine Scotland, 2016). The minimum distance between the WTGs will be a minimum of 1140m). The proposed Array Area is also relatively small at 0.05 km^2, meaning that animals can also transit around the proposed Array Area without a significant increase in distance, relative to the large distances regularly travelled by marine mammals. There is also evidence that infrastructure can provide additional foraging opportunities for marine mammals which may negate the potential barrier or displacement effects for some species (Russell *et al.,* 2014).

262. Marine mammals are likely to be able to pass through the proposed Array Area between mooring lines and cables, or instead transit around the Array Area with minimal disruption to transit routes. The presence of marine mammals around offshore infrastructure at other offshore windfarms also suggests that some marine mammal species may have a high tolerance to changes in infrastructure in their environment and are able to adapt to its presence.

263. Therefore, the potential risk of barrier effects occurring has been assessed to be of **negligible** magnitude.

264. Marine mammals are assessed to be of **negligible** sensitivity to barrier effects from the proposed Project.

265. Therefore, the significance of barrier effects during operation and maintenance concluded to be of **negligible** significance, which is **not significant** in EIA terms.

Table 21-50. Summary of significance conclusion for barrier effects from mooring lines and cables

	Magnitude	Sensitivity	Consequence	Impact significance
Barrier effects				
All marine mammals	Negligible	Negligible	Negligible	**Not significant**

Entanglement with Mooring Lines and Cables

266. Inter-array cables and mooring lines connected to the floating WTGs may present an entanglement risk to marine mammals, where animals are unintentionally captured or restrained by anthropogenic materials such as ropes, lines and cables (Benjamins *et al*., 2014). This may occur directly with the cables or mooring lines themselves, or indirectly by entanglement with derelict fishing gear and other marine litter which can become attached to the sub-sea structures of the proposed Project, termed 'ghost-fishing'. Entanglement may occur due to a variety of factors, such as difficulty in marine mammals detecting cables or mooring lines in low light or high turbidity, perception that the structures are a threat, entanglement during pursuit of prey or deliberate approach and encounter of the substructures (Benjamins *et al*., 2014). Entanglement can result in injury or mortality to marine mammals.

267. As the offshore export cable will be buried or laid on the seabed with rock protection, there is not considered to be any pathway for impact for entanglement with this component and so it has not been considered further in this assessment.

268. Smaller cetaceans such as dolphins or porpoises are thought to be less susceptible to entanglement with mooring lines or cables, in comparison to larger cetaceans such as minke whale (Benjamins *et al*., 2014). Approximately half of reported minke whale strandings in Scotland have been attributed to entanglement associated with creel fishing equipment (Northridge *et al*., 2010). It is thought that large cetaceans have less manoeuvrability, and lesser ability to flex their bodies, making them more likely to become entangled, and less able to escape. There is also evidence that whales can become entangled with submarine telegraphic cables (Heezen, 1957; Wood and Carter, 2008) where loose ends or slack cables are able to form a loop which can trap animals passing through (Garavelli, 2020).

269. FLOW is a relatively new technology which is not well understood in terms of potential to impact marine mammals and entanglement events. However, offshore floating oil platforms which use similar mooring structures have been used extensively, with negligible impacts for marine mammals (Morandi *et al*., 2018). At the proposed Project tensioned and catenary spread are in the design envelope both have been widely used widely in the oil and gas industry. The inter-array cables will use a 'lazy wave' configuration, with bend stiffeners and buoyancy devices to maintain appropriate tension as part of the design of the cable (see **Chapter 02: Project Description** for more details).

270. A review of risk from different mooring configurations under different sea states undertaken by Benjamins *et al*. (2014) and Harnois *et al*. (2015) suggest that in all mooring systems examined, including catenary mooring systems as suggested for the proposed Project, the lines were under too much tension for loops to occur. Mooring lines and array cables at the proposed Project will be sufficiently tensioned as part of their design, such that loops are unable to occur, and will occupy a very small cross section of the water column further reducing the risk of entanglement with the mooring lines and cables directly.

271. Therefore, the risk of marine mammals becoming entangled in ghost-fishing gear, should this become attached to the sub-sea structures of the proposed Project, may be more relevant than the risk from mooring lines / cables themselves (Benjamins *et al.,* 2014; OSC, 2022). Entanglement or interaction with ghost-fishing gear has been reported to be a dominant cause of minke whale strandings (Northridge *et al*., 2010). According to the CSIP (2017), between 2011 and 2017, postmortem examinations of stranded animals attributed the cause of death to entanglement for 14.3% of harbour porpoise, 22.5% common dolphin, 4.3% bottlenose dolphin and 34.7% minke whales (as the percentage of animals which underwent a formal postmortem). Lusher *et al*., (2018) reported that 8.2% of the 2,934 cetacean strandings recorded in Irish waters between 1990 and 2015 had signs of entanglement or injury from ghost and/ or active fishing gear. In all these studies entanglement in fishing gear was identified as the likely cause rather than entanglement with larger diameter cables or substructures.

272. Given the design and tension of mooring lines and array cables, they are unlikely to pose an entanglement threat to marine mammals. Although there is a concern for ghost-fishing gear to become attached to the proposed Project mooring lines, array cables and substructures resulting in an entanglement risk. The magnitude of the risk of entanglement is considered to be **small**, because it is anticipated to be of low incidence, or low intensity.

273. However, should entanglement occur, this would result in serious injury or mortality for all marine mammal species. Therefore, the sensitivity to entanglement with mooring lines and cables has been assessed as **high** sensitivity.

274. The significance of the effect from entanglement with mooring lines or array cables during operation due to the area potentially affected and the low likelihood of occurrence is therefore concluded to be **moderate**, which may be **significant** in EIA terms.

Table 21-51. Summary of significance conclusion for entanglement risk from mooring lines and cables and potential ghost gear

	Magnitude	Sensitivity	Consequence	Impact significance
Entanglement risk				
All marine mammals	Small	High	Moderate	**Significant**

275. However, it is worth highlighting that in order to prevent damage to the mooring lines or sub-structure, the proposed Project has committed to regular monitoring to identify any snagged fishing gear or other marine litter, which can then be removed (**Chapter 04: Description of the Project**). This will reduce the likelihood of entanglement for marine mammals at the proposed Project. Consideration of the commitment to regularly monitor and remove any marine litter, would reduce the magnitude conclusion to **Negligible**, resulting in a **minor conclusion** which is **not significant** under EIA regulation.

Effects of Electromagnetic Field (EMF) Emissions

276. EMFs are generated by the electricity transfer from Alternating Current (AC) and Direct Current (DC) and are comprised of an electric field and magnetic field component. EMFs have the potential to alter the behaviour of marine organisms which are able to detect these fields. The majority of research to-date has considered subsea cables which are often buried or have cable protection which separates animals from the EMF source, thus reducing the exposure to EMFs (Copping and Hemery, 2020). However, in FLOWs the inter-array cables can be suspended within the water column and buoyed in mid-water to achieve a ‘lazy wave’ configuration, without any trenching or shielding by sediment or rock armouring which may pose a greater risk to pelagic animals, such as marine mammals. Therefore, this impact has been precautionarily included for assessment.

277. The design of the proposed Project includes up to two electricity export cables transmitting electricity from the wind turbines to the shore over a distance of 49 km. The export cables will be within separate trenches 50m apart with a minimum burial depth of 1.2m. The proposed Project offshore export cable route will require a 150m minimum separation distance from the and project Erebus cables. In addition, there will be inter-array cables linking the WTGs with a total length of up to 17.6km.

278. The highest EMF emissions are expected to occur where the cable crossings are located. However, elevated EMF emissions are expected to be highly localised and cable protection will be used, which will mitigate effects. Dynamic cabling is exposed in the water column; however, it is anticipated that EMF effects are reduced to negligible at a distance of 2m from the cable **(Chapter 24: Fish and Shellfish).** Some cetacean species may be able to detect variations in magnetic fields (Normandeau Associates Inc., 2011; OSC, 2022), however, marine mammals are considered to be less sensitive to EMFs than electro-receptive species such as elasmobranchs which may utilise natural EMFs during migration, orientation and prey location (Copping and Hemery, 2020). Whilst there is limited evidence of marine mammals’ detection (Taormina *et al*., 2018), there is no evidence to support whether EMFs from marine renewable

energy devices or subsea cables have any adverse impact on marine mammals. Any detection of EMF is likely to only occur in close proximity to the cables (approx. 50 m; OSC, 2022), and given the highly mobile nature of marine mammals, animals are unlikely to remain in close proximity to the cables or array for any significant length of time (Copping and Hemery, 2020; OCS, 2022). Therefore, impact from EMF emissions for all marine mammals is expected to be minimal.

279. The magnitude of the impact has been assessed as **negligible** due to limited range of effect.

280. The sensitivity of marine mammals has been assessed as **low** as it is anticipated that marine mammals are likely to be able to adapt their behaviour and tolerate the effect with no impact to survival or reproductive rates.

281. Therefore, the significance of the effect from EMF emissions is concluded to be of **negligible** significance, which is **not significant** in EIA terms.

Table 21-52. Summary of significance conclusion for EMF emission risk

	Magnitude	Sensitivity	Consequence	Impact significance
EMF				
All marine mammals	Negligible	Low	Negligible	**Not significant**

Airborne Sound and Visual Disturbance (Pinnipeds Only)

282. As in the construction stage (**Section 21.9.1**), there is potential for disturbance to hauled-out grey seals during operation from maintenance activities associated with the export cable in the nearshore area to the landfall, or at the landfall site itself.

283. However, the potential for disturbance during maintenance is considered to be less during the construction stage. If required, any maintenance works to the export cable, are anticipated to be on small, isolated sections and for much shorter durations than the installation itself during construction. Therefore, the assessment of sensitivity and magnitude for hauled-out grey seals in **Section 21.9.1** are also considered to be adequate to cover the worst-case disturbance during the operation and maintenance stage and is not repeated here.

284. The significance of effect for airborne sound and visual disturbance during operation and maintenance is also not significant under EIA regulations.

Collision with Project Vessels

285. As in the construction stage (**Section 21.9.1**) there may be an increase in vessel activity from operation and maintenance vessels. As described in **Section 21.9.1**, the proposed Project site already experiences high levels of vessel traffic (further detailed in **Chapter 25: Shipping and Navigation**). Therefore, the introduction of additional vessels during the operation and maintenance stage is not a novel impact for marine mammals which are present in the area.

286. Up to 168 additional transits are anticipated to be made by operation and maintenance vessels for over the 25-year operational lifetime of the proposed Project, with a maximum of 12 vessels consecutively at the site. However, a proportion of vessels would be stationary or slow moving for significant periods and would therefore pose a low collision risk.

287. Given the lower number of vessels and vessel passes estimated, the risk of vessel collision during operation and maintenance is predicted to be analogous with, or less than, that of the construction stage. Therefore, the assessment of the sensitivity of each receptor, and the magnitude of the potential impacts due to collision risk during construction in **Section 21.9.1** also applies during the operation and maintenance stage and is not repeated here.

288. As per **Section 21.9.1**, vessel activity during the operation and maintenance stage will also be managed under a vessel management plan, as part of the proposed Project's Management Plans (**Section 21.8**).

Accidental Pollution or Contamination

289. The potential impact to marine mammals from accidental pollution or contamination during operation and maintenance is considered analogous with, or less than, that of the construction stage, with up to 168 additional transits anticipated to be made during operation and maintenance. The assessment of accidental pollution or contamination during construction in **Section 21.9.1** also applies here.

290. The significance of the effect for accidental pollution or contamination from with Project vessels during operation is concluded be of **minor significance**, which is **not significant** in EIA terms.

Potential for Indirect Effects through Impacts to Prey Species

291. It is unlikely that operation and maintenance activities will result in a negative impact on marine mammal prey species. The presence of FLOW structures could function as artificial reefs which may result in increased foraging opportunities. At Egmond aan Zee, echolocation activity (harbour porpoise) was noted to be higher than pre-construction (Scheidat *et al.,* 2011), and seal behaviour suggested targeted foraging around the offshore wind farm (Russell *et al.,* 2014). Therefore, there is the potential for a positive effect on prey species.

21.9.3 Decommissioning Effects

292. At the time of application, there is no detailed decommissioning information to inform a specific impact assessment for this stage. Decommissioning activities are broadly expected to be a reversal of the installation process. It is assumed that all infrastructure will be removed.

293. The likely potential impacts from decommissioning would be, underwater noise due to the removal of structures, underwater noise due to vessel activity, collision risk from vessel activity, accidental pollution or contamination and the potential for indirect effects through impacts to prey species.

294. The maximum noise levels generated are likely to be from the cutting of the piles as needed, this will have far less noise than impact piling. Typical methods for cutting are abrasive wire cutters, or diamond wire cutting. The choice of equipment will be made at the time, based on the best available technology.

295. In addition to the cutting of the piles, other activities likely to be needed include vessel activity used to tow WTGs from the site. Vessel involved with the pin pile cutting. ROV inspection of the FLOW infrastructure, and removal of any debris.

296. Data is scarce on the noise levels, or disturbance effects from decommissioning activities. However, a recent study (Fernandez-Betelu et al, 2024) has just published results from the monitoring of the decommissioning of an oil and gas platform. With the aim to characterise the underwater noise generated, and to investigate any changes in harbour porpoise behaviour. The total removal of the platform was monitored, and this included cutting, drilling, and vessel activity.

297. The study found that vessel noise was the main source of sound, and that porpoises were displaced less than 2 km and returned to the area as soon as the vessels departed. There was no significant difference in the sound pressure levels from the other decommissioning activities, such as cutting, drilling, and ROV. They conclude that any noise produced by these other activities, was likely to have been masked by the vessel noise.

298. Regarding the potential collision risk from vessel activity, the supporting information and conclusions from construction and operational phases (**Section 21.8**) are relevant to the decommissioning activity, and therefore not repeated here. It is not expected that an increase in vessel activity will increase the risk of collision for any marine mammal considered in this Chapter.

299. The risks of accidental pollution and contamination and indirect effects to prey species from decommissioning are likely to be at worst, the same as for construction and operation, but more realistically likely to be less, due to the time frame for decommissioning being far shorter than for construction. Any effect would be limited in space, and temporary in effect.

300. The exact methods for decommissioning are unknown, therefore qualitative assessment of PTS-onset and disturbance cannot be undertaken. However, given the nature of decommissioning of FLOW structures overall, it is likely that the impacts will be analogous to construction activities, or more likely less than.

301. Marine mammal sensitivity remains consistent with construction impacts already assessed.

Risk of auditory injury (PTS-onset)

302. The risk of auditory injury (PTS-onset), as noise from vessel activity is the main contributor, sensitivity is **low** and the magnitude is **negligible,** therefore the significance of effect is **negligible**, which is not significant under EIA Regulations.

Risk of Disturbance

303. The risk of disturbance from any activity is concluded to be of **low** sensitivity, and **negligible** magnitude due to localised and temporary effects, with full recovery once vessels have departed. Therefore, the significance of effect is **negligible**, which is not significant under EIA Regulations.

304. The risks of accidental pollution and contamination is concluded to be of **medium** sensitivity, with small magnitude of impact, therefore the significance of effect is **minor**, which is **not significant** under EIA Regulations.

Indirect effects from impacts to prey species

305. Indirect effects from impacts to prey species, have been assessed as **low** significance, and **negligible** magnitude, therefore, the significance of effect is **negligible**, which is **not significant** under EIA Regulations.

306. A Decommissioning Programme will be developed in accordance with the standard industry practice at that time and approved prior to the commencement of any decommissioning activities and secured as a condition of the Marine Licence. This may be accompanied by a MMMP and / or VMP specific to the decommissioning stage, as required by statutory advisers and the Regulator at the time. Further, should it be necessary, a Marine Mammal Mitigation Plan will be implemented subject to the decommissioning Marine Licence application.

21.10 Summary of Additional Mitigation Measures

307. For activities, such as impact piling, pre-construction surveys and UXO clearance, the impact significance has been assessed as **not significant** in EIA terms. However, there is a residual risk to individual animals. All cetaceans are EPS and therefore mitigation will be required to minimise any injury risk to negligible.

308. The Applicant has committed to the development of MMMP; these will be based on JNCC guidance (JNCC, 2017; 2020a; 2020b). Further, for UXO clearance activities, the Applicant has committed to the prioritisation of low-order methods. The MMMP will be agreed via

consultation with stakeholders and the Regulator during EPS license applications. The Outline MMMP is presented in **Appendix 4A: Outline Construction Environmental Management Plan.**

309. The only activity assessed with a potential residual risk was the risk of entanglement with ghost gear. However, to mitigate this risk the Applicant proposes regular inspections of moorings and cables (**Chapter 04: Description of the Project**), and the subsequent removal of ghost gear will reduce the likelihood of entanglement occurring. This would then reduce the conclusion of significance to **minor,** and therefore would **not be significant** in EIA terms.

21.10.1 Monitoring

310. As noted in the section above, regular inspection of the moorings and cables will be required as standard (**Chapter 04: Description of the Project**). Details to be agreed within the Operational CEMP.

311. Underwater noise will be monitored within both the construction phase and the operational phase. A noise monitoring plan will be consulted upon and agreed with the statutory advisors and the Regulator. This will include noise monitoring of, impact piling (if utilised), of UXO clearance events and of operational noise as there are so few data on FLOW systems in operation and used to validate the conclusions of this Chapter**.**

21.11 Summary of Effects and Conclusions

312. This **Chapter** of the ES has assessed the potential environmental effects on marine mammals from the construction, operation and maintenance, and decommissioning phases of the proposed Project. There were no significant effects predicted. **Table 21-53** summarises the impact assessment undertaken and confirms the significance of any effects, following the application of additional of additional mitigation.

Table 21-53. Summary of effects and significance conclusions (JNCC guidance - JNCC, 2010b; 2010c; 2017)

Potential Impact	Receptor	Receptor Sensitivity	Magnitude of Impact	Significance of Effect	Additional Mitigation	Residual Significance of Effect
Construction						
PTS-onset risk from pre-construction geophysical survey	All marine mammals	Medium	Negligible	Negligible	**JNCC guidance**	Not significant
Disturbance risk from pre-construction geophysical surveys	All marine mammals	Low	Negligible	Negligible	None required	Not significant
PTS-onset risk from UXO Clearance	Common dolphin Bottlenose dolphin Harbour porpoise Grey seal	Medium	Negligible	Negligible	**JNCC guidance**	Not significant
PTS-onset risk from UXO Clearance	Minke whale	High	Negligible	Minor	**JNCC guidance**	Not significant
Disturbance risk from UXO Clearance	All marine mammals	Low	Negligible	Negligible	None required	Not significant
PTS-onset risk from Impact piling	All marine mammals	Medium	Negligible	Negligible	**JNCC guidance**	Not significant
Disturbance risk from impact piling	Harbour porpoise Grey seal Bottlenose dolphin Minke whale	Low	Negligible	Negligible	None required	Not significant
	Common dolphin	low	Medium	Minor	None required	Not significant
PTS-onset risk from 'other' construction activities	Common dolphin Bottlenose dolphin Harbour porpoise Grey seal	Low	Negligible	Negligible	None required	Not significant
	Minke whale	Medium	Negligible	Negligible	None required	Not significant

Potential Impact	Receptor	Receptor Sensitivity	Magnitude of Impact	Significance of Effect	Additional Mitigation	Residual Significance of Effect
PTS-onset risk from ‘other’ construction activities	Minke whale	Medium	Negligible	Minor / Negligible	None required	Not significant
Disturbance risk from ’other’ construction activities	All marine mammals	Low	Negligible	Negligible	None required	Not significant
PTS-onset risk from vessel activity	All marine mammals	Low	Negligible	Negligible	None required	Not significant
Disturbance risk from vessel activity	All marine mammals	Low	Negligible	Negligible	None required	Not significant
Disturbance risk from airborne sound and visual disturbance	Grey seals (only)	Low	Small	Negligible	None required	Not significant
Collision with Project vessels	All marine mammals	High	Small	Minor	None required	Not significant
Accidental pollution or contamination	All marine mammals	Medium	Small	Minor	None required	Not significant
Indirect effects from impacts to prey species	All marine mammals	Low	Negligible	Negligible	None required	Not significant
Operation and Maintenance						
PTS-onset risk from operational noise	All marine mammals	Negligible	Negligible	Negligible	None required	Not significant
Disturbance risk from operational noise	All marine mammals	Low	Negligible	Negligible	None required	Not significant
Barrier effects	All marine mammals	Negligible	Negligible	Negligible	None required	Not significant
Entanglement risk	All marine mammals	High	Small	Moderate	**Mooring and cable monitoring**	Not significant
Electromagnetic Field mission risk	All marine mammals	Low	Negligible	Negligible	None required	Not significant

Potential Impact	Receptor	Receptor Sensitivity	Magnitude of Impact	Significance of Effect	Additional Mitigation	Residual Significance of Effect
Disturbance risk from airborne sound and visual disturbance	Grey seals (only)	Low	Small	Negligible	None required	Not significant
Accidental pollution or contamination	All marine mammals	Medium	Small	Minor	None required	Not significant
Decommissioning						
Any potential impacts are considered to be analogous or less that those during the construction phase.						
The risk of Auditory injury (PTS-onset) from underwater noise due to the removal of structures, underwater noise due to vessel activity	All marine mammals	Low	Negligible	Negligible	None required	Not significant
Disturbance risk from vessel activity	All marine mammals	Low	Negligible	Negligible	None required	Not significant
Accidental pollution or contamination	All marine mammals	Medium	Small	Minor	None required	Not significant
Indirect effects from impacts to prey species	All marine mammals	Low	Negligible	Negligible	None required	Not significant

21.12 Cumulative Effects of the Project

21.12.1 Introduction

313. Cumulative effects are those effects upon receptors arising from the proposed Project alongside all existing, and / or reasonably foreseeable projects, plans and activities that result in cumulative effects with any element of the proposed Project. Existing projects are generally considered as part of the baseline and as such are considered within the impact assessment presented in **Section 21.9** above.

314. This section assesses potential cumulative effects on marine mammals from identified projects, plans and activities that have the potential to act cumulatively with the proposed Project.

315. PINS Advice 17: Cumulative Effects Assessment (2019) suggests that CEA follows a four-stage process. The aim of this approach is to accurately determine relevant projects and associated relationships with scoped in receptors identified in the ES, to be included within the interproject CEA.

316. The approach to the assessment of cumulative effects is detailed in **Appendix 5A: Approach to Cumulative Effects Assessment** and is also summarised in **Table 21-54.**

Table 21-54. PINS Advice Note 17 : Stages of the CEA process

CEA Stage	Activity
Stage 1	Determine a zone of influence (ZoI) via desk study for each topic receptor scoped into the **ES**. This will establish a *long list* of projects within each ZoI that will be shortlisted in Stage 2. This list of plans and projects / activities is drawn up through a desk study of planning applications, development plan documents, relevant development frameworks and any other available sources to identify 'other development' within the ZoI. Information on each project (location, development type, status, etc.) is documented, along with the certainty or tier assigned to the 'other development' (i.e. confidence it will take place in the current form and when it will take place in relation to the project). PINS notes that the project should then consult with the relevant planning authority / authorities and statutory consultees regarding the long list.
Stage 2	Screening of the long list identified in Stage 1, to establish a short list for the CEA. Screening is based on the criteria presented in the scoping report and subsequent comments by the Regulator and statutory consultees. PINS has provided inclusions / exclusion threshold criteria, against which the potential for 'other development to give rise to significant cumulative effects by virtue of overlaps in temporal scope, the scale and nature of the 'other developments' and / or receiving environment, or any other relevant factors is assessed. From this assessment, a shortlist of 'other developments' to be included in the CEA is produced. It is noted that documented information on each of the 'other developments' is likely to be high level at this stage, outlining the key issues to take forward.
Stage 3	Gathering of all information available on short listed projects generated in Stage 2. At this stage all available data and information about the shortlisted projects that will be included in the CEA is collected to inform the assessment. This should utilise the most current information for each project in the public domain and assess the assumptions and limitations of the information collected on each shortlisted project.
Stage 4	Each of the shortlisted projects are reviewed in turn by the different topics to assess whether cumulative effects may arise and the nature of those effects (i.e. beneficial or adverse). The significance of the effects on environmental receptors

CEA Stage	Activity
	is established within each **ES** technical chapters. Where significant adverse cumulative effects are identified, mitigation measures are also considered within the CEA alongside the mechanism to secure that mitigation, e.g. consent condition requirements.

21.12.2 Scope of Cumulative Effects Assessment for Marine Mammals

317. An initial long list of projects which have the potential for a cumulative effect with the proposed Project has been produced and is presented in **Appendix 5A: Approach to Cumulative Effects Assessment**. The assessment has considered projects and information available up to 31 October 2023.

318. The following offshore plans and projects have been considered in the CEA for marine mammals:

- marine renewables (wind, wave and tidal);
- port and harbour developments;
- marine aggregate extraction and dredging;
- licensed disposal sites;
- oil and gas exploration and extraction; and
- subsea cables and pipelines.

319. The CEA for marine mammals has screened in existing and proposed projects within the species-specific MUs (as per **Section 21.5**) with the exception of common dolphin and minke whale, where it was agreed with NRW (A) (advice note received 23 May 2023; **Table 21-4**) that the Celtic and Irish Sea MU could be used to provide a more proportionate approach to assessment.

320. The long list of projects (as per **Appendix 5A: Approach to Cumulative Effects Assessment**) has been reviewed to produce a short list to be taken forward into the marine mammal CEA. Projects screened out included,

- project, plan or activity included as part of the baseline environment and hence, not a consideration in the CEA;
- project, plan or activity with low data confidence[9] (i.e. meaningful assessment could not be undertaken);
- project, plan or activity where no potential impact-receptor pathway exists;
- project, plan or activity with no potential for a spatial effect interaction (i.e. for marine mammals all projects located outside of the Celtic and Irish Sea MU, Offshore Channel and SW England and OSPAR Region III); and / or
- project, plan or activity with no potential for a temporal effect interaction.

321. Therefore, project types identified in the long list, that have been screened out for this assessment are presented in **Table 21-55**.

[9] Where there was limited information or not enough certainty to carry out the cumulative appraisal, these projects have been scoped out. It should be noted that best efforts have been made to either source publicly available information or contact appropriate developers prior to the decision to scope out a project based on lack of information. This process is in line with the guidance (MMO, 2014) and ensures that only cumulative effects for which there is a high degree of confidence are appraised.

Table 21-55. Screened out project types from the long-list of CEA

Project type	Rationale
Maintenance dredging and disposal	Impacts considered were: • Collision with vessels; • Vessel noise; • Localised sediment plumes, and • Behavioural reaction. Collision is considered unlikely due to slow vessel speeds; any behavioural reaction is considered to be highly localised and temporary. Long list examples all commenced prior to Baseline assessment and were therefore scoped out.
Aggregate extraction	Longlist examples all commenced prior to Baseline assessment and therefore were scoped out.
Oil and Gas	Oil and Gas activities (Irish Sea) in operation prior to Baseline (exploration via seismic surveys included).
Military, aviation, and radar	Present and operational prior to Baseline.
Coastal developments	This includes harbour developments. Key noise impacts include dredging, and impact / pile driving. Injury impacts are reduced to negligible with the employment of standard JNCC mitigation guidelines. Two developments were identified in the longlist. • The Port of Mostyn Marine Energy Park[10] has consent to construct a quay wall (impact and vibro-piling) and capital dredge and disposal. The ES concluded no significant impact to any marine mammal from this activity. • The Pembrokeshire Dock Slipway[11] works includes improvements to the slipway. Construction commenced in August 2022, and is anticipated to be finished by 2024. Slipway construction is not likely to present a significant impact to marine mammals as this activity is typically highly localised in terms of noise impacts to the surrounding marine environment. Therefore, any cumulative impact from coastal developments is not expected, and therefore excluded from further assessment.
Wave energy developments	All projects identified in the longlist were either in planning with no further update, or test devices that have completed the testing phases. The three META projects identified (East Pickard Bay, Dale Roads and Warrior way) all relate to close to shore wave and wind test sites, these were excluded due to lack of impact pathway, due to locations close to shore, within Milford Haven and Pembroke Dock. These therefore represent small scale projects with low potential for marine mammals' interaction.
Tidal barrage/lagoon	All projects identified in the longlist were either in planning or development, but no further information available. This includes Swansea Bay, which has been consented, but not progressed to date.
Interconnector Projects	The Greenlink interconnector project is consented, and due to be installed between Pembrokeshire and Hook Head Peninsula, County Wexford. It is predicted to be fully installed by the end of 2024. There is therefore no temporal overlap between this project and the proposed Project's construction. Although potentially within the ± 1year window, consent documentation indicate that provided the agreed marine mammal mitigation is adhered to, there will not be any significant impact

[10] https://publicregister.naturalresources.wales/ [Accessed: 14 November 2023]
[11] https://www.pembrokeport.com/about/pembroke-dock-marine/pembroke-dock-marine-slipway-pontoon-construction-information [Accessed: 14 November 2023]

Project type	Rationale
	to marine mammals. It is assumed that all pre-construction activities (geophysical surveys) have been completed. Disturbance impacts to marine mammals from the cable laying activity is possible; however, this is likely to be localised and temporary, no greater than from the vessel activity itself, and completed prior to this proposed Project's construction timeline. Therefore, no cumulative impact is anticipated. The Celtic Interconnector is an electricity connection between Ireland and France. Construction is underway and due to be completed and fully operational by 2027. As such there is temporal overlap with the proposed Project. The cable will either be buried or laid on the seabed and covered for protection. The overall schedule of cable lay is 139 days (excluding inclement weather or mechanical breakdown). There is potential for disturbance to marine mammals caused by the cable lay vessel activity, however, as above, this is unlikely to be greater than that caused by the vessel itself, and so will be a localised and temporary effect. Therefore, no cumulative impact is anticipated.
Tidal stream developments	Potential impacts to marine mammals from tidal stream projects are displacement, disturbance and collision during operation, and noise impacts during construction, operation and decommissioning. Two tidal stream projects have been identified as spatially and potentially temporally relevant: Ramsey Sound TIGER and Morlais Orbital O2. 1. Ramsey Sound TIGER project has a marine licence for 1.4 MW capacity. Previously, the Tidal Energy Ltd (TEL) Deltastream was deployed at the site; however, the project has not been progressed as TEL went into administration. The TIGER project has taken over the lease area and seeks to remove the Deltastream device, and subsequently deploy a new device at the site. However, there is no further information pertaining to this TIGER development, and therefore cannot be taken forward to CEA. 2. Morlais Orbital O2 is a consented tidal energy development site. Consent for the site was awarded in December 2021 with the intention to deploy the first tidal devices in 2026. The tidal stream company Orbital Marine Power (Orbital) has signed an agreement with Menter Môn Morlais Ltd to demonstrate the Orbital O2 2 MW devices at this site. However, there is no further detail in terms of deployment dates and duration available and therefore cannot be taken forward to CEA.

322. Several potential impact pathways considered for the proposed Project alone have not been taken forward to cumulative assessment, where the impact is anticipated to be highly localised, or where the Applicant has committed to management or mitigation measures that will reduce the risk of the impact occurring. The impact pathways not taken forward to the CEA are detailed in **Table 21-56** below, together with the rationale for exclusion:

Table 21-56. Impact pathways Screened out of CEA

Impact Pathway	Rationale
Auditory injury (PTS-onset)	PTS-onset may result from pre-construction geophysical surveys, impact piling and UXO clearance activities. In all cases, the effects have been assessed as not significant under EIA regulations. Further, the Applicant has committed to applying mitigation to reduce the injury risk to negligible based on JNCC standard mitigation guidelines, to be agreed

Impact Pathway	Rationale
	within MMMP (**Table 21.15**; **Section 21.8**); All cetaceans are protected under European Protect Species legislation, and therefore mitigation will be required to reduce the risk of injury to negligible. Mitigation applied, will also protect seals This requirement for mitigation will apply to all consented Plans and Projects, and therefore there is no potential for auditory injury to combine to result in a significant impact.
Wind turbine operational noise	Available evidence has shown that any impact resulting from operational noise has negligible effect. The range of impact is likely to be localised, due to the noise levels produced, and the interaction with existing environmental noise (**section 21.9.2**).
Disturbance from UXO clearance	The noise resulting from a clearance event is short lived in the environment, i.e. in the order of seconds (Robinson et al., 2022). Further, Southall et al. (2007) state that “due to the transient nature of a single pulse, the most severe behavioural reactions will usually be temporary responses, such as a startle, rather than prolonged effects such as modified habitat utilization”. Therefore, any disturbance will be temporally limited, with negligible impact and so unlikely to combine to result in a cumulative significant effect.
Airborne sound and visual disturbance for pinniped species	Airborne sound and visual disturbance from array construction and vessel activity, is localised and assessed as negligible impact. Seals have been shown to avoid construction during impact piling but have also been shown to return shortly after the activity has ceased. Due to rapid recovery to pre-construction activity, together with the scale of the OSPAR III management unit, there is no scope for this impact pathway to combine into a cumulative impact. In-combination impacts to hauled out grey seals has been assessed in **Appendix 08E: HRA RIAA**.
Collision with vessels	The project alone assessment concluded this risk to be negligible, based on a combination of the likely size and speeds of vessels used together with the known agility of all marine mammals likely to be within this area. Individually, this is a low risk, and therefore unlikely to combine to result in a cumulative impact. Further, it is expected that all offshore projects considered in the CEA will include the commitment to a vessel management plan, and / or follow best practice guidelines in order to reduce the collision risk to negligible.
Accidental pollution or contamination	This has been assessed as localised and negligible. The amount of fuel held in the vessels used in offshore development is relatively small and so in the unlikely event of an accidental release of pollutants, it is predicted that it would be localised, of short-term duration and low intensity. Further, it is expected that all offshore projects considered in the CEA will be required to commit to mitigation measures that minimise the risk of accidental pollution through the PEMP.
Potential for indirect effects through impacts to prey species	This has been assessed as having negligible impact significance. Any negative impact during construction is likely to be highly localised in time and space. During operation, there is potential for a positive impact should the presence of offshore development structures become areas of increased productivity. Further, given all marine mammals likely to be within the area are wide ranging and considered generalist feeders.
Barrier effects from moorings and cables	This impact pathway exists for FLOW projects only. For the proposed Project alone, the conclusion is that this impact pathway is of negligible impact. Only five of the 16 projects considered (**Table 21-58**) are FLOW and therefore the consideration of the available environment in relation to the area taken up by the FLOW, indicates that there is no significant loss of space within the Celtic and Irish Sea, that would result in a cumulative barrier effect.

Impact Pathway	Rationale
Entanglement with mooring lines and cables.	This impact pathway exists for FLOW projects only. The risk to marine mammals from primary entanglement (moorings and cables) is thought to be minimal because the cables and moorings are often taut and of a diameter large enough to preclude entanglement (Benjamins et al., 2014; Maxwell et al., 2022). A secondary entanglement risk exists should lost or discarded fishing gear become caught on the cables and moorings. The likelihood of this occurring is low. Having debris caught on the FLOW structures, would add load to the structures themselves, therefore it is likely that all FLOW projects will put in place regular inspections, and removal of any ghost gear found. There is little risk of entanglement combining to result in a significant cumulative impact.
Electromagnetic Field Emissions (EMF)	The project alone concluded that any potential impact would be localised with negligible impact. Any detection of EMF is likely to only occur in close proximity to the cables (approx. 50m; OSC, 2022), and given the highly mobile nature of marine mammals, individuals are unlikely to remain in close proximity to the cables or array for any significant length of time (Copping and Hemery, 2020; OCS, 2022). Therefore, cumulative impact from EMF emissions is not expected.

323. The potential impact pathways that have been considered further within the marine mammal CEA are as follows:

- disturbance arising from underwater noise during construction of offshore renewable energy projects; and
- the potential for disturbance from vessel activity during pre-construction, construction, operation and maintenance, and decommissioning.

324. The identified plans and projects have been allocated into tiers in order to reflect the current state within the planning and development process, the Tiers and definitions are detailed in **Table 21-57**.

Table 21-57. Tier allocation process used for screening in projects

Tier	Definition
1	Operational and under construction projects which were not in place when baseline data were collected; projects with a legally secure consent (not in hold due to Judicial Review) and have been awarded CFD, but not yet implemented. Any due to be commissioned prior to the construction, but with an ongoing impact not considered in the baseline.
2	Legally secure consent – but no CFD – uncertainty regarding the timeline.
3	Application submitted but not yet determined.
4	Projects expected to be submitted for application, but still at the development stage. However, some information may be available in order to assess potential for CEA.

325. The short-listed projects used in this CEA are detailed **Table 21-58**. Listed projects included varied levels of information depending on the current stage in the development process. Therefore, it is probable that construction and technology disclosed in the early stages are refined. It is also possible that not all projects detailed in the short list will reach the construction phase. Therefore, there exists significant uncertainty in the timelines for all projects taken forward to CEA.

326. This CEA will focus on those offshore wind projects that overlap with the proposed Project's construction timeline together with one year before, and one year following (± 1year). This has therefore included all projects being constructed between Q3 2024 and Q3 2027.

Table 21-58. List of projects short listed for the marine mammal cumulative effects assessment

Project Name / Developer	Project Type	Tier	Status	Approx. Distance and direction from the proposed Project	
				Array Area	OfECC
Seismic surveys Irish Sea	Seismic Survey	1	Ongoing	Irish Sea	Irish Sea
Seismic surveys Celtic Sea	Seismic Survey	1	Ongoing	Celtic Sea	Celtic Sea
Twin Hub	Offshore Wind	2	Consented	102 km SW	102 km SW
Erebus	Offshore Wind	2	Consented	5 km NW	5 km NW
Awel y Mor	Offshore Wind	2	Consented	251 km NE	214 km NE
South Irish Sea Array	Offshore wind	3	Application submitted	137 km NW	115 km NW
White Cross	Offshore Wind	3	Application submitted	19 km SE	17 km SE
Codling Wind Park	Offshore Wind	4	Pre-App	188 km NW	160 km NW
Cooley Point (now Clogherhead)	Offshore Wind	4	Pre-App	263 km NW	236 km NW
North Irish Sea Array	Offshore Wind	4	Pre-App	252 km NW	224 km NW
Morgan	Offshore Wind	4	Pre-App	314 km NE	277 km NE
Arklow Bank 2	Offshore Wind	4	Pre-App	330km NE	280km NE
Mona	Offshore Wind	4	Pre-App	289 km NE	251 km NE
Dublin Array	Offshore Wind	4	Pre-App	207 km NW	181 km NW
Morecambe	Offshore Wind	4	Pre-App	305 km NE	267 km NE
Petroc	Offshore Wind	4	Pre-App	39 km S	39 km SE
North Celtic Sea	Offshore Wind	4	Pre-App	214km NW	216km NW
Rampion 2	Offshore Wind	4	Pre-App	342 km SE	327 km SE

327. Two project types remain for quantitative assessment, these are potential seismic surveys and the short list offshore wind projects.

21.12.3 Cumulative Effect Assessment (CEA)

Disturbance Arising from Underwater Noise During Construction of Offshore Renewable Energy Projects

328. The key potential cumulative impact from offshore wind projects is an accumulated behavioural response from activities generating underwater noise. During construction, this primarily would include any impact piling and any increased disturbance due to increased vessel movements. Construction is the development phase for CEA, as this is the phase where the greater potential for noise impact can occur. Operational noise for marine mammals has been assessed as negligible impact. Decommission noise impacts can be included they are likely to occur during the CEA assessment timeframe window.

329. This section presents the CEA for each of the key species; harbour porpoise, common dolphin, bottlenose dolphin, minke whale, and grey seal. **Figure 21-7** details the management units used for this assessment, together with the short-listed projects within these MUs.

330. Those projects identified for CEA have been selected on the basis that they have concurrent activity (construction/decommissioning) ± 1year of the construction activity period for the proposed Project. The projects included are therefore between Q3 2024 and Q3 2027. Operational noise impacts are not included in the CEA, as these have been concluded to be limited in space, and therefore not likely to become a cumulative impact. This assessment has focused on the impacts with the greatest potential to accumulate, primarily during construction.

331. As agreed with NRW(A) (advice note received 23 May 2023; **Table 21-5**), identified projects within the OSPAR Region III have been used for grey seals, the Offshore Channel, Celtic Sea and South West England MU has been used for bottlenose dolphins, and the Celtic and Irish Seas MU has been used for harbour porpoise, common dolphin and minke whale (as agreed with NRW (A) (advice note received 23 May 2023)).

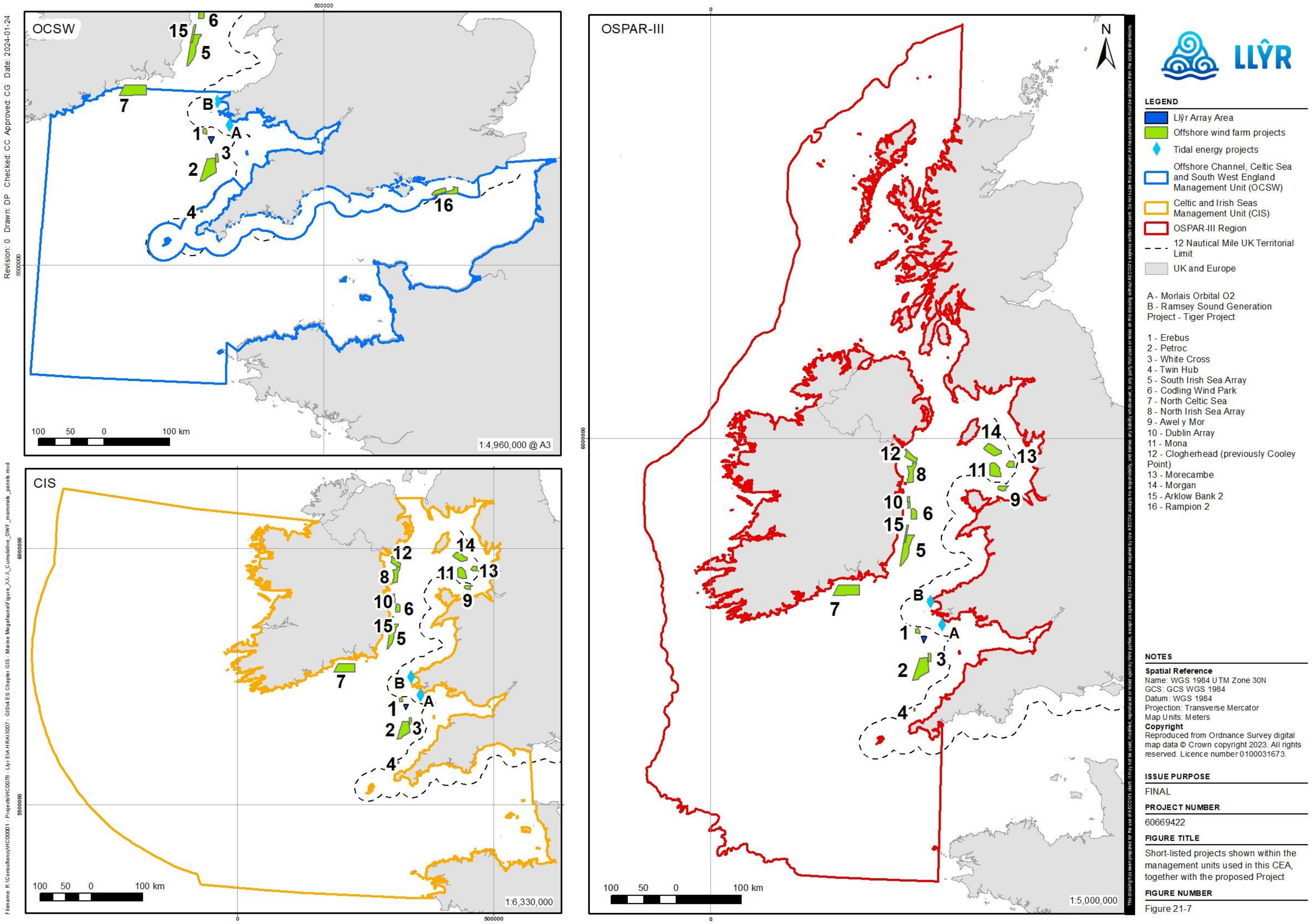

Figure 21-7. Short-listed projects shown within the MUs used in this CEA, together with the proposed Project Array Area

Assumptions Made in CEA

332. There is no consistent approach within impact assessments for offshore wind farm EIAs. This means that disturbance is assessed using a variety of methodologies and impact thresholds (i.e. various fixed noise thresholds and dose response curves). Therefore, the numbers of animals predicted to be at risk of disturbance is not directly comparable between projects. Consequently, for the purposes of this CEA, the approach taken has been to follow the advice in JNCC (2020) and use the standard Effective Deterrence Ranges (EDR) (**Table 21-59**). Whilst these EDRs were developed for harbour porpoise, they have conservatively been used for all species in the absence of any species-specific EDRs. Using this approach has the benefit of standardising the methodology across all projects in order to assess the level of cumulative risk. Further, this approach is consistent with other projects CEA in the Celtic and Irish Seas (e.g. Awel y Môr and Erebus).

Table 21-59. Recommended Effective Deterrence Ranges (EDRs) reproduced from JNCC (2020)

Activity	EDR (km)	References
Monopile	26	Tougaard *et al.,* 2013; Dähne *et al.,* 2013
Pin-pile	15	Graham *et al.,* 2019
Seismic (airguns)	12	Thompson *et al*., 2013; Sarnocińska *et al.,* 2020

333. A summary of the offshore wind farm projects taken forward to quantitative assessment are detailed in (**Table 21-60**) together with the key assumptions used for the estimation of disturbance radii.

Table 21-60. Summary of offshore wind projects assessed in CEA, together with key parameters

Project	location	Foundation type	Installation period
Erebus	Celtic Sea 35km SW from Pembrokeshire coastline 5km NW from the proposed Project	FLOW 6 – 10 WTGs Pin pile (15km EDR)	June 2026- October 2026
Petroc	Celtic Sea Devon/Cornwall	FLOW 75 WTGs Pin pile (15km EDR)	From 2027
White Cross	Celtic Sea North Devon	FLOW 5 – 8 WTGs Pin pile (15km EDR)	2026 - 2027
TwinHub	Celtic Sea WaveHub site; Cornwall	FLOW 2 WTGs Pin pile (15km EDR)	2026
South Irish Sea Array	Irish Sea Wexford and Co Wicklow	Fixed 40-60 WTGs Monopile (26km EDR)	2026

Project	location	Foundation type	Installation period
Codling Wind Park	Irish Sea Dublin	Fixed 100 WTGs Monopile (26km EDR)	2026-2028
North Celtic Sea Array	Irish Sea Dublin	Fixed 35 – 46 WTG Monopile (26km EDR)	2026-2028
Awel y Mor	Celtic Sea North Wales	Fixed 34-50 WTGs Monopile (26km EDR)	2027-2029
Dublin Array	Irish Sea	Fixed 39-50 WTGs Monopile (26km EDR)	2026-2028
Mona	Celtic Sea	Fixed 96 WTGs Pin pile (have removed monopile option) (15km EDR)	2026-2027
Clogherhead	Irish Sea	Fixed 48-58WTGs Monopile (26km EDR)	2027-2028
Morecambe	Irish Sea	Fixed 40 WTGs Monopile (26km EDR)	2026-2028
Morgan	Irish Sea	Fixed 96 WTGs Pin pile (have removed monopile option) (15km EDR)	2026-2028
Arklow Bank 2	Irish Sea	Fixed 36-60 WTGs Monopile (26km EDR)	2027-2028
Rampion 2	English Channel	Fixed 90 WTGs Monopile (26km EDR)	2025-2027(?)

334. In addition to offshore wind farm projects, the potential for seismic surveys coinciding with offshore wind farm construction has been included. It has been assumed that one seismic survey is conducted in either the Irish Sea or the Celtic Sea at any one point in time.

335. Each identified plan or project is situated within a relevant MU and, for cetaceans, within a relevant SCANS-IV survey block. For those identified plans / projects that are situated in the same SCANS-IV block as this proposed Project, the density estimates chosen for the project alone assessment have been used. For those projects situated in other SCANS-IV blocks, the

SCANS-IV estimate has been used instead. Seal density estimates have been extracted from the Carter *et al*. (2022) density surfaces (corrected to represent absolute values) (**Table 21-61**).

Table 21-61. Density estimates used in the CEA from SCANS-IV (Gilles et al., 2023), and / or density estimates as used in this ES Chapter 21. Grey seal average density estimate used for CEA (Carter et al., 2022). N/A should be taken to mean that the density estimate from these blocks for these species is not relevant to the species-specific management units used in assessment

SCANS-IV block	Harbour porpoise	Bottlenose dolphin	Common dolphin	Minke whale	Grey seal
NS-A	0.105	0.003	N/A	N/A	
CS-A	0.070	N/A	N/A	N/A	
CS-B	0.059	0.060	1.031	0.002	
CS-C	0.016	0.420	0.841	0.008	
CS-D	0.280	0.235	0.027	0.014	
CS-E	0.515	0.010	0.000	0.009	
Density estimates used in this ES Chapter 21					
	0.137	0.420	0.841	0.011	Grid cell specific

336. It has been assumed that there could be vessel disturbance at any point throughout the construction period. Although piling could occur at any point during the construction period, it is more likely to occur during the summer months in good weather; therefore, for the purposes of this CEA, impact piling was timetabled to occur in Q2 and Q3 within the construction period. The assumption that all projects will timetable piling within the same period during the year presents the worst-case scenario.

337. Impact piling, where used, will not occur throughout the entire construction timeframe. Moray West (60 monopiles) planned for seven months of impact piling (Piling Strategy[12]). Beatrice offshore wind farm jacket foundations (84 WTGs) took eight months to install (Piling Implementation Report[13]). Therefore, as a precautionary approach it has been assumed, that if a project has planned for less than 60 WTGs, impact piling takes place within one year. Where there are more than 60 WTGs planned, impact piling takes place over two years.

338. Other assumptions included; there is vessel activity for every quarter within the construction timeframe and that there is one seismic survey every quarter throughout each project construction timeframe.

339. This assessment presents the worst-case scenario based on the information available at the time of writing. It is worth highlighting again, that the timelines may be subject to change, and for those projects in Tier 4 the timing of construction is particularly uncertain. The CEA can therefore only provide an indication in the level of risk, rather than a prediction of impact with any certainty.

Harbour Porpoise

340. Cumulative impacts have been assessed within the harbour porpoise Celtic and Irish Sea MU (CIS; IAMMWG, 2022). Two scenario assessments are presented for the identified Projects that are situated within this MU and have noisy disturbance activities likely within ± 1 year of

[12] 8460005-dbha04-mww-pln-000003_moray_west_revised_piling_strategy_19042023.pdf (marine.gov.scot) [Accessed: 04 January 2023]

[13] lf000005-rep-2397_bowlpilingstrategyimplementationreport_rev1_redacted.pdf (marine.gov.scot) [Accessed: 01 January 2023]

this proposed Project's construction timeframe. These are presented in **Table 21-62** (including Tier 4 projects) and **Table 21-63** (excluding Tier 4 projects) and detail the number of harbour porpoise predicted to be at risk for the short-listed projects.

Table 21-62. Cumulative number of harbour porpoise at risk of disturbance. Includes vessel activity, piling activity and, seismic survey (x1) for all shortlisted projects. Bold indicates piling activity for the projects, and percentage of reference populations above 1%. Blue shading indicates Tier 1-3 projects, and grey shading indicates Tier 4 projects

			# days piling	Year												
				2024		2025				2026				2027		
	Tier	Density		Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3
Llyr		0.137	10					11	11	11	**97**	**97**				
Erebus	2	0.137	10							11	**97**	**97**	11			
Petroc Wind	4	0.137	75											11	**97**	**97**
White Cross	3	0.137	8							11	**97**	**97**	11	11	11	11
TwinHub	2	0.137	2							11	**97**	**97**	11			
Codling Wind Park	4	0.2803	100							22	**595**	**595**	22	22	**595**	**595**
South Irish Sea Array	3	0.2803	60										22	22	**595**	**595**
North Irish Sea Array	4	0.2803	46							22	**595**	**595**	22	22	**595**	**595**
Awel y Mor	2	0.5153	50											40	**40**	**40**
Dublin Array	4	0.2803	50							22	**595**	**595**	22	22	**595**	**595**
Mona	4	0.5153	96							40	**1094**	**1094**	40	40	**1094**	**1094**
Clogherhead	4	0.2803	58											22	**595**	**595**
Morecambe	4	0.5153	40							40	**1094**	**1094**	40	40	**1094**	**1940**
Morgan	4	0.5153	96							40	**364**	**364**	40	40	**364**	**364**
Arklow Bank 2	4	0.2803	60											22	**595**	**595**
Seismic Survey (x1)		0.137		62	62	62	62	62	62	62	62	62	62	62	62	62
Total #				62	62	62	62	73	73	292	4787	4787	303	376	6332	7178
% of MU				0.10	0.10	0.10	0.10	0.12	0.12	0.47	**7.66**	**7.66**	0.48	0.60	**10.13**	**11.48**
% of MU excl.Llyr				*0.10*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*	*0.45*	***7.50***	***7.50***	*0.48*	*0.54*	***10.13***	***11.48***

Table 21-63. Cumulative number of harbour porpoise at risk of disturbance. Includes vessel activity, piling activity and, seismic survey (x1). Excluding tier 4 projects. Bold indicates piling activity for the projects, and percentage of reference populations above 1%. Blue shading indicates Tier 1-3 projects, and grey shading indicates Tier 4 projects

			# days pilin	Year												
				2024		2025				2026				2027		
	Tier	Density		Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3
Llyr		0.137	10					11	11	11	**97**	**97**				
Erebus	2	0.137	10							11	**97**	**97**	11			
White Cross	3	0.137	8							11	**97**	**97**	11	11	11	11
TwinHub	2	0.137	2							11	**97**	**97**	11			
South Irish Sea Array	3	0.28	60										22	22	**595**	**595**
Awel y Mor	2	0.515	50											40	**1094**	**1094**
Seismic Survey (x1)		0.137		62	62	62	62	62	62	62	62	62	62	62	62	62
Total #				62	62	62	62	73	73	106	450	450	117	135	1762	1762
% of MU				0.10	0.10	0.10	0.10	0.12	0.12	0.17	0.72	0.72	0.19	0.22	**2.82**	**2.82**
% of MU excl.Llyr				*0.10*	*0.10*	*0.10*	*0.10*	*0.10*	*0.10*	*0.15*	*0.56*	*0.56*	*0.19*	*0.22*	***2.82***	***2.82***

341. The worst-case percentage of population at risk of disturbance is in Q2 and Q3 in 2026 and 2027 at 11.48% (**Table 21-62**). However, in the scenario excluding Tier 4 projects, the percentage of the harbour porpoise MU at risk above 1% occurs in 2027 only and therefore the driver of the percentage reference population disturbed is unrelated to the proposed Project.

342. In both scenarios (with, and without Tier 4projects), if the proposed Project is excluded, the difference between the percentages of the MU population is negligible suggesting that the proposed project is not a key driver of any cumulative impact.

Cumulative iPCoD – harbour porpoise

343. It is challenging to investigate the population impact of cumulative projects due to the uncertainties and assumptions made relating to the timelines and schedules for each project considered.

344. Assumptions have been made for this assessment; specifically, it was assumed that the number of WTGs directly related to the number of piling disturbance days. In terms of the piling schedules for each project, this is not yet known, therefore it was assumed that piling occurred consecutively during Q2 and Q3 for each year this was relevant for each project included. The very worst case was taken through so all projects including Tier 4 projects were included in the assessment (**Table 21-62**).

345. Species parameters used were the same as for project alone (**Table 21-35**) and the numbers of animals disturbed were taken from **Table 21-62**. The iPCoD results in **Table 21-64** and **Figure 21-8** indicate that there is no risk to the harbour porpoise population from the cumulative impact plans/projects as assessed. The impacted population shows a slight overall decrease in numbers, but the difference is small. Note, the population means fluctuate, and this is an artifact of the demographic parameters, alongside the small effect of disturbance It’s worth highlighting that iPCoD does not include any density dependence, this means the model cannot account for any recovery within a disturbed population. Ignoring density dependence will likely result in an overestimation of marine mammals’ populations, and therefore can be considered to be precautionary (Harwood *et al.,* 2014).

Table 21-64. Summary results for harbour porpoise iPCoD cumulative assessment

Output variable	Value
Un-impacted population mean (after 1 year)	62499
Impacted population mean (after 1 year)	62492
Impacted population as % of un-impacted population (after 1 year)	99.99%
Median impacted: un-impacted population size (after 1 year)	99.99%
Unimpacted population mean (after 6 years)	62572
Impacted population mean (after 6 years)	62429
Impacted population as % of un-impacted population (after 6 years)	99.77%
Median impacted: un-impacted population size (after 6 years)	99.65%
Unimpacted population mean (after 12 years)	62567
Impacted population mean (after 12 years)	62409
Impacted population as % of un-impacted population (after 12 years)	99.75%
Median impacted: un-impacted population size (after 12 years)	99.73%
Unimpacted population mean (after 25 years)	62547
Impacted population mean (after 25 years)	62390
Impacted population as % of un-impacted population (after 25 years)	99.75%
Median impacted: un-impacted population size (after 25 years)	99.72%

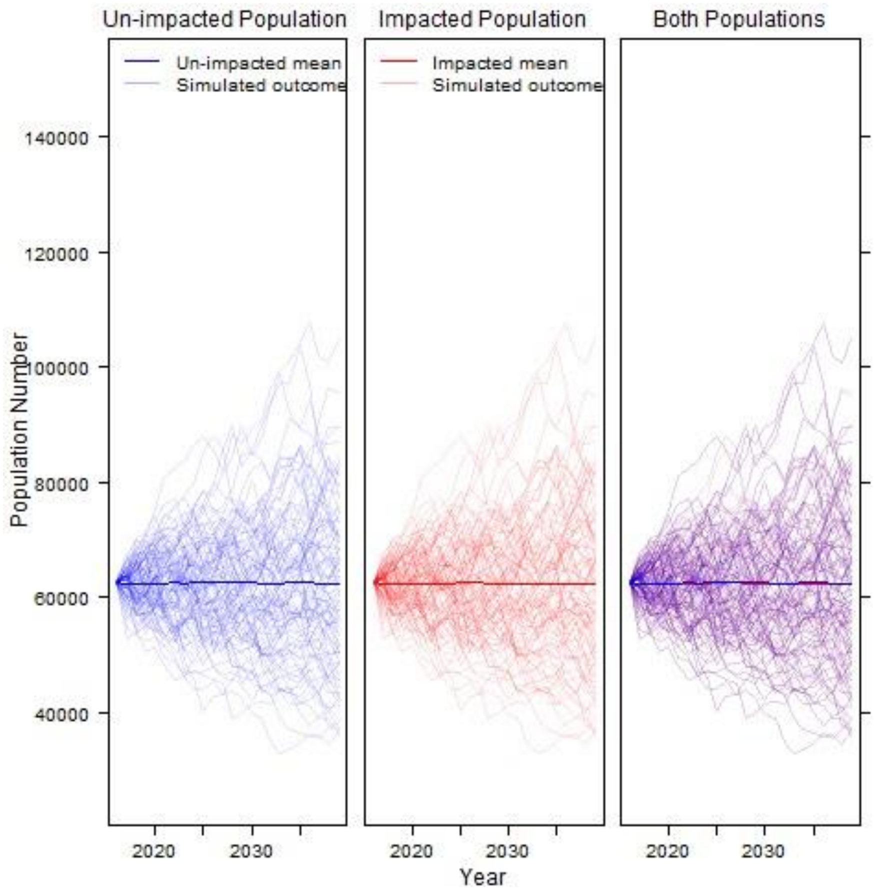

Figure 21-8. Population trajectory for both the impacted and unimpacted harbour porpoise population modelling for the cumulative assessment

346. The sensitivity of harbour porpoise is considered to be **low,** in keeping with the project alone conclusion**,** and the magnitude of the effect is assessed as **negligible** due to the very small, modelled decrease in the harbour porpoise population. Therefore, the cumulative effect of disturbance arising from underwater noise on harbour porpoise is considered to be. **negligible** and **not significant** under EIA Regulations.

Common Dolphin

347. Cumulative impacts have been assessed within the Celtic and Irish Sea MU (CIS; IAMMWG, 2022) for common dolphin. Projects that are situated within this MU, and within ± 1 year of this proposed Project's construction timeframe are presented in

348. Table 21-65 (including Tier 4 projects) an**d Table 21-66** (excluding Tier 4 projects) and detail the number of common dolphin predicted to be at risk for the short-listed projects.

Table 21-65. Cumulative number of common dolphin at risk of disturbance. Includes vessel activity, piling activity and, seismic survey (x1). For all shortlisted projects. Bold indicates piling activity for the projects, and percentage of reference populations above 1%. Blue shading indicates Tier 1-3 projects, and grey shading indicates Tier 4 projects

			# days piling	Year												
				2024		2025				2026				2027		
	Tier	Density		Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3
Llyr		0.841	10					66	66	66	**594**	**594**				
Erebus	2	0.841	10							66	**594**	**594**	66			
Petroc Wind	4	0.841	75											66	**594**	**594**
White Cross	3	0.841	8							66	**594**	**594**	66	66	66	66
TwinHub	2	0.841	2							66	**595**	**595**	66			
Codling Wind Park	4	0.0272	100							2	**58**	**58**	2	2	**58**	**58**
South Irish Sea Array	3	0.0272	60										2	2	**58**	**58**
North Irish Sea Array	4	0.0272	46							2	**58**	**58**	2	2	**58**	**58**
Awel y Mor	2	0	50											0	0	0
Dublin Array	4	0.0272	50							2	**58**	**58**	2	2	**58**	**58**
Mona	4	0	96							0	**0**	**0**	0	0	**0**	**0**
Clogherhead	4	0.0272	58											2	**58**	**58**
Morecambe	4	0	40							0	**0**	**0**	0	0	**0**	**0**
Morgan	4	0	96							0	**0**	**0**	0	0	**0**	**0**
Arklow Bank 2	4	0.0272	60											2	**58**	**58**
Seismic Survey (x1)		0.841		380	380	380	380	380	380	380	380	380	380	380	380	380
Total #				380	380	380	380	446	446	650	2931	2931	586	524	1388	1388
% of MU				0.37	0.37	0.37	0.37	0.43	0.43	0.63	**2.86**	**2.86**	0.57	0.51	**1.35**	**1.35**
% of MU excl.Llyr				*0.37*	*0.37*	*0.37*	*0.37*	*0.37*	*0.37*	*0.57*	***2.28***	***2.28***	*0.57*	*0.51*	***1.35***	***1.35***

Table 21-66. Cumulative number of common dolphin at risk of disturbance. Includes vessel activity, piling activity and, seismic survey (x1). Excluding tier 4 projects. Bold indicates piling activity for the projects, and percentage of reference populations above 1%. Blue shading indicates Tier 1-3 projects, and grey shading indicates Tier 4 projects

			# days piling	Year												
				2024		2025				2026				2027		
	Tier	Density		Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3
Llyr		0.841	10					66	66	66	**594**	**594**				
Erebus	2	0.841	10							66	**594**	**594**	66			
White Cross	3	0.841	8							66	**594**	**594**	66	66	66	66
TwinHub	2	0.841	2							66	**595**	**595**	66			
South Irish Sea Array	3	0.0272	60										2	2	**58**	**58**
Awel y Mor	2	0	50											0	0	0
Seismic Survey (x1)		0.841		380	380	380	380	380	380	380	380	380	380	380	380	380
Total #				380	380	380	380	446	446	644	2757	2757	580	448	504	504
% of MU				0.37	0.37	0.37	0.37	0.43	0.43	0.63	**2.69**	**2.69**	0.56	0.44	0.49	0.49
% of MU excl.Llyr				*0.37*	*0.37*	*0.37*	*0.37*	*0.37*	*0.37*	*0.56*	***2.11***	***2.11***	*0.56*	*0.44*	*0.49*	*0.49*

349. The worst-case percentage of the MU is Q2 / 3 2026 when 2.86% of the MU is predicted to be at risk of disturbance (versus 2.69% for the excluding Tier 4 project scenario). However, the proposed Project is not the driver of disturbance to common dolphin, as the percentage of the MU affected without the proposed project is 2.28% (including Tier 4 scenario, in comparison to 2.86%). All scenarios are highly contingent on the build-out schedule for all

activities considered being consistent with this timeline, which is highly uncertain, particularly for the Tier 4 projects.

350. As noted previously, iPCoD modelling is not available for common dolphin and therefore assessment has been made based on the percentage of reference population at risk alone.

351. The sensitivity of common dolphin to disturbance is considered to be **low** (as assessed for the proposed Project alone. **Section 21.9**). The magnitude of the effect is assessed as **small**. This conclusion has been reached because the main drivers of the highest predicted percentage of the MU, are the proposed Project, Erebus, White Cross and TwinHub, and these projects all involve ten days of piling or less. The assessment is precautionary as it has assumed all piling from these projects takes place at the same time. Dependant on the scheduling, this could be 10 days, all projects concurrently, or 30 days if projects build out sequentially, more likely something in-between. In all scenarios, the temporal extent is short term and therefore any disturbance experienced is not likely to affect the conservation status of common dolphin.

352. Therefore, the cumulative effect of disturbance arising from underwater noise on common dolphin is considered to be **minor / negligible** and therefore **not significant** in EIA terms.

Bottlenose Dolphin

353. Cumulative impacts have been assessed within the Offshore Channel, Celtic Sea and south west England MU (OCSW; IAMMWG, 2022) for bottlenose dolphin. Projects that are situated within this MU, and within ± 1 year of this proposed Project's construction timeframe are presented in **Table 21-67** (including Tier 4 projects) and

354. **Table 21-68** (excluding Tier 4 projects) and detail the number of bottlenose dolphin predicted to be at risk for the short-listed projects.

Table 21-67. Cumulative number of bottlenose dolphin at risk of disturbance. Includes vessel activity, piling activity and, seismic survey (x1) for all shortlisted projects. Bold indicates piling activity for the projects, and percentage of reference populations above 1%. Blue shading indicates Tier 1-3 projects, and grey shading indicates Tier 4 projects

			#	Year												
			days	2024		2025				2026				2027		
	Tier	Density	piling	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3
Llyr		0.4195	10					33	33	33	**297**	**297**				
Erebus	2	0.4195	10							33	**297**	**297**	33			
Petroc Wind	4	0.4195	75											33	297	**297**
White Cross	3	0.4195	8							33	**297**	**297**	33	33	33	33
TwinHub	2	0.4195	2							33	**297**	**297**	33			
Rampion 2	4	0.0029	90						0	6	**6**	**6**	0	0	**6**	**6**
Seismic Survey (x1)		0.4195		190	190	190	190	190	190	190	190	190	190	190	190	190
Total #				190	190	190	190	223	223	328	1384	1384	289	256	526	526
% of MU				**1.74**	**1.74**	**1.74**	**1.74**	**2.04**	**2.04**	**3.00**	**12.64**	**12.64**	**2.64**	**2.34**	**4.80**	**4.80**
% of MU excl.Llyr				***1.74***	***1.74***	***1.74***	***1.74***	***1.74***	***1.74***	***2.69***	***9.93***	***9.93***	***2.64***	***2.34***	***4.80***	***4.80***

Table 21-68. Cumulative number of bottlenose dolphin at risk of disturbance. Includes vessel activity, piling activity and, seismic survey (x1) excluding Tier 4 projects. Bold indicates piling activity for the projects, and percentage of reference populations above 1%. Blue shading indicates Tier 1-3 projects, and grey shading indicates Tier 4 projects

			#	Year												
			days	2024		2025				2026				2027		
	Tier	Density	piling	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3
Llyr		0.4195	10					33	33	33	**297**	**297**				
Erebus	2	0.4195	10							33	**297**	**297**	33			
White Cross	3	0.4195	8							33	**297**	**297**	33	33	33	33
TwinHub	2	0.4195	2							33	**297**	**297**	33			
Seismic Survey (x1)		0.4195		190	190	190	190	190	190	190	190	190	190	190	190	190
Total #				190	190	190	190	223	223	322	1378	1378	289	223	223	223
% of MU				**1.74**	**1.74**	**1.74**	**1.74**	**2.04**	**2.04**	**2.94**	**12.59**	**12.59**	**2.64**	**2.04**	**2.04**	**2.04**
% of MU excl.Llyr				***1.74***	***1.74***	***1.74***	***1.74***	***1.74***	***1.74***	***2.64***	***9.87***	***9.87***	***2.64***	***2.04***	***2.04***	***2.04***

355. The percentage of the bottlenose dolphin MU population at risk of disturbance is high. The highest being in Q2 and Q3 of 2026. With Tier 4 projects this is 12.64% and without, 12.59%. The Tier 4 project Rampion 2 makes little difference to the assessment. Assessment of impact with and without the proposed Project suggests the proposed Project is responsible for approximated 21% of the disturbance.

356. Due to the level of uncertainties involved in assessing the cumulative impact, including for example the lack of certainty in project build-out timeframes, the CEA by necessity can only be considered in generic terms, based on the best available information available at the time of assessment. This includes the use of generic EDRs to estimate the impacted ranges. In addition, a single density estimate is used to assess the number of impacted individuals. Using this methodology this applies an even density over the wider area. Coastal bottlenose dolphins tend to stay in relatively shallow waters (i.e. 20-25 m depth contour), although SCANS-IV highlighted an incursion of the offshore ecotype into the region, and the current reference population used for assessment is based on SCANS-III data. Therefore, this assessment should be considered as highly over precautionary as it is highlighting that a seismic survey alone results in a percentage of the population at risk being over 1% of the MU.

357. The primary driver of the percentage impacted are again from the small FLOW projects with ten or fewer days piling, this combines to a low number of disturbed days.

Cumulative iPCoD – bottlenose dolphin

358. As noted above for harbour porpoise, it is challenging to investigate the population impact of cumulative projects due to the uncertainties and assumptions made relating to the timelines and schedules for each project considered.

359. Assumptions have been made for this assessment; specifically, it was assumed that the number of WTGs directly related to the number of piling disturbance days. In terms of the piling schedules for each project, this is not yet known, therefore it was assumed that piling occurred consecutively during Q2 and Q3 for each year this was relevant for each project included. The very worst case was taken through so all projects including Tier 4 projects were included in the assessment (**Table 21-67**).

Bottlenose dolphin species parameters used were obtained from Sinclair *et al.,* (2019) and are presented in **Table 21-69** below, as iPCoD was not required for the project alone assessment (see **Section 21.9.1**).

Table 21-69. Input parameters used for the cumulative impact assessment for bottlenose dolphin

	Parameter description	Parameter	Value
Population	Number of simulations run	nboot	1000
	Species	spec	BND
	Proportion of population that is female	propfemale	0.5
	Population size at the start of simulations	pmean	10947
Demographic	Calf survival rate	Surv[1]	0.86
	Juvenile survival rate	Surv[7]	0.94
	Adult survival rate	Surv[13]	0.94
	Fecundity rate	Fertility	0.25
	Age at independence	age1	2
	Age at first birth	age2	9
Piling and impacts	Number of piling years	pile_years	Project specific
	Proportion of animals in vulnerable component	vulmean	C(1.0)
	Days of residual disturbance	days	0
	Number of piling operations	pilesx1	1
	Seasonal variation (1=no variation)	seasons	1
	Number of animals predicted to experience disturbance during 1 day of piling	numDt[1,]	Project specific
	Number of animals predicted to experience PTS during 1 day of piling	numPt[1,]	0
	Number of collisions resulting in mortalities per year	Ncollisions	0
	Years for simulation	years	25
	Density dependence (0=no density dependence)	z	0
	Piling schedule	N/A	Project specific

360. The numbers of animals disturbed were taken from **Table 21-67**. The iPCoD results in **Table 21-70** and **Figure 21-8** indicate that there is no risk to the bottlenose dolphin population from the cumulative impact plans/projects as assessed. The impacted population shows a slight decrease in numbers, but the difference is small. Note, the population means fluctuate, and

this is an artifact of the demographic parameters, alongside the small effect of disturbance. It's worth highlighting that iPCoD does not include any density dependence, this means the model cannot account for any recovery within a disturbed population. Ignoring density dependence will likely result in an overestimation of marine mammals' populations, and therefore can be considered to be precautionary (Harwood *et al.,* 2014).

Table 21-70. Summary results for bottlenose dolphin iPCoD cumulative assessment

Output variable	Value
Un-impacted population mean (after 1 year)	10969
Impacted population mean (after 1 year)	10968
Impacted population as % of un-impacted population (after 1 year)	99.99%
Median impacted: un-impacted population size (after 1 year)	99.99%
Unimpacted population mean (after 6 years)	10991
Impacted population mean (after 6 years)	10970
Impacted population as % of un-impacted population (after 6 years)	99.81%
Median impacted: un-impacted population size (after 6 years)	99.81%
Unimpacted population mean (after 12 years)	11007
Impacted population mean (after 12 years)	10989
Impacted population as % of un-impacted population (after 12 years)	99.84%
Median impacted: un-impacted population size (after 12 years)	99.94%
Unimpacted population mean (after 25 years)	11006
Impacted population mean (after 25 years)	10988
Impacted population as % of un-impacted population (after 25 years)	99.84%
Median impacted: un-impacted population size (after 25 years)	99.85%

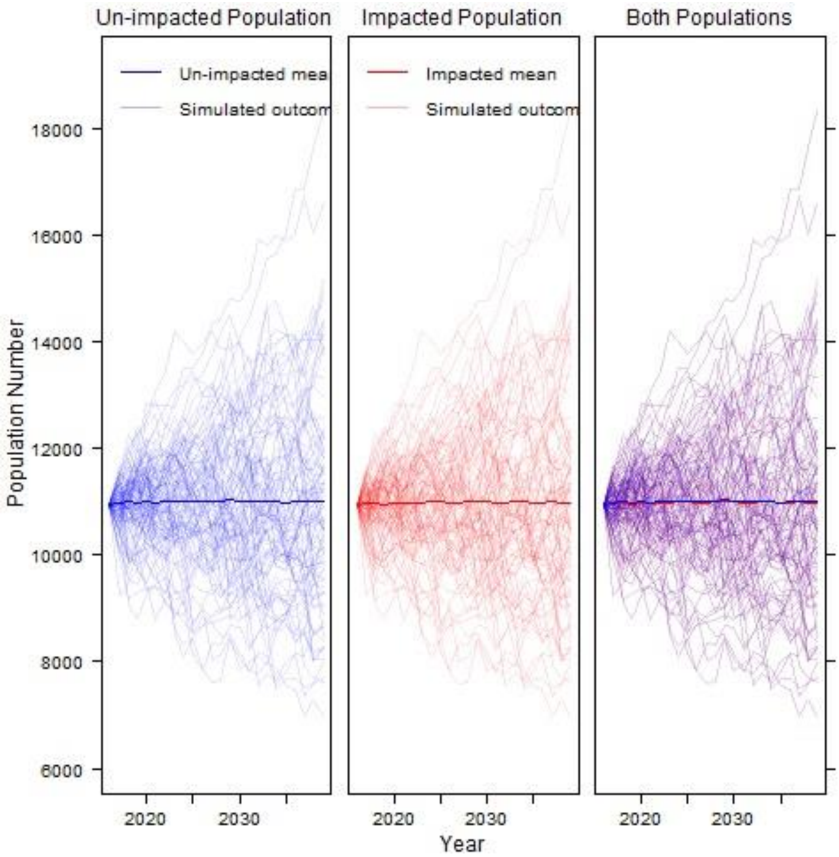

Figure 21-9. Population trajectory for both the impacted and unimpacted bottlenose dolphin population modelling for the cumulative assessment

361. The sensitivity of bottlenose dolphin is considered to be **low,** in keeping with the project alone conclusion**,** and the magnitude of the effect is assessed as **negligible** due to the very small, modelled decrease in the harbour porpoise population. Therefore, the cumulative effect of disturbance arising from underwater noise on harbour porpoise is considered to be. **negligible** and **not significant** under EIA Regulations.

Minke Whale

362. Cumulative impacts have been assessed within the Celtic and Irish Sea MU (CIS; IAMMWG, 2022) for minke whale. Projects that are situated within this MU, and within ± 1 year of this proposed Project's construction timeframe are presented in **Table 21-71** (including Tier 4 projects) and

363. **Table 21-72** (excluding Tier 4 projects) and detail the number of minke whale predicted to be at risk for the short-listed projects.

Table 21-71. Cumulative number of minke whale at risk of disturbance. Includes vessel activity, piling activity and, seismic survey (x1) for all shortlisted projects. Bold indicates piling activity for the projects, and percentage of reference populations above 1%. Blue shading indicates Tier 1-3 projects, and grey shading indicates Tier 4 projects

				Year												
			# days	2024		2025				2026				2027		
	Tier	Density	piling	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3
Llyr		0.011	10					1	1	1	**8**	**8**				
Erebus	2	0.011	10							1	**8**	**8**	1			
Petroc Wind	4	0.011	75											1	**8**	**8**
White Cross	3	0.011	8							1	**8**	**8**	1	1	1	1
TwinHub	2	0.011	2							1	**8**	**8**	1			
Codling Wind Park	4	0.0137	100							1	**29**	**29**	1	1	**29**	**29**
South Irish Sea Array	3	0.0137	60										1	1	**29**	**29**
North Irish Sea Array	4	0.0137	46							1	**29**	**29**	1	1	**29**	**29**
Awel y Mor	2	0.0088	50											1	**19**	**19**
Dublin Array	4	0.0137	50							1	**29**	**29**	1	1	**29**	**29**
Mona	4	0.0088	96							1	**6**	**6**	1	1	**6**	**6**
Clogherhead	4	0.0137	58											1	**29**	**29**
Morecambe	4	0.0088	40							1	**19**	**19**	1	1	**19**	**19**
Morgan	4	0.0088	96							1	**6**	**6**	1	1	**6**	**6**
Arklow Bank 2	4	0.0137	60											1	**29**	**29**
Seismic Survey (x1)				5	5	5	5	5	5	5	5	5	5	5	5	5
Total #				5	5	5	5	6	6	15	155	155	15	17	238	238
% of MU				0.02	0.02	0.02	0.02	0.03	0.03	0.07	0.77	0.77	0.07	0.08	**1.18**	**1.18**
% of MU excl.Llyr				*0.02*	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*	*0.07*	*0.73*	*0.73*	*0.07*	*0.08*	***1.18***	***1.18***

Table 21-72. Cumulative number of minke whale at risk of disturbance. Includes vessel activity, piling activity and, seismic survey (x1 y) excluding Tier 4 projects. Bold indicates piling activity for the projects, and percentage of reference populations above 1%. Blue shading indicates Tier 1-3 projects, and grey shading indicates Tier 4 projects

				Year												
			# days	2024		2025				2026				2027		
	Tier	Density	piling	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3
Llyr		0.011	10					1	1	1	**8**	**8**				
Erebus	2	0.011	10							1	**8**	**8**	1			
White Cross	3	0.011	8							1	**8**	**8**	1	1	1	1
TwinHub	2	0.011	2							1	**8**	**8**	1			
South Irish Sea Array	3	0.0137	60										1	1	**29**	**29**
Awel y Mor	2	0.0088	50											1	**19**	**19**
Seismic Survey (x1)				5	5	5	5	5	5	5	5	5	5	5	5	5
Total #				5	5	5	5	6	6	9	37	37	9	8	54	54
% of MU				0.02	0.02	0.02	0.02	0.03	0.03	0.04	0.18	0.18	0.04	0.04	0.27	0.27
% of MU excl.Llyr				*0.02*	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*	*0.04*	*0.14*	*0.14*	*0.04*	*0.04*	*0.27*	*0.27*

364. The sensitivity of minke whale to disturbance is considered to be **low**, and the magnitude of the effect is assessed as **small** due to the percentage impacted being slightly over 1% for the full short listed project scenario (including Tier 4), although well under 1% for the excluding Tier 4 project scenario. Conclusions can therefore be made without running iPCoD for minke whale. It is worth highlighting that the updated expert elicitation for the iPCoD framework was not conducted for minke whale, therefore the model framework with regard to the effect of disturbance on vital rates have not changed since iPCoD v3 (Sinclair *et al.,* 2019) and is now considered to be over-precautionary (SMRUC *pers comm*).

365. Therefore, the cumulative effect of disturbance arising from underwater noise on minke whale is considered to be **minor / negligible** and **not significant.**

Grey Seal

366. Cumulative impacts for grey seals have been assessed within the OSPAR Region III MU. Projects that are situated within this MU, and within ± 1 year of this proposed Project's construction timeframe are presented in **Table 21-73** (including Tier 4 projects) and in

Table 21-74 (excluding Tier 4 projects) and detail the number of grey seals predicted to be at risk for the short listed projects.

Table 21-73. Cumulative number of grey seals at risk of disturbance. Includes vessel activity, UXO clearance (x1), piling activity and, seismic survey (x1). Bold indicates piling activity for the projects, and percentage of reference populations above 1%. Blue shading indicates Tier 1-3 projects, and grey shading indicates Tier 4 projects

				Year												
			# days	2024		2025				2026				2027		
	Tier	Density	piling	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3
Llyr		0.012	10					1	1	1	**8**	**8**				
Erebus	2	0.005	10							1	**8**	**8**	1			
Petroc Wind	4	0.005	75											1	**8**	**8**
White Cross	3	0.005	8							1	**8**	**8**	1	1	1	1
TwinHub	2	0.245	2							1	**8**	**8**	1			
Codling Wind Park	4	0.262	100							1	**29**	**29**	1	1	**29**	**29**
South Irish Sea Array	3	0.047	60										1	1	**29**	**29**
North Irish Sea Array	4	0.008	46							1	**29**	**29**	1	1	**29**	**29**
Awel y Mor	2	0.256	50											1	**19**	**19**
Dublin Array	4	0.294	50							1	**29**	**29**	1	1	**29**	**29**
Mona	4	0.016	96							1	**6**	**6**	1	1	**6**	**6**
Clogherhead	4	0.326	58											1	**29**	**29**
Morcambe	4	0.101	40							1	**19**	**19**	1	1	**19**	**19**
Morgan	4	0.039	96							1	**6**	**6**	1	1	**6**	**6**
Arklow Bank 2	4	0.085	60											1	**29**	**29**
Seismic Survey (x1)				133	133	133	133	133	133	133	133	133	133	133	133	133
Total #				133	133	133	133	134	134	143	283	283	143	145	366	366
% of MU				0.21	0.21	0.21	0.21	0.21	0.21	0.23	0.45	0.45	0.23	0.23	0.59	0.59
% of MU excl.Llyr				0.21	0.21	0.21	0.21	0.21	0.21	0.23	0.44	0.44	0.23	0.23	0.59	0.59

Table 21-74. Cumulative number of grey seal at risk of disturbance. Includes vessel activity, piling activity and, seismic survey (x1) excluding Tier 4 projects Bold indicates piling activity for the projects, and percentage of reference populations above 1%. Blue shading indicates Tier 1-3 projects, and grey shading indicates Tier 4 projects

				Year												
				2024		2025				2026				2027		
	Tier	Density	# days piling	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3
Llyr		0.012	10					1	1	1	**8**	**8**				
Erebus	2	0.005	10							1	**8**	**8**	1			
White Cross	3	0.005	8							1	**8**	**8**	1	1	1	1
TwinHub	2	0.245	2							1	**8**	**8**	1			
South Irish Sea Array	3	0.047	60										1	1	**29**	**29**
Awel y Mor	2	0.256	50											1	**19**	**19**
Seismic Survey (x1)				133	133	133	133	133	133	133	133	133	133	133	133	133
Total #				133	133	133	133	134	134	137	165	165	137	136	182	182
% of MU				0.21	0.21	0.21	0.21	0.21	0.21	0.22	0.26	0.26	0.22	0.22	0.29	0.29
% of MU excl.Llyr				0.21	0.21	0.21	0.21	0.21	0.21	0.22	0.25	0.25	0.22	0.22	0.29	0.29

367. The maximum percentage of the MU at risk throughout the entire assessed period is less than 1% (**Table 21-73**; **Table 21-74**). Therefore, conclusions can be drawn without modelling population impacts using iPCoD.

368. This assessment concluded the sensitivity of grey seals to all pre-construction and construction underwater noise impacts to be **low** (**Section 21.11**). The magnitude of the effect is assessed as **negligible**.

369. Therefore, the cumulative effect of disturbance arising from underwater noise during construction, on grey seal is considered to be **negligible**, and therefore **not significant**.

The potential for Disturbance from Vessel Activity During Pre-Construction, Construction, Operation, and Maintenance

370. This CEA has already included disturbance from vessels within the assessment of disturbance arising from underwater noise in the previous section. This used an EDR of 5 km to estimate the number of individuals potentially affected based on JNCC (2020). This is considered reasonable based on Benhemma-Le Gall et al. (2021) who found that increased vessel activity influenced porpoise occurrence at distances up to 4 km.

371. The proposed Project Design Envelope estimates that there could be a maximum of 12 vessels working offshore at any one time. This would include a combination of vessel types, from the smaller crew transfer vessels and tugs to the larger offshore construction vessels. During operation, this will be reduced to maintenance transits only. It is not likely this will represent a significant increase from vessel activity in the region.

372. Detailed information with regards to the cumulative increase in vessel traffic from all plans or projects considered is not available. It is therefore difficult to quantify the increase disturbance risk. It is for that reason that vessel movement has been assumed to be occurring at all times (previous section). There will be spatial and temporal variation in movement of vessels.

373. The Applicant has committed to the employment of a vessel management plan, and adherence to good practice. It is likely that all offshore wind construction projects will also adopt these practices. All vessel movements within construction areas, are likely to be limited and relatively slow. Therefore, increases in underwater noise from offshore energy projects is likely to be limited in the context of the vessel use in the wider area.

374. Disturbance from vessel activity for all marine mammals from the proposed Project alone has been assessed as low sensitivity, and negligible magnitude resulting is a negligible conclusion which is not significant.

375. Sensitivity to disturbance from vessel activity for all marine mammals in the cumulative assessment remains **low**. Using the precautionary principle, the magnitude of cumulative effect is considered to be **small**. The majority of the increase in vessel activity will be related to the construction period, and the temporal extent considered here is of short-term (i.e. one to five years). Whilst operation and maintenance will occur over a longer term, the increase in use compared to the existing activity in the region is likely to be very small.

376. Therefore, the cumulative effect of disturbance from vessel activity on all marine mammals is considered to be **minor / negligible** and **not significant**.

21.13 Inter-Related Effects of the Proposed Project

377. The term 'inter-related' takes into account the environmental interactions ('inter-relationships') with other receptors within the proposed Project. These are referred to in the

Infrastructure Planning (Environmental Impact Assessment) Regulations 2009 and further described in **Chapter 31: Inter-related and Cumulative Effects.**

378. As set out in PINS Advice Note 17 (PINS), 2019, inter-related project effects, or 'interrelationships between topics', derive from combinations of different project specific impacts which, when acting together on the same receptor, could result in a new or different effect, or an effect of greater significance than the project effects, when considered in isolation.

379. Inter-related effects comprise the following:

- **Project lifetime effects**: effects that have the potential to occur during more than one phase of the proposed Project (i.e. construction, operation and maintenance and decommissioning) and also to interact in a way that could potentially create a more significant effect than if it was assessed in isolation; and
- **Receptor-led effects**: effects that have the potential to interact, spatially and temporally, to create inter-related effects on a receptor.

380. **Chapter 31: Inter-related Effects Assessment** details the approach to the inter-related effects assessment and includes a description of the likely inter-related effects that may occur as a result of the proposed Project on marine mammals.

381. The potential for impacts relating to displacement or barrier effects on marine mammals from the FLOW structures could only occur during the operation and maintenance phase and therefore there will not be any combined effect with the construction or decommissioning phase.

21.13.1 Inter-Related Project Lifetime Effects

382. Inter-related effects that may occur throughout the project lifetime on marine mammals are detailed in **Table 21-75.**

Table 21-75. Inter-related Project lifetime effects assessment – marine mammals

Development Phase	Nature of inter-related effect	ES Reference	Inter-related effects assessment
Construction, operation and decommissioning	PTS-onset	**Sections 21.9.1; 21.9.2; 21.9.3**	The risk of PTS-onset from pre-construction geophysical surveys, UXO clearance, impact piling, other construction activities (e.g. cable laying), vessel activity and operational noise have all been assessed as not significant independently. The commitment to apply appropriate mitigation further reduces this risk such that it is not anticipated these multiple activities over the various phases relating to the proposed Project will combine to an inter-related effect.
Construction, operation and decommissioning	Disturbance arising from underwater noise	**Sections 21.8; 21.9.1; 21.9.2; 21.9.3**	The majority of underwater noise associated with the proposed Project will occur from impact piling and UXO clearance activities in the pre-construction and construction phases only. Underwater noise from these activities will be intermittent and temporary, and it is

Development Phase	Nature of inter-related effect	ES Reference	Inter-related effects assessment
			not anticipated that any disturbance or displacement effect will persist in the long-term as a result of these activities. Vessel disturbance (all project phases) has been assessed as not significant, localised, and temporary. Disturbance from operational noise has been assessed as highly localised and not significant. It is therefore considered that there is limited potential for an interaction during the construction, operation and decommissioning stages that would result in a greater effect than each stage assessment in isolation.
Construction, operation and decommissioning	Collision with Project vessels	**Sections 21.9.1; 21.9.2; 21.9.3**	The risk to the marine mammal species relevant for this assessment is low. Collision with project vessels is unlikely. The potential for collision is further reduced by the implementation of a VMP. No inter-related effect anticipated.
	Impacts to prey species	**Sections 21.9.1; 21.9.2; 21.9.3**	Should prey availability or distribution be affected, during pre-construction, construction and decommissioning phases, marine mammals may have to forage different prey. However, marine mammals are highly mobile and wide-ranging and therefore, it is anticipated individuals would be able to forage in alternative areas, if required. All marine mammal species in this assessment are also considered to be generalist feeders, and thus are not dependent on a single prey species. Therefore, it is likely that marine mammals can supplement their diet with other available species if required, making them resilient to changes in prey availability. It is unlikely that operation and maintenance activities will result in a negative impact on marine mammal prey species. The presence of FLOW structures could function as artificial reefs which may result in increased foraging opportunities. Therefore, no inter-related effect is anticipated.

21.13.2 Inter-Related Receptor-Led Effects

383. Within the proposed project, there is the potential that the development for all impacts, which are assessed independently, interact on each marine mammal and combine to become greater overall effect. Any marine mammal could be exposed to the combined effect of vessel activity (all phases) construction activity (impact piling as worst-case foundation; UXO clearance, if any) any subsequent maintenance activity, and the presence of the FLOW infrastructure once operational.

384. in addition, there is the potential for spatial and temporal interactions between the benthic effects arising from habitat loss / disturbance and increases in suspended sediment concentration and sediment deposition and marine mammals during the project lifetime.

385. With respect to this interaction, individual impacts were assigned as minor or negligible significance as standalone impacts and although potential combined impacts may arise (i.e. spatial and temporal overlap of direct habitat disturbance), for marine mammals it is predicted that this will not be any more significant than the individual impacts in isolation.

386. Marine mammals range widely, they are not restricted to the proposed Project development area, and therefore will experience temporary disturbance from each activity. Because marine mammals' transit, it is not the case that the same individuals will be impacted throughout the proposed Project's construction, operation and decommissioning timeframe.

387. In terms of the combined area of habitat potentially affected, this would be very limited, the biotypes affected are widespread, and where temporary disturbance occurs, full recovery of the benthos is predicted within one to ten years of disturbance. Likewise, there is no predicted potential for indirect impacts to marine mammals, from a reduction in prey availability. Rather, it is likely that prey availability may be enhanced due to the presence of the proposed Project's infrastructure.

388. As such, these interactions are predicted to be no greater in significance than that for the individual effects assessed in isolation. There is no requirement for additional mitigation beyond embedded mitigation already considered.

21.14 Transboundary Effects

389. A transboundary effect refers to the impacts or effects of a project that extend beyond the boundaries of the United Kingdom and have the potential to affect the environment of other countries within the European Economic Area (EEA). These effects can occur either from the proposed Project on its own or when combined with the effects of other projects or activities in the wider geographical area.

390. For the majority of activities, potential impacts to marine mammals will be localised to the Array Area and surrounding area and will be fully contained within UK EEZ waters. Therefore, there is no potential for the proposed Project to have a direct impact on animals which are outside the UK EEZ, with the exception of underwater noise during construction.

391. There is potential for behavioural disturbance or displacement of marine mammals in Irish waters from underwater noise during construction. Any transboundary impacts that do occur as a result of underwater noise at the proposed Project are predicted to be short-term and intermittent, with the recovery of marine mammal populations to affected areas following the completion of construction activities.

392. As marine mammals are mobile species, animals which are within the marine mammal study area may also range within waters of other EEA states. For example, the MUs for harbour porpoise and bottlenose dolphin extend into Irish and French international waters, whilst the

Celtic and Greater North Seas MU for common dolphin and minke whale also extend into Norwegian, Swedish, Danish, German, Dutch, Belgian and French international waters (IAMMWG, 2022). Therefore, there is also potential for indirect transboundary impacts upon marine mammals from the proposed Project. However, the assessment of potential effects from the proposed Project alone and cumulatively (when mitigation measures are considered) determined that there will be no significant effect to marine mammals. Any transboundary impacts that do occur as a result of underwater noise at the proposed Project are predicted to be short-term, localised and intermittent. Consequently, there is no potential for any significant transboundary effects upon marine mammal receptors in other EEA states across the proposed Project stages.

393. The magnitude of the impact has been assessed as **negligible** and the sensitivity of receptors as **low**. Therefore, potential for transboundary effects is concluded to be of **negligible significance**, which is **not significant** in EIA terms.

21.15 References

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